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HISTORY AND STATUS OF STEELHEAD IN CALIFORNIA COASTAL DRAINAGES SOUTH OF SAN FRANCISCO BAY

by

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FOREWORD

The drainage-by-drainage accounts in this manuscript are pending revision of steelhead status designations. Most notably, the "extinct" designation is being replaced by a term which indicates that, given current habitat conditions, the steelhead life history of coastal rainbow trout is no longer supported in the stream. In all cases, viable trout habitat still exists in the system, typically in headwater areas. These areas support the resident life history of coastal rainbow trout. However, the lack of connectivity between the ocean and these viable spawning and rearing areas, as a result of habitat alterations, no longer allows anadromy to occur and noticeably persist. Thus, these populations are not extinct as previously indicated, because the species still occurs in the stream system, but life history is restricted to the resident type because of current habitat limitations.

TABLE OF CONTENTS

INTRODUCTION

Populations of native anadromous salmonids all along the Pacific coast of the continental U.S. have declined sharply within the last 150 years. Steelhead (*Oncorhynchus mykiss irideus*, following Behnke 1992) along the central and southern coast of California have been especially hard-hit within the last 50 years, primarily because of reductions in the amount and quality of freshwater habitat. In a partial list of depleted stocks published recently by the American Fisheries Society (Nehlsen et al. 1991), nine principal steelhead stocks south of San Francisco Bay were included, six of which were rated as having a high risk of extinction. At least 11 other stocks were listed as extinct.

The steelhead leads a seemingly tenuous existence under natural conditions in this arid, southern extent of its range. Stream flows are highly stochastic, and vary greatly both seasonally and annually. During the dry summer, stream flow often becomes interrupted, especially in the lower river reaches. Sufficient surficial flow is needed during the winter rainy season to breach a sandbar which closes the mouth of most of these streams. With a connection provided, steelhead and other migratory fishes may migrate between marine and fresh water, where different phases of their life cycles are completed.

In addition to these natural fluctuations in stream flow, a burgeoning human population has put an even greater demand on already limited freshwater resources. During the past 50 years, dams and water diversion systems have been built, and groundwater pumping has increased, to meet the growing human demand for water. Dams block steelhead access to upstream spawning and rearing areas, and regulate stream flow so that below-dam releases may be very low or eliminated altogether. Diversions and pumping also remove water from the stream channel, the effects of which are many from the standpoint of steelhead production. The gross effects include loss of the migratory corridor between the stream and the ocean, and reduction or complete elimination of spawning habitat for adults and rearing habitat for juveniles. Virtually every large coastal river system south of San Francisco Bay has been developed for water extraction, leaving only some of the smaller streams as more-or-less intact, natural steelhead habitats.

The high priority of maintaining stream flows for anadromous salmonid production in

California was exemplified by the results of a workshop presented by the California Advisory Committee on Salmon and Steelhead Trout (Vondracek and Callaham 1987). The workshop was commissioned to identify researchable questions, and produce a research and development plan to address these questions, as the first step in formulation of a comprehensive management plan for California's declining salmon and steelhead stocks. Among the 12 general topics addressed, five aspects of water supply needs topped the final list of 18 specific problems given a "critical" status by both technical experts and resource users.

A recently published compilation of essays (Lufkin 1991) illustrates in lay terms the array of problems that have led to the precipitous decline of California salmon and steelhead during the past century or so. One striking trend in both Vondracek and Callaham (1987) and Lufkin (1991) is the slant toward Central Valley and North Coast salmonid stocks (e.g. see Map 1 in Lufkin 1991). Overall, relatively little consolidated effort has been expended on determining the status and factors which affect steelhead stocks south of San Francisco Bay.

The purpose of this paper is to present the historical and current status of steelhead in coastal California streams south of San Francisco Bay. Habitat conditions, in conjunction with population information, are used as the means for making assessments. When possible, factors that regulate population size are identified, both on an interannual basis and with regard to long-term population trends. In addition, existing biological information is inventoried for future use in ecologically characterizing these populations. Finally, contemporary theories in both basic and salmonid ecology are integrated with the results to develop future research ideas.

THE STUDY AREA

The study area consists of the California coastal region from south of San Francisco Bay to northern Mexico (Fig. 1). Specifically, the California counties of San Mateo, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego are included, as is the northern portion of the Mexican state, Baja California. When appropriate, headwater tributaries in inner California coastal counties are also included and identified as such.

Although average annual precipitation generally decreases from north to south in the study area, a commonality throughout is that most precipitation within any region falls during winter (Espenshade 1970). Summers are dry during which freshwater discharge from coastal drainages is greatly reduced and sandbars close the mouths of many streams entering the Pacific Ocean. Under such conditions, movements of migratory fishes to and from the ocean are blocked until the first heavy rains of the wet season remove the sandbars. Under extreme drought conditions, stream channels may essentially be dewatered which results in high levels of mortality of stream fishes, including juvenile steelhead. Thus, the streams included in the study area are characterized as being hydrologically unstable, an important factor to consider in an analysis of steelhead life history patterns.

Another indicator of general climatic conditions in the study area is the vegetation, and like precipitation, vegetation too generally follows a gradient from north to south (Espenshade 1970). The coastal drainages in San Mateo and Santa Cruz counties are included in the southernmost portion of the humid redwood (*Sequoia sempervirens*) belt, although a narrow strip of coastal scrub also extends into San Mateo County from its more northerly distribution (Munz 1959). South of the Pajaro River, which comprises the Santa Cruz/Monterey county line, redwoods only occur along the lower portion of some streams in central Monterey County (e.g. the Big Sur River). Otherwise in Monterey County, arid plant communities dominate, such as chaparral, oak woodland, and grassland. From San Luis Obispo County and southward, arid landscapes are the norm, including grassland, chaparral, and coastal sage scrub. Shapovalov and Taft (1954), Cooper et al. (1986), and Woelfel (1991) present descriptions of redwood, chaparral, and coastal sage scrub/chaparral dominated drainages, respectively, which span the continuum of steelhead stream types found in the study area.

MATERIALS AND METHODS

Stream-specific information on steelhead in central and southern California was gathered from three main sources. (i) A literature search was conducted for pertinent journal articles, California Department of Fish and Game (CDFG) administrative reports and fish bulletins, and other resource agency, university, and consultant publications. (ii) Resource agency files were reviewed, especially CDFG stream survey files. (iii) Interviews were conducted with professional biologists, academicians, and representatives of sportfishing organizations and other special interest groups for information from personal files, and anecdotes based on personal observations.

The information collected was used to construct drainage-by-drainage historical reviews and current status reports. When available, data were presented to demonstrate actual population trends and characteristics. Information on the presence and distribution of conspecific resident rainbow trout (see below) within a drainage was also given when available, as an indication of the overall presence and distribution of suitable habitat for *O. m. irideus*, even where steelhead no longer occur. Information on hatchery operations in the study area was compiled, as were trout stocking records. The reports were organized by county (from north to south), and then alphabetically, by drainage system entering the Pacific Ocean within each county, and by main tributary within each drainage. The information for each stream is generally presented in chronological order.

Some of the extensive data presented by Shapovalov and Taft (1954) were reanalyzed to provide a clear and concise summary of their results within the context of contemporary salmonid ecology. This summary was used as the basis for the forthcoming section, "Life History Analysis".

Smith (1982b) and coworkers surveyed 34 Santa Cruz County steelhead streams during late fall 1981. The density of smolt-sized juvenile steelhead was determined by electrofishing at 1–10 sites in each stream. These fish were ≥76 mm (3 inches) in standard length and usually age 1+ (see below for technical definitions). Densities reported herein were converted from no. trout/10 ft of stream channel to no. trout/m. When more than one site was sampled in a stream, the mean (± SD) density was calculated and reported for that stream. Smith (1982b) also gave the mean standard length of smolt-sized steelhead at each stream site. Again, when more than one stream site was sampled, the mean (± SD) of mean standard lengths was calculated and reported for that stream. The county-wide average in fall 1981 of both density and standard length of smolt-sized steelhead was calculated (3.8 trout/m and 95.8 mm, respectively), and actual values presented herein for each stream are compared against these overall averages.

Statistical analyses, using mostly parametric tests, were made of several other small data sets, primarily to strengthen the presentation of previous findings. Examples of such analyses were that of Keegans's (1990a) data on steelhead habitat use in Malibu Creek (Los Angeles County), and CDFG data on juvenile steelhead size and growth in the Arroyo de la Cruz (San Luis Obispo County). Numerous other unpublished data sets contained in CDFG stream survey files, mostly of fish lengths, were summarized for presentation herein using simple descriptive statistics (e.g. mean, standard deviation, etc.). Some of these data were also used to produce figures which illustrate population characteristics, such as juvenile and adult population structure.

All data are reported in metric units. Visual estimates of juvenile trout lengths were rounded to the nearest 0.5 cm, and those of adults to the nearest cm. Visual estimates of adult weights were converted to the nearest 0.1 kg. Conversions of both visually estimated and measured trout densities reflect the measurement scale used in the original report. For example, trout density estimates were often made on a scale of 100 ft of channel length. These values have been converted to no. trout/30 m (100 ft = 30.5 m). Fish density reports on a scale of ≤ 10 ft have been converted to no. trout/m.

The reporting of fish length measurements followed common convention (Bagenal 1978): standard length (SL), from the tip of the snout to the base of the median caudal (tail) fin rays; fork length (FL), from the tip of the snout to the fork in the caudal fin; and total length (TL), from the tip of the snout to the end of the longest lobe of the caudal fin. Visually estimated lengths, and lengths not specified otherwise, were presumed to approximate total lengths.

Age-classes were designated as age 0+ for young-of-the-year, 1+ for 1-year-olds (also called yearlings), 2+ for 2-year-olds, etc., using the approximate period of hatching (late winter–spring) as the birth date. The '+' sign indicates growth beyond the birth date, and is typically used for fish sampled during summer–winter. The ages of steelhead that have returned from the ocean were designated as A/B, where A and B are the number of years spent in fresh and salt water, respectively, and are additive to give the total age of the fish.

CALIFORNIA STEELHEAD LIFE HISTORY

The coastal rainbow trout, *O. m. irideus*, is a polymorphic subspecies (Behnke 1992). Populations may be anadromous (sea-run), resident, or mixtures where the two forms presumably interbreed. Although they comprise the same subspecies, the different forms have unique common names: the anadromous form is called steelhead; the resident form is simply called rainbow trout. Both forms may exist in the same stream system, and in some instances may be physically discrete from one another due to an impassable barrier to upstream migration, such as a waterfall. In these situations, rainbow trout occur above the barrier, and steelhead, or a mixed morph population, exist below.

In polymorphic salmonids, males exhibit an especially high degree of life history variation. The literature is replete with examples which demonstrate that, relative to females, males mature at an earlier age and smaller size on average. This variation is particularly striking in anadromous salmonids where males often mature as parr prior to migration to the sea. In some cases, mature male parr[1] may have a relatively high probability of remaining in fresh water and functionally assuming a resident life style (e.g. Dellefors and Faremo 1988; Hansen et al. 1989). In other instances, most mature male parr eventually migrate to the sea following spawning (e.g. Titus and Mosegaard 1992) and return following a growth period as much larger migrant spawners (H. Mosegaard and R. Titus, Institute of Limnology, Uppsala University, Uppsala, Sweden, unpubl. data). So, in iteroparous anadromous salmonids (i.e. those which spawn more than once) such as steelhead, brown trout (*Salmo trutta*), Atlantic salmon (*S. salar*), and Arctic charr (*Salvelinus alpinus*), males are able to spawn several times during their lifetime, beginning potentially as parr (often age 1+) and continuing as large migrants that return from the ocean to spawn. This general life-history plasticity in males results in higher age-specific mortality rates for males than females because they begin breeding at an earlier age (e.g. Shapovalov and Taft

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[1] *Although these fish have been referred to as "precocious males" for many years, this term inadvertently and inaccurately suggests that this life history pattern is an abnormality. The preferred contemporary terminology is instead "mature male parr" (J. E. Thorpe, Freshwater Fisheries Laboratory, Pitlochry, Scotland, pers. comm.).*

1954; see below). Interestingly, even in typically semelparous anadromous salmonids (i.e. those which spawn once and die) such as chinook salmon (*O. tshawytscha*), mature male parr are anomalous in that they survive after spawning (Robertson 1957).

Trends in specific life history characters among populations of anadromous salmonids have also been detected. For example, mean smolt age and size of Atlantic salmon and anadromous brown trout generally increase as a function of increasing latitude (Fahy 1978; L'Abée-Lund et al. 1989; Metcalfe and Thorpe 1990). Much of this variation is explained by an index of growth opportunity which integrates two primary growth regulating factors in fishes, light and temperature (reviewed by Thorpe 1990). Another environmental factor which may be important in the selection of life history traits in anadromous salmonids is hydrological stability, especially in small streams (Borgstrøm and Heggenes 1988; Titus and Mosegaard 1989, 1992).

Geographic variation in steelhead life-history traits has been studied in much less detail, although Withler (1966) presented data for six coastal locations from central California to southern British Columbia. In contrast to Atlantic salmon and brown trout, mean smolt age of steelhead did not vary clinally with latitude (Fig. 2a; $r^2 = 0.04$, $p = 0.72$). However, mean sea age at maturity (Fig. 2a; $r^2 = 0.50$, $p = 0.11$) and mean adult length (Fig. 2b; $r^2 = 0.96$, $p<0.01$) clearly increased with increasing latitude, despite the small sample size (data adapted from Withler 1966).

Within- and between-population variation in life history traits is not well documented for California steelhead, especially south of San Francisco Bay where environmental conditions follow a sharp gradient. Yet, Shapovalov and Taft's (1954) comprehensive life history study was conducted within this area, namely at Waddell Creek in Santa Cruz County. For use as a general reference with which comparisons may be made, the following is a summary and analysis of several key life history characteristics from Shapovalov and Taft's (1954) landmark study, except as otherwise noted.

South of San Francisco Bay, steelhead are all winter-run fish. Entry into freshwater is dependent upon breaching of the sandbar at the stream mouth following the onset of the winter rainy season. At Waddell Creek, the upstream spawning migration was rather protracted and varied among years (Fig. 3a; see also Fig. 23 in Shapovalov and Taft). On average, most upstream movement occurred during December–April. Males dominated numerically in the early portion of the run.

Steelhead life histories were highly variable at Waddell Creek. Yet, of 32 observed life histories, four categories were dominant: 2/1 (29.8%), 2/2 (26.5%), 3/1 (10.5%), and 2/1S.1 (8.1%). All other categories comprised less than 5% of the run each. So, most migrant spawners were total ages 3 (35%) and 4 (46%), and maximum age was 7 (Fig. 4). Overall, the run consisted of 82.8% first-time spawners, and 17.2% repeat spawners among which 15.0% were second spawners, 2.1% were third, and 0.1% were fourth spawners.

The mean smolt age of males (2.08 yr; calculated as in Fahy 1978) was only slightly lower than that of females (2.15 yr), although based on the frequency distribution of smolt ages for each sex (Fig. 5a), this difference was significant ($\chi^2 = 13.965$, DF = 3, $p<0.003$; data from Table 28 in Shapovalov and Taft 1954). The mean smolt age for both sexes combined was 2.12 yr.

The mean sea age of males spawning for the first time was 1.31 yr, while that for females was 1.55 yr (calculated as in Fahy 1978). Based on the frequency distribution of sea ages for each sex (Fig. 5b), this difference was highly significant ($\chi^2 = 190.392$, DF = 2, $p<0.0001$; data from Table 28 in Shapovalov and Taft 1954). The mean sea age for both sexes combined was 1.43 yr.

Overall, the mean total age of male migrant spawners was 3.51 yr, while that for females was 3.91 yr (calculated as for mean smolt age). Based on the frequency distribution of total ages for each sex (Fig. 4), this difference was highly significant ($\chi^2 = 233.645$, DF = 5, $p<0.0001$; data from Table 28 in Shapovalov and Taft 1954). Age-specific mortality rates were higher for males than females, as evidenced by (i) the lower average age of males; and (ii) the increase in the ratio of migrant females:migrant males with spawning experience, such that the sex ratio among first spawners was 1.06 females:1 male, among second spawners was 1.44 females:1 male, among third spawners was 3.71 females:1 male, and fourth-spawning females (n = 5) had no fourth-spawning male mates (data from Table 28 in Shapovalov and Taft 1954). Note, however, that the sex ratio in the estimated total run averaged 1.06 females:1 male (SD = 0.12) over the years, and there was no significant trend in sex ratio over time ($r^2 = 0.12$, p>0.35; data from Table 35 in Shapovalov and Taft 1954).

Mean fork lengths of migrant males among all life history categories ranged from 38.5 to 79.5 cm, the mean of weighted means being 54.8 cm. Corresponding lengths of migrant females ranged from 40.2 to 80.5 cm, with a mean of weighted means of 61.4 cm. The mean of weighted mean fork lengths for both sexes combined was 58.3 cm (data from Table 32 in Shapovalov and Taft 1954).

Thus, relative to females on average, males smolted and migrated to the ocean at a slightly earlier age, matured and began breeding at an earlier sea age, were smaller in length at spawning, and had a shorter life span.

On the spawning grounds, the female dug a redd (gravel nest) at the tail of a pool, typically where current velocity increased at the head of a downstream riffle. Little basic research has been done on steelhead mating systems, although Needham and Taft (1934) described one spawning aggregation from Waddell Creek in detail (summarized also in Shapovalov and Taft 1954). A large migrant female was accompanied by one similarly sized migrant male; four smaller subordinate migrant males; and two mature male parr, 15–23 cm in length (in total, 7 males:1 female) (c.f. Campbell 1977; Maekawa and Onozato 1986; Titus and Mosegaard 1992 on the composition of spawning aggregations in other polymorphic salmonids). In addition to a dominant migrant male, subordinate migrant males and mature male parr also participate in spawning by adopting a "sneaking" behavior. The proportion of eggs fertilized by mature male parr can be substantial (Maekawa and Onozato 1986; Hutchings and Myers 1988; Jordan and Youngson 1992), and even in the absence of a migrant male, mature male parr successfully mate with a large migrant female (Shapovalov and Taft 1954; Maekawa and Onozato 1986; Myers and Hutchings 1987).

As with the upstream spawning migration, the downstream migration of spent adult steelhead was also protracted and variable among years (Fig. 3b). On average, most downstream movement occurred during March–July. Fish which did not return to the ocean immediately after spawning held in larger pools.

The development rate of steelhead eggs is dependent upon water temperature in the gravel. Based on the results of Wales (1941), hatching occurs after about 19 d at an average temperature of 15.5° C (295 degree-days), and 80 d at about 4.5° C (360 degree-days). Shapovalov and Taft (1954) estimated that hatching time in Waddell Creek was from 25 to 35 d, emergence from the gravel began 2–3 weeks after hatching, and another 2–3 weeks was required to complete emergence. Mortality rates of salmonid fry are typically high following emergence (reviewed by Titus 1990), and age 0+ steelhead utilize habitats with swift currents, moving gradually into deeper water as they grow (Shapovalov and Taft 1954).

Downstream migrants captured in the trap at Waddell Creek (Shapovalov and Taft 1954) comprised five age-classes, 0+ to 4+, in the following proportions, respectively: 0.40, 0.40, 0.19, 0.01, and a negligible proportion of 4+ fish (0.04% of the total number of fish passed through the trap for all years combined). Steelhead moved downstream essentially during all months of the year, but the main migrations were in the spring and summer, with the oldest fish appearing in the trap first: 92% of age 2+ and 3+ fish during March–May; 68% of age 1+ fish during April–June, with a secondary migration (26%) during October–early January; 73% of age 0+ fish during June–July, and an additional 20% during August–September (Fig. 6a). Variation in the time of downstream migration was apparently related to interannual differences in precipitation and thus stream flow and water temperature.

Because the trap was situated well above the mouth of Waddell Creek (2.2–2.8 km, the location of the mouth depending upon the amount of freshwater outflow and oceanic conditions), downstream movement was not necessarily always equivalent with smolt emigration. Indeed, Shapovalov and Taft (1954) found from returns of marked first spawners, that the proportion of marked fish which had entered the ocean in the same year of their initial downstream migration, relative to those which entered the ocean the following year, was only about 0.08 for age 1+ migrants, but increased to 0.90 and 0.69 for 2+ and 3+ migrants, respectively (see Table 71 in Shapovalov and Taft 1954). So, functionally, the downstream movements of different age-classes, or individuals within age-classes, were probably associated with a variety of behaviors or population processes. For example, the downstream movement of 0+ trout may have resulted from the dispersal of emergent fry clusters during the period of intense population regulation in the early free-swimming stage. Movement of 1+ trout may have primarily reflected an ontogenetic habitat shift to deeper water in the lower stream and lagoon, in addition to seaward migration of smolts. The majority of 2+ and 3+ trout were apparently smolts on their way to the ocean.

The total number of upstream migrants (3,104) captured in the trap was small, relative to the total number of trapped downstream migrants (36,779; data for all years combined). Thus, most trout which moved downstream either remained in the lower stream or lagoon, migrated to the ocean, or died. Among upstream migrants, only 1% were age 0+, 29% were age 1+, 53% were age 2+, 15% were age 3+, and 2% were age 4+. Overall, 80% of upstream movement occurred during December–January, for all age-classes and years combined (Fig. 6b). Shapovalov and Taft (1954) observed that many upstream migrants were sexually mature. These mature trout were probably moving upstream to spawn, along with migrant spawners returning from the ocean.

Shapovalov and Taft (1954) knew little about the ocean migrations of California steelhead, with few being captured at sea by commercial salmon trollers. This knowledge gap continues to exist for the most part. Tagged individuals from more northerly stocks of North American steelhead have been recovered on the high seas as far west as 42° 44'N, 163° 32'E, and as far south as 40° 58'N, 159° 39'W (Burgner et al. 1992). Although based on few data, California steelhead may make more restricted westward migrations than more northerly stocks. Shapovalov and Taft (1954) did determine, however, that homing rates of marked steelhead at Waddell Creek and nearby Scott Creek were very high; 98.1% and 97.1%, respectively (see also Taft and Shapovalov 1938).

Estimated survival of Waddell Creek steelhead, from eggs to first spawning adults, ranged from 0.017% to 0.029%, and averaged 0.023% (SD = 0.005%, n = 5; see Table 58 in Shapovalov and Taft 1954). There was a strong negative correlation ($r^2 = 0.88$, $p<0.02$) between the number of first spawners recruited and the number of eggs laid at the start of the life cycle (Fig. 7). Thus, observed recruitment was negative density-dependent in relation to egg production. Of course, to consider this apparent functional relationship as true, one must assume that oceanic conditions and angling had relatively constant effects on survival to first spawning.

Survival of all age-classes of marked Waddell Creek steelhead, from time of downstream migration to first spawning, ranged from 1.7% to 6.0%, and averaged 3.5% (SD = 1.8%, n = 5; see Table 75 in Shapovalov and Taft 1954). For all age-classes and years combined, 383 first spawner adults returned from 12,679 downstream migrants marked at the trap, for an overall survival of 3.0%. Furthermore, there was a strong positive correlation ($r2$ = 0.86, $p<0.02$) between the age at which steelhead made their initial downstream migration and were marked at the trap, and the proportion of fish in each age-class surviving to return from the ocean as first spawners (Fig. 8). If it is assumed that fish size is directly proportional to age, then survival increased with size as well. However, these relationships are confounded by the fact that the various age/size-classes would not be experiencing the same potential mortality factors simultaneously through time because of their differing, age-class specific life histories, especially with regard to the proportion of each age-class entering the ocean in any given year (see above). To fully evaluate age-class specific survival of downstream migrants to first spawning, mortality rates would have to be determined for each age-class for both the remainder of their freshwater period, as well as in the ocean.

DRAINAGE-BY-DRAINAGE ACCOUNTS

SAN MATEO COUNTY

Ano Nuevo Creek Drainage

Although no detailed historical information was discovered for Ano Nuevo Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a very small steelhead run, relative to the runs observed at Scott and Waddell creeks during the 1930’s–40’s. Juvenile steelhead were observed in the creek as recently as 1992 (J. Nelson, CDFG, pers. comm.).

Cascade Creek Drainage

No juvenile steelhead/rainbow trout, or any other fishes, were observed in Cascade Creek when surveyed by the CDFG on 20 July 1978. However, a local resident reported the former presence of “trout” in the 5 km long creek. Several agricultural diversion dams throughout the stream created complete migration barriers and reduced stream flow. The stream bottom was heavily silted as a result of agriculture, grazing, and road crossings. Overall, Cascade Creek did not provide habitat conditions conducive to steelhead/rainbow trout production.

Denniston Creek Drainage

Denniston Creek is a short-run tributary to Half Moon Bay. In a 1941 listing, the CDFG (unpubl. file document of 26 April 1941) described Denniston Creek as having a fair year-round flow, a small lagoon which opened and closed throughout the summer, known steelhead and coho salmon spawning migrations, fair summer trout fishing, and water used for irrigation.

By 1953, a small dam had been built on the creek about 1.6 km above the mouth. The CDFG maintained a catchable rainbow trout fishery in the impoundment during 1953, but it was discontinued in 1954 because of private property access restrictions (CDFG, unpubl. field notes of 26 February 1953–29 March 1955). The dam presumably blocked upstream migration of adult steelhead at that time.

The CDFG conducted a cursory electrofishing survey at Denniston Creek on 21 October 1974 (W. E. Strohschein, CDFG, unpubl. memo. of 28 October 1974). Access to the stream was limited because of dense riparian vegetation. In a 4.6 m section about 0.6 km above the dam, four juvenile steelhead/rainbow trout were captured that averaged 78 ± 19 mm FL (range, 61–99 mm FL). In a 9 m section about 0.2 km above Highway 1, two young-of-the-year steelhead were captured, both about 64 mm FL. The spillway from the dam appeared to be an impassable barrier to upstream migrants. Stream flow was continuous above the dam but nearly interrupted below because of a water diversion.

The lowermost 4.8 km of Denniston Creek was surveyed by the CDFG on 20 April 1992. The stream was heavily overgrown with riparian vegetation. Adjacent soils were highly erosive and sand dominated the stream substrate. Areas with spawning gravel were small, patchy, and highly embedded or compacted. Small shallow pools with heavy cover provided adequate rearing habitat for young-of-the-year steelhead. The dam was still a migration barrier, as was a 1.8 m culvert located about 0.8 km above the dam. One water diversion was seen upstream from the culvert. Juvenile steelhead/rainbow trout, 10–15 cm in length, were seen in pools throughout the stream. Presumably, those above the dam were resident trout.

Frenchman's Creek Drainage

Frenchman's Creek, which enters the Pacific Ocean near the community of Half Moon Bay, was surveyed by the CDFG during the mid-1930's. Juvenile steelhead were present and natural propagation was rated as fair. Small irrigation diversion dams were present, but they were not thought to be barriers to steelhead migration. The stream was fished lightly. The population was supplemented with 10,000 juvenile steelhead in 1930, and 8,000 in 1932.

The creek was not surveyed again by the CDFG until 25 September 1958. Due to a high amount of sand in the stream bottom, salmonid spawning areas were poor in the lowermost 4.8 km of stream, and poor to fair in the next 3.2 km upstream. Rearing habitat, in the form of pools, undercut banks, and vegetative cover, was apparently abundant throughout. Temporary dams were noted, from which several diversions were made. Steelhead reportedly used the stream for spawning, but juveniles were not seen due to low water clarity. Streamside erosion was noted as a problem. Private landowners had apparently stocked brown trout in the upper canyon portion of the stream some years before the survey. Overall, Frenchman's Creek was rated as a minor steelhead stream.

In a CDFG electrofishing survey in October 1974 (W. E. Strohschein, CDFG, unpubl. memo. of 1 November 1974), two juvenile steelhead/rainbow trout (15–18 cm FL) and a brown trout (27 cm FL) were captured in a short stream section immediately downstream from the Highway 1 bridge. In a 15 m section in the upper stream, eight juvenile steelhead/rainbow trout were captured which averaged 7.9 cm FL (range, 6.4–10.4 cm). Two brown trout, 18.8 and 19.3 cm FL, were also captured.

The CDFG surveyed the lowermost 5.5 km of Frenchman's Creek on 19–20 September 1979. Salmonid spawning and rearing habitat were apparently much the same as in the 1958 survey (see above). Three flashboard dams, 0.9–2.4 m high, were noted as potential barriers to fish migration. Five active water diversions were identified. Age 0+ salmonids were observed throughout the survey area. Electrofishing samples were taken in two reaches which totalled about 366 m (L. Fish and I. L. Paulsen, CDFG, unpubl. memo. of 23 October 1979). A total of 63 juvenile steelhead (mean FL = 9.7 cm; range, 6.4–20.3 cm) and 14 brown trout (mean FL = 11.4 cm; range, 7.9–22.9 cm) were captured. Among the steelhead, three age-classes (0+, 1+, and ≥ 2+) were apparent with corresponding mean fork lengths of 8.4, 15.7, and 19.6 cm, respectively. Age 0+ fish comprised 84% of the total steelhead catch.

In subsequent environmental documents contained in the CDFG file, it was noted that since 1971, water use in the drainage had increased and cumulative effects posed a direct threat to fishery resources.

Locks Creek is the principal tributary to Frenchman's Creek, but no information was available regarding the stream or its status as a steelhead production area.

Gazos Creek Drainage

Gazos Creek was surveyed by the CDFG in 1934. Spawning grounds were abundant, no barriers or diversions were noted, and steelhead were present. The stream was apparently heavily fished by local residents. Early CDFG stocking records showed that the population was supplemented with 12,000 juvenile steelhead in 1930; 16,000 in 1931; 12,000 in 1932; 12,000 in 1933; 10,000 in 1934; 15,000 in 1935; 15,000 in 1936; 20,000 (@ 917–1,270/kg) in 1938; and 7,000 (@ 2,116/kg) in 1939, for a grand total of 119,000 fish.

The stream was surveyed again by the CDFG in July 1964, from the mouth to headwaters for a distance of 13 km. Suitable gravels for salmonid spawning were ample, and comprised an estimated streambed area of about 20,000 m2. Salmonid rearing habitat was also abundant and apparently of high quality. Many partial and complete barriers to fish migration were observed, and one diversion in the lower stream stopped all stream flow and fish passage to the ocean.

Siltation in the stream, from an adjacent road and past logging, was occurring. Juvenile steelhead occurred in visually estimated densities of 50 fish/30 m in the lower stream, and 5 fish/30 m in the headwaters. Lengths were 2.5–15 cm, averaging about 5 cm. One 56 cm adult male steelhead was seen. Natural spawning success was rated as good. Catchable rainbow trout were planted in the stream at the time of this survey, which resulted in heavy angling pressure on 2-year-old steelhead. Coho salmon also used Gazos Creek.

A sample of juvenile steelhead taken by the CDFG on 28 February 1970 comprised 36 fish which ranged in fork length from 79 to 165 mm, and averaged 128 mm (SD = 26 mm).

The CDFG conducted several electrofishing surveys during the 1970's–80's which provided at least cursory information on the natural variation in the size/age structure of the juvenile steelhead population in Gazos Creek. On 21 October 1974 (K. R. Anderson, CDFG, unpubl. memo. of 28 October 1974), 59 steelhead were captured in a single sweep through a 305 m reach of stream, about 0.3 km upstream from the Highway 1 bridge. Age 0+ fish comprised 93% of the catch, and averaged 91 mm FL (range, 71–132 mm FL). The remaining four steelhead were age 1+ and averaged 155 mm FL (range, 150–165 mm FL).

On 13 October 1975 (G. G. Scoppettone, CDFG, unpubl. memo. of 3 February 1976), 28 juvenile steelhead were captured in a single sweep through a 46 m reach adjacent to the Campbell Soup Co. diversion. Again, fish ranging in fork length from 38 to 127 mm (mean, 86 mm FL) made up 96% of the catch. Only one clearly older individual was captured, which was 203 mm FL.

During the winter of 1975-1976, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. No adult steelhead were observed at three sites on Gazos Creek on 2 March 1976 even though the stream was open to the ocean (G. Scoppettone, CDFG, unpubl. memo. of 19 April 1976).

Salmonids, probably juvenile steelhead, were observed, but not captured, upstream from the Campbell diversion on 10 August 1976 (M. Cogger, CDFG, unpubl. memo. of 30 August 1976).

On 30 May and 15 June 1978, the CDFG surveyed Gazos Creek from the headwaters to the mouth at the Pacific Ocean. Spawning and rearing habitats for salmonids were still abundant and of very high quality. Juvenile steelhead were abundant. Most fish were young-of-the-year averaging about 4 cm, although some trout were up to 20 cm long. Many potential migration barriers were noted, mostly in the form of woody debris and log jams as the result of prior logging operations. Siltation and water diversion had a negative impact on salmonid habitat in the lowermost portion of the stream. It was also noted that 4,000–5,000 catchable rainbow trout had been planted in Gazos Creek annually during 1960–73.

Two very small samples were taken by electrofishing at Gazos Creek on 8 August 1978 (S. G. Torres and I. L. Paulsen, CDFG, unpubl. memo. of 17 August 1978). In an upstream section, 8 steelhead were captured which averaged 64 mm FL (range, 46–79 mm FL). Near the Muzzi diversion site, 4 steelhead were captured which averaged 89 mm FL (range, 69–104 mm FL). Many more salmonids escaped capture in the sample sections due to equipment failure.

On 27 September 1979, 59 steelhead averaging 86 mm FL (range, 53–160 mm FL) were captured during a single electrofishing pass in two reaches totaling 236 m near the Muzzi and Campbell diversions (L. Fish and I. L. Paulsen, CDFG, unpubl. memo. of 23 October 1979). In a 69 m reach upstream of stream km 3.7, 46 steelhead were captured which had a mean fork length of 74 mm (range, 46–178 mm FL). Based on the composite of the above samples, three age-classes of steelhead were apparent: 0+ which averaged 71 mm FL (range, 46–102 mm; n = 85), 1+ which averaged 124 mm FL (range, 107–160 mm; n = 19), and a single, older 178 mm individual.

No adult steelhead or coho salmon were observed during fish count surveys made on six occasions from late November 1979 through late April 1980 (K. R. Anderson, CDFG, unpubl. memo. of 14 July 1980). It was concluded that anadromous salmonid resources had greatly declined in Gazos Creek.

Logjams were removed in Gazos Creek during July 1980 (D. Eimoto, CDFG, unpubl. memo. of 5 August 1980). Juvenile salmonids were observed in the stream at that time. The CDFG also electrofished two reaches for a total of 213 m on 5 September 1980 (P. Walkup, CDFG, unpubl. memo. of 18 September 1980). Age 0+ steelhead averaged 71 mm FL (range, 48–97 mm FL; n = 113 or 88% of the catch), 1+ steelhead averaged 114 mm FL (range, 102–140 mm FL; n = 14), and ≥ 2+ steelhead averaged 260 mm FL (range, 236–284 mm FL; n = 2). Thus, despite the absence of adult sightings during the 1979–80 spawning season, at least some spawning and recruitment did indeed occur.

On 7 September 1984, the CDFG surveyed 8 km of Gazos Creek, beginning at the mouth of Old Woman's Creek and working upstream. High quality spawning and rearing habitats for salmonids were still present, yet very few juvenile steelhead were seen. Those observed were 5–15 cm TL. Siltation persisted as a problem in the lower stream, and logjams and a landslide created potential migration barriers. Water continued to be diverted from the stream at several locations.

The CDFG electrofished two reaches of Gazos Creek on 12 September 1985 (F. Gray, CDFG, unpubl. memo. of 15 October 1985). In a 61 m reach about 2.4 km upstream from the mouth, 76 steelhead were captured which ranged in fork length from 38 to 130 mm and averaged 68 mm. In a 91 m reach about 3.2 km above the mouth, 84 steelhead averaged 69 mm FL and ranged from 45 to 142 mm FL.

In August 1992, Smith (1992) electrofished two reaches totalling 84 m in the lowermost 3.2 km of Gazos Creek. Only pools and glides were sampled. A total of 112 juvenile steelhead/rainbow trout was captured; 67% of the catch was age 0+ and 33% was age 1+. Ages were assigned based on length-frequency distributions.

During 12–16 January 1994, Smith (1994) resampled the two reaches in lower Gazos Creek, and added two reaches between 5 and 7 km above Highway 1. Again, only pools and glides were sampled. Both age 0+ and 1+ steelhead occurred in all four reaches. Of the 165 juvenile steelhead captured, 72% were age 0+ and 28% were age 1+ that occurred at mean ± SD densities of 95 ± 52 trout/100 m and 30 ± 10 trout/100 m, respectively. Overall, juvenile steelhead population structure in pools and glides was stable between August 1992 and January 1994. In 1993, Nelson (1994c) inventoried the stream habitat in the lowermost 10.5 km of Gazos Creek, and monitored juvenile steelhead emigration. The detailed habitat typing effort corroborated earlier observations that spawning and rearing habitats were adequate for maintaining the steelhead population. However, siltation continued to degrade habitat quality by armoring spawning gravel and filling in pools. During the May–June 1993 survey period, water quality in the upper stream area (SKM 10) was also degraded by suspended sediment. Signs of chemical pollution were seen in the lowermost 1.6 km of the creek, although these were not fully investigated. A well field and surface diversion in the lower creek decreased stream flow during late summer–early fall, which presumably reduced rearing habitat quantity and quality. There were 28 logjams in the survey area, seven of which were potential migration barriers except under very high flow conditions.

Emigrating juvenile steelhead were monitored by use of a downstream migrant trap. The trap was located just upstream from the well field at about SKM 0.5, and was fished from 29 March 1993 to 1 June 1993. Only 25 steelhead parr and 29 smolts were captured during the nine weeks of trapping. Peak catches (40% of parr, 34% of smolts) occurred during the week of 26 April 1993. Captured parr averaged 97 mm FL (range, 52–153 mm FL), while smolts averaged 151 mm FL (range, 104–178 mm FL). The low catches suggested a small population, although more emigration may have occurred prior to the trapping period.

<u>Old Woman's Creek</u>

Old Woman's Creek was surveyed from its mouth to headwaters by the CDFG on 23 July 1964. The stream contained suitable spawning and rearing habitat for steelhead. One potential migration barrier was noted, but no diversions were seen. Juvenile steelhead and coho salmon, 5–15 cm long, were observed at a total estimated abundance of ≤ 500 for the entire stream. One spawned-out adult female steelhead was seen as well.

In 1993, Nelson (1994c) inventoried the stream habitat in the lowermost 1.2 km of Old Woman's Creek. An elevated culvert created a likely migration barrier to upstream migrants, and the creek was not surveyed above this point. Rearing pools and spawning beds were silted, and the creek contained logjams that created potential migration barriers. Despite what appeared to be relatively poor habitat, juvenile steelhead/rainbow trout were seen throughout the survey reach.

STATUS: Nelson (1994c) described the Gazos Creek steelhead population as viable but declining. This assessment was consistent with observed reductions in habitat quality, quantity, and access due to siltation, water diversions, and logjams.

Green Oaks Creek Drainage

No juvenile steelhead/rainbow trout, or any other fishes, were observed in Cascade Creek when surveyed from its mouth to headwaters (6 km) by the CDFG on 10 August 1978. Five dams located throughout the stream created complete migration barriers. There were five agricultural diversion pumps. Reservoirs in the lowermost 3 km obscured the structure and function of the natural stream channel. No suitable spawning areas for steelhead were observed. A local resident reported that reservoirs on the creek were stocked with rainbow trout. Overall, Green Oaks Creek did not provide habitat conditions conducive to steelhead/rainbow trout production.

Lobitos Creek Drainage

Early CDFG records showed that the Lobitos Creek steelhead population was supplemented with 8,000 juveniles in 1930 and 14,000 in 1932. In a mid-1930's CDFG stream survey, the creek was described as having intermittent summer flow and scattered spawning grounds for steelhead, and that natural propagation of steelhead had been limited, presumably because of limited spawning and rearing habitat. The adult steelhead population was lightly fished. Several "large" steelhead were apparently caught at Lobitos Creek on 25 May 1939 (L. Shapovalov, CDFG, unpubl. file note).

The CDFG surveyed Lobitos Creek on 24 June 1975, from its headwaters to the mouth at the Pacific Ocean, for a distance of 4 km. Spawning substrate was rated as poor to fair, with patches of suitable gravel scattered throughout the survey area. Silt cemented the substrate in some areas of the stream, especially near the headwaters where logging operations were underway. Rearing habitat in the form of pools and cover was rated as fair to good. Several potential barriers to fish migration were noted, including logjams, culverts, small dams, and a natural 1.8 m bedrock waterfall downstream from Highway 1. Several small diversions were identified. Juvenile steelhead and/or rainbow trout, 2.5–15 cm in total length, were observed throughout the survey area, although trout density was relatively low above the natural bedrock waterfall in the lower stream, and much higher in the 0.3 km of stream below the fall where access by migratory trout was unobstructed. Overall, the stream was underutilized by steelhead, primarily because of fish passage problems, and it was recommended that future water applications be protested because of the limited water resources in this small stream drainage. Several such applications, contained in the CDFG files, were submitted during the late 1970's.

During the winter of 1975-1976, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. The mouth at Lobitos Creek did not open, even following rainfall events during mid–February to early March 1976, and no adult steelhead were observed in the stream (G. Scoppettone, CDFG, unpubl. memo of 25 March 1976 and 19 April 1976).

Pescadero Creek Drainage

Historically, the Pescadero Creek system has supported the largest steelhead population and fishery in San Mateo County. During the mid-1970's, the size of the annual adult steelhead run was estimated at 1,500 fish of which about 400 were harvested in the sport fishery each year (Elliott 1975). The system undoubtedly supported many more steelhead, and coho salmon as well, before any major exploitation of the stream drainage began. For example, in 1870 a commercial fishery existed where a wagon load of steelhead and coho weighing 1–14 kg each was taken daily from Pescadero Creek between October and March (Skinner 1962). Degradation of the system was already underway at that time, however, due to the effects of logging, saw mills, and flour mills. So, it is reasonable to assume that the anadromous fish populations were previously even larger than the ones which supported the commercial fishery in 1870.

The modern chronicle charting the Pescadero steelhead population begins with early CDFG records. The upper creek was surveyed by the CDFG on 7 August 1962, from its headwaters to Portola State Park for a distance of 2.7 km. There were suitable spawning areas for steelhead and rainbow trout in the headwaters and from 0.8 km above Oil Creek to the state park. The remainder of this portion of the creek was heavily silted, and thus unsuitable for salmonid spawning. Rearing habitat, in the form of pools and shelter, was adequate for young trout. Three low-flow migration barriers and one diversion were identified, and the Santa Cruz Lumber Company was indicated as a pollution source in the stream. Juvenile steelhead and/or rainbow trout occurred in visually estimated densities of 10–275 trout/30 m (average, 110 trout/30 m), and were 2.5–18 cm long (average, 5 cm). At that time, the CDFG stocked catchable rainbow trout in the creek from Portola State Park to San Mateo County Memorial Park to support the summer trout fishery.

On 8 August 1963, the CDFG surveyed the lowermost 17.5 km of the stream, from the mouth to Memorial Park. The uppermost 3.5 km of the survey area contained an estimated 3,479 m2 of suitable spawning grounds. Much of the remaining 14 km of streambed in the survey area was heavily silted and contained only an estimated 1,254 m2 of utilizable spawning substrate for steelhead. Local residents reportedly observed steelhead spawning near the community of Pescadero during the 1962-63 season. Pools and shelter provided adequate rearing habitat for juvenile steelhead. No migration barriers were noted, but 35–50 diversions were observed along 12.9 km of stream, with most of the water being used in agriculture. Siltation was noted as a major pollution problem in this portion of the stream as well. The density of juvenile steelhead and/or rainbow trout was estimated at 300 trout/30 m in the upper 6.4 km of the survey area, and 100 trout/30 m in the 11.1 km below (overall average, 175 trout/30 m). The average trout length was estimated at 7.5 cm with a range of 5–30.5 cm. Steelhead production was judged to be at its maximum under the existing conditions in this portion of Pescadero Creek.

Conditions in Pescadero Creek were apparently very much the same when the entire stream, from its mouth to headwaters for a distance of 37 km, was surveyed by the CDFG during 24–30 August 1965. Young trout densities were determined by seining out several blocked-off stream sections along 27.4 km of the creek. The average density was about 60 trout/30 m, and total abundance was estimated at 55,385 trout. The fish were 3.6–7.6 cm long and averaged 5.3 cm, which based on their size would suggest that all trout observed were young-of-the-year.

As in most California streams, fish production in Pescadero Creek was negatively impacted by the drought of water years 1975-76 and 1976-77. During the winter of 1975-76, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. However, adult steelhead and coho salmon did enter lower Pescadero Creek following rainfall events during mid-February to early March 1976 (G. Scoppettone, CDFG, unpubl. memo of 25 March 1976 and 19 April 1976).

When observed by the CDFG on 10 August 1976 (R. Curtis, CDFG, unpubl. memo. of 31 August 1976), low flow conditions were exacerbated by diversions and stream flow approached intermittency in the lower creek where no salmonids were seen. Flow was continuous but minimal further upstream and a few juvenile trout were observed ranging in length from 5 to 15 cm. The Pescadero tributary, Honsinger Creek, was also observed during this brief survey and found to have a minimal continuous flow that was predicted to become intermittent later in the season. Juvenile steelhead, 10–18 cm long, reportedly inhabited a small impoundment on the creek.

The CDFG surveyed 9.3 km of lower Pescadero Creek, from stream km 8.5 upstream from Pescadero to Memorial Park, during the second year of the drought on 8 & 11 July 1977. The survey report indicated that the sandbar at the mouth of the creek had only been breached twice by storms during the winter of 1976-77. Limited entry by adult steelhead severely reduced steelhead propagation in the system. Aside from the very low flow conditions which reduced the quantity, the quality of physical habitat for spawning and rearing was apparently similar as in previous surveys, except that silt deposition in the stream was perhaps enhanced because of a lack of flushing flows. Seven dams and one logjam were identified as partial migration barriers within the survey area, depending on actual flow conditions. Nine diversion sites were noted. Age 0+ steelhead, averaging 3.8 cm in fork length, occurred at an estimated abundance of 35 trout/30 m in pools in a 2.1 km boulder-strewn reach, near the community of Loma Mar. Few juvenile steelhead were seen above or below this stream reach.

On 8 August 1978, several age 0+ steelhead averaging about 6.5 cm FL were observed in a

23 m reach of lower Pescadero Creek (S. G. Torres and I. L. Paulsen, CDFG, unpubl. memo. of 17 August 1978). About 15 young-of-the-year steelhead, averaging about 7.5 cm FL, were also seen immediately upstream of the fish ladder in Memorial Park. Thus, spawning of adults and recruitment of age 0 steelhead were apparently successful following the abundant rains and high flow conditions during the winter of 1977-78.

The 1976-77 drought greatly increased the demand on water resources in the Pescadero Creek system, as evidenced by the volume of water applications, protests, and other related documents contained in the CDFG files. To provide protest dismissal terms for water applications in the lowermost 8 km of Pescadero Creek, a CDFG instream flow study determined that a minimum bypass flow of 0.4 m3 was required during 1 November–1 May to allow passage of upstream migrating adult steelhead and coho salmon (K. R. Anderson and I. L. Paulsen, CDFG, unpubl. memo. of 1 October 1979). This flow would also allow for downstream passage of post-spawning adult steelhead and emigrating smolts.

A CDFG file document from 1980 indicated that, following Fish and Game Commission policy, catchable rainbow trout were no longer stocked into Pescadero Creek to provide for a summer trout fishery (B. Hunter, CDFG, unpubl. letter of 6 March 1980). However, it was also mentioned that about 10,000 yearling steelhead were planted into Pescadero annually as a stock enhancement measure. For example, 10,120 Mad River steelhead (@ 22.0/kg) were planted on 14 April 1975; 10,070 Mad River steelhead (@ 209.4/kg) on 22 August 1978; 8,013 Mad River steelhead (@ 23.4/kg) on 29 April 1980; and 8,140 steelhead (@ 8.2/kg) from Point Arena Ponds (lot or egg source not specified) on 21 March 1985.

The abundance of age 0+ and 1+ steelhead was determined at the fifth and sixth road crossings upstream from the mouth of Pescadero Creek, by use of the removal method during fall 1986 (J. J. Smith, San Jose State University, unpubl. data). Density estimates based on two–three electrofishing passes were 32.6 and 57.1 trout/30 m at bridge 5 and 6, respectively (site lengths were 85 m and 37 m, respectively). On 30 October 1987, trout densities were very similar to the year before: 28.0 and 64.0 trout/30 m. The standard lengths (± SD) of trout at each site in the 1987 survey were 71 ± 14 mm and 73 ± 17 mm; thus, most trout were age 0+ at these sites.

With acquisition of the marsh lands at the mouths of Pescadero Creek and Butano Creek (see below) by the California Department of Parks and Recreation, much attention during the 1980's was directed toward development of a management plan for the Pescadero Marsh Natural Preserve. As part of this interagency effort, Smith (1987, 1990) determined the importance of the Pescadero lagoon as rearing habitat for juvenile steelhead prior to their migration to the ocean.

Butano Creek and tributaries

The largest tributary to the Pescadero Creek drainage is Butano Creek, which is in reality a separate major drainage that only shares a common lagoon with Pescadero Creek. As for the Pescadero, the contemporary record of steelhead use of Butano Creek is fairly substantial and draws heavily from information contained in the CDFG files.

Juvenile steelhead were observed in Butano Creek during a mid-1930's CDFG stream survey. The surveyor had seen adult steelhead spawning and spawning success was apparently good. Fishing pressure was noted as heavy. High quality spawning grounds existed in the middle portion of the drainage, and small irrigation diversions were identified in the middle and lower portions of the stream. Early CDFG stocking records showed that the population was supplemented with 10,000 juvenile steelhead in each of 1930, 1932, 1933, and 1934; 15,000 in each of 1935 and 1936; 20,000 (@ 1,340/kg) from Big Creek in June 1938; and 2,000 (@ 2,116/kg) from Big Creek in June 1939.

The next CDFG survey occurred in December 1948. The surveyor found that a barrier waterfall, Butano Falls, blocked upstream migration of steelhead spawners, about 4.8 km above the entrance to Butano Canyon. Logging was underway further upstream in the watershed. One or two adult steelhead were observed, fingerlings were abundant, and juveniles up to 15 cm were seen in the summer. Fishing pressure on the stream was heavy during the summer trout season when anglers fished for juvenile steelhead and resident rainbow trout, the latter of which occurred above the barrier waterfall.

During a survey of Butano Creek on 25–26 August 1958, the CDFG noted that spawning areas had become silted since the 1948 survey, the cause being the combined effect of upstream logging operations and heavy winter rains. Rearing habitat in the form of pools and shelter was apparently adequate for steelhead. Below Butano Falls, 5–10 cm long juvenile steelhead were common except near the stream mouth, while above the falls young-of-the-year resident rainbow trout were scarce, there were some 5–7.5 cm trout, and a few 15 cm trout. Few fish were seen in the north fork of Butano Creek, and slashings from logging covered the south fork which precluded the evaluation of fish resources there. The total survey distance, from the mouth to the forks, was about 13 km. Fishing pressure in summer was only moderate by this time.

Problems with sedimentation and logging debris in Butano Creek were persisting when the CDFG surveyed the stream again in July 1964. Despite the effects of poor watershed management in the headwaters, the steelhead and rainbow trout populations also persisted although the impacts on population growth could not be assessed based on available information.

South Butano Creek was surveyed more closely by the CDFG on 30 July 1964, from its confluence with the main stem to the headwaters, for a distance of nearly 9 km. This stream was regarded as an important tributary to Butano Creek because of its contribution of perennial summer flow. The creek contained several major migration barriers and was heavily silted due to the effects of logging. Nonetheless, a small population of resident rainbow trout was able to exploit the small gravel patches and rearing pools. Young-of-the-year, 4–5 cm in length, occurred in a visually estimated density of 8 fish/30 m, while older trout, 9–13 cm in length, had a density of about 2 fish/30 m. The population was reportedly established as the result of plants made several years before by an ex-warden of the CDFG. Fishing pressure was light.

The 1976-77 drought greatly increased the demand on water resources in the Pescadero Creek system, as evidenced by the volume of water applications, protests, and other related documents contained in the CDFG files. To provide protest dismissal terms for water applications in the lowermost 7.1 km of Butano Creek, a CDFG instream flow study determined that a minimum bypass flow of 0.3 m3 was required during 1 November–1 May to allow passage of upstream migrating adult steelhead and coho salmon (K. R. Anderson and I. L. Paulsen, CDFG, unpubl. memo. of 1 October 1979). This flow would also allow for downstream passage of post-spawning adult steelhead and emigrating smolts.

The main tributary to Butano Creek, Little Butano Creek, is also a known steelhead/rainbow trout stream. Early CDFG records showed that the steelhead population was supplemented with 10,000 juveniles in 1935 and 8,000 in 1936. When surveyed by the CDFG on 28 August 1958, a 6 m high silted-in flashboard dam, located about 4.5 km upstream from the confluence with Butano Creek, marked the upstream extent of steelhead access in the Little Butano. The dam diverted water to Upper Bean Hollow Lake via a flume. Spawning grounds below the dam were rated as fair; the best spawning gravels for steelhead existed above the dam. Rearing habitat in the form of pools and shelter was best in the lowermost stream area. Young-of-the-year steelhead, 5–7.5 cm in length, were abundant in the portion of stream below the dam, and were estimated in densities up to about 23 trout/30 m. Young-of-the-year were generally less abundant above the dam, and were considered to be the progeny of resident rainbow trout. Near the headwaters, resident rainbows up to about 23 cm in length were observed. Removal of the abovementioned dam would allow steelhead access to another 2.4 km or more of production area.

When surveyed from the mouth to headwaters by the CDFG during 10–17 August 1962, spawning and rearing conditions in Little Butano Creek were apparently much the same as in the 1958 survey. However, a 4.5 m high bedrock falls, located about 250 m above the confluence with Butano Creek, was identified as a complete barrier to upstream migration of anadromous salmonids. Interestingly, this barrier was either formed during the interim, or was simply overlooked in the 1958 survey. A culvert, located about 500 m below the flashboard dam, was also a potential migration barrier. In addition to the abovementioned flume, there was a new diversion at a sandbag dam. Siltation caused by old logging operations was noted as a pollution problem. Juvenile steelhead/rainbow trout were seen from the mouth to the headwaters, although they were scarce in the uppermost stream area. The fish above the barriers were considered to be rainbow trout, most of which were 2.5–5 cm long young-of-the-year, but a few 10–12.5 cm trout were also seen. Trout density above the barriers was visually estimated at 15–

20 fish/30 m. Juvenile steelhead and coho salmon were observed below the bedrock falls.

The entire Little Butano Creek was surveyed by the CDFG on 7–8 June 1977, during the second year of the 1976-77 drought. The status of spawning and rearing habitat for rainbow trout was apparently much the same as in previous surveys. New potential migration barriers and diversions were identified. Cattle caused some pollution (manure and eroded soil in the stream) in the lower creek area. Rainbow trout, 2.5–15 cm in length, occurred at a visually estimated density of 20 fish/30 m between the bedrock falls near the stream mouth and the flashboard dam. Rainbow trout were not seen above this point; thus, trout distribution in the Little Butano was greatly reduced relative to observations made during the previous 20 years. Although the exact cause was not readily identifiable, upstream water development in Butano State Park, which included a pumping station at a concrete dam, may have been a factor. Evidently, this trend has not been evaluated since 1977.

Fall Creek

The Pescadero tributary, Fall Creek, was surveyed by the CDFG on 16 August 1962. An 2.4 m natural bedrock barrier limited steelhead access to the lowermost 274 m of stream. About 40% of this stream length comprised high quality spawning grounds, and old redds were observed. Rearing habitat was apparently only suitable for age 0+ salmonids, due to the shallowness of the creek. No diversions were seen. Steelhead and/or rainbow trout juveniles, 2.5–5 cm long, were present at a visually estimated abundance of 20 fish/30 m.

Little Boulder Creek

When surveyed by the CDFG on 15 August 1962, Little Boulder Creek was noted as an important tributary to Pescadero Creek because of its perennial flow. Only the lowermost 1.2 km of the creek was available to steelhead because of an impassable bedrock barrier. However, within this reach, the creek contained high quality spawning gravel and suitable rearing habitat for steelhead. Juvenile trout, 2.5–5 cm in length, were abundant and visually estimated at 75 trout/30 m. Older trout up to 23 cm long were also observed. No fish were seen above the bedrock barrier. There was a water diversion to a lumber mill.

Peters Creek

Peters Creek was surveyed by the CDFG on 5 August 1962, from its confluence with Pescadero Creek to a natural waterfall barrier located about 9.3 km upstream. Suitable spawning habitat for salmonids was scarce in the lowermost 2.4 km of stream due to siltation caused by logjams, but was generally abundant further upstream. Rearing habitat in the form of pools and shelter was apparently adequate for juvenile steelhead. Logjams consisting mostly of debris from prior logging operations created potential barriers to fish migration in the lowermost 3.2 km of the stream. One water diversion was noted. Steelhead and/or rainbow trout were abundant throughout the stream, at visually estimated densities of 50–150 trout/30 m. An estimated 98% of these fish were 2.5–5 cm long (age 0+) while the remaining 2% ranged in length from 7.5 to 20 cm.

Pilarcitos Creek Drainage

During the winter of 1975-76, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. No adult steelhead were observed at one check point on Pilarcitos Creek on 26 February 1976 despite recent rainfall (G. Scoppettone, DFG, unpubl. memo. of 25 March 1976).

Arroyo Leon

The Arroyo Leon is a major tributary which has its confluence with Pilarcitos Creek at the community of Half Moon Bay. Juvenile steelhead were present in the Arroyo Leon during a mid-1930's CDFG survey of the creek. Spawning grounds for steelhead were patchily distributed, but natural propagation was successful. Two 6 m diversion dams were barriers to steelhead migration. Fishing pressure was moderate on what was mentioned to be a small steelhead run. The population was supplemented with 10,000 juvenile steelhead in 1930.

Pomponio Creek Drainage

Within recent geological history, only the lowermost 1.6 km of Pomponio Creek has been available to steelhead because of a 7.5 m waterfall at that point. The CDFG surveyed the entire

9.7 km of stream on 29 August 1958. Spawning areas were of generally poor quality above the fall, and only somewhat better below. Pools with cover provided rearing habitat both above and below the fall, although they were especially numerous and deep below. Local residents supported the view that steelhead could not ascend the waterfall. Relatively many juvenile steelhead, 5–7.5 cm long, were captured by seine and otherwise observed downstream from the fall, along with a 56 cm post-spawner. Only two trout, 12.5 and 15 cm long, were captured at two locations above the waterfall. These results corroborated the presence of steelhead below the fall, and presumably resident rainbow trout above. Local residents reported trout 30–35 cm long above the fall. There was a small reservoir near the headwaters from which water was diverted for agricultural purposes. Releases from the reservoir reportedly maintained a perennial flow in Pomponio Creek.

Smith (1987, 1990) captured no steelhead by seining the small Pomponio Creek lagoon on 11 & 16 June 1985 and 16 June 1986. Water quality was unsuitable for steelhead rearing in summer. In contrast, two smolts over 20 cm long were captured there on 30 December 1985. Smith (1990) suggested that the lagoon was used as a winter feeding area by juvenile steelhead prior to their migration to sea.

Purisima Creek Drainage

Purisima Creek has evidently not been populated by steelhead within recent geological history because of a 10 m waterfall at the creek mouth. When surveyed by the CDFG on 18 August 1956, the creek had high quality spawning and rearing habitats for rainbow trout. Trout were seen ranging in length from about 7.5 to 20 cm. The population had also been supplemented with catchable rainbow trout, and the stream was managed for its resident trout fishery. There were several flashboard dams along the middle and lower creek sections from which water was pumped for irrigation.

The condition of the creek and status of its rainbow trout population were essentially unchanged when surveyed by the CDFG on 26 September 1958. No catchable trout were planted that year and it was assumed that the rainbow trout population was self-sustaining.

Trout plants by the CDFG were discontinued in 1963. The CDFG has conducted two electrofishing surveys in the creek since that time, which have confirmed the persistence of the rainbow trout population. On 25 October 1974, one 30.5 m section was sampled and 17 rainbow trout were captured that averaged 98 ± 55 mm FL (range, 51–216 mm FL; W. E. Strohschein, CDFG, unpubl. memo. of 13 November 1974). Forty-three trout were captured on 21 August 1986; these fish averaged 55 ± 21 mm SL (range, 35–113 mm SL; CDFG, unpubl. file data).

San Gregorio Creek Drainage

The San Gregorio Creek system is one of the principal steelhead production areas in San Mateo County. The creek apparently produced steelhead and coho salmon in commercial quantities when surveyed in 1870 (Skinner 1962). Degradation of the system was already underway at that time, however, due to the effects of logging, saw mills, and flour mills. So, it is reasonable to assume that the anadromous fish populations were previously even larger than the ones which supported the commercial fishery in 1870.

In February 1962, the local CDFG warden reportedly observed a group of about 25 adult steelhead entering San Gregorio Creek at one time (CDFG, unpubl. field notes of 28 February 1962). The warden also indicated that maximum spawning run size in the creek was about 1,000 adults, and that the 1961-62 run was not this large but possibly comprised a few hundred fish.

Coots (1973) investigated steelhead rearing and emigration in San Gregorio Creek and lagoon. He fished a downstream migrant trap, situated about 450 m upstream from the lagoon, from the last week of February 1971 through 2 July 1971. Juvenile steelhead displaying smolt characteristics ranged from 55 to 246 mm FL. Based on scale ageing and length-frequency distributions, about 60% of smolts were one year olds, 39% were two year olds, and <1% were three year olds or older. Movement of yearling and older (≥ 100 mm FL) smolts through the trap followed a nearly normal distribution with tails extending from the first of March through the end of June; the mode was at the end of April–first of May. The adipose fin was clipped from 4,775 yearling and older smolts for recovery in lagoon sampling.

Coots (1973) sampled the lagoon weekly by seining from 17 June 1971 through 26 August

1971. The lagoon was open to the ocean throughout most of this period, thus making it impossible to make an accurate estimate of smolt population size using a traditional mark-recapture model. Because only 181 clipped smolts were recovered in the lagoon, Coots (1973) suggested that most smolts trapped and marked in the creek did not remain in the lagoon but instead proceeded directly to the ocean. Most steelhead captured in the lagoon were "subyearlings" and yearlings. Yearling steelhead given individual tags in the lagoon during early July 1971 (n = 26) and recaptured there during mid- to late July 1971 (n = 5) grew in length and weight at an average rate of 0.28 mm/d and 0.29 g/d, respectively.

Coots (1973) also captured 215 spent adult steelhead in the downstream migrant trap, of which 123 were males and 92 were females. Although downstream movement occurred during all four months of trapping, 83% of adults were captured during April and May 1971. Males averaged about 43 cm FL, females about 47 cm FL, and both sexes combined about 45 cm FL (range, 30.5–80.0 cm FL). Thus, these fish were about 22% smaller on average than those sampled at Waddell Creek by Shapovalov and Taft (1954), assuming post-spawners were representative of the entire sea-run spawner population. Spawning activity in the creek was observed through the first week of May 1971. Two peaks in spawning activity were detected: one in December 1970 and another during March–April 1971 when an increase in stream flow allowed spawners to enter the creek. Consequently, two distinct fry emergence periods were also observed: one in April 1971 and another that started in mid-May and continued through June 1971.

Coots (1973) also surveyed several sections of San Gregorio Creek in August 1971 for presence of juvenile steelhead. Few were found in a 0.5 km low-velocity reach just upstream from the lagoon. Juveniles were abundant in a riffle area near San Gregorio, about 1.6 km upstream from the lagoon. Young-of-the-year steelhead were abundant in riffles, and yearling and older steelhead were present in pools and cutbank areas, in a sheltered stream area about 8 km from the mouth. Coots (1973) surmised that reduced rearing habitat associated with low summer flow was likely a limiting factor for steelhead production in San Gregorio Creek.

The CDFG surveyed San Gregorio Creek from the mouth to its headwater streams, Alpine and La Honda creeks, for a distance of about 17 km on 3 & 6 October 1975. Spawning areas were abundant in the upper stream, and frequent but intermittent in the middle and lower stream. Rearing habitat for juvenile steelhead was apparently adequate. No barriers to fish migration were noted, but 19 diversions were identified, most of them for agriculture. Siltation, due to logging and agricultural activities, was noted as a pollution problem. Juvenile steelhead were present in the stream. Angling pressure for adult steelhead at San Gregorio Creek was noted as moderate.

An electrofishing survey was conducted on 13 October 1975 to verify steelhead presence in the stream (G. G. Scoppettone and K. R. Anderson, CDFG, unpubl. memo. of 3 February 1976). In a 37 m reach about 2.3 km above the mouth, only two steelhead, 18–20 cm FL, were captured. In 91 m approximately 6.8 km from the mouth, about 25 young-of-the-year steelhead were shocked. In 91 m of stream near the confluence of La Honda and Alpine creeks, juvenile steelhead were numerous and all but one (age 1+, 12.7 FL) were probably young-of-the-year. These fish ranged from 4.8 to 11.2 cm FL, and averaged 7.4 cm FL (n = 66).

Despite a confluence with the ocean, no adult steelhead or redds were observed at three sites on two occasions during late February–early March 1976 in San Gregorio Creek (G. Scoppettone, CDFG, unpubl. memo. of 25 March 1976 and 19 April 1976). Entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation during the winter of 1975-76, and thus reduced stream flow. In relation to protests of subsequent water applications, the CDFG determined that a minimum bypass flow of 0.55 m3/s in winter and spring was necessary for unimpaired upstream and downstream migration of adult steelhead in the creek (I. L. Paulsen and K. R. Anderson, CDFG, unpubl. memo. of 11 March 1980).

On 26 October 1979, the CDFG surveyed 4.7 km of the middle portion of San Gregorio Creek. The stream mouth was open to the ocean at this time, following a major autumn storm. The condition of spawning substrate and presence of fish could not be evaluated because of high turbidity. The stream appeared to provide suitable rearing conditions for juvenile salmonids, however, and no migration barriers were observed within the survey area. Five water diversions were noted. Even though fish were not directly observed during this survey, the stream system was still assumed to be a major production area for both steelhead and coho salmon.

An adult steelhead was observed in the upper creek area on 23 January 1981 during inspection of an oil spill by CDFG personnel (H. W. Jong, CDFG, unpubl. memo. of 23 February 1981).

On 20 March 1985, 8,140 juvenile steelhead (@ 8.2/kg) from Point Arena Ponds in Mendocino County were planted in San Gregorio Creek, from Skyline Boulevard downstream to the Coyote Creek confluence.

The CDFG surveyed San Gregorio Creek during August–September 1985 in nearly its entirety, from the headwaters at La Honda and Alpine creeks to the mouth. Spawning habitat was rated from poor to good with an average of fair. Rearing habitat was rated as good. Siltation persisted as a pollution problem in the stream. Two logjams created potential migration barriers, and 33 water diversions were identified. The juvenile steelhead/rainbow trout population ranged from moderate in size to abundant within the survey area. Two adult steelhead, about 51–61 cm long, were observed in the upper stream.

The use of San Gregorio Creek lagoon as rearing habitat for juvenile steelhead has also been investigated over the years. On 21 November 1969, 15 juvenile steelhead, averaging 142 mm in length (range, 109–178 mm) were captured in the lagoon in an overnight gill net set (CDFG, unpubl. file data). Similarly, on 4 December 1969, 49 juvenile steelhead captured in a 30 m seine averaged (± SD) 129 ± 15 mm in length and 24.8 ± 8.1 g in wet weight (ranges, 99–163 mm and 10–46 g, respectively). The slight difference in mean size and range may have been due to differences in gear types used on each date. Coots (1973) sampled the lagoon in 1971 (see above). Smith (1987, 1990) determined the importance of the San Gregorio Creek lagoon as a rearing area for juvenile steelhead prior to their migration to the ocean as smolts.

Alpine Creek

Alpine Creek is one of the main headwater tributary streams in the San Gregorio Creek system. Juvenile steelhead were present in the creek during a mid-1930's CDFG survey.

Natural propagation was noted as successful, fishing pressure as heavy, and that adult steelhead had been caught that season. Early CDFG stocking records showed that the population was supplemented with 8,000 juvenile steelhead in 1930; 10,000 in 1932; 20,000 (@ 917/kg) from Big Creek in June 1938; and 5,000 (@ 2,116/kg) from Big Creek in June 1939.

A total of about 6.4 km of Alpine Creek was surveyed by the CDFG on 14 October 1963. Spawning areas were plentiful although some gravels were cemented with sand and silt. Pools were abundant but generally shallow, and many provided little shelter for juvenile steelhead/rainbow trout because they were filling in with sediment. Overall, however, it was judged that the stream provided rearing habitat for a substantial number of young steelhead. Several pump and pipe diversions were noted on the stream. About 1.8 km above the confluence with La Honda Creek, a 2.1 m high concrete dam formed a complete barrier to steelhead migration. Only six juvenile steelhead/rainbow trout, 7.5–15 cm long, were seen above the concrete dam. Below the dam, juvenile steelhead averaging 2.5–5 cm in length were highly abundant and occurred in a visually estimated density of about 1,000 fish/30 m of stream.

The CDFG surveyed 5.3 km of Alpine Creek on 17 August 1973. Spawning and rearing habitats for steelhead were still abundant and of high quality; the siltation problem identified 10 years earlier had apparently not progressed to any noticeable degree. The concrete dam barrier mentioned above had been removed by use of dynamite to allow for steelhead passage. Two large water diversions were noted. Juvenile steelhead, 5–10 cm long, occurred in densities of about 10–20 fish/pool throughout the entire survey area, and were also present in the two tributaries comprising the headwaters of Alpine Creek. One 18 cm long steelhead was observed in the lower creek area. Because of its perennial flow and overall natural state, Alpine Creek was viewed as an important component in maintaining production of the San Gregorio steelhead stock.

On 29 March 1974, 18 adult steelhead, about 36–76 cm in length, were captured and transported over a road culvert barrier near La Honda where they were released to continue their spawning migration in Alpine Creek (W. E. Strohschein, CDFG, unpubl. memo. of 5 April 1974). Scales were taken from five fish which ranged from 56 to 66 cm in length. Yearling steelhead, 10–12.5 cm long, were also observed during the rescue operation.

On 13 October 1975, the CDFG evaluated the success of a fishway which had been installed to enhance steelhead passage at the aforementioned culvert barrier (G. G. Scoppettone, CDFG, unpubl. memo. of 18 February 1976). Thirty-seven juvenile steelhead were electrofished for length measurment from an 73 m reach of Alpine Creek, just downstream from the confluence with Mindego Creek, a major Alpine Creek tributary. Fork lengths ranged from 4.3 to 10.9 cm, and averaged 6.6 cm (SD = 1.8 cm); all trout captured were probably age 0+. Thus, adult passage and parr recruitment were successful due to the fishway.

This same 73 m reach was sampled again by the CDFG on 8 August 1978 (S. G. Torres and I. L. Paulsen, CDFG, unpubl. memo. of 17 August 1978). Despite equipment malfunction, about 25 juvenile steelhead were electrofished which ranged from 6.1 to 16.8 cm FL and averaged 8.4 cm FL. Two age-classes, 0+ and 1+, were apparently represented. Juvenile steelhead averaging about 10 cm FL were also seen in pools near the base of the Alpine Creek fishway.

During the winter of 1975-76, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. No adult steelhead or redds were observed in Alpine Creek during late February and early March 1976 despite recent rainfall events (G. Scoppettone, CDFG, unpubl. memo of 25 March 1976 and 19 April 1976).

On 17, 19 & 21 November 1985, the CDFG surveyed Alpine Creek from its headwaters to the confluence with La Honda Creek, covering a distance of 6.9 km. Spawning and rearing conditions for steelhead seemed much the same as in previous surveys. One potential migration barrier was identified, as was one water diversion. Steelhead reportedly still spawned throughout Alpine Creek, and a few post-spawners trapped in the stream had successfully oversummered there in 1985.

El Corte de Madera Creek and tributaries

El Corte de Madera Creek is a major tributary to San Gregorio Creek. Juvenile steelhead were present during a mid-1930's CDFG survey of the stream. A barrier waterfall was noted in the upper stream area, and the stream received heavy fishing pressure from local residents. Early CDFG stocking records showed that the population was supplemented with 10,000 juvenile steelhead in 1930; 6,000 in 1932; 10,000 in 1933; 8,000 in 1934; 10,000 (@ 847/kg) from Big Creek in June 1938; and 3,000 (@ 1,905/kg) from Big Creek in June 1939.

When surveyed by the CDFG in July 1942, juvenile steelhead were common in the lowermost 1.6 km of the creek, and comprised young-of-the-year, yearlings, and 2-year-olds. Migrations barriers were present in the stream above which there were presumably resident rainbow trout, based on the observation that young-of-the-year were present but in relatively low densities. There were 10–15 cm long juvenile steelhead/rainbow trout throughout the survey area. Suitable spawning grounds for steelhead were present, and no pollution sources were noted. Four small diversions were observed, one of which required a fish ladder. The El Corte de Madera tributary, Deer Creek, was also surveyed at this time by the CDFG. Suitable spawning grounds for steelhead were present but scattered, and natural propagation was noted as successful. Juvenile steelhead were observed, most of which were 5–7.5 cm in length and up to about 15 cm.

The CDFG surveyed El Corte de Madera from the mouth to 7.2 km upstream on 4 August 1964. Gravels otherwise suitable for steelhead spawning were heavily silted. The spawning area was estimated at about 1,472 m2, most of which was located in the lowermost 3.2 km of the stream. Rearing habitat, in the form of pools and shelter, was adequate for juvenile steelhead, although pools too were heavily silted. Fifteen migration barriers were identified, some of the major ones including a 3 m high cement dam, 3.7 m and 7.6 m bedrock falls, and two 9.1 high logging bridges. Three minor water diversions were noted. Siltation from logging operations was a major pollution problem. Juvenile steelhead/rainbow trout averaged 5 cm in length (range, 2.5–15 cm), and ranged in visually estimated densities of about 10 trout/100 m in the upper stream to about 550 trout/100 m in the lower stream. So, despite the apparently degraded condition of the stream with regard to substrate quality for salmonids, production of juvenile steelhead/rainbow trout was still substantial, at least in the lower creek area.

The CDFG made a cursory inspection of the stream on 2 April 1985 (F. Gray, CDFG, unpubl. memo. of 3 April 1985) at which time two adult steelhead were observed, the larger of which was estimated at about 3.6 kg. A heavy sediment load was noted in the stream. Cattle grazing effects on the stream were also observed; for example, removal of streamside vegetation.

A comprehensive stream survey was conducted by the CDFG on 10, 11 & 18 October 1985, covering 16 km from the headwaters to the mouth. Spawning sites were very limited throughout the survey area due to siltation resulting from logging and cattle grazing. Rearing habitat was also degraded. Several major barriers were still in place throughout the survey area, and several new diversions had been installed since the 1964 survey. With cattle grazing, cattle wastes and silt were polluting the lower stream, the latter caused by bank erosion. A substantial silt load and woody debris were entering the upper stream as well, as a result of logging operations in the drainage. Rainbow trout and/or young steelhead were observed throughout the survey area, except in the uppermost section. Both juveniles (<15 cm long) and older trout (15–46 cm) were observed, and their abundance was generally greater in the lower stream area.

Kingston Creek

Kingston Creek is a perennial San Gregorio Creek tributary. Nothing was present in the CDFG file regarding the stream's historical salmonid resources. However, on 6 June 1985, the CDFG electrofished a 38 m long section of the stream and captured 11 juvenile steelhead/rainbow trout which ranged from 11.7 to 16.5 cm FL and averaged 14.2 cm FL (SD = 1.8 cm; L. Bordenave, CDFG, unpubl. memo. of 15 July 1985). No young-of-the-year were observed. This survey was made in connection with a water application on the stream.

The CDFG conducted a follow-up survey of the lowermost 0.8 km of the creek on 22 August 1985 to determine its suitability as a steelhead production area. Spawning and rearing habitats were adequate for steelhead/rainbow trout. A possible water diversion was noted. An impassable logjam barrier in the lower creek blocked steelhead access to most of the stream. Therefore, it was assumed that the fish captured in June 1985 were rainbow trout.

La Honda Creek

La Honda Creek is one of the main headwater tributary streams in the San Gregorio Creek system. Juvenile steelhead occurred in the creek during a mid-1930's CDFG survey. High quality spawning grounds were available for steelhead use, and natural propagation was successful. One diversion dam was present, but it was equipped with a fish ladder and intake screen. Fishing pressure for steelhead was noted as heavy. Early CDFG stocking records showed that the population was supplemented with 12,000 juvenile steelhead in 1930; 7,000 in 1931; 12,000 in 1932; 10,000 in 1935; and 8,000 in 1936.

About 11 km of La Honda Creek, from the mouth to headwaters, were surveyed by the CDFG on 3 August 1964. Suitable spawning gravels for steelhead were located primarily in the lowermost 4.8 km of the stream, and comprised an area of about 22,000 m2. High quality rearing habitat was available to salmonids. Two water diversions were noted, and there were three complete logjam barriers and 20 partial barriers. Siltation was noted as a pollution problem and was attributed to past logging operations. Juvenile steelhead and/or rainbow trout occurred at a visually estimated density of 50 fish/30 m in the lowermost 4.8 km of stream. These trout ranged from about 1.5 to 12.5 cm in length, and averaged 5 cm. No fish were seen in the upper 6.4 km of the stream.

The CDFG conducted a similar survey of La Honda Creek on 27 September 1973. Spawning and rearing habitats were apparently in similar condition as in 1964. Several barriers and diversions were noted, and there was an increase in pollution consisting mostly of urban debris, in addition to the already present silt and woody debris from logging. Juvenile steelhead occurred in the lowermost 9 km of the stream at visually estimated densities of 15–20 trout/pool and 20–50 trout/pool in the middle and lower reaches, respectively. Most trout were 5–10 cm in length (age 0+), although a few 15–18 cm trout (age 1+) were also seen in the lower stream.

No juvenile steelhead/rainbow trout were seen under extremely low flow conditions in La Honda Creek above the confluence with Woodruff Creek on 10 August 1976 (M. Cogger, CDFG, unpubl. memo. of 30 August 1976). In contrast, young-of-the-year steelhead averaging about 6.5 cm FL were observed at this location on 4 August 1978, at a visually estimated density of 100 fish/30 m (S. G. Torres, CDFG, unpubl. memo. of 14 August 1978).

No juvenile steelhead/rainbow trout were captured by electrofishing a 53 m reach below a concrete dam in upper La Honda Creek near the community of Sky Londa on 31 May 1985 (J. Ford, CDFG, unpubl. memo. of 19 July 1985). Lamprey ammocoetes were captured, however, which indicated that there was an anadromous connection to this stream area, at least for the lamprey.

The most recent comprehensive CDFG survey of La Honda Creek was made during 19–20 July 1985. Spawning areas were of low quality except for scattered sites containing high quality gravels. Overall, though, spawning habitat was considered adequate. Rearing habitat was also considered adequate for juvenile steelhead, although reduced stream flow and its related effects (e.g. reduced delivery rate of drifting food particles) was judged to be a limiting factor for steelhead production. Many migration barriers (mostly logjams) and five water diversions were noted, and a campground construction site was identified as a pollution source. Juvenile steelhead and/or rainbow trout, up to 20 cm in length, were observed throughout the survey area, except in the uppermost sections near Sky Londa where the stream was dry.

The most recent observation of juvenile steelhead in La Honda Creek was made on 2 October 1987 when a kill of 60 juvenile steelhead (estimated at a density of 1,243 trout/km) resulted from a massive sediment load to the stream which greatly altered water quality and filled in pool habitat (L. Ulmer, CDFG, unpubl. file letter of 13 October 1987).

San Pedro Creek Drainage

San Pedro Creek is somewhat unique in that it is a highly urbanized stream which continues to support a naturally reproducing steelhead stock, in part due to the interests and efforts of local residents in the community of Pacifica. From an historical perspective, the CDFG files indicate that adult steelhead were seen ascending the stream to spawn in April 1941. At that time, ranches dominated the drainage area and it is assumed that the creek system was in relatively good condition. There was tidewater at the stream mouth, but no real lagoon. The main stem was about 4 km long and formed by flow from three forks, the “east” fork being the only one with perennial flow. Water was diverted from the creek system for irrigation.

However, by 1971 the creek habitat was severely degraded due to the effects of garbage dumping, rat poisoning, and wastewater discharge in conjunction with urbanization of the area. Apparently, a fish kill had occurred on 22 December 1970. Local citizens formed a committee to promote the protection and enhancement of San Pedro Creek (J. Ladd, CDFG, unpubl. memo. of 14 January 1971).

Two adult steelhead were seen in the stream during a single spot check on 6 April 1972 (E. Armstrong, CDFG, unpubl. memo. of 7 April 1972). Adults ascended the stream during the winter of 1972-73 as well (D. C. Erman, UC Berkeley, unpubl. letter of 9 February 1973). San Pedro Creek was surveyed by the CDFG in July 1973. Urban debris was still common in the streambed, and spawning areas were both quantitatively and qualitatively limited. Rearing habitat was adequate, with the presence of pools and abundant riparian cover. Several barriers to upstream migration were identified, especially at culverts, and several diversions were observed, the largest being that for the North Coast County Water District. Storm drains discharged into the creek. Juvenile steelhead were observed in all reaches of the main stem. As determined from electrofishing samples, the trout ranged from 3.8 to 20.3 cm in length and averaged 8.9 cm. Steelhead were observed above all culverts on the main stem, but only below the water district diversion in the south fork of the creek system.

The size-structure of the juvenile steelhead population in San Pedro Creek was investigated on four occasions during the 1970's. On 3 July 1973, steelhead were sampled by electrofishing at four main stem stations (K. R. Anderson, CDFG, unpubl. memo. of 29 August 1973). The fish ranged in size from 3.6 to 16.0 cm FL, and averaged 8.0 cm FL (SD = 1.8 cm, n = 220). Thus, rearing juveniles were age 0+ and 1+, and 0+ trout were proportionately dominant in number. Abundance estimates were also made in late summer 1973, by electrofishing seven stream reaches (15–61 m) and applying the two-pass removal method of population estimation (K. R. Anderson, CDFG, unpubl. memo. of 13 November 1973). Juvenile steelhead densities ranged from about 2.0 to 7.6 trout/m, and averaged (± SD) 5.1 ± 2.3 trout/m. Despite its somewhat degraded condition, the creek system continued to support relatively high densities of juvenile steelhead.

On 10 October 1974, the average size of juvenile steelhead electrofished in four main stem reaches was 10.2 cm FL (range, 5.1–18.8 cm FL; n = 125). The largest trout (21.3 cm FL) was found in the South Fork San Pedro Creek (K. R. Anderson, CDFG, unpubl. memo. of 28 October 1974). On 17 September 1976, the average size of juvenile steelhead electrofished in two main stem reaches was 8.9 cm FL (range, 3.3–17.3 cm FL; n = 26). Overall abundance of juvenile steelhead was apparently lower than in previous surveys (K. R. Anderson et al., CDFG. unpubl. memo. of 24 September 1976). Finally, on 15 November 1979, the mean size of juvenile steelhead electrofished in two main stem reaches was 9.4 cm FL (range, 5.6–16.8 cm FL; n = 43) (I. L. Paulsen and L. Fish, CDFG, unpubl. memo. of 21 November 1979). Estimated densities were 0.2 and 0.9 juvenile steelhead/m, which were much lower than those measured in 1973.

Despite apparent differences in relative year-class strength, these four surveys demonstrated that the juvenile steelhead population in San Pedro Creek consistently comprised two age-classes, 0+ and 1+, and that the 0+ group dominated numerically. The relatively small proportion of 1+ trout present in any given survey indicates that the main smolting age of steelhead in San Pedro Creek is age 1.

During the winter of 1975-76, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. Consequently, no adult steelhead or redds were observed in San Pedro Creek on 26 February 1976. Several adult steelhead, two estimated at 2.7 kg each, were observed in the creek on 1–2 March 1976, however. The local warden estimated that 60 adult steelhead had been poached at Adobe Road Bridge during this period (G. Scoppettone, CDFG, unpubl. memo of 25 March 1976 and 19 April 1976).

In March 1978, about 600 steelhead died in San Pedro Creek due to the storm drain discharge of an unknown poison, possibly chlorinated swimming pool water (The Times, San Mateo, 22 June 1978).

By 1985, the headwaters of San Pedro Creek were protected by virtue of their inclusion in San Pedro Valley County Park. In March 1985, 800 Dry Creek steelhead (8.8/kg) were stocked into the stream. When surveyed by the CDFG in May 1985 (J. Ford and L. Bordenave, DFG, unpubl. memo. of 29 July 1985), the creek system was in good condition overall. Steelhead spawning habitat was abundant in the upper main stem, or middle fork, but lacking in the north and south forks. Most spawning occurred within the park boundaries. Spawning reportedly occurred as late as May, and during the 1984–1985 spawning season, there were about 40 pairs of spawning steelhead within a 30 m spawning reach. Obstructions for upstream migrating spawners were identified, and storm drain pollution was still cited as a problem. Indeed, on 10 March 1987, 600–700 steelhead fry, yearlings, smolts, and adults were killed in the north fork and 2 km of the main stem as the result of a toxic storm drain discharge, probably chlorinated swimming pool water.

The lowermost 880 m of San Pedro Creek was surveyed by the CDFG on 28 September 1988 (C. Dayes and D. Becker, CDFG, unpubl. memo. of 21 October 1988). Age 0+ and 1+ steelhead, up to about 20 cm in length, were observed throughout the reach, including the lagoon. Riffles provided over 464 m2 of spawning gravel for steelhead. Rearing habitat was good to excellent, and included abundant streamside riparian vegetation. Notably, the creek had continuous flow to the lagoon and contained two consecutive year-classes of juvenile steelhead, despite two consecutive drought years.

Tunitas Creek Drainage

The CDFG surveyed the upper 6.4 km of Tunitas Creek on 18 April 1962, and the lower 3.2 km on 11 May 1962. Spawning areas for steelhead were scarce in the headwaters, but of high quality in the lower 3.2 km. Pool development and shelter were rated as fair, although the frequency of pools was low, thus potentially limiting rearing habitat. Logjams occurred throughout the stream. One logjam about 1.2 km above the mouth was a probabe partial migration barrier to adult steelhead. Several small pump diversions for domestic use were observed. Steelhead usually had access to the lowermost 3.2 km of stream, up to the confluence with the East (South) Fork, and no juvenile steelhead were observed above this point. The average of four visual estimates of abundance was 26 trout/100 m. Very few steelhead over 13 cm were observed. The local CDFG warden estimated the annual steelhead run at 100–200 adults.

In contrast to the 1962 survey, juvenile steelhead were found in Tunitas Creek above the confluence with the East Fork when sampled by the CDFG on 25 October 1974 (W. E. Strohschein, CDFG, unpubl. memo. of 13 November 1974). Fourteen steelhead, 56–137 mm FL, were captured in a single electrofishing pass through 7.5 m of stream.

During the winter of 1975-1976, entry of adults from the ocean and their migration to upstream spawning grounds were apparently restricted due to a lack of precipitation and thus reduced stream flow. No adult steelhead were observed in lower Tunitas Creek on 25 February 1976 even though there was a shallow confluence with the ocean (G. Scoppettone, CDFG, unpubl. memo of 25 March 1976).

East Fork Tunitas Creek

The CDFG surveyed the entire 1.6 km of the East Fork Tunitas Creek on 28 July 1964. This stream was described as a valuable steelhead spawning and young-of-the-year rearing area. High quality spawning gravels were continuous throughout the stream. Small pools and cover provided excellent rearing conditions. There were nine windfall barriers although there were fish above all of them. Only young-of-the-year steelhead, averaging about 4 cm, were observed, at a visually-estimated density of 164 trout/100 m throughout most of the creek.

Whitehouse Creek Drainage

Although no detailed historical information was discovered for Whitehouse Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a very small steelhead run, relative to the runs observed at Scott and Waddell creeks during the 1930's–40's. In 1929, the steelhead population had been supplemented with 4,000 juveniles from the Scott Creek Egg Taking Station. A more recent CDFG document (P. Bontadelli, CDFG, unpubl. memo. of 16 November 1987) stated that "Whitehouse Creek has historically been and continues to be a steelhead stream". The CDFG surveyed the creek from its headwaters to mouth (8.2 km) on 22 June 1978. The uppermost 1 km was dry. Most of the creek had adequate spawning areas for steelhead, with quality generally increasing with distance upstream. Rearing habitat, in the form of pools and cover, was also adequate. There were, however, heavy silt and detritus deposits in the lowermost 5 km of stream due to adjacent agriculture and grazing. In addition, the lowermost 1 km of stream contained several migration barriers: the concrete culvert passing the stream under Highway 1, a 2 m-high man-made log dam near Highway 1, and debris jams caused by streamside vegetation cleared for agriculture and bulldozed into the creek. The only surface diversion observed also occurred in this reach. There was also a light silt load in the upper creek from the adjacent dirt road. Juvenile steelhead/rainbow trout, visually-estimated at about 3 cm long, were only observed in one reach about 4–5 km above the mouth.

When surveyed again by the CDFG on 2 May 1988 and 1 June 1988, suitable spawning and rearing habitats for steelhead were still found throughout most of the stream. Siltation from cattle grazing and other streamside activities continued to degrade habitat quality, especially in the middle and lower stream areas. In addition to the migration barriers identified in 1978, many more were seen through most of the stream. Notable were a sacked concrete dam directly below the Highway 1 bridge, a 4.6 m long culvert 1.2 m above water surface elevation, and various other logjams, dams, road crossings, and blocked culverts. One active surface diversion was seen, which carried water to Chandler Reservoir, an off-stream storage facility. Despite the various impediments to access, juvenile steelhead occurred at several locations throughout the lower half of the drainage up to a concrete dam that was a complete barrier. Three live adult steelhead and one carcass were also seen. Age 0+ resident rainbow trout were observed above the concrete dam. Overall, Whitehouse Creek was rated as good to excellent for steelhead production, aside from localized siltation. The main factors limiting the population appeared to be migration barriers and low summer stream flow.

SANTA CRUZ COUNTY

Aptos Creek Drainage

Snyder (1913) found juvenile steelhead/rainbow trout in Aptos Creek when he sampled there in summer 1909. Juvenile steelhead were present in Aptos Creek during a 1934 CDFG survey. Spawning grounds were found throughout the stream, natural propagation was rated as very good, and fishing pressure for steelhead was heavy. When surveyed again by the CDFG in

May 1941, the condition of the stream was apparently similar as in 1934, although both young-of-the-year and older steelhead occurred in low abundance in the stream, and none was seen in the lagoon.

Aptos Creek was not surveyed again by the CDFG until July 1960. At that time, high quality spawning and rearing habitats were still available, and no migration barriers or diversions were seen. Densities of juvenile steelhead in non-pool habitats ranged from about 5–10 trout/30 m in the upper survey area to 40–65 trout/30 m in the lower stream. In pools, densities ranged from about 10–20 trout/pool. Siltation below Bridge Creek was believed to have reduced the steelhead production capacity of the stream somewhat through loss of cover for rearing fish. Fishing pressure was noted as light.

In a summer 1965 CDFG survey, it was estimated that nearly 9 km of the stream contained intermittent reaches of spawning gravels, 13 km contained high quality rearing habitat, and there were no barriers or diversions. The average density of juvenile steelhead over the entire stream was about 3.3 trout/m, except for a 0.8 km reach which contained 4.6 trout/m. (Fish were sampled by use of a Braille seine, cresol poisoning, and direct visual counts). The estimated total abundance of young steelhead was over 43,000 trout. These fish ranged in length from 4.3 to 8.9 cm, and averaged 6.1 cm. Thus, all steelhead observed were young-of-the-year; natural propagation was rated as good. Fishing pressure was noted as moderate.

The adult steelhead run in Aptos Creek as of 1968 was estimated by the CDFG at about 1,500 fish, although the method used to attain this estimate was not described.

In April 1976, the CDFG supplemented the Aptos Creek steelhead population with 1,000 juveniles from the Noyo River.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at five sites was 3.1 ± 2.9 trout/m, which was somewhat below the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 94 ± 11 mm SL, which was near average.

The creek was surveyed by the CDFG in late May 1982, from the mouth to 2.4 km above the confluence with Bridge Creek, following the disastrous rainstorms of January 1982 (L. Turner, CDFG, unpubl. memo. of 1 June 1982). Siltation, as a result of landslides, had degraded both spawning and rearing habitat. In addition to landslides, logjams created full or partial barriers to fish migration. Fish food organisms were scarce, and no juvenile steelhead were observed. Apparently, the pre-smolts present the previous fall were killed or displaced by the high flow, or emigrated to the ocean. In addition, the entire 1982 year-class was apparently eliminated by siltation of the gravels where eggs were incubating.

The most recent CDFG surveys of Aptos Creek were conducted during 12–26 August 1985 (D. Marston, CDFG, unpubl. memo. of 12, 20, & 26 August 1985). The stream was surveyed over nearly 9 km, from the mouth to the area known as the bottom of the incline, within the Nisene Marks State Park boundary. Within the lowermost 2.4 km, there remained a logjam from the 1982 flood which created at least a partial barrier to upstream migration of adult steelhead. Suitable spawning areas were lacking below the barrier, but as one progressed upstream through the survey area, substrate particle size increased on average and the overall abundance of suitable spawning gravel increased. Pools and shelter for rearing juveniles were present throughout the survey area. Yearling steelhead were abundant below the barrier in the lower stream, but few young-of-the-year were present there. Trout were also present above the barrier, and their abundance generally increased toward the upstream area. Their lengths ranged from about 2.5 to 20 cm. Some of these fish were believed to be resident rainbow trout. In the uppermost 2.8 km of the survey area, both young-of-the-year and yearling steelhead/rainbow trout were abundant. A state park ranger had seen an adult steelhead in this area.

Bridge Creek

The Aptos Creek tributary, Bridge Creek, was surveyed by the CDFG in July 1960. Spawning areas were fair to good in the middle and lower stream, but very poor above an impassable waterfall barrier, about 2.5 km upstream from the confluence with Aptos Creek. Rearing habitat was adequate, especially in the middle and lower stream. Juvenile steelhead, 5–15 cm long, were common throughout the middle and lower stream, but absent above the waterfall.

Bridge Creek was not surveyed again until May 1982, following the devastating storms of January 1982 (L. Turner, CDFG, unpubl. memo. of 2 June 1982). Landslides, logjams, and falls rendered the stream unuseable for steelhead. Besides restricted access due to barriers, the stream bottom was composed primarily of rubble and silt. No fish were observed in the creek at that time, although juvenile steelhead/rainbow trout were reportedly present in Bridge Creek in 1985 up to Maple Falls (D. Marston, CDFG, unpubl. memo. of 26 August 1985).

Valencia Creek

In late fall 1981, the mean ± SD density of smolt-sized steelhead at two sites in the Aptos Creek tributary, Valencia Creek, was 4.9 ± 0.9 trout/m, which was above the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 94 ± 0 mm SL, which was near average.

Arana Gulch Drainage

Arana Gulch is a small urbanized stream which discharges into Woods Lagoon, the location of the Santa Cruz Small Craft Harbor. Mention of steelhead in this stream dates back to 1966 in the CDFG files; the run was apparently small. A 46 m section of Arana Gulch was surveyed by the CDFG in January 1983 (J. Lorenzana, CDFG, unpubl. memo. of 26 January 1983). Two 1-year-old juvenile steelhead (8.5 and 11 cm in length) were captured, about 1.6 km above the harbor. Generally, the stream was in poor condition due to upstream erosion and resultant sedimentation. Suitable spawning substrate for steelhead was lacking in the survey reach, and rearing habitat was very limited. An adult female steelhead was reportedly observed spawning in Arana Gulch on 1 March 1984 (F. Gray, CDFG, unpubl. memo. of 7 March 1984). The size of the fish was estimated at 3.5 kg.

Baldwin Creek Drainage

As a relative measure of adult run size, Shapovalov and Taft (1954, p. 201) mentioned that the Baldwin Creek steelhead run was smaller than those observed at Scott and Waddell creeks during the 1930’s–40’s. When surveyed in its entirety by the CDFG on 16 May 1960, Baldwin Creek was described as having a perennial flow that was not diverted during the summer, and a larger population of O. mykiss than either of nearby Majors and Laguna creeks to the north. Salmonid spawning areas were proportionately abundant, and juvenile rearing habitat in the form of pools and cover was seemingly ample and of high quality. A concrete apron was identified as a migration barrier for steelhead, and three flashboard dams as potential barriers, one of which created a sizeable reservoir about 1.6 km above the mouth of the stream. Juvenile trout were seen in nearly every pool along the 4.8 km survey area; their lengths ranged from about 2.5 to 15 cm. The landowner at Baldwin Creek estimated the average adult run size to be 50 steelhead.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at five sites was 3.6 ± 3.4 trout/m, which was very near the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 94 ± 7 mm SL, which was also near average.

Finny Creek Drainage

Although no detailed historical information was discovered for Finny Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a very small steelhead run, relative to the runs observed at Scott and Waddell creeks during the 1930's–40's.

Laguna Creek Drainage

As a relative measure of adult run size, Shapovalov and Taft (1954, p. 201) mentioned that the Laguna Creek steelhead run was smaller than those observed at Scott and Waddell creeks during the 1930's–40's. The lowermost 6.4 km of Laguna Creek were surveyed by the CDFG on 26 February and 1 March 1960. Suitable spawning areas for salmonids were lacking and thought to be a limiting factor to steelhead production. In contrast, rearing habitat for juvenile steelhead, in the form of pools and cover, was abundant and of high quality. Natural bedrock falls, beginning at about 3.2 km above the mouth, were identified as migration barriers to adult steelhead. Water was diverted from the stream for both domestic and agricultural uses. An adult steelhead, about 61 cm in length, was seen below the first bedrock barrier. Resident rainbow trout were noted in pools in upstream sections of the creek.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at five sites was 2.3 ± 1.5 trout/m, and thus below average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 102 ± 18 mm SL, which was above the county-wide average.

In June 1985, the CDFG surveyed two reaches, totalling about 460 m, in lower Laguna Creek downstream from the bedrock falls (D. Marston, CDFG, unpubl. memo. of 28 June 1985). Spawning habitat was limited in one reach but abundant in the other. Rearing habitat for juvenile steelhead was adequate. Pollution types were silt and cattle waste. Both young-of-the-year and yearling steelhead were observed. There was no indication of overall stream condition and status of the steelhead/rainbow trout population.

Liddell Creek Drainage

As a relative measure of adult run size, Shapovalov and Taft (1954, p. 201) mentioned that the Liddell Creek steelhead run was smaller than those observed at Scott and Waddell creeks during the 1930's–40's. In late fall 1981, the density of smolt-sized steelhead at one site below the confluence of the east and west headwater forks of Liddell Creek was 2.0 trout/m, which was below average (derived from Smith 1982b). The mean length of these fish, 112 mm SL, was well above average. The mean ± SD density of smolt-sized steelhead at two sites in the west fork was 1.6 ± 2.3 trout/m, and thus below the county-wide average (derived from Smith 1982b). The mean length of these fish, 104 mm SL, was above average. The mean ± SD density of smolt-sized steelhead at five sites in the east fork, 1.0 ± 0.5 trout/m, was below average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish, 87 ± 12 mm SL, was also below average.

Majors (Coja) Creek Drainage

Although no detailed historical information was discovered for Majors Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a steelhead run which was smaller than those observed at Scott and Waddell creeks during the 1930's–40's. According to early CDFG records, the Majors Creek steelhead population was supplemented with a plant of 2,500 juveniles (@ 1,023/kg) from Brookdale Hatchery on 25 July 1938. During 1940–44, juvenile resident rainbow trout were planted at sizes of 176–1,235/kg and total annual weight allottments of 1.6–16.3 kg. The April 1945 allottment was 5,000 juvenile rainbow trout at 7.5/kg (total allottment, 7.1 kg).

As of 1953, most, if not all, of the flow of Majors Creek was diverted for use by the City of Santa Cruz, and steelhead fishing in 4.8 km of available tidewater was poor (CDFG, unpubl. field notes of 24 June 1953).

The lowermost 4.8 km of the creek were surveyed by the CDFG on 6 May 1960. A 4.6 m waterfall about 0.8 km upstream from the mouth marked the limit for upstream migration of steelhead. Another major migration barrier was the 4.6 m City of Santa Cruz dam about 3.2 km from the mouth. Spawning gravels available to steelhead in the lowermost 0.8 km of the stream were apparently scarce, but were more abundant for resident rainbow trout between and above the barriers. Rearing habitat in the form of pools and cover was also poor for steelhead and generally better for resident rainbow trout in upstream sections. Siltation, due to extensive logging damage in the watershed, was a pollution problem in the lower stream below the Santa Cruz dam. About 200 young-of-the-year steelhead, 2.5 cm in length, were counted in the 0.8 km of stream below the waterfall barrier. Only six rainbow trout, 10–25 cm long, were seen between the migration barriers. Densities of 10–15 cm long trout above the dam were about 125 fish/km and 60 fish/km in two consecutive 0.8 km reaches. Silt, in addition to low summer flows because of the diversion, were thought to limit trout production below the dam.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at six sites was 2.6 ± 2.4 trout/m, which was below the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 89 ± 9 mm SL, which was below average.

On 27 October 1983, the CDFG made a single electrofishing pass through a 46 m section below the Santa Cruz dam and above the lower waterfall barrier and captured 33 rainbow trout which averaged XX mm FL (range, XX–XX mm FL; in prep). Due to dam operations and other factors, sediment input into this portion of the stream was high. Low flow conditions below the dam possibly increased predation risk of the trout (F. Gray, CDFG, unpubl. memo. of 8 November 1983).

The CDFG surveyed Majors Creek on 21 November 1988, from the mouth to its headwater east and west branches. Spawning habitat was limited throughout the survey area due to the persistently high sediment load. However, there were scattered sections of exposed, loose gravels in high gradient areas where the flushing effect of the flow was presumably greatest. Rearing habitat in the form of pools and cover was apparently quite adequate for salmonids. Waterfalls, dams, culverts, and logjams created either potential or complete migration barriers for steelhead. Three diversions were noted. The distribution of O. mykiss within the drainage was the same as in earlier surveys: juvenile steelhead inhabited the lowermost 0.8 km of the stream below the first waterfall barrier, while resident rainbow trout occurred in both the main stem and branches above the waterfall barrier. The average total length of resident rainbow trout in the upper main stem and west branch was XX mm (range, XX–XXX mm TL; in prep). Local residents indicated that the adult steelhead run in Majors Creek was large at one time, and that it had supported a local consumptive fishery.

Medler Creek Drainage

Although no detailed historical information was discovered for Medler Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a steelhead run which was smaller than those observed at Scott and Waddell creeks during the 1930's–40's.

Pajaro River Drainage, including portions in Monterey, San Benito, and Santa Clara counties

Relatively detailed information on the historical distribution of juvenile steelhead/rainbow trout in the Pajaro River drainage was available because of the comprehensive surveys conducted by Snyder (1913) in 1909, the CDFG in 1967 (Lollock 1968), Smith (1982a) during 1972–74, and Smith (1982b) in 1981. The CDFG files also contained a variety of information from over the years which is included in the following accounts.

Snyder (1913) collected juvenile steelhead at four mainstem Pajaro River sites: upstream from the Corralitos Creek confluence to shortly above the San Benito River confluence. The species was neither present in the main stem below the Corralitos Creek confluence nor above the Uvas Creek confluence. Juvenile steelhead/rainbow trout were also present in the main stem, from its upper to lower reaches, during a 1934 CDFG survey. Spawning grounds apparently existed all along the river. Rainbow trout were not planted because of a high density of exotic predatory fishes present in the stream and lagoon, such as black bass (*Micropterus spp.*) and striped bass (*Morone saxatilis*), respectively.

By 1960, juvenile steelhead use of the lower Pajaro River as rearing habitat may have ceased, as none was captured at the Highway 101 crossing or in the lagoon when sampled with a seine and gill net by the CDFG during 9–10 December 1959 (M. R. Schreiber, CDFG, unpubl. intraoffice corr. of 24 February 1960). Fish collections made in the lower Pajaro with a minnow seine during 1964–66, from near the mouth to near the Highway 101 crossing, also revealed an absence of juvenile steelhead (R. N. Lea, unpubl. fish collection data of 20 September 1964–5 June 1966).

Adult steelhead were reportedly taken by anglers in the Pajaro River lagoon in late January 1962, but intermittent flow in the lower river prevented the ascent of the spawning run (R. N. Hinton, CDFG, unpubl. field notes of 28 January–12 February 1962). By 5 February 1962, steelhead were taken as far upstream as the Highway 1 crossing, and they were migrating into tributaries such as Eureka Gulch on Corralitos Creek and possibly lower Uvas Creek by 12 February 1962.

The 1963-64 steelhead run was reportedly the largest and comprised the largest fish since 1955 (M. L. Johnson, CDFG, unpubl. memo. of 18 March 1964). The local game warden estimated the Pajaro steelhead run at 1,500 adults, and spawning occurred in Corralitos Creek and its tributary, Brown's Valley Creek, in Pescadero Creek as far upstream as about 5 km, in Uvas Creek, and at a gravel plant near Gilroy in the main stem (see below for further information on the tributaries mentioned). As of 1965, the average annual steelhead spawning run was estimated at about 1,000 adults (M. L. Johnson, CDFG, unpubl. memo. of 1 April 1965). Run size was generally greater in years of high rainfall. As part of a planning effort, the CDFG listed the annual steelhead spawning run in the Pajaro River at about 2,200 fish (California Department of Fish and Game 1965). Lollock (1968) reported that the annual run fluctuated between about 500 and 2,000 adult pairs, based on local game warden observations during the previous decade or so (M. L. Johnson, CDFG, unpubl. memo. of 22 August 1966). The 1965-66 run was conservatively estimated at 1,000 spawning pairs.

When the Pajaro drainage was surveyed by the CDFG during July–August 1967 (Lollock 1968), the Pajaro River lagoon was used primarily as a migration corridor for adult steelhead returning to spawn in the river system, and for steelhead smolts emigrating to the ocean. The sandbar at the mouth was seldom completely closed, and so passage to and from the ocean was possible during most of the year. The lagoon was apparently not an important rearing area for juvenile steelhead, based on a complete lack of steelhead captures during this and previous surveys (see above). Agricultural drains were a persistent source of plant nutrients and probably pesticides. The Watsonville sewage treatment plant and storm drain system were occasional pollution sources, and in 1967 a large sediment load entered the lower river from the Granite Rock Company which silted fish habitat in the upper lagoon.

About 40 km of the main stem Pajaro River was also surveyed at this time, from the upper end of the lagoon to San Felipe Lake in the Santa Clara-San Benito counties portion of the river (Lollock 1968). The lower river below the Granite Rock Company's quarry was heavily silted and no longer served as spawning and rearing habitat for steelhead, but remained important as a migration corridor to upstream areas. The lower river area was also channelized annually for flood control purposes. The river section from the quarry to the Highway 101 crossing contained high quality spawning and rearing habitat, although no juvenile steelhead were observed during this survey. Water was extracted from the river by several pumps along this section, for agricultural and industrial uses. The section upstream from Highway 101 was again unsuitable for steelhead spawning and rearing, but important for migration to and from Uvas and Llagas creeks. Types and sources of pollution included sediment from the Granite Rock Company, which eliminated steelhead spawning and rearing habitat in the lower Pajaro River, and pesticides from agricultural drainage. The Granite Rock Company compensated the CDFG for the stocking of 5,000 Mad River steelhead yearlings, as mitigation for losses due to their sediment input in the lower river (M. L. Johnson, CDFG, unpubl. memo. of 17 December 1974).

Conditions in the lower Pajaro River remained unimproved for steelhead spawning and juvenile rearing when, on 24 July 1973, an electrofishing survey in three sections downstream from Murphy's Crossing revealed the continued absence of steelhead (R. Johansen, CDFG, unpubl. memo. of 13 August 1973). This finding was corroborated by fish collections made in the lagoon and lower river during 1970–1974 by local ichthyology students (G. M. Cailliet, Moss Landing Marine Laboratories, unpubl. file letter and attachments of 30 May 1974).

Smith (1982a) did not find juvenile steelhead at the four mainstem Pajaro River sites, upstream from the Corralitos Creek confluence to shortly above the San Benito River confluence, where they were collected by Snyder (1913). The degradation of steelhead spawning and rearing habitat, as described above, was cited as the likely cause for this reduction in distribution. These conditions persisted when Smith (1982b) electrofished five mainstem reaches in late fall 1981, from the river mouth to the mouth of Pescadero Creek, and captured no steelhead, although several other native fish species were present. Smith (1982a) found that spawning success was low throughout the system during the very dry water years of 1971-72, 1975-76, and 1976-77. Steelhead spawning occurred at two mainstem sampling sites in the wet water year of 1972-73, but very few young survived summer rearing conditions.

On 6 March 1985, the CDFG planted 6,750 juvenile steelhead (@ 9.9 fish/kg) of Warm Springs Hatchery (Russian River, Sonoma County) origin into the Pajaro River at the Highway 101 crossing.

The current status of the Pajaro River steelhead population is uncertain (K. R. Anderson, CDFG, pers. comm. of 9 July 1992). Nehlsen et al. (1991) listed the Pajaro River steelhead stock as being at a high risk of extinction.

Corralitos Creek and Tributaries

The Pajaro River tributary, Corralitos Creek, is the first major tributary that spawning steelhead can access as they migrate into the Pajaro River drainage. Neither this creek nor its tributaries were sampled by Snyder (1913), but CDFG records beginning in the 1930's, and Smith's (1982a,b) later work, provide a comprehensive impression of steelhead and rainbow trout use in these streams.

The CDFG surveyed an approximate 0.4 km portion of upper Corralitos Creek, and about 1.6 km of the Corralitos tributary, Shingle Mill Gulch, to Grizzly Flat, on 16 November 1960. There were scattered spawning areas in Corralitos Creek downstream from Shingle Mill Gulch, but virtually none in the tributary itself. Rearing habitat was adequate for young steelhead throughout the area. There were several small domestic diversions. Juvenile steelhead and/or rainbow trout were present throughout the survey area. Density estimates were made by the CDFG along Corralitos Creek on 1 July 1960. There was an average of 30 trout/30 m in the lower reaches; 20 trout/30 m between Eureka Gulch and Grizzly Flat in Shingle Mill Gulch; and 10 trout/30 m in upper Corralitos Creek. As of 1960, Corralitos Creek was allotted monthly plants of 2,000 catchable rainbow trout during May–July of each year. Angling pressure was high for rainbow trout during late spring–early summer, and in addition to planted trout, the catch probably also included juvenile steelhead.

Lower Corralitos Creek, from the mouth to Eureka Gulch, was surveyed by the CDFG on 20 January 1961. Gravel occurred in scattered patches throughout the survey area, but the substrate contained a high proportion of sand which may have reduced the quality of these areas for steelhead spawning. Suitable juvenile steelhead rearing habitat, in the form of pools and cover, was found especially upstream from the town of Corralitos. The City of Watsonville maintained a diversion dam on the creek, equipped with an adequate fish ladder, about 1.1 km north of Corralitos. This diversion removed a large proportion of the stream flow. Several other pump diversions and wells were also observed along the stream. Urban debris polluted the lower reaches of the creek. Few juvenile steelhead and/or rainbow trout were seen; steelhead production below the diversion dam was apparently limited by a lack of stream flow and suitable spawning substrate. Fishing pressure was high above Corralitos during late spring–early summer when catchable rainbow trout were planted (see above).

An adult steelhead was observed at the base of the fish ladder at the Watsonville diversion dam on 14 February 1962. Brown trout, which were introduced to Corralitos Creek during the 1940's, were captured throughout the creek by anglers during spring 1962; one fish was reportedly about 38 cm in length. Juvenile steelhead, 5–10 cm in length, were common throughout upper Corralitos Creek above the Watsonville diversion dam, on 24 July 1962 (CDFG, unpubl. field notes of February–July 1962).

When the entire 24 km of the creek, including its headwater tributaries, was surveyed by the CDFG in late August 1967 (Lollock 1968), the most favorable spawning areas were still found between the Watsonville diversion dam and Shingle Mill Gulch. Small proportions of upper Corralitos, Shingle Mill Gulch, and its tributary, Rattlesnake Gulch, also comprised suitable spawning grounds. Rearing habitat for juvenile steelhead was of particularly high quality throughout the area upstream from the diversion dam; pools generally increased in size as one proceeded downstream from the headwaters. The area below the diversion dam functioned only as a migration corridor as channelization for flood control eliminated all steelhead spawning and rearing habitat. Juvenile steelhead and/or rainbow trout were observed throughout the survey area, except in the lowermost portion of the main stem Corralitos Creek. Fishing pressure was high during the spring and early summer when the creek received 7,500 catchable rainbow trout annually.

During an electrofishing survey on 28 July 1972 (R. Whaley, CDFG, unpubl. field corr. to M. Johnson of 28 July 1972), the CDFG found juvenile steelhead and/or rainbow trout, 2.5–20 cm in length, in two sample sections of Shingle Mill Gulch. Trout, 2.5–15 cm in length, were also captured in sample sections of Corralitos Creek both above and below the Shingle Mill Gulch confluence, and in a section further downstream but still above the Watsonville diversion dam. No fish were captured in the small Corralitos headwater tributary, Diablo Gulch. Smith (1982a) found juvenile steelhead and/or rainbow trout in Corralitos Creek during 1972–74, both above and below the confluence with Brown's Valley Creek.

Some 350 yearling steelhead from Mad River Hatchery were planted in Corralitos Creek in spring 1976 as mitigation for fish losses caused by an unspecified event.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at nine Corralitos Creek sites was 5.3 ± 6.2 trout/m, which was well above the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 98 ± 4 mm SL, which was also above average.

Corralitos Creek was surveyed by the CDFG during 21–23 June 1982, from near Brown's Valley Creek to about 0.6 km above the confluence with Shingle Mill Gulch (L. Turner, CDFG, unpubl. memo. of 29 June 1982). The negative influence of fine sediment was still evident in the creek. The only suitable spawning grounds within the survey area were found between the confluences of Clipper and Shingle Mill gulches, where gravels were 5–7.5 cm in diameter and 25 cm deep. Juvenile steelhead rearing habitat, in the form of pools and cover, was adequate, although the pools were silted. Visually estimated abundances of young-of-the-year and yearling steelhead were very low downstream from Clipper Gulch (≤10/30 m and ≤ 2/30 m, respectively) but high upstream from there, especially between Clipper and Shingle Mill gulches (≤ 100+/30 m and ≤ 10/30 m, respectively). Eight logjams and four chutes or falls were located; six of the logjams were classified as partial migration barriers. Improvements were subsequently made at two sites to enhance fish passage. In addition, stream bed conditions, which were degraded from sediment input from the January 1982 flood, were restored to normal through natural processes by the end of 2 years, except in areas where land use resulted in chronic input (Hecht 1984).

The Corralitos tributary, Brown's Valley Creek, was surveyed by the CDFG in 1934. Steelhead were present, and it was noted that natural propagation was very successful. Early stocking records showed that the steelhead population was supplemented with 12,000 juveniles in 1930, 18,000 in 1932, and 10,000 in 1933. The City of Watsonville maintained a diversion dam with a fish ladder, about 3.2 km above Corralitos. Juvenile steelhead, 5–10 cm long, were common in the stream above the dam when observed by the CDFG in August 1945. Steelhead this size were also common below the dam in January 1961, in densities of 15–25 trout per pool. Expanded densities were estimated at about 185–800 trout/km. Spawning and rearing habitat was of high quality. Above the dam, juvenile steelhead densities were much lower; 2–5 trout per pool, or about 60–185 trout/km. A local resident reported that "fair numbers" of steelhead ascended the stream in winter, and that the fish ran far up the system when flows were great enough. When surveyed by the CDFG between Gamecock Canyon Creek and the diversion dam in January 1962, spawning gravels were limited and scattered, and juvenile steelhead (2.5–10 cm long) were very scarce. Adults were reportedly taken by poachers. A fish kill of undetermined cause below the diversion dam on 16 February 1964 revealed the presence of at least seven adult steelhead, two "grilse", and about 50 juvenile steelhead.

When Brown's Valley Creek was surveyed by the CDFG in early August 1967 (Lollock 1968), flow became subterranean about 0.8 km above the confluence with Corralitos Creek. Suitable spawning gravels were found in this dry section, which may have provided favorable spawning areas for steelhead during the winter when surficial flow was continuous. Otherwise, the highest quality spawning areas existed between the diversion dam and the mouths of the headwater tributaries, Ramsey Gulch and Gamecock Canyon Creek; limited spawning areas also occurred in the tributaries. Rearing habitat for juvenile steelhead, in the form of pools and cover, was adequate where perennial flow existed. Impassable cascades, created by bedrock and boulders, existed in upper Gamecock Canyon Creek, and three logjams limited fish movements on Ramsey Gulch, about 3.2 km upstream from the confluence with Brown's Valley Creek. In addition to the diversion dam, several pumps and wells diverted water from the creek system. Juvenile O. mykiss existed throughout the survey area, including above the barriers in the tributaries. Several 20 cm long trout were seen in Gamecock Canyon Creek, which were likely resident rainbows. Smith (1982a) also found juvenile steelhead and/or rainbow trout in Brown's Valley and Gamecock Canyon creeks during 1972–74.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at two sites in Brown's Valley Creek was 5.4 ± 4.9 trout/m, which was well above the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 105 ± 5 mm SL, which was also well above average. The density of smolt-sized steelhead at this time at one site in each of Ramsey Gulch and Gamecock Canyon creeks, tributaries to Brown's Valley Creek, was 2.0 and 1.3 trout/m, respectively, both of which were well below average (derived from Smith 1982b). Mean length in Ramsey Gulch, 119 mm SL, was well above average, while that in Gamecock Canyon, 84 mm SL, was well below average.

The following are miscellaneous bits of information discovered for other Corralitos Creek tributaries. Eureka Gulch was surveyed by the CDFG on 24 August 1945. The stream contained high quality spawning areas, and juvenile steelhead were present. In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites in Shingle Mill Gulch was 4.2 ± 0.8 trout/m, which was slightly above average (derived from Smith 1982b). The mean ± SD of the site-specific lengths of these fish, 90 ± 6 mm SL, was below average.

Llagas Creek

The material on steelhead in this stream is currently being reviewed.

Pacheco Creek

Pacheco Creek is a tributary of the northeastern portion of the basin that enters the Pajaro

River via Tequisquita Slough. The entire creek system was surveyed by the CDFG on 14 June 1957 (R. F. Elwell, CDFG, unpubl. stream survey report). Suitable spawning and rearing habitat was observed throughout the survey area, although surface flow was interrupted in the lowermost creek. According to local California Department of Forestry (CDF) personnel, flow typically became interrupted in summer. The dam on the North Fork Pacheco Creek was the only barrier to anadromous fishes seen. No water diversions or pollution were observed. Local forestry personnel reported that juvenile steelhead/rainbow trout 7.5–20 cm in length occurred throughout the live stream portions of the drainage, in addition to other native fishes such as California roach and Sacramento sucker, and various introduced warmwater fishes. The local warden reported that there was a strong steelhead run as far upstream as the north fork dam and into the South Fork Pacheco Creek in 1952 and 1955. The stream supported a local sport fishery for trout. The overall assessment made was that Pacheco Creek provided spawning and rearing habitat for Pajaro River steelhead when sufficient flow occurred in winter to allow adult passage through Tequisquito Slough. Elwell recommended that Pacheco Creek be managed primarily as a steelhead spawning tributary.

The above survey was essentially repeated by the DFG on 19–20 December 1972 (R. R. Johansen, CDFG, unpubl. stream survey report). The overall assessment of the creek system as a steelhead production area was essentially the same, although some habitat degradation was noted that was not apparent in 1957. Dairy waste and refuse from streamside ranches polluted the lower half of the stream. Road construction on the South Fork Pacheco Creek and release of sediment-laden water from Pacheco Dam on the north fork resulted in heavy siltation. Aquatic insects were absent or occurred at very low densities and were dominated by black flies (Simuliidae). Low insect densities may have reflected the combined effects of interrupted stream flow in summer and siltation.

Johansen's stream survey was preceded by a fish sampling survey conducted in the mainstem Pacheco Creek and its tributary, Cedar Creek, on 14–15 December 1972 (R. R. Johansen, CDFG, unpubl. memo. of 9 January 1973 to M. L. Johnson). Four stream sections, from CDF's Pacheco Ranger Station to the North Fork, were sampled with a single electrofishing pass to determine fish species composition and size ranges. A total of 1.2 km of stream was sampled in which few fish (one California roach, and two sculpin) and few aquatic insects were observed. The lack of fishes and invertebrates was attributed to dry stream conditions the previous summer. Three wetted sections of Cedar Creek totaling 590 m sampled in the same manner produced 22 juvenile steelhead/rainbow trout that averaged 12.5 cm and ranged in length from 6.0 to 20.0 cm, thus likely representing at least age 0 and age 1 fish. Other native species included California roach and Sacramento sucker; non-native green sunfish were also captured. Apparently, perennial pools in headwater reaches such as Cedar Creek provided suitable over-summering habitat for juvenile steelhead.

The local Fish and Game Warden summarized his observations of steelhead use of Pacheco Creek system between 1958 and 1973 (W. I. Donahue, CDFG, unpubl. memo. of 10 January 1973 to R. Johansen). Donahue indicated that strong runs of adult steelhead were associated with years of high rainfall, such as 1966 and 1968 (> 49 cm of precipitation), and that poor runs occurred in low rainfall years such as 1971 (15 cm of precipitation). High quality spawning and rearing habitat with perennial flow occurred upstream from Pacheco Dam on the North Fork, but was unavailable to steelhead because of the dam. His impression was that South Fork Pacheco Creek received modest use by steelhead spawners because of its high gradient and lack of gravel for spawning, although it contributed perennial flow to the system. In contrast, Cedar Creek was a relatively high use area for steelhead spawning. He also mentioned another tributary, Harper Canyon, as having reports of steelhead use although he had not observed them there. Finally, the mainstem Pacheco Creek supported trout when stream flow was sufficient.

Smith (1974, and summarized in Smith 1982) electrofished six locations in the Pacheco Creek system during 1973–1974. Beginning in the upper system, the South Fork and its east branch were sampled on 20 October 1973. Stream flow was interrupted to dry in the South Fork, although there was continuous flow in the upper East Branch where water temperature was < 19ºC. Steelhead/rainbow trout occurred in isolated pools in the south fork, representing two size/age classes at 7.5–10.0 cm SL and 21.5–24.0 cm SL. Steelhead/rainbow trout were highly abundant in the East Branch and represented young-of-the-year at 6.0–13.0 cm SL and ≥ age 1+ fish up to 29.0 cm FL. Other native fishes and green sunfish occurred there also. The North Fork above Pacheco Reservoir was sampled on 29 October 1973 where stream flow was interrupted but pools were available. No steelhead/rainbow trout were captured although other native and introduced fishes were observed.

The uppermost main stem of Pacheco Creek was sampled at Rancho Los Laureles during fall 1973 and late spring 1974. During 29–30 September 1973, juvenile steelhead were very abundant in this area, with 10 to 30 at the head of each pool, and were most abundant in deep riffles and runs. All trout were young-of-the-year which had grown well and averaged 14 cm SL and ranged up to 20.0 cm SL (n = 69). Juvenile steelhead in this area averaged 16.5 cm SL when sampled again on 26 December 1973, and all of them had apparently migrated from this area by 3 May 1974 when sampling occurred again. No 1974 year-class trout were observed at that time.

The Pacheco tributary, Cedar Creek, was sampled at the stream gauging station on 3 November 1973. This area was at the lower limit of surface flow and steelhead/rainbow trout were abundant: 37 trout were collected from five small pools, and these fish averaged 8.0 cm SL (range: 6.5–9.5 cm SL).

The abundance of juvenile steelhead declined markedly at mainstem sampling stations downstream from the confluence with Cedar Creek. Only one juvenile steelhead was collected from a section at Casa de Fruta on 29 October 1973, a very fast growing young-of-the-year at 18.0 cm SL. Sacramento suckers and hitch dominated the catch. In isolated pools farther downstream at the Highway 156 crossing, one juvenile steelhead at 7.5 cm SL was taken, among a variety of other native and introduced fishes.

The uppermost main stem of Pacheco Creek was sampled at Rancho Los Laureles again on 22 November 1975 (J. J. Smith and G. Scoppettone, unpubl. file memo. of 1 December 1975). Electrofishing yielded 72 young-of-the-year steelhead that averaged 11.0 cm SL (range: 9.0–16.5 cm SL) and that occurred at an approximate density of 4 trout/m of stream. Two age 2+ post-spawners at 40.0 and 41.5 cm SL were also collected. Scale analsysis indicated these fish had spent one year in fresh water and one year in salt water before returning to fresh water to spawn and where they remained. Although juvenile steelhead recruitment in the area sampled was high, substantial production was apparently lost due to loss of flow farther downstream as a result of decreased flow releases from Pacheco Reservoir. Maintenance of adequate releases was recommended to support the remaining population until winter rains began.

No juvenile steelhead were found in the creek at Rancho Los Laureles when sampled during summer and fall 1978 (J. J. Smith, San Jose State University, unpubl. file memo.). The lack of production in both 1976 and 1977 was attributed to drought conditions. Population enhancement with stocked smolts in permanent pools below Pacheco Dam was recommended as a management action. On 23 August 1978, the CDFG planted 9,975 steelhead (@ 209/kg) from the Silverado Field Operations Base into the mainstem creek near the Pacheco Ranger Station.

The CDFG electrofished the stream at two sites on 16 December 1982 (J. Lorenzana, CDFG, unpubl. file memo. of 20 December 1982): downstream from the Highway 152 crossing on the uppermost main stem, and at the confluence of Cedar and Pacheco creeks. A total of 18 steelhead was collected at the two sites. Fish from the upper site were 18.0–23.0 cm SL and age 0+ based on scale analysis. The survey indicated steelhead recovery in Pacheco Creek, following the 1976–1977 drought, and presence of steelhead in the mainstem creek upstream from Casa de Fruta.

Additional observations of steelhead use of Pacheco Creek during the 1980s were also available (J. J. Smith, San Jose, CA, unpubl. comment letter of 3 March 1992 to Santa Clara Co. Advance Planning Office). Successful spawning and rearing occurred in 1983, based on the observation of 1-year-old steelhead smolts in 1984. Successful spawning and rearing also occurred in 1984, with direct observation of spawning adjacent to Casa de Fruta in March 1984. Adult steelhead were observed while migrating in lower Pacheco Creek in 1985. Smith also explained that steelhead use of the creek in the vicinity of Casa de Fruta is sensitive to overall water year type. In average to wet water years, suitable flow and temperature conditions occur in this stream reach for steelhead spawning and rearing, recognizing that the likelihood of these conditions being met improves farther upstream in the drainage.

In summary, this sequence of surveys over nearly 30 years demonstrates the persistence of steelhead in the Pacheco Creek system, with high recruitment in wet years, and little or no recruitment in dry years. The importance of upper watershed refugia and maintenance flows as available to get steelhead through drought events is also clear.

Pescadero Creek

The Pajaro River tributary, Pescadero Creek, was surveyed by the CDFG in 1967 (Lollock 1968). This survey is currently being reviewed.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at two Santa Clara County sites was 2.0 ± 0.5 trout/m, which was well below the survey-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 127 ± 0 mm SL, which was the highest survey-wide average.

San Benito River and tributaries

The material on O. mykiss in this stream is currently being reviewed.

Uvas Creek

The material on steelhead in this stream is currently being reviewed.

Respini Creek Drainage

Although no detailed historical information was discovered for Respini Creek, Shapovalov and Taft (1954, p. 201) mentioned that the stream supported a steelhead run which was smaller than those observed at Scott and Waddell creeks during the 1930's–40's.

San Lorenzo River Drainage

The San Lorenzo River has played a central role in the history of steelhead in Santa Cruz County. Prior to 1905 and the enactment of law which set the daily bag limit at 50 trout, fishermen would catch from 200 to 350 juvenile and adult steelhead per day in the San Lorenzo and other local streams and sell them at Santa Cruz (Welch 1929). In 1905, the County of Santa Cruz established a hatchery in the San Lorenzo drainage at Brookdale (Shebley 1922). An egg collecting station was built on Scott Creek to provide eggs for the Brookdale Hatchery. The Scott Creek facility was operated jointly by the California Fish Commission and the County. Production from Brookdale was primarily used to enhance the steelhead populations of Santa Cruz, San Mateo, Santa Clara, and Monterey counties, although fry were shipped elsewhere as well. Both Brookdale Hatchery and the Scott Creek Egg Collecting Station were taken over by the State of California in 1912. The work conducted at these facilities was apparently very successful (Fish and Game Commission 1913). Heavy flooding in early 1940 severely damaged the egg collecting station, and its operation was discontinued (D. Streig, Monterey Bay Salmon and Trout Project, unpubl. report: History of fish cultural activities in Santa Cruz County with reference to Scott and Waddell creeks). The Brookdale Hatchery continued production through 1953 hatching surplus eggs from CDFG hatcheries in northern California.

Regarding the natural distribution and abundance of steelhead in the San Lorenzo system, in summer 1909 Snyder (1913) found juvenile steelhead/rainbow trout at each of six sites, from the Kings Creek confluence in the upper drainage to Santa Cruz in the lowermost drainage. The CDFG conducted a creel census on the San Lorenzo and tributaries during 1–2 May 1943, the opening of the summer trout season (CDFG, unpubl. file data). This survey reflected the same widespread distribution of juvenile steelhead/rainbow trout throughout the system. In addition to in the main stem, catches were made in Zayante, Fall, Newell, Bear, Boulder, and Kings creeks. The mean size of 592 trout seen in the 85 creels checked averaged 112 ± 20 mm (range, 76–178 mm), and the average catch rate was 2.87 ± 3.44 trout/h (range, 0–17 trout/h).

In an earlier survey conducted on 1 May 1939, the CDFG checked creels from Ben Lomond to 1.6 km above Brookdale Hatchery (CDFG, unpubl. file data). Fifty-one anglers were checked who had captured 105 marked steelhead that averaged 165 mm, and 406 unmarked steelhead that averaged 127 mm. During 1–3 May 1942, 176 creels were checked which contained 1,110 trout caught at a rate of 3.03 trout/h. These creel surveys indicated that the harvest of large numbers of small juvenile steelhead continued to occur as of c. 1940.

In relation to these fishery assessment activities, from June 1938 through July 1939, the CDFG supplemented the steelhead population in the San Lorenzo with 526,355 juveniles from the Big Creek and Brookdale hatcheries. Of these, 7,046 were marked (L. Shapovalov, CDFG, unpubl. memo. of 23 November 1954). During 1940–41, 11,080 marked, Mt. Whitney strain rainbow trout were stocked in the river, and 538 marked, Mt. Shasta strain rainbow trout were stocked during 1941–42.

By the 1940's, fishery management at the San Lorenzo River had intensified in an attempt to balance various fishery needs in the face of a growing local human population and associated development. A CDFG document of late 1948 provided a snapshot view of the San

Lorenzo and its steelhead/rainbow trout population at that time (Assistant Fisheries Biologist [unsigned], CDFG, unpubl. memo. to G. I. Murphy of 14 December 1948). Adult steelhead entered the river to spawn following the first fall rains in October and November. The run typically peaked in January and continued through March and sometimes into June. Steelhead used an estimated 125 km of stream for spawning in the main stem and tributaries. The stream was managed for basically three fisheries: (i) the winter steelhead fishery in the lower main stem, (ii) a summer trout fishery in tributaries below Boulder Creek, and (iii) an early summer only trout fishery in the main stem and tributaries from Boulder Creek and above. Stream flow was typically very low during August–November. There were many diversions for domestic water supply. The river mouth remained open to the ocean throughout the year in all but below normal water years.

As of 1951, the CDFG estimated that over 300,000 trout were caught each year in the San Lorenzo system (R. M. Paul, CDFG, unpubl. memo. of 6 April 1951). These fish included both juvenile steelhead/rainbow trout caught in the summer fishery, and adult steelhead in the winter. CDFG stocking was limited despite the presence of the Brookdale Hatchery in the system. Natural production was large enough to maintain the population and associated fisheries. CDFG efforts to maintain the run were limited to pollution and barrier control. Sand and gravel plants on Zayante Creek and their discharge of silt were a chronic pollution source, although a court ruling stopped discharges in summer. Swimming pool drain water was an occasional source of fish mortality.

During 1954–55, the CDFG (Pintler 1956) conducted electrofishing surveys immediately before and after the opening of the summer trout season to determine (i) if maintaining open and closed fishing areas of the river protected yearling steelhead from angling, and (ii) if planting of catchable rainbow trout had a negative effect on the juvenile steelhead population. Of 36 km of mainstem river, about 11 km above the Boulder Creek confluence were open to summer fishing, while the 25 km below were closed. Near absolute counts of fish were made on four occasions in nine 30.5 m sections in the open area, and in 10, 30.5 m sections in the closed area from late April 1955, just prior to the opening of the trout season, through late July 1955. The average density of yearling-size (>75 mm FL) steelhead in the open area decreased from 110 trout/100 m to 25 trout/100 m over the course of the study. There was a corresponding increase in average density in the downstream closed area of 83 trout/100 m to 309 trout/100 m. Thus, there appeared to be a net downstream movement of yearling steelhead into the closed area from late April to late July. Pintler (1956) concluded that maintaining the downstream closed area did indeed protect the yearling steelhead. During the same period, the average density of young-of-the-year size (<75 mm FL) steelhead increased in both areas as emergence progressed; from 80 to 498 trout/100 m and 42 to 565 trout/100 m in the open and closed areas, respectively.

To get at the second question, two small plants of catchable rainbow trout were made in the upstream area open to fishing: 2,504 on 9 June 1955 and 3,001 on 23 June 1955. None of these fish was found in the closed area while electrofishing there, and their depletion in the sampling program in the open area suggested they were readily harvested, thus minimizing the opportunity for competition with juvenile steelhead. Creel censuses on the weekends following these plants showed that, on average, about 82% of the catch was composed of planted trout. Stomach content analysis of 96 catchable rainbow trout did not suggest predation on juvenile steelhead. Although these results suggested little direct impact of planted catchable rainbows on juvenile steelhead, Pintler (1956) concluded that a continued planting program should be approached conservatively so as not to induce significant fishing mortality on the wild fish. For example, he suggested that the opening of the summer trout season be delayed until 30 May to provide a larger window of opportunity for yearling steelhead to escape to the downstream closed area.

Following heavy flooding in December 1955, the lower San Lorenzo River within the city of Santa Cruz was dredged and channelized to enhance flood control. The CDFG reported concern over steelhead passage under low-flow conditions at the city's diversion dam where large rocks had been placed for reinforcement (S. C. Smedley, CDFG, unpubl. memo. of 16 March 1959). This document also mentioned that between 7,600 and 18,000 anglers fished the river for steelhead annually, resulting in an estimated catch of between 1,350 and 5,650 steelhead.

The local CDFG warden reported that anglers caught about 200 adult steelhead in the San Lorenzo lagoon on 1 December 1962 (CDFG, unpubl. field notes of 5 December 1962). About

100 were taken on 2 December 1962. These steelhead weighed up to 2.7 kg but averaged only about 0.7 kg. Angling was much slower on 5 December 1962 when only two steelhead were observed in 2 h.

In 1965, the CDFG estimated the annual steelhead spawning run in the San Lorenzo River at about 23,000 fish, based on the observations of local field personnel (California Department of Fish and Game 1965).

The CDFG surveyed the mainstem San Lorenzo from headwaters to mouth during 15–18 September 1966. Spawning gravels were in suitable condition for steelhead use above Boulder Creek, but were silted from there to the mouth. Siltation resulted from logging, road building, grading, and sand plant operations throughout the drainage (see tributary information below), and constituted 8% of the stream bottom in the mainstem San Lorenzo. Rearing habitat in the form of pools and cover was present throughout the stream. There was a culvert barrier at the Highway 9 crossing in the Waterman Gap area in the upper San Lorenzo, and a logjam barrier about 2 km downstream. These barriers marked the upstream limit for steelhead spawners. Many small pumps diverted water to vacation homes in summer, and the pumping facility at the dam in Santa Cruz was a major year-round diversion. Juvenile rainbow trout were seen above the culvert barrier, and juvenile steelhead occurred in high densities throughout the stream below this point. Despite what appeared to be high steelhead production, the surveyor still cautioned that unless sedimentation was curbed, spawning and rearing habitat for steelhead would be seriously damaged.

In 1970, the CDFG estimated the abundance of juvenile steelhead from Waterman Gap to the mouth of the San Lorenzo by electrofishing several randomly-selected 30.5 m reaches in 15 1.6-km sections (L. K. Puckett, CDFG, unpubl. memo. of 30 December 1971). Abundance was estimated using the two-pass removal method. Juvenile steelhead abundance ranged from 48 trout/100 m in the upper river to 239 trout/100 m in SKM 16, and averaged 115 ± 45 trout/100 m among the 15 sections. Although abundance was lowest through the three uppermost km, overall abundance did not vary significantly with SKM ($p>0.15$).

During the last week of April and first week of May 1972, a coalition of volunteers and the CDFG rescued >500 adult steelhead from the lagoon of the San Lorenzo River (W.

Greenwald, CDFG, unpubl. photo report, Operation Steelhead, of 31 May 1972). The steelhead had entered the river to spawn but were unable to migrate upstream because of low flow. These fish were trucked to holding ponds at Silver King Oceanic Farms, at the mouth of Waddell Creek in Santa Cruz County, where they were spawned. The eggs were hatched at the CDFG hatchery on the Mad River, Humboldt County where the young steelhead would be reared to yearlings and then stocked back in the San Lorenzo and elsewhere.

During the mid-1950's (Fisher 1957) and the first half of the 1970's (M. L. Johnson, CDFG, unpubl. memo. report of 22 November 1971; B. Snider, CDFG, unpubl. memo. of 5 September 1974; Johansen 1975; L. B. Boydstun, CDFG, unpubl. memo. of 2 September 1975), the CDFG monitored fishing effort and catch in the San Lorenzo River winter steelhead fishery. The objective of these studies was to develop a baseline against which to (i) evaluate the contribution of future plants of hatchery-reared yearling steelhead to the fishery (Fisher 1957), and (ii) evaluate proposed water development in the system (Johansen 1975). The catch rate during the 1953-54 and 1954-55 seasons averaged 0.044 ± 0.013 trout/h (range, 0.035–0.053 trout/h). Catch rates from 1970-71 through 1974-75 averaged 0.026 ± 0.004 trout/h (range, 0.020–0.030 trout/h), and thus tended to be lower. This apparent difference was also reflected in expanded estimates of total seasonal catch which averaged 3,770 ± 2,652 steelhead (range, 1,895–5,645 steelhead) during the mid-1950's and 1,546 ± 544 steelhead (range, 1,035–2,368 steelhead) during the first half of the 1970's. Johansen (1975) discussed the fact that habitat degradation in the system, in particular siltation which had increased to an estimated 65% of the stream bottom by 1972, along with the apparent decrease in catch rates and annual catches suggested an actual decline in the steelhead population. He reiterated that logging and associated activities, subdivision development, and water project construction were primarily responsible for observed habitat degradation.

Johansen (1975) also collected size information on steelhead captured in the fishery. Although the minimum steelhead size seen in the census was about 20 cm FL, only those >25 cm FL were considered adults. In 1971-72 and 1972-73, angler-caught adults averaged 52 cm FL and 47 cm FL, respectively. The combined season average was 49 cm FL. The largest adult observed in the census was 81 cm FL, although an angler caught a 86.4 cm long fish at the river mouth on 19 November 1974 (Salinas Californian, 20 November 1974, p. 26).

On 26 April 1977, the CDFG rescued 114 emigrating adult steelhead from the forebay of the Felton Diversion Dam on the San Lorenzo River (P. P. Chappell, CDFG, unpubl. memo. of 5 May 1977). An estimated 75–80% of the fish were spent, but few appeared moribund with bacterial and fungal infections. The fish were released in the San Lorenzo lagoon.

The CDFG conducted a creel census on the upper San Lorenzo and several tributaries during 26–28 May 1979, the opening of the summer trout season (M. L. Johnson, CDFG, unpubl. memo. of 4 June 1979). This later opening date reflected Pintler's (1956) recommendation for a delayed season on the San Lorenzo to protect yearling steelhead (see above). Angling pressure was light as only 18 anglers were seen during 90 h of census time over the 3 d period. About 89% of the anglers were on the upper San Lorenzo and Fall Creek, where 100% of the fish seen were caught. The average catch rate, 0.96 ± 2.15 trout/h, was three times lower than that seen in creel surveys conducted c. 1940 (see above). Only 17 juvenile steelhead were seen in creels, and these fish averaged 140 ± 47 mm TL (n = 16). The relatively low use, low catch rate, and small catch could be attributed to the delayed opening date and escapement of yearling steelhead to the downstream closed area, a reduced steelhead population, the absence of planted trout, or some other factor(s).

During the 1976-77 through 1978-79 steelhead seasons, the CDFG made fish counts at the Felton Diversion Dam. As of 10 March 1977, 628 adult steelhead had moved up the San Lorenzo (B. Graham, CDFG, unpubl. memo. of 10 March 1977), which was about 39% of the total of 1,614 for the 1976-77 season (M. L. Johnson, CDFG, 17 September 1979). A minimum of 242 adult steelhead passed during 1977-78, and 452 during 1978-79. These were considered minimum counts as the trap was not operable all the time.

Johnson also mentioned that up to 25,000 yearling steelhead, when available, were stocked annually in the San Lorenzo. A stocking summary in the CDFG stream survey file showed that between 1963 and 1980, 230,716 juvenile steelhead were stocked in the San Lorenzo, of which 95% were yearlings and 5% were young-of-the-year. In addition, from 1960 through 1972, the CDFG planted 231,403 catchable rainbow trout in the mainstem San Lorenzo to support summer trout fishing. The stocking program was discontinued after 1972 because of an increase in private ownership and shrunken public access to the river (M. L. Johnson, CDFG, unpubl. memo. of 13 November 1973).

In late fall 1981, the mean density of smolt-sized steelhead at 10 mainstem river sites was 980 ± 930 trout/100 m, which was the highest county-wide average (derived from Smith 1982b). The mean of the site-specific mean lengths of these fish was 97 ± 10 mm SL, which was also above average.

Bear Creek and tributaries

The San Lorenzo tributary, Bear Creek, was surveyed by the CDFG in November 1956. The stream was described as an important spawning and rearing area for San Lorenzo River steelhead. Logging operations were underway in the vicinity 9 km upstream from the mouth. Barriers were present in the logging area, and silt and debris polluted the stream immediately below this point. The stream contained adequate spawning and rearing habitat in the middle and lower survey area. Juvenile steelhead were scarce above the logging area, but common below. Local residents reported that the creek supported a substantial run of steelhead each year. The Bear Creek steelhead population was supplemented with juvenile plants during 1940–47, and in 1956.

Bear Creek was briefly surveyed by the CDFG in January 1961. Spawning and rearing habitats were in good condition. Natural propagation was highly successful as an abundance of 5–10 cm juvenile steelhead was observed, roughly estimated at 185–370 trout/km. Adult steelhead reportedly spawned in the creek during the winter of 1960-61, and redds and 3–4 cm long young-of-the-year were observed in high abundance near Elks Park on 19 April 1961. In a related document from that time, it was mentioned that the CDFG had planted 6,000 catchable rainbow trout in Bear Creek each summer, but that this practice had been discontinued.

The creek still consisted of high quality spawning and rearing habitat when surveyed by the CDFG in July 1971. At least two age-classes of juvenile steelhead were observed in abundance. Catchable-size trout were noted. Potential barriers and the upstream limit of trout distribution were identified.

Cabrillo College students made abundance estimates of juvenile steelhead in Bear Creek during September–October 1972. Two to four reaches within each of six 1.6-km sections were sampled by electrofishing using the two-pass removal method of population estimation. Densities over the 10 km study area ranged from 99 to 708 trout/km, and averaged (± SD) 612 ± 412 trout/km.

About 60 steelhead redds were observed in lower Bear Creek in June 1980 (L. Turner, CDFG, unpubl. file report of 30 July 1980). Steelhead fry were abundant, and individuals ranging in length from 15 to 35.5 cm were common from the creek mouth to a series of waterfalls located about 0.3 km below the confluence with Shear Creek. These falls were judged to be the upstream limit for adult steelhead immigration. A few fry were observed between the falls and Shear Creek; these fish may have been the progeny of resident rainbow trout inhabiting the stream above the barrier falls. The Bear Creek tributary, Deer Creek, contained an abundance of steelhead fry and older trout (10–30.5 cm long) from its mouth up to a permanent waterfall barrier. Again, above this point, trout density was low and may have represented an isolated resident rainbow trout population.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites in Bear Creek was 3.9 ± 2.3 trout/m, which was about the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 102 ± 6 mm SL, which was above average.

Bear Creek was generally in good condition following the heavy storms of January 1982, as determined by a CDFG survey in May 1982 (L. Turner, CDFG, unpubl. memo.). Redds were observed in the lower stream. Steelhead fry were present but apparently in low densities. Older trout, 15–30.5 cm long, were common in deep pools. Several barriers were identified.

Boulder Creek and tributaries

Both age 0+ (<7.5 cm) and older juvenile steelhead (>7.5 cm) were captured during a CDFG electrofishing survey in a 61 m reach of the San Lorenzo tributary, Boulder Creek, in May 1954. When surveyed again by the CDFG in November 1956, spawning areas were rated as lacking to fair, rearing habitat was especially good in the middle and lower sections of the stream, and both young-of-the-year (5–7.5 cm) and older juvenile steelhead (7.5–20 cm) were observed. Six partial or complete barriers were identified, but no diversions were noted. It was also noted that the Boulder Creek steelhead population had been supplemented with juvenile plants during 1940–47.

By the tine of the next CDFG survey in August 1966, habitat degradation due to siltation was becoming an increasing problem in the stream, although suitable spawning and rearing habitat was still observed. The abundance of juvenile steelhead (4–10 cm) was noted as low, and average density was estimated at about 1 trout/m. The condition of the stream was apparently similar when surveyed by the CDFG in July 1971; spawning and rearing habitat was noted as good below Bracken Brae Creek where the greatest abundance of young-of-the-year and yearling steelhead and resident rainbow trout was seen. Several potential or full barriers were noted.

A total of 19 partial and full barriers, including logjams, were identified by the CDFG in June 1980 (L. Turner, CDFG, unpubl. file report of 31 July 1980). Low densities of juvenile steelhead were observed in the lower and mid-creek sections, with 20–30.5 cm fish common in pools. At least some of these larger fish were probably resident rainbow trout. The distribution of suitable spawning substrate was apparently much more restricted than in previous surveys; two steelhead redds were seen.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at four sites was 3.4 ± 2.7 trout/m, which was slightly below average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 105 ± 4 mm SL, which was well above average.

The stream was judged to be in fair condition by the CDFG in May 1982 (L. Turner, CDFG, unpubl. memo. of 18 May 1982). Spawning areas were scattered and often cemented with silt in the lower stream. The best spawning areas were now located above Hare Creek where numerous steelhead redds were observed. This area also contained an abundance of steelhead fry. Siltation was still noted as a problem, especially below the Boulder Creek Country Club, and several partial and complete barriers were identified.

The effect of sedimentation in the creek was investigated by the CDFG in August 1982, in relation to a construction project (R. C. Benthin, CDFG, unpubl. file report of 2 September 1982). The density of both invertebrates and juvenile steelhead was clearly lower downstream from the construction site, where the percentage of fine material in the substrate was higher than above the construction site.

In late fall 1981, the density of smolt-sized steelhead at one site in Jamison Creek, a Boulder Creek tributary, was 2.6 trout/m, which was below average (derived from Smith 1982b). The mean length of these fish was 94 mm SL, which was slightly below average. The upper portion of this stream was choked with logging debris when observed by the CDFG in June 1980 (L. Turner, CDFG, unpubl. file report of 31 July 1980). A few juvenile steelhead and/or resident rainbows up to 25 cm in length were observed in the lower creek.

Branciforte Creek and tributaries

Branciforte Creek, a tributary to the San Lorenzo River, was surveyed by the CDFG in October 1956. Spawning grounds for steelhead were practically nonexistent in Branciforte Creek due to extensive sedimentation, but apparently there were some suitable areas in tributary streams. Rearing habitat was also of generally poor quality. Several barriers were identified, some of which were permanent blockages to upstream migrants. Juvenile steelhead were very scarce. The stream was stocked with juvenile steelhead and catchable resident rainbow trout from 1940 to 1956.

Branciforte Creek was surveyed briefly by the CDFG in December 1960; no adult or juvenile steelhead were observed. During another brief survey on 3 February 1961, two adult steelhead (about 30 and 61 cm long) were seen spawning on a riffle at the downstream end of a small pool. No juveniles or other adults were observed.

The CDFG surveyed Branciforte Creek from its mouth to its headwaters, a distance of about 14.5 km, in mid-August 1966. Although regarded as an insignificant steelhead stream in earlier surveys, the creek was now described as an important spawning and rearing area for San Lorenzo steelhead and coho salmon. Suitable spawning gravel was available for steelhead, but siltation was still cited as a growing problem. Rearing habitat was apparently best in the middle and upper stream areas. Despite a somewhat improved habitat rating, juvenile steelhead (4–7.5 cm long) still occurred only in low densities, at an average of about 2 trout/30 m.

By the time the creek was surveyed by the CDFG in August 1971, siltation and septic tank leakage had ruined historic spawning and rearing areas below Jarvis Road, above which there was little steelhead habitat. Juvenile steelhead were present throughout the stream, but only in very low densities (<3 trout/30 m).

During a CDFG barrier survey in July 1980, juvenile steelhead were seen again only in low densities. In addition, about 80 steelhead redds were observed in silty substrate, about 0.3 km downstream from the confluence with Granite Creek. It was noted that silt covered the substrate along the entire observed length of stream, to above the confluence with Crystal Creek.

The condition of Branciforte Creek was largely unchanged when surveyed by the CDFG in June 1982 (L. Turner, CDFG, unpubl. memo. of 7 July 1982). Juvenile steelhead were scarce, and age 0+ trout were concentrated at a few locations in the lower stream. Numerous dams appeared to have inhibited the flushing of silt from the system, rendering the stream unsuitable for salmonid production.

The Branciforte Creek tributary, Carbonera Creek, was surveyed by the CDFG on 16 October 1956, from the mouth to Zanze's, 5.6 km upstream, where there was a 12 m high bedrock waterfall barrier. There was also a logjam barrier in the lower stream, near the county hospital. Although spawning gravels were present throughout the survey area, they were of the highest quality in the mid-section, above the logjam. Rearing habitat was adequate, in terms of pools and shelter. Several diversions were observed, which were adequately screened. Siltation was a pollution problem in a 0.8 km mid-section reach where logging had occurred; the stream was clogged with logging debris there as well. Juvenile steelhead, 5–10 cm long, were common throughout the survey area. The fish were relatively abundant in the mid-section and scarcer in the upper and lower sections. Overall, the stream was rated as the most important steelhead spawning and rearing tributary to Branciforte Creek. The steelhead population was supplemented with a plant of juveniles in 1953.

When surveyed again by the CDFG in August 1966, the condition of Carbonera Creek was largely unchanged, although the overall abundance of juvenile steelhead was apparently lower. In the lower stream, the estimated density was 100 trout/30 m. These fish were 4–5 cm long. No fish were seen in the mid-section of the survey area, and few were seen further upstream.

By the time of the next CDFG survey on 21 September 1974, siltation, as a result of logging operations, had become a greater problem. Most spawning areas were apparently degraded.

O. mykiss, about 5–30.5 cm in length, occurred in low densities throughout the creek, from the mouth to the bedrock waterfall, when surveyed for barriers by the CDFG on 11 August 1980. Several partial and full barriers were identified, and a fish kill was observed in the lower stream which included 32 steelhead.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites was 0.5 ± 0.5 trout/m, which was the lowest county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 95 ± 9 mm SL, which was very near average.

Carbonera Creek was surveyed up to the bedrock waterfall by the CDFG in late June 1982, following the heavy storms of January 1982 (L. Turner, CDFG, unpubl. memo. of 8 July 1982). Spawning gravels were still best in the middle portion of the survey area, and the deepest rearing pools were in the middle and upper sections. Age 0+ O. mykiss were present in the middle and lower sections, but in low densities. Larger trout, 10–25 cm long, were observed in the deep pools in the upper section. Overall, the stream was in fair condition. No other major barriers were present besides the bedrock waterfall. Silting was moderate.

A small Carbonera Creek tributary, Camp Evers Creek, was surveyed by the CDFG in January 1985 (W. Strate, CDFG, unpubl. memo. of 9 January 1985). The stream was highly degraded due to a lack of riparian vegetation and siltation, and no fishes were seen. However, no barriers were present and with habitat improvement, the creek was judged to have potential as a steelhead production area.

Clear Creek

The San Lorenzo tributary, Clear Creek, junctions with the San Lorenzo River at Brookdale. When surveyed by the CDFG in January 1957, the stream was described as unimportant for steelhead because a permanent bedrock barrier at the mouth precluded upstream migration of adult spawners. No fish were observed in the creek, despite plantings of hatchery-reared resident rainbow trout in 1945 and 1947. Nor were any fish seen in the lower stream in October 1959. During a CDFG barrier survey in mid-May 1980, three resident rainbow trout, 20–25 cm long, were observed in lower Clear Creek. The creek mouth still contained a complete migration barrier, and other barriers were identified upstream.

Fall Creek

The San Lorenzo tributary, Fall Creek, was surveyed by the CDFG in June 1956. Natural reproduction was rated as poor for that year; juvenile steelhead were observed only in low densities up to an impassable waterfall, about 5 km upstream from the mouth. In the lowermost stream area, the density of 2.5–4 cm long juveniles was about 5–6 trout/pool. Juvenile steelhead were also observed in lower Fall Creek in October 1959.

In an August 1966 CDFG survey, it was indicated that about 11 km of Fall Creek was available to steelhead for spawning and rearing. Spawning gravels were abundant throughout most of the stream, and rearing habitat was at least adequate. However, the diversion dam for the community of Felton's domestic water supply acted as a barrier to adult upstream migration. Few juvenile steelhead were seen above the dam; below, they occurred at a density of about 15–20 trout/30 m. At the time of this survey, the CDFG planted about 1,000 catchable rainbow trout per week during the summer trout season. Overall, the stream was judged to be in excellent condition.

Abundance estimates of juvenile steelhead in 3.2 km of Fall Creek in 1970 were 77 trout/100 m in the lowermost 1.6 km, and 52 trout/100 m in the contiguous 1.6 km upstream (L. K. Puckett, CDFG, unpubl. memo. of 30 December 1971). The CDFG observed two adult steelhead in the stream on 20 November 1973.

In October 1975, the CDFG determined the abundance, size, and biomass of juvenile steelhead in four 30 m sections in Fall Creek (P. P. Chappell, CDFG, unpubl. memo. of 13 November 1975). The average abundance was 2,842 trout/km or 8,028 trout/ha, and average biomass was 33.5 kg/ha. Average trout size was about 68.5 mm FL.

The CDFG captured juvenile steelhead, 5–20 cm long, by electrofishing in early June 1978 (D. M. Eimoto, CDFG, unpubl. memo. of 11 July 1978). Steelhead fry were seen both above and below the Felton water filter plant.

The CDFG conducted a survey of barriers in Fall Creek in April 1980. A total of 15 partial and complete barriers, including logjams, was identified in the main creek, and the tributaries, Bennett Creek and South Fork Fall Creek, were completely impassable for upstream migrating fish due to waterfalls and slash in the streams from old logging operations. By this time, fish passage problems at the Felton diversion dam had been solved by installation of a fishway. Steelhead fry were common in Fall Creek from its mouth to above the confluence with the south fork, after which fry became scarce. Three adult steelhead were seen in a pool in the lower stream, and one 20 cm trout further upstream.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at two sites was 3.9 ± 2.3 trout/m, which was just about average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 93 ± 2 mm SL, which was somewhat below average.

Fall Creek was surveyed again by the CDFG in April 1982, following the January 1982 storms. Spawning habitat apparently remained intact from the mouth to the confluence with the south fork. Above this point, siltation as a result of two major landslides had degraded both spawning and rearing habitat. Several migration barriers were identified. Eight adult steelhead were seen in the lower stream area.

In November 1983, a composite electrofishing sample from five sample reaches of Fall Creek (4–11.5 m) produced the following abundance estimates: 0.70 age-0+ trout/m and 0.46 age-1+ trout/m. The mean standard length of 0+ and 1+ fish was 61.0 mm and 109.2 mm, respectively.

Kings Creek

The San Lorenzo headwater tributary, Kings Creek, was surveyed by the CDFG in 1956, 1966, 1971, 1974, and 1980 (Smith 1982b), although the CDFG file containing these survey reports was not discovered. In late fall 1981, the density of smolt-sized steelhead at one site was 3.3 trout/m, which was below average (derived from Smith 1982b). The mean length of these fish, 84 mm SL, was also below average.

Newell Creek

Newell Dam forming Loch Lomond Reservoir on the San Lorenzo tributary, Newell Creek, was built during 1962-63. The dam blocks steelhead access to the upper creek. The CDFG stocked the reservoir with 611,729 catchable rainbow trout from 1963 through 1976. In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites was 4.3 ± 2.0 trout/m, which was above average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 100 ± 5 mm SL, which was also above average.

Zayante Creek and tributaries

The San Lorenzo tributary, Zayante Creek, was surveyed from its mouth to headwaters for a distance of 13 km, by the CDFG in October 1956. This creek was described as one of the best steelhead spawning and rearing areas in the entire San Lorenzo drainage. Spawning gravels were in excellent condition in the upper stream, but became increasingly silted as one progressed downstream. Rearing habitat was also of higher quality in the middle and upper stream areas. Correspondingly, juvenile steelhead were scarce to common in the lower stream up to Quail Hollow Road, and increased in abundance further upstream. There were 14 partial and four complete logjam barriers, and several unscreened diversions. Siltation was cited as the main pollution problem, the sources being eroded materials from a logged area in the upper watershed, and a sand plant in the lower stream area. The steelhead population was supplemented with plants of hatchery-reared juveniles from 1940 to 1947.

The lowermost 2.4 km of the South Branch Zayante Creek were also surveyed by the CDFG in October 1956. High quality spawning and rearing habitats for steelhead were observed. Juvenile steelhead, 7.5–10 cm long, were common to abundant in the lower section of the survey area, and scarce in the upper section. Three complete logjam barriers were identified, and there was a natural bedrock barrier about 2.8 km upstream from Zayante Creek. No diversions or signs of pollution were seen.

On 3 February 1961, the CDFG observed seven adult steelhead resting in pools between Quail Hollow bridge and Lompico Creek. A steelhead redd was seen just upstream from the confluence with Lompico Creek on 13 April 1961. The CDFG surveyed lower Zayante Creek, from the mouth to the confluence with Lompico Creek, in April 1964. Siltation was still a chronic problem in this portion of the stream, especially in the lowermost 2.4 km where O. mykiss fry occurred at an approximate density of 375 fish/km. Above this area, 188 trout were counted which ranged in length from 5 to 46 cm, and averaged about 10 cm. Total abundance in this upper area was estimated at 400–500 fish, consisting of a mixed migratory and resident rainbow trout stock. Additional stocking of O. mykiss in Zayante Creek occurred from 1956 to 1960. Fishing pressure was noted as heavy.

The upper Zayante Creek headwaters were also surveyed by the CDFG around this time. Siltation had apparently become a problem in this area since the 1956 survey. The survey section included a 9 m bedrock barrier. O. mykiss occurred in relatively lower densities above the barrier, and these fish were likely resident rainbow trout. Young-of-the-year, about 5 cm long, were abundant, and older trout were common with numerous individuals up to 28 cm. As one progressed downstream from the barrier, juvenile steelhead density increased from about 100 trout/km to about 260 trout/km.

The adult steelhead run in Zayante Creek as of 1968 was estimated by the CDFG at about 800 fish, although the method used to attain this estimate was not described. Juvenile steelhead sizes and densities were measured in the lower creek from Quail Hollow Bridge to just above the confluence with Lompico Creek on 18 June 1968 (M. L. Johnson, CDFG, unpubl. file report of 10 July 1968). Fish were sampled by use of electroshocking in 30–60 m long sections, and abundances were determined with the two-pass removal method of population estimation. Densities in three mainstem sections were 40 trout/30 m (below Lompico Creek), 275 trout/30 m (above Lompico Creek), and 25 trout/30 m (Quail Hollow Bridge). Most fish captured were young-of-the-year and mean lengths in each section were about 37 mm, 55 mm, and 48 mm, respectively. No fish were captured in lower Lompico Creek, and in a headwaters section, trout density was low (4 trout/30 m) but mean length (114 mm), and thus age, of these fish was greater. The largest individual measured 160 mm.

In October–November 1970, the CDFG determined juvenile steelhead lengths, weights, and abundances in the uppermost 9.7 km of Zayante Creek (L. K. Puckett, CDFG, unpubl. memo. of 25 June 1971). Fish were sampled by use of electroshocking in 10 30-m sections, and abundances were determined with the two-pass removal method of population estimation. The average section density was about 61 trout/30 m, and total abundance was estimated at 19,100 trout (95% C.L., 15,900–22,360). The number and percent of age 0+, 1+, and 2+ trout was 18,031 (94.4%), 1,012 (5.3%), and 57 (0.3%), respectively. Age 0+ steelhead ranged in length from about 4 to 11 cm, and the mode in their length-frequency distribution was between 5 and 7.5 cm. Age 1+ steelhead ranged in length from about 11 to 15 cm, and the single age 2+ trout captured was about 22 cm. Based on age-class specific survival rates to adulthood from Shapovalov and Taft (1954), the number of adults produced from the juvenile population observed in fall 1970 would be about 540 adult steelhead[2] (95% C.L., 450–630). The total biomass of the juvenile population was estimated at 95.5 kg, or 9.8 kg/km.

Juvenile steelhead samples were taken on 19–20 January 1977 by electrofishing three 30-m sections in lower Zayante Creek (CDFG, unpubl. memo. of 27 January 1977). Mean (± SD) steelhead length in the composite sample was 8.8 ± 2.6 cm (n = 82; range, 4.8–15.2 cm). Age 1 fish were roughly <9.5 cm long and comprised 62% of the sample, while age 2 fish were ≥ 9.5 cm long and comprised 38% of the sample.

During the 1978-79 spawning season, 53 redds were located in Zayante Creek; 34 (64%) were downstream from a proposed dam site near the confluence with Mountain Charlie Gulch, 19 (36%) were upstream from the dam site (D. W. Kelley, Zayante Creek Fish and Wildlife Investigation Report for the Month of April 1979, 9 May 1979). Adult steelhead had migrated into Zayante Creek during high flows in February 1979. Moving sand was identified as a potential problem for embryo survival in the redd, although some survival occurred as evidenced by the presence of emergent steelhead fry.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites was 7.2 ± 7.0 trout/m, which was relatively high (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 89 ± 3 mm SL, which was below average.

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2. In a reworking of Puckett's data, D. Dettman (unpubl. file report attached to letter of D. W. Kelley, 9 May 1979) arrived at a lower estimate of 153 returning adult steelhead.

In 1984, removal of a bedrock waterfall barrier allowed steelhead access to an additional 8 km of stream habitat in the Zayante Creek system.

The Zayante Creek tributary, Bean Creek, was surveyed by the CDFG in October 1956. The stream was noted as one of the better steelhead production areas in the San Lorenzo River drainage. High quality spawning grounds were apparently abundant throughout the 11 km survey area, and rearing habitat seemed adequate. Logjams created complete migration barriers at two locations in the middle and upper survey area. Juvenile steelhead, 5–7.5 cm in length, were abundant throughout the survey area. The largest trout seen were about 15 cm long. It was also noted that hatchery-reared juvenile steelhead and resident rainbow trout had been stocked in Bean Creek during 1940–43 and 1950–51.

Three pairs of adult steelhead were seen spawning on a riffle near the Salvation Army camp bridge on 1 March 1957.

Juvenile steelhead were observed in Bean Creek in June 1962 during a CDFG spot check. The stream was surveyed from the mouth to its headwaters (14.5 km) by the CDFG in September 1966. By this time, siltation had reduced spawning areas for steelhead; there were short reaches of loose gravel in the middle stream area, but none was found in the lower stream area. Discharge from sand processing plants was the main silt source. Pools were very shallow, but shelter was adequate, and migration barriers were identified, the uppermost being a bedrock waterfall which marked the upstream limit for migrating fish. The lower stream contained juvenile steelhead (5–7.5 cm in length) at a density of about 10–15 trout/30 m. No fish were observed in the upper stream area.

Abundance estimates were made by electrofishing several randomly-selected 30 m reaches in six 1.6-km sections of Bean Creek in 1970, using the two-pass removal method (L. K. Puckett, CDFG, unpubl. memo. of 30 December 1971). Juvenile steelhead abundance ranged from 24 trout/100 m at the mouth to 74 trout/100 m in the upper stream, and averaged 53 ± 17 trout/100 m among the six sections.

When surveyed by the CDFG in July 1971, the siltation problem, especially in lower Bean Creek, was apparently alleviated. Spawning and rearing areas were present, and in good condition, from the mouth to above Glenwood. Juvenile steelhead, including young-of-the-year, were abundant.

The mean (± SD) length of juvenile steelhead electrofished at two stations in Bean Creek on 13 October 1973 was 7.1 ± 1.4 cm; lengths ranged from 4.6 to 13.7 cm (derived from unpubl. CDFG data). So, juveniles were mostly age 0+, although a few 1+ trout were also present. Five adult steelhead (38–50 cm long) and one 25-cm male O. mykiss were observed in a 122 m reach of Bean Creek near Mt. Herman on 20 November 1973.

Erosion/siltation and barrier problems in Bean Creek were identified by the CDFG in early June 1980. Young steelhead, mostly 2.5–5 cm but up to 25 cm in length, were observed from the mouth to above Camp Redwood Glen. Six steelhead redds were seen between MacKenzie Creek and Camp Redwood Glen (L. Turner, CDFG, unpubl. memo. of 5–8 June 1980).

In late fall 1981, the mean ± SD density of smolt-sized steelhead at four sites was 3.1 ± 2.9 trout/m, which was slightly below average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 98 ± 5 mm SL, which was above average. The density of smolt-sized steelhead at this time at one site in Lockhart Gulch, a Bean Creek tributary, was 1.0 trout/m, which was well below average (derived from Smith 1982b). The mean length of these fish was 119 mm SL, and thus well above average.

The CDFG surveyed Bean Creek in April 1982 following the heavy storms in January 1982. Steelhead access was blocked by numerous logjam and debris dams, and spawning areas were very limited due to extensive siltation. Some young-of-the-year steelhead were observed.

Another Zayante Creek tributary, Mountain Charlie Gulch, contained numerous juvenile steelhead at its mouth when surveyed by the CDFG in October 1959. Smith (1982b) also noted this creek as a productive spawning tributary for steelhead, but did not sample it.

San Vicente Creek Drainage

The San Vicente Creek steelhead population was supplemented by the CDFG with a total of 71,000 hatchery-reared juveniles during 1930–39. As a comparative measure of adult run size, Shapovalov and Taft (1954, p. 201) mentioned that the San Vicente steelhead run was smaller than those observed at Scott and Waddell creeks during the 1930s–1940s. Naturally propagated juveniles (7.5 cm in length) were seen in the stream by the CDFG in August 1960. In March 1962, both adult and juvenile steelhead were observed below a landslide which had temporarily blocked the stream. The stream and its drainage area were developed considerably during the late 1960s and early 1970s; development activities substrate extraction, water diversion and/or impoundment, and logging.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at six stream sites was 4.7 ± 2.3 trout/m, which was above the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 88 ± 5 mm SL, which was below average.

In July 1985, the CDFG rescued a 79 cm, 5-year-old adult steelhead from San Vicente Creek and transferred it to the mouth of Scott Creek. An approximately 1.6 km section of the creek, above the Pfyffer diversion, was surveyed by the CDFG on 26 June 1985 (D. Marston, CDFG, unpubl. memo. of 27 June 1985). Unembedded spawning gravel was abundant, and young-of-the-year steelhead juveniles were also abundant. Some yearlings were seen in larger pools. Screened diversions were present, and some siltation was occurring from the washing out of temporary dams, and from bank erosion. Fish passage was rated as good, and rearing habitat for juvenile steelhead was excellent.

An adjacent downstream section of San Vicente Creek was surveyed in early July 1985 (D. Marston, CDFG, unpubl. memo. of 3 July 1985). Suitable spawning gravels were present throughout this 2 km section, and young-of-the-year steelhead were abundant (about 700 seen). One adult was also observed. Potential barriers were identified.

The lower portion of the stream was surveyed by the CDFG in late July 1985 (D. Marston, CDFG, unpubl. memo. of 25 July 1985). High quality spawning substrate was not present in this area, but numerous young-of-the-year and yearling steelhead were observed there. Rearing habitat appeared adequate. A diversion dam acted as a temporary migration barrier, and there was an unscreened off-stream diversion channel which entrained juvenile steelhead. There was also some pollution in this lower stream area, located within the town of Davenport. So, despite considerable development, San Vicente Creek was still a highly productive steelhead stream.

Mill Creek. In the San Vicente tributary, Mill Creek, in late fall 1981, the mean ± SD density of smolt-sized steelhead at two sites was 3.4 ± 2.6 trout/m, or slightly below average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 79 ± 0 mm SL, which was the lowest county-wide average.

Scott Creek Drainage

Estimates of the number of females in the spawning runs during 1905–40 (Fig. 12) are currently being developed from egg collection and fecundity data (p. 148 in Shapovalov and Taft 1954 for length-fecundity relationship of Scott Creek steelhead).

Early fish planting records for Santa Cruz County showed that the Scott Creek steelhead population was supplemented with 121,000 juveniles in 1913 and 148,000 in 1915 (D. Streig, Monterey Bay Salmon and Trout Project, unpubl. report: History of fish cultural activities in Santa Cruz County with reference to Scott and Waddell creeks). Planting data for other years during 1905–1929 were either missing or were composites for all of Santa Cruz County and, thus, did not specify the number of juvenile steelhead stocked in Scott Creek alone. These plants were of Scott Creek steelhead cultured at either the Big Creek or Brookdale hatcheries, except in 1928 when 152,000 steelhead from the Mt. Shasta Hatchery were planted in Santa Cruz County because furunculosis (*Aeromonas salmonicida*) destroyed most of the production at the local hatcheries.

CDFG fish stocking records from the 1930's showed that the population was supplemented with 8,000 juvenile steelhead in 1930; 65,000 in 1932; 42,340 in 1933; 37,764 in 1934; 5,614 in 1935; 115,000 in 1936; 174,986 (@ 37–1,340/kg) in 1938; and 221,034 (@ 44–4,233/kg) in 1939. All these plants comprised Scott Creek steelhead hatched at Big Creek or Brookdale. No specific Scott Creek planting record was discovered for 1940 when the Big Creek Hatchery was closed (Leitritz 1970; see Big Creek, below), but all steelhead planted in Santa Cruz County that year were of Scott Creek origin. Juvenile steelhead planted in Santa Cruz County in 1941 were from eggs of Prairie Creek Hatchery origin which were hatched at Brookdale. The hatchery operation at Brookdale continued until 1953 (Leitritz 1970; see San

Lorenzo River Drainage) supplied with surplus eggs from other CDFG hatcheries in northern California. In a CDFG file letter of 27 May 1948, it was indicated that 6,000 resident rainbow trout (@ 705 fish/kg) would be stocked during the 1948 season. It was also mentioned that stocking had not been carried out in Scott Creek in 1947. No records have been found which specify plants made in Scott Creek or other Santa Cruz County streams during the remainder of the period, 1942–53 (D. Streig, Monterey Bay Salmon and Trout Project, unpubl. report: History of fish cultural activities in Santa Cruz County with reference to Scott and Waddell creeks). Consult Dayes (1987) for further information pertaining to the history of fish culture and related activities in Santa Cruz County.

When Scott Creek was surveyed by the CDFG in 1934, it was already apparent that the stability of the stream environment was being impacted by water extraction. Twelve diversions, which consisted of pumps with screened intakes, were counted. The surveyor indicated in the report that the creek dried up in two major reaches due to the effects of pumping: from the mouth to 3.2 km upstream; and from Seaside School to the mouth of Big Creek, for a distance of about 2.4 km.

Of course, the Scott Creek drainage at that time was still very important for both the natural and artificial production of steelhead and coho salmon in Santa Cruz County. Abundant spawning grounds were available to anadromous salmonids up to a 6 m waterfall in the headwaters (distance upstream not indicated in this survey). Angling pressure for these fishes was heavy upstream from the confluence with Mill Creek, the only portion of Scott Creek where fishing was allowed.

On 30 September 1942, the CDFG observed several schools of 200–400 juvenile steelhead each in the lower portion of Scott Creek which usually comprises a lagoon, although no lagoon was formed on this date because the creek was open to the ocean. The total number of trout in about 90 m of stream was estimated at 1,500–3,000 fish. The steelhead ranged in length from about 10 to 25 cm, although most were about 13–18 cm long. The observer believed that these fish would be migrating back upstream later during the fall and winter, as was seen in nearby Waddell Creek (L. Shapovalov, CDFG, unpubl. field corr. of 15 October 1942).

During a survey of low flow conditions in coastal streams during July 1952, the

California State Division of Water Resources reported that juvenile steelhead were present in lower Scott Creek, about 450 m upstream from Highway 1.

The CDFG made an informal survey of Scott Creek on 23 December 1960 to check for the presence of adult steelhead. The creek had no freshwater connection with the ocean on that date, thus blocking entry of migrant spawners. Although no adults were observed in the creek, juvenile steelhead, 5–7.5 cm in length, were common throughout the survey area.

A more extensive survey of the lowermost 6.4 km of the creek was conducted by the CDFG on 5 February 1961. High quality spawning grounds were abundant, especially upstream from Big Creek. Rearing habitat in the form of pools and cover was abundant in the upper 4.8 km of the survey area. No migration barriers were noted in the survey area, although the 6 m waterfall in the headwaters was mentioned as still being a barrier. The numerous pump diversions for irrigation continued to desiccate portions of the lower stream. On this date, however, the creek was open to the ocean. The Scott Creek headwaters and tributaries had perennial flow. One adult steelhead was observed about 90 m above the confluence with Mill Creek. Juvenile steelhead, 5–10 cm in length, were common throughout the survey area, and occurred at visually estimated densities of about 100–150 trout/km and 150–300 trout/km, above and below Big Creek, respectively. Natural propagation appeared to be highly successful. Angling pressure for adult steelhead was thought to be heavy.

CDFG file documents from 1961–64 reiterated the annual problems associated with unscreened diversion of irrigation water from lower Scott Creek, and resultant losses of large numbers of juvenile steelhead and coho salmon from entrainment and desiccation.

Instream conditions at Scott Creek had apparently degraded appreciably by the time of the next CDFG survey on 14–16 June 1982 (L. Turner, CDFG, unpubl. memo. of 25 June 1982). The stream was surveyed from the mouth to about 10.5 km upstream from the Pacific Ocean in the headwaters. Siltation had apparently become a problem in the stream, perhaps as a result of the heavy storms of January 1982. Spawning gravels were shallow and occurred only in scattered patches. Pools were shallow and silted in, and logjams provided the only cover in most of the survey area; there were some deeper pools and undercut banks in the upper stream. Thirty-five logjams were counted in the survey area, of which 22 were rated as partial and 10 as complete barriers to fish migration. Despite the lack of potential spawning sites and numerous hindrances to fish movement, local residents reported that the stream received its largest run of adult steelhead and coho salmon since the 1976–77 drought. Furthermore, reproduction was apparently highly successful because, according to the surveyor, any 30 m section of the creek, from the mouth to the headwaters, “literally explode(d)” with hundreds of young-of-the-year salmonids.

On 14 August 1984, the CDFG captured 192 juvenile steelhead in Scott Creek, by electrofishing seven reaches comprising 195 m of habitat upstream from the bridge crossing on Big Creek Lumber Company property (trout density ≥ 1 fish/m). The fish averaged 6.4 cm SL (SD = 2.8 cm; range, 3.0–20.8 cm SL); thus, the sample reflected dominance of 0+ trout in the age structure of the juvenile population in this portion of the creek. Similarly, age 0+ and 1+ steelhead were abundant in an approximately 180 m reach of Scott Creek, just upstream from the Mill Creek confluence, during a brief CDFG survey on 10 July 1985.

The long-term problem of water extraction in lower Scott Creek intensified during the recent six-year (1986-87 to 1991-92) drought in California. During August 1987, most of creek, from the lagoon to a diversion point about 1.6 km upstream, was dewatered, leaving only stagnant, isolated pools as fish habitat (L. Ulmer, CDFG, unpubl. memo. of 30 September 1987). One known downstream-moving adult steelhead and several juveniles were able to survive, at least temporarily, in these pools, although dead steelhead were also observed in this stream reach. About 0.5 km above the diversion, the abundance of juvenile steelhead and coho salmon was estimated at 974 fish/km (SE = 203 fish/km; estimate made by use of electrofishing and three-pass depletion method), with coho salmon representing 9% of the catch. Thus, the potential loss of juvenile steelhead in the lower creek was on the order of about 1,400 fish, due to the effects of water removal and subsequent deterioration of water quality in remaining pools. Steelhead losses may have also occurred in the lagoon as the water level dropped due to reduced inflow, and maximum surface water temperature approached 25° C and salinity increased to over 5 ppt (J. J. Smith, San Jose State University, unpubl. data). Similar conditions occurred in the lagoon again in August 1988 when most steelhead present died. Observed dead steelhead ranged from 11 to 40 cm FL (mean ± SD = 16 ± 3 cm FL; n = 97), while stressed and dying individuals were generally smaller, 8–14 cm FL (n = 9). Large sculpins were also found dead.

In addition to Jennifer Nelson's memorandum on downstream migrant trapping results in 1992, population estimation data collected by Snider in 1988 and Jones in 1991 are also currently being summarized.

Big Creek

Scott Creek's largest tributary, Big Creek, has played an important role in the culture of steelhead in Santa Cruz County. The Big Creek Hatchery began operations in 1927 as a supplement to the Brookdale Hatchery on the San Lorenzo River, because of a deficient water supply at the latter site (D. Streig, Monterey Bay Salmon and Trout Project, unpubl. report: History of fish cultural activities in Santa Cruz County with reference to Scott and Waddell creeks). As at Brookdale, eggs from Scott Creek steelhead were hatched at the new facility, and the young reared for local stocking. The Big Creek Hatchery was not without its own problems, however, where breakouts of furunculosis greatly reduced production in 1928 and 1939. Heavy flooding in early 1940 severely damaged the hatchery (Leitritz 1970), as well as the Scott Creek Egg Collecting Station, and operations at both facilities were discontinued. Consult Dayes (1987) for further information pertaining to the history of the Big Creek Hatchery.

CDFG fish stocking records from the 1930's showed that the Big Creek steelhead population was supplemented with 26,000 juveniles in 1930 (10,000 above and 16,000 below an impassable waterfall, respectively); 27,000 in 1932 (12,000 above and 15,000 below the waterfall, respectively); 7,220 in 1933; 14,768 in 1934; 60,000 in 1935; 30,000 in 1936; 136,956 (@ 268–1,340/kg) from Big Creek Hatchery in 1938; and 183,971 (@ 38–4,233/kg) from Big Creek Hatchery in 1939.

Historically, Big Creek has supported a small run of wild steelhead. The creek was surveyed by the CDFG in 1934. Anadromous salmonids had access to only the lowermost 4 km of the creek because of an impassable waterfall barrier, leaving about 7 km upstream. Juvenile steelhead and coho salmon were present in the stream portion below the waterfall. Salmonid spawning grounds, and consequently the extent of natural propagation, were described as poor.

The surveyor believed that no wild population of rainbow trout existed above the waterfall, and that the trout present above the fall were only the result of stocking and not natural propagation. An hydroelectric power generating plant was located in the upper watershed which temporarily diverted water from the creek; its intake was unscreened. Fishing pressure on Big Creek was rated as heavy.

The CDFG surveyed the lowermost 4 km of the creek up to the waterfall barrier, and the uppermost 1.6 km of the headwaters, on 13–14 January 1958. The intervening 4.8 km were not surveyed because of limited access to this stream reach. Much of the stream substrate was granitic sand. There were some salmonid spawning areas in the lower section but none in the upper section. Rearing habitat in the form of pools and cover was adequate for juvenile steelhead in the lower section. In addition to the abovementioned waterfall barrier, two more such natural barriers reportedly existed in the unsurveyed portion of the stream. One small summer diversion occurred in the extreme headwaters. No steelhead or coho salmon were observed during this survey, although local residents reported that these fishes continued to utilize the lower creek available to them. Contrary to the 1934 survey, a wild population of resident rainbow trout reportedly inhabited the stream above the waterfall.

The CDFG observed juvenile steelhead in lower Big Creek, at the confluence with Scott Creek, on 13 October 1959.

When the CDFG surveyed the lower creek up to the first waterfall on 7 July 1960, spawning and rearing conditions for steelhead were apparently much the same as in the 1958 survey. The visually estimated density of young-of-the-year steelhead was 3–4 fish/30 m throughout the survey area. These fish were 4–5 cm in length. Siltation was noted as a factor which was possibly limiting steelhead production in the creek. The local land owners claimed that the adult steelhead run had declined considerably since 1930.

During a brief check of a 400 m reach of lower Big Creek on 5 February 1961, the CDFG saw no adult spawners, but juvenile steelhead were observed at a visually estimated density of 1–3 fish/pool.

The overall condition of lower Big Creek as a salmonid production area apparently improved during the ensuing 20 years. When surveyed for logjam barriers by the CDFG on 17

June 1982 (L. Turner, CDFG, unpubl. memo. of 29 June 1982), spawning areas for steelhead were described as being adequate and existed from the mouth to the first waterfall, the upstream limit of the survey. Pools and cover were generally adequate for juvenile steelhead, although low-velocity areas for newly-emerged fry were scarce. Young-of-the-year salmonids were common in lateral habitats. Siltation was noted as minor, and none of the six logjams in the survey area comprised a complete barrier to fish migration.

The CDFG observed an abundance of young-of-the-year steelhead in lower Big Creek on 9 July 1985. A screened agricultural diversion existed on the creek, about 18 m upstream from the Swanton Road bridge crossing.

During habitat mapping surveys conducted by the CDFG during July–September 1987, juvenile steelhead were observed at several locations in Big Creek, from the confluence with Scott Creek to near the confluence with Berry Creek. Maximum estimated trout lengths ranged from 15 to 25 cm in some pools. Sediment sources were identified; e.g. eroding stream banks and road crossings.

Dean Marston's 1992 report is currently being reviewed for inclusion here.

In 1982, fish culture activities on Big Creek were resurrected at the old CDFG hatchery site by the Monterey Bay Salmon and Trout Project. A summary of these operations is currently being prepared.

<u>Little Creek</u>

Jennifer Nelson's 1992 survey report for Little Creek is currently being reviewed for inclusion here.

<u>Mill Creek</u>

Mill Creek is the uppermost of the larger tributaries to Scott Creek. Steelhead and coho salmon have historically had access to the lowermost 4.2 km of the creek, at which point a series of natural waterfalls blocks upstream migration of fishes. There is a reservoir in the headwaters of the creek, the dam of which was constructed in 1889. The dam, which diverted water for power production, lacked a fishway. The report of a 1934 CDFG survey indicated that spawning grounds existed in the lower creek which were utilized by steelhead and salmon. Fishing pressure was rated as heavy. Stream flow was apparently very low during late summer. Early records showed that the CDFG supplemented the Mill Creek steelhead population with 8,000 juveniles in 1932.

In a CDFG survey made of Mill Creek Reservoir on 29 July 1948, it was reported that "considerable numbers" of rainbow trout inhabited the reservoir, and that natural reproduction was highly successful in the high quality spawning grounds which existed in Mill Creek above the impoundment. The reservoir had apparently been stocked with rainbow trout at irregular intervals since at least the early 1920's. It was not mentioned if wild resident rainbow trout were historically also present in the drainage above the waterfalls.

The CDFG surveyed the lowermost 2.4 km of Mill Creek on 25 July 1957. High quality spawning grounds still existed in the lower creek, and rearing habitat for juvenile steelhead in the form of pools and cover was at least adequate. Young steelhead, averaging 5–7.5 cm in length, were very abundant, and natural reproduction was considered highly successful. Angling pressure was light. In addition to the abovementioned waterfalls and dam, a logjam created a potential migration barrier at the creek mouth. The main diversion on the creek was at Mill Creek Reservoir, although one small residential diversion was also noted in the lower stream. The Mill Creek Dam had washed out the previous winter, and the earthen dam material, as well as soft sediment from the reservoir bottom, covered the stream substrate for about 1.6 km below the dam. However, this condition did not persist into the downstream steelhead production area on the survey date.

The CDFG observed an abundance of juvenile steelhead in Mill Creek, at its confluence with Scott Creek, on 13 October 1959.

The lowermost 4.2 km of Mill Creek, up to the first waterfall barrier, were surveyed by the CDFG on 7 July 1960. Spawning and rearing conditions for steelhead were apparently unchanged from the 1957 survey. Visually estimated densities of juvenile steelhead were high and generally increased as one progressed downstream through the survey area. The estimates ranged from 30 trout/30 m near the waterfalls, to 100 trout/30 m near the creek mouth. The trout were about 2.5–12.5 cm in length, and averaged 5–7.5 cm. So, the juvenile population apparently comprised age 0+ and 1+ trout, with 0+ trout probably dominating in number. Mill

Creek was rated as an exceptional steelhead stream for its size, although it was the surveyor's opinion that any increase in upstream water diversion would significantly impact steelhead production.

The CDFG checked an approximate 1.6 km reach of lower Mill Creek on 5 February 1961. No adult steelhead were seen, but juveniles were abundant and occurred at densities of 5–10 trout/pool.

Soquel Creek Drainage

Soquel Creek is historically one of the most important steelhead spawning and rearing streams in Santa Cruz County. Snyder (1913) found juvenile steelhead/rainbow trout in Soquel Creek when he sampled there in summer 1909. The steelhead population was supplemented with a total of 30,800 juveniles (@ 1,060–1,130/kg) from Brookdale Hatchery during June–July 1938. A local angler reported that an estimated 5,000–6,000 juvenile steelhead (mostly <18 cm long) were taken on hook-and-line from Soquel Creek lagoon during May 1947.

Soquel Creek, below the confluence of the east and west branches, was surveyed by the CDFG on 8 October 1959. Spawning and rearing habitats for steelhead were adequate, and there were no migration barriers. Juvenile steelhead were observed at every survey station. These fish ranged in length from 2.5 to 25 cm, and averaged about 5 cm. Juvenile abundance in mainstem pools was generally not as great as in pools in the east and west branches (see below). At the time of this survey, Soquel Creek was stocked with catchable rainbow trout during the summer trout season each year.

Based on data collected during the 1959 surveys in the main stem and east and west branches of Soquel Creek, the abundance of juvenile steelhead in the system was estimated at 17,500 fish. CDFG population surveys during the summer of 1962 indicated a similar number of young steelhead. This juvenile abundance corresponded to an adult steelhead run of approximately 500–1,000 spawning pairs (W. A. Evans, CDFG, unpubl. memo. of 5 November 1962).

The CDFG made two streamflow surveys in Soquel Creek during the summer of 1965, during which fish measurements were made. At a single station on 24 June 1965, juvenile steelhead averaged 9.1 cm in length (range, 6.9–13.0 cm) at a visually estimated density of about 330–460 trout/100 m. On 19 August 1965, juveniles at one site averaged 6.9 cm in length (range, 5.6–7.9 cm) at a visually estimated density of about 330–490 trout/100 m.

A CDFG document from early 1973 summarized a variety of statistics regarding the Soquel Creek steelhead stock and fishery up to that time (E. C. Fullerton, CDFG, unpubl. memo. of 5 January 1973). In addition to the estimate of adult run size mentioned above, the winter fishery for steelhead and coho salmon comprised about 1,000 angler-use days in 1970. The summer trout fishery, which targeted juvenile steelhead rearing in the stream, comprised about 12,000 angler-use days in 1970. Steelhead used about 32 km of the Soquel Creek system for spawning and rearing. Resident rainbow trout existed in about 26 km of stream above barriers to migratory salmonids.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at four main stem sites was 1.0 ± 0.7 trout/m, which was well below the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish was 94 ± 7 mm SL, which was slightly below average.

Young steelhead were observed during a water quality investigation of Soquel Creek lagoon in May 1988 (CDFG, unpubl. file report of 21 May 1988). Juvenile steelhead were observed feeding beneath the bridge in the lower lagoon. In the upper lagoon, juveniles were 4–6 cm long at a density of 30–40 trout/100 m. Some 30–40 juvenile steelhead were observed at the inflow to the lagoon.

STATUS: The Soquel Creek steelhead stock declined significantly during the 1970’s, coincident with increased diversions and drought which reduced stream flow. Siltation and other pollution, as well as the presence of migration barriers, have likely also contributed to this decline.

Bates Creek

Bates Creek, a lower Soquel Creek tributary, was surveyed by the CDFG in March 1957, and was rated as a poor spawning and rearing stream for steelhead. The watershed was logged and, in addition to debris in the stream, erosion had led to extensive siltation. Spawning substrate was generally lacking throughout the survey area. Juvenile steelhead, about 7.5 cm in length, occurred only in low densities, and spawning success was rated as low. There was a dam lacking a fishway about 2.4 km above the mouth. No fish were seen during brief CDFG surveys in December 1960 and January 1962.

However, steelhead have continued to use this stream. For example, in late fall 1981, the density of smolt-sized steelhead at one site in Bates Creek was 2.0 trout/m, which was about half the county-wide average (derived from Smith 1982b). The mean length of these fish was 91 mm SL, which was also below average. In July–August 1986, juvenile steelhead were observed in numerous pools downstream from the dam, and resident rainbow trout above the dam (County of Santa Cruz 1986).

East Branch Soquel Creek

The CDFG surveyed 11 km of the East Branch Soquel Creek on 28 September 1959, beginning at the confluence with the west branch. Spawning and rearing habitats were in excellent condition. There were natural boulder and bedrock barriers in the upper stream. Young trout observed above the barriers may have been resident rainbow trout. The east branch was rated as the most productive steelhead area in the Soquel drainage system; 11,500 juvenile steelhead were counted along the length of stream available to migratory trout. These fish averaged about 5 cm in length (range, 2.5–15 cm). At the time of the survey, the lower section of the east branch was stocked annually with catchable rainbow trout.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites in the east branch was 2.0 ± 2.0 trout/m, which was below the county-wide average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish, 102 ± 14 mm SL, was above average. In July–August 1986, juvenile steelhead were abundant in the east branch, from its confluence with the west branch to a bedrock waterfall nearly 10 km upstream (County of Santa Cruz 1986). Resident rainbow trout populated high quality salmonid habitat above the falls.

The east branch tributary, Amaya Creek, was surveyed by the CDFG in March 1957. It was noted as a mostly pristine spawning and nursery stream for Soquel Creek steelhead. The stream had good to very good spawning areas and adequate rearing habitat. There were no diversions and only partial barriers formed by logjams. Juvenile steelhead, averaging about 7.5 cm in length, were common throughout the 1.6 km survey area. A local resident reported that adult steelhead had historically migrated nearly up to Stetson-Longridge Roads to spawn.

By the time Amaya Creek was surveyed again in October 1959, the effects of logging had significantly degraded the stream habitat quality for producing steelhead. Spawning areas were now practically nonexistent in the upper two-thirds of the stream, siltation as a result of erosion was common, and the large amount of logging debris clogging the stream created many migration barriers. About 1,500 young-of-the-year steelhead were observed, but only in the lowermost third of the stream.

Amaya Creek was not surveyed again by the CDFG until May 1982, following the heavy storms of January 1982. Only the lowermost 0.4 km of the stream was accessible due to fallen trees and logjams, and a few steelhead fry were seen only at the creek mouth. The stream apparently no longer supported a run of steelhead. In July–August 1986, O. mykiss were observed in the creek; these fish were believed to be resident rainbow trout due to the presence of major logjam barriers (County of Santa Cruz 1986).

The east branch tributary, Hinkley Creek, was surveyed by the CDFG in 1959 and 1977 (Smith 1982b), although the file containing these survey reports was not located. In late fall 1981, the density of smolt-sized steelhead at one site in Hinkley was 1.0 trout/m, which was well below average (derived from Smith 1982b). The mean length of these fish was 84 mm SL, which was also well below average.

Moore's Gulch

In late fall 1981, the density of smolt-sized steelhead at one site in Moore's Gulch, a main stem Soquel tributary, was 1.6 trout/m, which was well below average (derived from Smith 1982b). The mean length of these fish was 97 mm SL, which was near average.

West Branch Soquel Creek

The CDFG surveyed the West Branch Soquel Creek on 30 August 1946, in its middle portion at the "Napier" dam located downstream from Laurel Creek. This dam was a complete barrier to migrant spawners. Young-of-the-year steelhead were abundant below the dam. Spawning areas were also observed above the dam, and juvenile resident rainbows, 5–9 cm long, were fairly common up to the confluence with Laurel Creek.

The headwaters of the west branch, upstream from Laurel, were surveyed by the CDFG on 25 August 1948. Siltation and rock- and logjams were noted as problems, the jams being the result of abandoned railroad and logging operations. Juvenile resident rainbow trout, 5–13 cm long, were scarce.

The west branch was fully surveyed by the CDFG on 5 October 1959. Spawning areas were abundant, and rearing habitat was adequate. Juvenile steelhead were present, apparently in low densities.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at three sites in the west branch was 3.7 ± 2.2 trout/m, which was about average (derived from Smith 1982b). The mean ± SD of the site-specific mean lengths of these fish, 87 ± 5 mm SL, was well below average. In July–August 1986, high densities of young-of-the-year steelhead were observed in the west branch, from its confluence with the east branch to the water supply dam near the confluence of Burns and Laurel creeks (County of Santa Cruz 1986). O. mykiss were seen in lower densities above the dam; these fish may have been resident rainbow trout.

In late fall 1981, the mean ± SD density of smolt-sized steelhead at two sites in Hester Creek, a west branch tributary, was 2.3 ± 0 trout/m, which was rather below average (derived from Smith 1982). The mean ± SD of the site-specific mean lengths of these fish was 88 ± 2 mm SL, and thus also below average. In July–August 1986, juvenile steelhead were abundant in the lowermost 1.3 km of Hester Creek. Fish believed to be resident rainbow trout inhabited the stream in relatively low densities above a bedrock waterfall.

Waddell Creek Drainage

Waddell Creek and its steelhead population are best known as the objects of study by Shapovalov and Taft (1954). This landmark study provided data on the natural variation in numbers of migrant spawners, as produced by the stream system during the 1930's[3]. During the

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3. A summary and analysis of the life history of Waddell Creek steelhead, based on data from Shapovalov and Taft

nine-year study period (1933–34 through 1941–42), estimated total run size ranged from 428 to 554 and averaged 481 (SD = 40; data from Table 35 in Shapovalov and Taft 1954). The overall decreasing trend in total run size (Fig. 13) was nearly significantly correlated with time ($r^2 = 0.42$, $p = 0.06$), although it is not known if this represented an actual decline in the population, or a temporary trend of suboptimal recruitment years, possibly as a function of the negative density-dependent stock-recruitment relationship of the population (see Life History Analysis).

Based on a CDFG file document (CDFG, unpubl. field note of 11 February 1962), a large run of adult steelhead reportedly entered Waddell Creek during the first week of February 1962. Yet another file document indicated that, as of 1967, local CDFG wardens estimated the adult steelhead run in Waddell Creek at 350 fish or more (M. L. Johnson, CDFG, unpubl. field corr. of April 1967).

Seining surveys were conducted in lower Waddell Creek, downstream from the Highway 1 bridge, on 11 November 1970 and 1 May 1971 (surveyors and their affiliation not identified). Juvenile steelhead were present throughout the survey area in both surveys, and in the November 1970 survey, all were <25 cm in length and appeared to be age 1+ fish.

SilverKing Oceanic Farms (originally Pacific Marine Enterprises) operated a commercial "salmon ranching" operation in the Waddell Creek lagoon during the late 1960's and early 1970's. Steelhead, coho salmon, and chinook salmon from exotic hatchery stocks were reared at their private hatchery on Bean Creek, marked, and then released at Waddell Creek to emigrate and grow to maturity in the Pacific Ocean. The mature fish would then return to be captured at a weir situated in lower Waddell Creek. A total of 77,000 steelhead yearlings was released at Waddell Creek through 1971, representing progeny from the 1967-68 through 1970-71 brood years (M. L. Johnson, CDFG, unpubl. progress report of 7 January 1972). Although the data

(1954), were presented earlier in the Results under Life History Analysis, and will not be repeated here.

were incomplete, adult returns during the 1970-71 season included 16 marked steelhead, comprising nine females and seven males. Among these fish, two females weighed about 5 and 7 kg each, two males were also full-size adults, and five males were “jacks” (males 25–35 cm in length which have spent only one summer rearing in the ocean). In addition, 272 wild steelhead were passed upstream at the trapping facility. As of 7 January 1972 (1971-72 season), 17 wild steelhead had been counted at the trap. The entire operation was discontinued after a flood in February 1973 destroyed the trapping facility.

Five adult steelhead, observed in a creel census conducted by Cabrillo College biology students during the 1971-72 season (unpubl. data in CDFG file), ranged in length from 53 to 75 cm. Capture dates for these fish extended from 26 December 1971 through 6 February 1972.

Juvenile steelhead were incidentally captured while seining for striped bass (Morone saxatilis) in the Waddell Creek lagoon on 14 March 1972 (K. Boettcher, unpubl. file letter of 16 March 1972 to M. Johnson, CDFG).

The main stem and east fork of Waddell Creek were surveyed by the CDFG during 4–7 & 18 August 1980, from the mouth to 12 km upstream (B. Jong, CDFG, unpubl. file report of September 1980). Siltation, from extensive streambank erosion, was occurring in especially the lowermost 2 km of the main stem. Suitable spawning and rearing habitats for steelhead were observed, presumably further upstream. Juvenile steelhead densities at two 30 m mainstem sites were 29 (95% C.I., 4–150) and 4 (0–180) trout/m2, as determined by electrofishing and application of the removal method of population estimation. Steelhead at one site in the lower east fork occurred at an estimated density of 14 (5–60) trout/m2. Beginning at about 0.8 km upstream from the confluence with the west fork, a series of falls marked the upstream limit for movement of anadromous fishes in the east fork. Densities of resident rainbow trout at three 30 m sites in the east fork were 33 (5–90), 3 (0–90), and 12 (0–120) trout/m2. Spawning and rearing habitats were reportedly limited in this high gradient stream area, yet densities of resident trout were comparable to those of juvenile steelhead. Sewage plant effluent from the Big Basin Redwoods State Park was identified as a potential pollution source of eutrophicating nutrients and toxic chlorine. Of five logjams located in the main stem, only one was a partial migration barrier. About 13% of the Waddell Creek watershed was logged between 1860 and 1966.

On 14 August 1984, the CDFG captured 93 juvenile steelhead by electrofishing in the main stem Waddell Creek immediately downstream from the forks, and upstream in both the east and west forks. The fish averaged 6.6 cm SL (SD = 2.0 cm; range, 3.3–13.7 cm SL); thus, the sample reflected dominance of 0+ trout in the age structure of the juvenile population in this portion of the creek system.

The negative effects of water extraction on California streams intensified during the recent six-year (1986-87 to 1991-92) drought. During August 1987, most of lower Waddell Creek, from the lagoon to an agricultural diversion dam about 1.4 km upstream, was dewatered (L. Ulmer, CDFG, unpubl. memo. of 30 September 1987). About 90 m above the diversion dam, the abundance of juvenile steelhead and coho salmon was estimated at 315 fish/km (estimate made by use of electrofishing and three-pass depletion method), with coho salmon representing 10% of the catch. Only 18 juvenile steelhead and coho salmon were collected in about 0.6 km of stream below the diversion. Thus, the potential loss of juvenile steelhead in the lower creek was on the order of about 400 fish, due to the effects of water removal and subsequent deterioration of water quality in remaining pools. Steelhead losses may have also occurred in the lagoon as the water level dropped because of reduced inflow, leading to unsuitable water quality conditions for juvenile steelhead. Similar conditions apparently occurred in the lower stream and lagoon again during the summer of 1988.

With regard to the latter point, Smith (1987, 1990) determined the importance of the Waddell Creek lagoon as rearing habitat for juvenile steelhead prior to their migration to the ocean.

The spring downstream migration of juvenile and post-spawner steelhead has been monitored by trapping since 1990, and this operation has produced at least preliminary results regarding the size and composition of this migration (J. J. Smith, San Jose State University, pers. comm.). In addition, an attempt was made to trap the upstream spawning migration during the 1992-93 season, although high flow conditions hampered this effort.

There are several small headwater tributaries to Waddell Creek for which there is no documentation of presence or absence of O. mykiss. These streamlets include the west branch tributaries, Timms and Kelly creeks; and the east branch tributaries, Blooms Creek (including its tributary, Sempervirens Creek along with Union Creek) and Opal Creek (including its tributaries, Rogers and Maddock creeks). These small feeder creeks are nonetheless important because they contribute to the perennial flow in the upper Waddell Creek drainage.

Wilder Creek Drainage

MONTEREY COUNTY

Alder Creek Drainage

When surveyed by the CDFG on 19 July 1961, steelhead apparently entered the lower reaches of Alder Creek during wet years. The stream had a relatively high gradient, and spawning areas were scarce and limited to pockets of fine gravel scattered throughout the upper and lower sections of the 3.2 km survey area. Rearing habitat for juvenile steelhead, in the form of pools and cover, was adequate. The middle section contained three complete barrier waterfalls. No permanent diversions were observed. The stream apparently contained both resident rainbow trout and juvenile steelhead throughout the survey area. Fish lengths were 2.5–15 cm, with the modal length at about 9 cm SL. In a series of 20 pools, the average trout density was 1.75 fish/pool. Shallow pools in the upper reaches of the creek contained few, if any, trout. Due to the barriers, it was recommended that the stream be managed for brown trout.

On 8 May 1962, 6,000 brown trout fingerlings were stocked in the creek. Survival was apparently low as no brown trout were captured by hook-and-line or hand braille when the creek was sampled during 1–2 September 1963 (M. L. Johnson, CDFG, unpubl. memo. of 14 October 1963). However, juvenile steelhead/rainbow trout were caught, ranging in length from 5 to 15 cm.

The overall condition of Alder Creek was apparently unchanged when the lowermost 1.2 km were surveyed by the U.S. Forest Service (USFS) on 17 September 1981. Small to moderate numbers of steelhead reportedly ran up the stream. The average estimated density of trout was 10–12 fish/30 m. Fish lengths ranged from 2.5 to 15 cm, and averaged about 7.5 cm.

Anderson Canyon Creek Drainage

Anderson Canyon Creek, a small steep-gradient perennial stream, has evidently not been populated by steelhead within recent geological history, owing to a 3.7 m waterfall near the creek mouth at the Pacific Ocean. Resident rainbow trout have reportedly been caught in the creek in the past, but none has been observed in recent years, including during an electrofishing survey just west of Highway 1 on 5 April 1989 (Rischbieter 1990c). The Rat Creek wildfire in 1985 and subsequent heavy storms during the winter of 1985-86 may have extirpated the trout, or nearly so. As of 1989, the drainage had apparently recovered from these perturbations, which would allow for the re-expansion or reintroduction of the species.

Big Creek Drainage

The Big Creek drainage is among the largest in southern Monterey County utilized by steelhead. Shapovalov (1946) wrote that, "Good runs of steelhead ascend the stream from the sea and spawn in both forks below the falls. Resident fish of the steelhead-rainbow complex and possibly some survivors and descendants of stocked trout are present both above and below the falls in each fork."

The lowermost 2.4 km of Big Creek were surveyed by the CDFG on 6 September 1961. Suitable spawning gravels were scarce in the upper portion of the survey area, but more abundant below the confluence with the Big Creek tributary, Devil's Canyon Creek, which is located about 1.1 km upstream from the mouth. Rearing habitat, in the form of pools and cover, was adequate. A bedrock waterfall barrier, about 2.4 km upstream from the mouth, marked the upstream limit for steelhead migration. No diversions were seen. At the confluence of Big Creek and Devil's Canyon Creek, 5–10 cm long juvenile steelhead/rainbow trout occurred at a visually-estimated density of 8 fish/30 m. Trout densities were lower above this point, but as high as 55 fish/30 m near the creek mouth. Trout in the lower stream were up to 15 cm long. Although none was seen, brown trout also reportedly occurred in the creek system, including Devil's Canyon Creek.

Since 1978, a significant portion of the Big Creek drainage has been in the possession of the University of California and administered as an ecological preserve and scientific research area. According to personnel at the reserve, both the frequency of large adult steelhead spawners (>50 cm TL) and the size of the runs appeared to decrease overall during the 1986/87–1991/92 drought (J. Smiley, Landels-Hill Big Creek Reserve, pers. comm. of 13 December 1993). For example, two runs of 10 or so readily-noticeable adults were seen during the 1986-87 spawning season. Nothing comparable has been observed since then. During the relatively wet 1992-93 spawning season, only smaller adults (about 35–45 cm TL) and their redds were seen. Juvenile steelhead/rainbow trout have persisted in the creek system; these fish are mostly <18 cm TL although an occasional 25–30 cm long individual is observed. Overall, the Big Creek drainage is a stable stream system that should continue to provide suitable spawning and rearing habitat for both steelhead and rainbow trout.

Devil's Canyon Creek

Devil's Canyon Creek (a.k.a. South Fork Big Creek) was surveyed by the CDFG on 24 July 1945, from the confluence with Big Creek to an impassable waterfall barrier about 2.8 km upstream, near the confluence with the North Fork Devil's Canyon Creek. Juvenile steelhead/rainbow trout, including young-of-the-year, were common up to the falls.

The entire creek (13 km) was surveyed by the CDFG during 29–30 August 1961. Spawning gravels were scarce in the upper survey area, and were largely cemented by limestone in the lower stream. Rearing habitat, in the form of pools and cover, was adequate for juvenile steelhead/rainbow trout. Bedrock falls were numerous. Juvenile steelhead/rainbow trout were seen throughout the stream, including 6–8 cm long young-of-the-year above the confluence with Big Creek. In the headwaters above the steelhead zone, resident rainbow trout, ranging in length from 2.5 to 18 cm and probably comprising at least three age-classes, were sampled by use of cresote. Based on very limited sampling, approximate densities were 10+ trout/30 m near Big Creek, and 30+ trout/30 m in the headwaters. Most fish were young-of-the-year.

Devil's Canyon Creek, from the confluence with the north fork to the middle and south fork headwaters, was surveyed by the U.S. Forest Service during 4–5 October 1981. The stability of the watershed was reduced by the Gamboa fires, although the stream itself was generally in good condition. Natural bedrock falls, 3 –18 m high, were common throughout the survey area and continued to preclude steelhead access beyond the north fork confluence, as described above. An abundance of deep pools continued to provide high quality rearing habitat for rainbow trout. Resident rainbow trout, about 2.5–23.0 cm long, were common in abundance, and occurred in average estimated densities of 82 and 49 trout/100 m in the main stem/south fork and middle fork, respectively.

Big Sur River Drainage

The Big Sur River drainage is currently among the largest (about 120 km^2) of those systems south of San Francisco Bay that remains mostly pristine. Within recent geological history, only the lowermost 12 km or so of the river have been accessible to steelhead. Upstream migration beyond this point in the steep and rugged gorge section of the river has been blocked by a natural bedrock fall. This feature marks the boundary above which the river flows through the Ventana Wilderness within the Los Padres National Forest. Pfeiffer Big Sur State Park is situated immediately downstream from this point along a portion of the lower river where redwoods are a major component of the riparian zone. This far south along the California coast, fog no longer maintains the moisture climate necessary for continuous stands of redwoods, and the steep hillsides that comprise the Big Sur drainage are otherwise dominated by grassland, chaparral, and oak woodland. The lowermost 6.4 km of the river flow through Andrew Molera State Park.

The following is a chronological rundown of available information on Big Sur River steelhead and resident rainbow trout. The catches of 48 anglers were checked on 1 May 1932, the opening day of the summer trout season (J. H. Wales, CDFG, unpubl. file report). A total of 451 juvenile steelhead/rainbow trout was observed, about 97% of which were age 1+ and 2+ and 10.0–15.0 cm long. The remainder of the observed catch was trout 18.0–25.0 cm in length and ≥age 2+. Three trout about 30.5 cm in length were reportedly caught, as were three adult steelhead. Recently-emerged steelhead fry were abundant along the stream margins. Wales indicated that juvenile steelhead/rainbow trout were planted in the Big Sur River, but did not know when or how old the fish were at planting.

On 9 April 1940, six adult steelhead were seen in the large pool immediately below the barrier falls, and many more were reportedly seen there a few weeks earlier attempting to ascend the falls (Shapovalov 1940). On 27 March 1946, the CDFG observed a fresh run of adult steelhead in the river, again as far upstream as the barrier falls. Recently emerged steelhead fry were also seen downstream from the falls. In 1953, the CDFG began stocking catchable rainbow trout annually during May–September to support a lower river sport fishery. Prior to that time, rainbow trout fingerlings had been planted for several years. The stocking area was a 5 km reach, mostly within Pfeiffer Big Sur State Park. Resident rainbow trout have not been planted in the Big Sur River since 1975, following adoption of the steelhead rainbow trout policy which prohibits the planting of resident fish in steelhead drainages.

About 19 km of the Big Sur River, from the bottom of the gorge upstream to Sykes Camp in the Ventana Wilderness, were surveyed by the CDFG during July–August 1957. Most of the survey area was upstream from the impassable steelhead barrier, and thus represented the stream portion inhabited primarily by wild resident rainbow trout. The river canyon was narrow and steep-sided, and contained many migration barriers. High quality spawning areas were limited. Rearing habitat was adequate for both juvenile and adult rainbow trout. Rainbow trout, 7.5–25 cm long, were observed throughout the survey area. However, recruitment to the 1957 year-class was regarded as poor since few young-of-the-year (fish ≤ 5 cm long) were seen.

On 4 January 1961, stream flow just above the lagoon was about 0.6 m3/s, and few adult steelhead had been reported in the river. Two steelhead, about 0.9 and 4.5 kg, were caught in the surf outside the lagoon. Other steelhead were also seen outside the river mouth. A 1.4 kg steelhead was captured on 31 January 1961.

Fisher (1961) captured 338 juvenile steelhead/rainbow trout in a downstream-migrant trap in the lower Big Sur River, during 30 April–2 June 1959. The number of downstream migrants captured per day was greatest during the first 3 days of the trapping period, and then decreased sharply and fluctuated around a much lower level through the remainder of the period. Most (87%) movement occurred during the night or early morning. Most downstream migrants were believed to be 1-year-olds. Some 0+ steelhead apparently also entered the trap, although their relative abundance was probably underestimated due to a low trapping efficiency for fish that size. Stream flow in the lower Big Sur River averaged 0.7 m^3/s during the study period, which was uncharacteristically low for the month of May. Thus, these steelhead emigration data may not be representative for normal or wet water years.

On 19 April 1961, young-of-the-year steelhead/rainbow trout were seen throughout the stream reach within Pfeiffer Big Sur State Park, and 12.5–15 cm long juveniles were common. An adult steelhead was caught in the lower river on 31 January 1962. On 28 April 1962, juvenile steelhead captured on hook-and-line in the lower river at a rate of 1.08 trout/angler hour ranged in fork length from 10 to 18 cm, and averaged about 14 cm (R. N. Hinton, CDFG, intraoffice corr. of 31 May 1962). On 15 May 1962, four steelhead estimated at 61 cm and 1.8–2.7 kg, and one at about 36 cm, were seen in a pool in the lower river area. On 22 May 1962, juvenile steelhead, 5–10 cm long, were common in abundance in pools up to the base of the barrier falls. In 1965, the CDFG estimated the annual steelhead spawning run in the Big Sur River at about 300 fish, based on the observations of local field personnel (California Department of Fish and Game 1965).

The CDFG surveyed the north and south forks of the Big Sur River in August 1978, following the Marble Cone fire of 1977 (P. Chappell, CDFG, unpubl. memo. of 11 June 1979). These headwaters were somewhat degraded due to the fire, yet resident rainbow trout were common in abundance, as determined by hook-and-line sampling.

Following several attempts and much discussion over the years regarding removal of the bedrock barrier in the lower gorge, the Big Sur drainage above the barrier was surveyed by the CDFG and USFS during 14 July–4 August 1981 to determine the quantity and quality of stream habitat that would become available to steelhead for spawning and rearing (USFS stream survey reports, and summary by R. C. Benthin, CDFG, unpubl. memo. of 26 August 1981). High quality steelhead spawning and rearing habitats were observed throughout the survey area, including: the entire 21.7 km of the main stem; the lowermost 1.6 km each of the mainstem tributaries, Ventana and Lion creeks, and the lowermost 160 m of the Ventana Creek tributary, Doolans Hole Creek; the lowermost 7.2 km of the North Fork Big Sur River; and the lowermost 4.0 km of the South Fork Big Sur River up to an 3.7 m high bedrock migration barrier. So, with removal of the bedrock barrier in the lower gorge, at least 36 km of habitat would become accessible to steelhead; an unknown proportion of another 19 km of unsurveyed stream sections would also become available. The mainstem tributaries, Logwood and Terrace creeks, and the

North Fork tributary, Cienega Creek, all had an impassable bedrock waterfall at their mouths. The North Fork tributary, Redwood Creek, was full of debris, apparently as a result of the Marble Cone fire. Resident rainbow trout, including young-of-the-year, were abundant in all stream sections surveyed, and occurred in section specific visually-estimated average densities of 40–100 trout/30 m. A subsample of 50 hook-and-line captured rainbow trout averaged about 15 cm FL (overall range, 10.0–35.0 cm FL). The USFS stream survey report indicated that the CDFG had planted rainbow trout at Barlow Flat in 1948, but none since that time in the stream area above the gorge.

Beginning in the fall of 1981 and through the fall of 1984, a series of modifications was carried out on the barrier to enhance steelhead passage. Six adult steelhead were observed by the CDFG on 18 March 1985 between Barlow Camp and the gorge. Adult steelhead have also been reportedly seen by anglers in upstream areas in subsequent years (K. R. Anderson, CDFG, pers. comm. of 9 July 1992).

On 7 November 1988, abundance estimates of juvenile steelhead were made by the CDFG in two sections of the lower river, each about 46 m long. Fish were sampled by electrofishing, marked, released, and resampled to make Lincoln-Peterson abundance estimates. In a section just below the confluence with Post Creek, the calculated abundance was 109 trout/30 m. These fish averaged 84 mm FL (range, 55–247 mm FL). The second section, located in Andrew Molera State Park, contained an estimated 128 trout/30 m. Average fish length was 82 mm FL (range, 55–140 mm FL). A sample of juvenile steelhead was also collected in Molera Park by electrofishing on 17 July 1990 (D. C. Rischbieter, California Department of Parks and Recreation, unpubl. data); these fish averaged 86 mm SL (SD = 32 mm SL; range, 50–175 mm SL).

The largest adult steelhead reported from the Big Sur River was an illegal catch that measured 90 cm and weighed about 7 kg (Rischbieter 1990a). During the 1992-93 season, the reported angler catch of adult steelhead in the Big Sur included one 79 cm female and several 56 cm fish (M. Fitzsimmons, CDFG, pers. comm. of 13 March 1993).

Recent study of juvenile steelhead habitat use in the lower Big Sur River shows that the entire area, from the lagoon to the gorge, remains highly functional for steelhead production (R.

G. Titus, CDFG, unpubl. data of 1992–1995). Preliminary analysis suggests that most juveniles leave the stream after only one year of rearing, and that there is a relatively small proportion of mainstem fish that appears to be resident rainbow trout. Most mainstem trout are infested with encysted metacercaria of the monogenetic trematode, *Neascus*, a condition commonly referred to as “black spot disease.”

Resident rainbows are still abundant above the barrier falls in the gorge, and these fish too have black spot disease (C. Carpanzano, U.S. Forest Service, unpubl. letter of 24 September 1993). Some of these trout may be juvenile steelhead, but it is not clear if adult steelhead are still able to negotiate the barrier falls.

STATUS: Overall, the Big Sur River continues to support a healthy steelhead population, one that Nehlsen et al. (1991) classified as a stock of special concern.

Juan Higuera Creek

Juan Higuera Creek is the largest perennial tributary to the lower Big Sur River. The CDFG surveyed the creek on 8 August 1961. Steelhead spawning areas were lacking as stream substrate materials were cemented by calcium carbonate precipitates. Rearing habitat in the form of pools and cover also appeared limited. Several potential barriers to upstream movement of adult steelhead were identified. Two small pipe diversions removed water from the stream. No fish were seen during the survey although local residents reported that each small pool in the stream supported one catchable size (15–20 cm long) juvenile steelhead/rainbow trout. Adult steelhead reportedly migrated into Juan Higuera Creek during high flow periods in winter (R. L. Moore, CDFG, unpubl. draft memo. of August 1960).

Another long-time streamside resident and landowner corroborated historical presence of adult steelhead in Juan Higuera Creek (K. Wright for D. Fee, Big Sur, CA, pers. comm. of 4 February 1994). Steelhead were seen and captured in the creek until 1972, when the combined effects of an upslope fire and heavy flooding washed out the road crossing near the creek mouth. A culvert was subsequently installed which then created at least a partial barrier to upstream migrating adult steelhead.

Recent study of juvenile steelhead habitat use in the lower Big Sur River reveals that

Juan Higuera Creek is still well-populated with juvenile steelhead/rainbow trout (R. G. Titus, CDFG, unpubl. data of 1992–95). Preliminary analysis of population structure suggests that lower Juan Higuera Creek is populated by a mixture of juvenile steelhead and resident rainbow trout, as evidenced by a relatively high proportion of age 0+ fish. What is not clear is whether steelhead actually spawn in the creek and their progeny rear there, or if juvenile steelhead migrate into the creek from the Big Sur River. The population in upper Juan Higuera Creek is much more sparse in comparison, and clearly characterized by a higher proportion of larger, older individuals, including mature adults, suggesting a resident rainbow trout population segment.

Post Creek

Post Creek enters the lower Big Sur River within Pfeiffer Big Sur State Park. Shapovalov (1940a) described the creek as "an inconsequential stream that is reported to go completely or nearly dry each summer", in his consideration of potential hatchery sites in the park and vicinity. In contrast, Rischbieter (1990d) noted the creek as an historically perennial stream, and when surveyed by the CDFG in 1980, the creek was identified as an important spawning and rearing area for steelhead. At that time, only the lowermost 275 m of the creek were accessible to steelhead because of an impassable logjam. The stream habitat consisted primarily of small pools and low gradient riffles. The calculated juvenile steelhead abundance for this area was >1,000 fish, or >365 trout/100 m of stream.

The stream habitat at Post Creek has degraded significantly in recent years (Rischbieter 1990d). In 1986, a landslide occurred about 335 m above the creek mouth which introduced a large amount of sediment into the lower creek. The sediment filled in pools and covered spawning gravels. The lower creek went dry during the summer–fall period of the drought years 1988 and 1989. Apparently, drought effects were exacerbated by water withdrawal by the Ventana Inn and other upstream water users. Rischbieter (1990d) concluded that these conditions precluded steelhead use of the creek, and no fish were seen during a brief survey of the lower creek on 18 September 1992 (R. G. Titus, Univ. Calif., Berkeley, unpubl. field notes).

Adult steelhead spawned in lower Post Creek during the wet winter of 1992–93, and steelhead fry were seen in the creek, above the upper road crossing in the campground, on 10 June 1993 (R. G. Titus, CDFG, unpubl. memo. of 12 August 1993). On 9 July 1993, a 64 m long section, from the upper road crossing to the first foot trail crossing upstream, was sampled by electrofishing. Juvenile steelhead abundance was estimated using the two-pass removal method. The estimated abundance of age 0+ steelhead was about 35 fish (54 fish/100 m), and that of age 1+ steelhead was 2 fish (3 fish/100 m). Age 0+ fish comprised about 94% of the steelhead catch. The mean (± SD) length of age 0+ steelhead was 55 ± 12 mm TL (n = 34), and the two age 1+ fish were 101 and 137 mm TL. Age 0+ steelhead also occurred between the upper road crossing and the creek mouth, but no fish were found in the 50+ m of stream spot-checked immediately above the foot trail crossing. Several potential migration barriers for adult steelhead still exist in lower Post Creek, including the support structure for the foot trail crossing mentioned above, and several logjams that have accumulated large volumes of sediment and gravel. Post Creek has probably supported more extensive steelhead spawning and rearing, as current poor conditions for steelhead production appear to be the product of logging effects and water diversion. It is not known if resident rainbow trout persist in the upper creek area.

Bixby Creek Drainage

Bixby Creek is a small, spring-fed perennial stream tributary to the Pacific Ocean. It was surveyed in its entirety (8 km) by the CDFG during 28 June–17 August 1976. The stream contained high quality spawning and rearing habitats for steelhead. About 25 logjams and snags existed in the survey area, but they apparently did not impede upstream migration of adult steelhead as juveniles were found at each of seven electrofishing stations, from the mouth to the headwaters. Juvenile steelhead abundance was estimated at six stations using the two-pass removal method. Mean (± SD) density was 112 ± 42 trout/100 m (range, 52–163 trout/100 m). The trout ranged in size from <3 cm FL to 30.4 cm FL; thus, potentially several age-classes were present but no details were given regarding population structure. No records were discovered regarding steelhead use of the Bixby Creek headwater tributaries, Mill and Turner creeks, nor its largest tributary, Sierra Creek.

Carmel River Drainage

In 1965, the CDFG estimated the annual steelhead spawning run in the Carmel River at about 1,650 fish, based on the observations of local field personnel (California Department of Fish and Game 1965).

The CDFG files and other material on the Carmel River are currently being reviewed as the basis for this account. Included is the long-term study summarized by Snider (1983); the assessment report of Dettman and Kelley (1986) and other reports by D. W. Kelley & Associates; and Kyle Murphy's 1992 survey report of the Carmel River tributary, San Clemente Creek. Nehlsen et al. (1991) listed the Carmel River steelhead stock as being at a high risk of extinction. The decline in this population is the result of blocked access to historic spawning and rearing areas upstream of dams, and extensive water diversion.

Doud Creek Drainage

No juvenile steelhead/rainbow trout were found in lower Doud Creek when spot-sampled with a dip net on 18 October 1989 (Rischbieter 1990b). Although perennial, this stream may simply be too small for steelhead use.

Garrapata Creek Drainage

Although a known steelhead stream, no early records were discovered regarding the wild steelhead population in Garrapata Creek. In early 1966, rainbow trout in a privately owned hatchery on the creek were diagnosed with whirling disease, which is caused by the protozoan, Myxosoma cerebralis. Evidently, the disease spread into the creek itself as uninfected fish placed in the creek became infected. Follow up studies were curtailed due to personnel constraints and it is generally unknown whether the wild steelhead stock was affected by the disease. However, in connection with permitting of a new trout farm on the creek in 1975, there was no evidence of whirling disease in test fish held in Garrapata Creek water on the farm property.

Considerable development occurred in the Garrapata Creek drainage during the 1980's for which there was great concern regarding impacts on fish and wildlife resources. The CDFG surveyed the stream in February 1990, from the mouth to the headwaters, for a distance of about

11 km. The survey report indicated that Garrapata Creek had perennial stream flow. Several barriers were identified which were created by landslides, logjams, and falls/chutes, the latter of which included a 9 m waterfall. Many barriers were judged to fully block upstream movement of adult steelhead. Several diversions were identified, two of which led water to trout ponds. There was an abundance of suitable spawning gravels in the upper stream, which were inaccessible to steelhead due to the 9 m fall. Sampling for resident rainbow trout was not conducted there. The lower reaches of the stream contained some spawning riffles and were relatively free of barriers. Rearing habitat for juvenile steelhead/rainbow trout was of highest quality in the inaccessible, upper stream area. Sedimentation of decomposed granite was a pollution problem throughout much of the stream, filling in pools and cementing spawning gravels. Barriers were also formed by granitic sand being trapped behind stream obstructions. Juvenile steelhead abundance was estimated, by electrofishing and the mark-and-recapture method, in three 46 m reaches in the lower and middle main stem, and one 46 m reach in the Garrapata Creek tributary, Wildcat Canyon Creek. Densities in the main stem, from downstream to upstream, were 26.0, 1.0, and 13.3 trout/46 m, and only 1 trout/46 m in Wildcat Canyon Creek. The corresponding mean fork lengths (range) were 107.2 mm (81–191 mm), 163 mm, and 79.7 mm (50–164 mm), respectively, in Garrapata Creek, and 104 mm in Wildcat Canyon. Overall, sedimentation, due to logging and improper road grading, was identified as the primary factor limiting steelhead production in the Garrapata Creek drainage.

Wildcat Canyon Creek

Sedimentation was formally identified as a problem in Wildcat Canyon Creek by the CDFG as early as 1964, through benthic invertebrate sampling and instream rainbow trout bioassays (M. L. Johnson, CDFG, unpubl. file report of 28 May 1964). When surveyed briefly by the CDFG in February 1981, the stream was not regarded as a probable salmonid production area, and in December 1988, the mean substrate composition, determined from three samples at one site by sieving sediment through 22.6, 7.95, 2.79, and 0.85 mm screens, was 19%, 8%, 11%, 26%, and 36% (<0.85 mm particles), respectively. The CDFG collected only one juvenile steelhead in a 46 m reach of the creek, by electrofishing in February 1990 (see Garrapata Creek, above).

Granite Canyon Creek Drainage

Granite Canyon Creek has evidently not been populated by steelhead within recent geological history. The CDFG conducted a cursory barrier survey of the stream on 27 February 1981 and found a 4.5 m waterfall at the creek mouth. The presence or absence of resident rainbow trout above the fall was apparently not investigated.

Kirk Creek Drainage

The U.S. Forest Service surveyed Kirk Creek on 13 July 1981, and found that a 4 m waterfall, located about 1.2 km above the creek mouth at the Pacific Ocean, would block the upstream migration of steelhead beyond that point. This very small stream had low to intermittent flow, a high gradient, lacked pools, and overall seemed underdimensioned for steelhead use. Indeed, no fish were observed between the mouth and the waterfall. The presence or absence of resident rainbow trout above the waterfall was apparently not investigated.

Limekiln Creek Drainage

The main stem of Limekiln Creek is joined by the tributaries, West Fork Limekiln and Hare Canyon creeks, within 0.8 km from its mouth at the Pacific Ocean. Steelhead only have access to the lowermost portions of each stream because of natural barriers. The most notable barrier is a ~20 m waterfall on Limekiln Creek, situated <0.8 km upstream from its confluence with the tributaries. Because of these natural restrictions on steelhead access within recent geological history, the limited available information on these three streams is presented compositely.

The entire portion of the lower drainage accessible to steelhead was surveyed by the CDFG on 28 August 1961 and 8 September 1961. Spawning areas were noticeably lacking because of the cementing effect of calcium carbonate precipitates. The stream provided high quality rearing habitat, in the form of pools and cover. Juvenile steelhead/rainbow trout, 7.5–10 cm in length, were very scarce; the lack of suitable spawning gravel was attributed as the main limiting factor. Seasonally intense fishing pressure may have also contributed to the apparently low juvenile abundance. No past stocking of steelhead/rainbow trout was known.

However, the Limekiln drainage was included in the CDFG's attempt to develop brown trout fisheries in Monterey County during the 1950's and 1960's. For example, on 8 May 1962, 3,000 brown trout fingerlings were planted in Limekiln Creek below the waterfall barrier; 3,000 in the West Fork Limekiln Creek above barriers to adult steelhead migration; and 6,000 in Hare Canyon Creek, above steelhead migration barriers (CDFG, unpubl. field notes of 8 May 1962). A few 10–15 cm long rainbow trout were observed in Hare Canyon Creek where, as below the barriers, the stream substrate was calcified and only occasional beds of loose pea-size gravel were available for spawning. Both upper Limekiln and Hare Canyon creeks, above steelhead barriers, were stocked with an additional 600 brown trout fingerlings each on 23 June 1963 (M. L. Johnson, CDFG, unpubl. memo. of 17 July 1963).

Survival from these plants was apparently low as only 10 brown trout were captured by hook-and-line and hand braille when the Limekiln Creek drainage was sampled during 1–2 September 1963 (M. L. Johnson, CDFG, unpubl. memo. of 14 October 1963). In contrast, the same sampling effort produced 69 juvenile steelhead/rainbow trout, ranging in length from about 5 to 25 cm.

The U.S. Forest Service surveyed Hare Canyon Creek on 17 October 1981, from the Los Padres National Forest boundary in the lower creek area to 3.2 km upstream. The condition of the stream seemed much the same as in earlier surveys. Few juvenile steelhead/rainbow trout were seen. The density of trout, 2.5–15 cm long (mean, 10 cm), was visually estimated at about 20 fish/100 m.

Little Sur River Drainage

The Little Sur River drainage may be one of the most productive steelhead rivers south of San Francisco Bay at this time, given its size (about 103 km^2) and condition. The lower drainage area is private property, while the headwaters are on public lands, primarily the Los Padres National Forest, that lack roads and trails. Lack of access has kept much of the Little Sur drainage in a relatively pristine state.

Little fishery management work has been conducted on the Little Sur River, although the

CDFG has long recognized it as a steelhead production area. In 1965, the CDFG estimated the annual steelhead spawning run in the Little Sur River at about 500 fish, based on the observations of local field personnel (California Department of Fish and Game 1965). On 4 August 1988, the CDFG made two electrofishing passes through a 58 m reach of the Little Sur River to estimate juvenile steelhead abundance with the Seber and Le Cren method. Abundance (± SD) was estimated at 28 ± 8 trout, or a density of 49 ± 14 trout/100 m. These fish were 50–148 mm in length (mean ± SD = 78 ± 29 mm; $n = 22$), with the catch dominated by young-of-the-year.

Nehlsen et al. (1991) classified the Little Sur River steelhead population as a stock of special concern.

Malpaso Creek Drainage

Malpaso Creek is about 7 km long, the middle third of which is included in Garrapata State Park. Rischbieter (1990b) surveyed the stream within the park on 4 April 1989. Pools provided adequate rearing habitat for juvenile steelhead/rainbow trout. Two steelhead migration barriers were identified: a 1.2 m high diversion dam at the downstream park boundary, and a 2 m fall created by a logjam about 46 m below the diversion dam. Trout electrofished in the park were assumed to be resident rainbows. These fish were 58–185 mm in length (mean ± SD = 102 ± 31 mm; n = 15), and apparently represented several age classes, including adults. The presence or absence of juvenile steelhead below the barriers was not investigated.

Resident rainbow trout were also sampled above the diversion dam on 22 August 1990 (D. C. Rischbieter, California Department of Parks and Recreation, unpubl. data). Three electrofishing passes were made through a reach which produced a catch of 19 trout. These fish were 35–102 mm in length (mean ± SD = 47 ± 15 mm). In contrast to the 1989 sample, young-of-the-year were present and dominated the catch.

The original source of the rainbow trout in Malpaso Creek is unclear. As in many of these small, Big Sur coastal streams with barriers that currently limit or block steelhead access, it is not known if resident rainbow trout above barriers are what remain of a pre-barrier steelhead colonization or if they are the result of an undocumented fish transfer by humans. Malpaso

Creek was reportedly stocked with juvenile steelhead/rainbow trout from nearby San Jose Creek by Walter Victorine, whose family had a ranch locally (J. G. Williams, CDFG, unpubl. letter of 16 June 1994).

McWay Creek Drainage

McWay Creek, a small steep-gradient perennial stream, has evidently not been populated by steelhead within recent geological history because of a 12 m waterfall at the creek mouth. Resident rainbow trout were reported in the creek as late as 1984, but none was captured there during a brief electrofishing survey on 5 April 1989 (Rischbieter 1990c). The Rat Creek wildfire in 1985 and subsequent heavy storms during the winter of 1985-86 may have extirpated the trout, or nearly so. As of 1989, the drainage had apparently recovered from these perturbations, which would allow for the re-expansion or reintroduction of the species.

Mill Creek Drainage

Mill Creek, a small, high-gradient perennial stream, was surveyed by the CDFG on 20 July 1961, from the mouth to headwater forks. Spawning gravels were covered with coarse sand, due at least in part to the effects of previous logging and road building in the drainage. Pools were also silted, especially in the lower creek. The mainstem creek had only one partial barrier to upstream migration of adult steelhead created by a log; access to the headwater forks was limited by natural bedrock falls. There was only one small domestic water diversion in the lower creek.

Despite the siltation problem in the drainage, at least two consecutive year-classes of juvenile steelhead/rainbow trout were observed during this survey: 5.0–10.0 cm long trout were moderately abundant, while those 15 cm long were scarce. Visually-estimated abundances were very low in the mid and upper sections of the creek, 1–2 trout/100 m, but much greater in the lower creek, 33–66 trout/100 m. Local residents reported that only a few adult steelhead ascended the stream during the 1960–61 spawning season, and that juvenile steelhead/rainbow trout were lightly fished because the maximum length reached was only 12.5–15.0 cm. Several limits of these small fish were apparently caught from the middle section of Mill Creek during the 1962 trout season (CDFG, unpubl. field note of 19 November 1962).

By 1977, gravels in the mid-section of Mill Creek, above the confluence with Lion Creek, were cemented by calcium carbonate precipitates (B. Graham, CDFG, unpubl. memo. of 4 March 1977). This condition was seen from the mouth to headwaters when the creek was surveyed by the U.S. Forest Service on 18 September 1981. Siltation was apparently less of a problem than in 1961 when the CDFG surveyed the stream (c.f. above). There was one partial migration barrier in the lower creek area created by a log and debris. Juvenile steelhead/rainbow trout were 2.5–15 cm long (mean ≈ 7.5 cm), and occurred at low visually-estimated densities of 7–13 trout/100 m. The low trout abundance was attributed to poor substrate quality for spawning and invertebrate food production. The survey report indicated that brown trout had been planted in Mill Creek in 1961, but apparently a population was not established.

Partington Creek Drainage

Partington Creek, a steep-gradient perennial stream along the Big Sur coast, was surveyed by the CDFG in 1972.

The California Department of Parks and Recreation (CDPR) spot sampled Partington Creek, both upstream and downstream of Highway 1, by use of electrofishing on 5 April 1989 (Rischbieter 1990c). Juvenile steelhead/rainbow trout were captured at all of three sites. Compositely, these fish averaged (± SD) about 11 ± 3 cm SL and ranged from about 6 to 20 cm SL (n = 40). Because the sampling effort was biased toward pools, larger fish may have been proportionately overrepresented in the catch. Trout captured above a 1.8 m debris dam, upstream from Highway 1, were most likely resident rainbow trout. The sample collected from three pools immediately above the creek mouth may have also contained steelhead progeny, since steelhead apparently have access to the lower stream.

Juvenile steelhead/rainbow trout were observed in lower Partington Creek on 30 August 1993 (R. G. Titus, CDFG, pers. obs.).

Plaskett Creek Drainage

Little is known about steelhead in Plaskett Creek, a small perennial stream. The U.S. Forest Service surveyed lower Plaskett Creek on 15 July 1981. Riffles were abundant but pools were few, small, and shallow. Cattle were causing streamside vegetation loss, erosion, and organic pollution, and were thus considered a major threat to the stream habitat and trout population. Water was diverted from the creek for domestic use. Juvenile steelhead/rainbow trout were 2.5–18.0 cm in length (mean ≈ 7.5 cm), and occurred at a low visually-estimated density of 16 trout/100 m.

The CDFG recognized Plaskett Creek as a viable steelhead stream in 1991 when it denied an application for private stocking of rainbow trout in the creek (B. Hunter, CDFG, unpubl. letter of 15 July 1991). The denial was based on the premise of maintaining the genetic integrity of the native steelhead.

Prewitt Creek Drainage

The CDFG surveyed the lowermost 5.6 km of Prewitt Creek on 24 July 1961. A series of natural bedrock falls and logjams limited steelhead access beyond the junction of the headwater forks, about 2 km upstream from the mouth. Spawning and rearing habitats for steelhead/rainbow trout were lacking in the high-gradient upper creek, as there was very little gravel and only small, shallow, cascading pools. Spawning gravels were also very limited in the lower creek, but pools were relatively better developed and thus more suitable for steelhead rearing during low flow periods. Water was diverted from the South Fork Prewitt Creek. Cattle grazed the area downstream from Highway 1, but no grazing impacts were noted.

The visually-estimated density of juvenile steelhead in the lowermost creek area was 39 trout/100 m. Most fish were young-of-the-year, 7.5–10.0 cm in length; age 1+ trout, ≥ 12.5 cm in length, were scarce. Few trout were seen in the upper creek. Local residents reported good fishing for juvenile steelhead/rainbow trout, 15.0–17.5 cm in length, for a short period following the opening of fishing in the spring. Fishing was also reportedly good for adult steelhead during "good steelhead years," presumably meaning in high precipitation years.

On 8 May 1962, 6,000 brown trout fingerlings were planted in Prewitt Creek, in the headwaters above the steelhead barrier area described above (CDFG, unpubl. field note of 8 May 1962). Many juvenile steelhead/rainbow trout, mostly 2.5–5.0 cm in length, were observed in the lower creek area, below the barriers; few juveniles were seen between the barriers and the headwater forks, and none in the forks.

Survival of brown trout planted in 1962 was apparently low as none was captured by hook-and-line or hand braille when the creek was sampled during 1–2 September 1963 to evaluate the plant (M. L. Johnson, CDFG, unpubl. memo. of 14 October 1963). However, juvenile steelhead/rainbow trout were caught, ranging in length from 5 to 15 cm.

The U.S. Forest Service surveyed the lowermost 4.8 km of Prewitt Creek on 16 July 1981. The condition of the stream and its use by steelhead seemed to be much the same as when surveyed by the CDFG in 1961 (see above), with one notable exception. Cattle grazing in the area downstream from Highway 1 was causing streamside vegetation loss, erosion, and organic pollution, and was thus considered a major threat to habitat quality and steelhead production in the lower creek. The estimated average density of juvenile steelhead/rainbow trout ranged from 49 trout/100 m in the lower creek, to 39 trout/100 m in the mid-section, to 33 trout/100 m in the headwater south fork. Overall, the trout were visually-estimated at 2.5–20.0 cm in length, and averaged 10.0–12.5 cm among sections.

Rocky Creek Drainage

No detailed historical information was discovered regarding the steelhead population in Rocky Creek, a small, perennial stream with a cobble and boulder dominated substrate. There was mention in a CDFG document of steelhead migrating up Rocky Creek to spawn following sufficient rainfall (CDFG, unpubl. letter of 8 November 1971).

Steelhead use of Rocky Creek is corroborated by a local resident who has fished and observed the stream since the late 1940’s (J. G. Williams, Carmel, CA, unpubl. letter of 16 June 1994). Three length-frequency modes of juvenile steelhead/rainbow trout were apparent, as observed in summer: young-of-the-year about 5 cm long in the shallow downstream end of pools, yearling fish about 10 cm long, and a less distinct group at about 15 cm. Trout over 23 cm long were rare, and fish >15 cm long occurred mainly in the larger pools. Angling for fish >13 cm long was very productive. Winter observations were few but adult steelhead were seen in the stream. There was a 1.5 m dam in the mid-creek area from about 1930 to 1980, but this structure apparently was not a complete migration barrier as an adult steelhead was seen upstream from it.

Natural waterfalls in the upper creek area, however, block steelhead access to the headwaters. Resident rainbow trout occur above the falls.

Although no inference could be drawn regarding the adult steelhead population trend at Rocky Creek, the relative abundance of juvenile steelhead/rainbow trout has dropped noticeably. This observed reduction has been associated with increased water diversion and silt input from roads in the upper watershed. The amount and quality of rearing habitat, especially in the form of pools, has decreased, thus exacerbating the effects of the recent six-year (1986-87 to 1991-92) drought when stream flow fell below 3 L/s.

Dettman (1989) calculated an index of the quality and quantity of juvenile steelhead rearing habitat in two reaches of Rocky Creek, at three stream flows ranging from 4 to 18 L/s. The rearing index increased with increasing flow and, according to the model, the optimum rearing index would have been observed at some flow higher than 18 L/s. In addition to low summer flow, the degree of cobble embeddedness from sand deposition was also determined to be a major constraint to juvenile steelhead rearing habitat quality. The source of erosion responsible for the input of sand was not identified, but was mentioned to be usually associated with road construction. No actual observations of steelhead habitat use or abundance relative to stream flow were included in the report.

Salinas River Drainage, Including Portions in San Luis Obispo County

Historically, steelhead have used the headwaters of the Salinas River, and the tributaries draining the western side of the basin (see below), for spawning and rearing. The lower main stem serves primarily as a migration corridor, when sufficient runoff provides a connection to the Pacific Ocean. Barclay (1975) described briefly the unsuitability of the valley portion of the mainstem Salinas River as spawning and rearing habitat for juvenile steelhead, because of the sandy and silty substrate, and high water temperature and lack of flow in summer. Although Snyder (1913) found juvenile steelhead/rainbow trout at three locations in the main stem from near Salinas to Soledad, these fish were probably emigrating smolts; trout found in the main channels of the rivers were “apt to be rather poor in quality”, perhaps indicating low condition factor, and “usually light silvery in color”, both of which are typical smolt characteristics.

Hubbs (1947) found no steelhead at six sampling locations in the lowermost 4.8 km of the river on 3 and 11 August 1946. Sampled habitats had muddy or sandy bottoms and semi-ponded to slow-moving water.

Salinas Dam, which forms Santa Margarita Lake (formerly Salinas Reservoir) in the upper Salinas River, was completed in 1942. Before the dam was built, adult steelhead migrated as far upstream as Pozo, and occasionally farther during winters of exceptionally high rainfall (F. W. Hecker, CDFG, unpubl. field corr. of 9 May 1947). The number of steelhead reaching the dam each year varied greatly and was apparently a positive function of the amount of rainfall; no steelhead reached the dam during the winter of 1946-47.

Based on available information, it was impossible to estimate even the relative magnitude of historical steelhead runs in the Salinas River drainage. Snyder (1913) wrote only that “large numbers” of steelhead entered all the streams tributary to Monterey Bay, including the Salinas River drainage. By the mid-1950’s, adult steelhead spawning runs occurred irregularly and the population supported only a “meager fishery” (Pelgen and Fisk 1955). As of 1965, the CDFG estimated the annual steelhead spawning run in the Salinas drainage at little more than about 500 fish, based on the observations of local field personnel (California Department of Fish and Game 1965).

Barclay (1975) found that viable rainbow trout habitat still existed in the upper mainstem Salinas River, above the Highway 58 bridge.

Impoundment and diversion of surficial stream flow, groundwater pumping, and blocked access to perennial headwaters have caused the decline of Salinas River steelhead. The integrity of the natural streambed has also been compromised by extensive extraction of streambed materials, as witnessed through documentation in the CDFG files. As a result of these negative impacts, the Salinas River steelhead was classified as having a moderate risk of extinction by Nehlsen at al. (1991).

Arroyo Seco and Tributaries

The Arroyo Seco is the first major spawning tributary to which steelhead have access as they enter the Salinas River drainage from the Pacific Ocean. Snyder (1913) found juvenile steelhead/rainbow trout in the Arroyo Seco at 3.2 km, 6.4 km, and 9.7 km above the confluence with the Salinas River, but not at 1.6 km. He also noted observations of carcasses of large steelhead post-spawners along the Arroyo Seco.

By the 1950's, the CDFG de-emphasized steelhead management in the Arroyo Seco and elsewhere in the Salinas drainage because of plans for increased development of water resources (Pelgen and Fisk 1955). Attempts were instead made to enhance resident trout fisheries through extensive planting of both rainbow and brown trout. The brown trout program was especially emphasized, beginning with a plant of about 3,400 nearly catchable-size fish in September 1953 (CDFG, unpubl. field notes of 26 September 1953).

Creel censuses and electrofishing surveys were conducted over the years to evaluate the brown trout stocking program, during which data were also collected on wild juvenile steelhead/rainbow trout. For example, 1,051 juvenile steelhead/rainbow trout were caught by anglers during 1–2 May 1954 (E. A. Best, CDFG, unpubl. intraoffice corr. of 5 May 1954). These fish averaged 17.0 cm (range, 8.1–29.5 cm), the majority of which were light and silvery in color and presumed to be hatchery fish. However, the observed coloration also suggests the presence of steelhead smolts in the catch, and appropriately so considering the time of year. Darkly colored fish with a prominent red lateral stripe were regarded as wild rainbow trout; some of these fish were gravid females.

The CDFG electrofished two 76 m sections of the Arroyo Seco on 4 November 1954 (E. A. Best, CDFG, unpubl. intraoffice corr. of 22 November 1954). In a section at Santa Lucia Memorial Park, 48 juvenile steelhead/rainbow trout were captured that ranged in length from 7.9 cm to 22.1 cm. In a section located about 1.6 km below Rooster Creek, 34 juvenile steelhead/rainbow trout were captured, 7.1 cm to 23.6 cm in length.

The CDFG surveyed about 5.5 km of the Arroyo Seco on 6 June 1957, from Santa Lucia Memorial Park to the headwaters. A visually estimated 15% to 20% of the survey area consisted of spawning grounds for trout, most of which was in the lower half of the area. The stream was cascading and provided an abundance of high-quality rearing habitat in the form of pools and cover. No barriers or diversions were observed. Both wild juvenile steelhead/rainbow trout and planted catchable rainbow trout were observed and caught on hook-and-line, with only the former ranging into the very high-gradient headwaters. The survey report indicated that, in addition to catchable rainbow trout, juvenile steelhead had also been planted previously in the Arroyo Seco, but no such records were discovered.

Memoranda and field notes contained in the CDFG files indicated that the rotary fish screen at the Greenfield Water District's diversion on the Arroyo Seco was persistently dysfunctional over the years. Observed documents regarding this problem ranged in dates from 12 May 1948 to 26 April 1966. The diversion is located on the Arroyo Seco about 3.2 km below Santa Lucia Memorial Park. No reliable estimates were made as to how many juvenile steelhead/rainbow trout may have been lost annually in the diversion.

On 30 March 1968, about 200 juvenile steelhead, 15 cm to 25 cm in length, were rescued from the desiccating lower Arroyo Seco at the Thorne Road crossing, and released farther upstream where presumably perennial flow occurred (R. Azbill, CDFG, unpubl. field corr. of 5 April 1968). Steelhead continued to be mentioned in CDFG file documents as a viable fishery resource in the Arroyo Seco as of 1978 (M. L. Johnson, CDFG, unpubl. letter of 17 February 1978). An estimated 300 juvenile steelhead/rainbow trout, about 7.5 cm to 15 cm in length, died in the Arroyo Seco at the Arroyo Seco Campground on 28 August 1979. Temperature stress was believed to be the cause of death. No juvenile steelhead were found in the lower Arroyo Seco on 13 September 1979, when several locations were spot-checked by use of electrofishing from the Greenfield Bridge to the Tassajara Creek confluence (S. Recknagel, CDFG, unpubl. memo. of 14 September 1979). Hatchery rainbow trout continued to be planted in the Arroyo Seco as of 7 June 1980, when 4,000 fish (@ 551/kg) were stocked in the headwaters by the Southern Monterey County Sportsmen's Association.

The USFS surveyed the headwaters of the Arroyo Seco during 3–4 November 1981, from Indian Station to a point 6.4 km upstream. The characteristics and condition of this portion of the stream appeared to be much the same as when surveyed by the CDFG in June 1957 (see above). Juvenile steelhead/rainbow trout were observed in average visually-estimated densities of about 66 trout/100 m in the lower survey area, and about 39 trout/100 m in the upper survey area. The fish ranged in length from about 2.5 cm to 20 cm, and averaged about 13 cm.

During 19–26 February 1983, 16 adult steelhead were landed at or below the Thorne

Road crossing on the lower Arroyo Seco (J. Barton, CDFG, unpubl. memo. of 11 January 1984). The road crossing created an upstream-migration barrier for which a fish ladder was needed. One adult, which measured about 75 cm in length, was also landed in this area on 2 January 1984, and four more steelhead were reportedly caught in the Arroyo Seco (M. L. Johnson, CDFG unpubl. memo. of 9 January 1984).

The CDFG surveyed by use of electrofishing five sections of the Arroyo Seco downstream from the Santa Lucia Memorial Park, during 8–25 September 1992 (K. D. Murphy, CDFG, unpubl. stream survey data). Mean (± SD) section length was 96 ± 5 m. Juvenile steelhead/rainbow trout had section-specific mean lengths of approximately 9 to 31 cm FL, and an overall mean length of about 10 ± 5 cm FL (n = 83); only one fish was >25 cm FL. Section-specific densities averaged 18 ± 13 trout/100 m (range, 1–38 trout/100 m), based on abundance estimates made with the three-pass depletion method.

During 26–29 August 1993, the CDFG continued its survey by electrofishing four more sections of the Arroyo Seco, this time upstream of Santa Lucia Memorial Park (K. D. Murphy, CDFG, unpubl. stream survey data). Mean (± SD) section length was 89 ± 10 m. Section-specific mean lengths of juvenile steelhead/rainbow trout had a small range (7–8 cm FL) as all sections were dominated numerically by young-of-the-year trout. The overall mean length was about 8 ± 3 cm (n = 410), and there were no juvenile steelhead/rainbow trout >25 cm FL. Section-specific densities averaged 141 ± 29 trout/100 m (range, 118–182 trout/100 m), based on abundance estimates made with the three-pass depletion method.

Adult steelhead were observed in the Arroyo Seco during the 1992-93 spawning season (J. Nelson, CDFG, pers. comm. of 17 March 1993). The nearly eight-fold increase in mean density of juvenile steelhead/rainbow trout between the 1992 and 1993 electrofishing surveys, with a pronounced dominance of age-0 fish, strongly suggested successful steelhead spawning; the 1992 data were not indicative of an adult resident rainbow trout population of the magnitude to result in such high young-of-the-year densities.

The Arroyo Seco headwater tributary, Lost Valley Creek, and its tributaries, Higgins and Zigzag creeks, have also historically provided high quality habitat for steelhead and rainbow trout. Nearly 10 km of Lost Valley Creek were surveyed by the CDFG during the mid-1930's.

The stream substrate was dominated by gravel which provided spawning habitat for steelhead and rainbow trout throughout the survey area. No migration barriers or diversions were observed. Juvenile steelhead/rainbow trout were present in the stream, all of which were the result of natural propagation as no known stocking had occurred.

The uppermost 2.4 km of Higgins Creek were surveyed by the CDFG on 7 June 1957. This cascading portion of the stream contained high quality spawning and rearing habitat for rainbow trout, although no fish were seen. One 4.5 m high bedrock and boulder waterfall was located within the survey area, which may historically have limited the upstream dispersal of steelhead/rainbow trout from below, thus accounting for their apparent absence. No past stocking was known, although the stream was later included in an extensive brown trout planting program that was undertaken in southern Monterey County during the 1950's–early 1960's. For example, 4,160 brown trout fingerlings (@ 564/kg) were planted in Higgins Creek on 27 August 1959.

CDFG personnel conducted an angling survey of Higgins Creek on 17 May 1966, from Pelon Camp to a point about 0.8 km upstream. This section was downstream from the fishless section surveyed in 1957 (see above), and also contained suitable spawning and rearing habitat for rainbow trout. Juvenile steelhead/rainbow trout up to about 20 cm in length were captured on hook-and-line at an approximate catch rate of 1.7 trout/hr. Young-of-the-year steelhead/rainbow trout were also observed.

As part of the same excursion, Lost Valley Creek was fished on 18 May 1966, from Lost Valley Camp to near the Zigzag Creek confluence. Spawning substrate may have been limited, but rearing habitat in the form of pools and cover seemed extensive. Compared to Higgins Creek, the abundance of juvenile steelhead/rainbow trout was relatively high, and the catch rate on hook-and-line was about 10 trout/hr. Observed young-of-the-year were about 2.5 cm in length, while captured trout ranged up to about 25 cm.

The mean (± SD) density of juvenile steelhead/rainbow trout in Lost Valley, Higgins, and Zigzag creeks was 33 ± 25 trout/100 m, 53 ± 5 trout/100 m, and 43 trout/100 m, respectively, when sampled during 1970–71 as part of a survey of steelhead standing crops between San Francisco and San Luis Obispo (L. K. Puckett, CDFG, unpubl. memo. of 30

December 1971). Juvenile steelhead/rainbow trout abundance was highly variable (c.v. = 114%) throughout this region; densities in the Arroyo Seco tributaries were well below the overall average of 155 ± 178 trout/100 m. Trout abundance was estimated by use of electrofishing and the two-pass depletion method in several randomly-selected 30.5 m sections per 1.6 km of stream.

The CDFG surveyed Lost Valley Creek and the Zigzag Creek system in August 1978, following the Marble Cone fire (P. Chappell, CDFG, unpubl. memo. of 11 June 1979). It was reported that Lost Valley Creek was in generally good condition, and that the stream supported an excellent rainbow trout fishery. Rainbow trout were sampled by hook-and-line, and all captured fish were infested with encysted metacercaria of the monogenetic trematode, Neascus, a condition commonly referred to as "black spot disease". No trout were observed in the Zigzag headwater tributary, Camp Creek, nor in Zigzag Creek itself until below the fourth waterfall about 0.4 km upstream from the confluence with Lost Valley Creek. Water conditions for trout were noted as excellent.

Hatchery rainbow trout continued to be planted in Lost Valley Creek as of 7 June 1980, when 3,000 fish (@ 551/kg) were stocked by the Southern Monterey County Sportsmen's Association.

The Arroyo Seco headwater tributary, Tassajara Creek, and its tributary, Willow Creek, have also historically provided high quality habitat for steelhead and rainbow trout. Tassajara Creek, at about 0.4 km above Tassajara Hot Springs, was surveyed by the CDFG on 29 June 1945. The survey area contained high quality spawning and rearing habitats for steelhead, the latter in the form of pools and cover. The report indicated that the stream was used extensively by steelhead for natural propagation, and juvenile steelhead were observed.

Willow Creek was surveyed by the CDFG in its entirety on 5 June 1957. Spawning gravels were scarce in the perennial, cascading stream, but rearing habitat in the form of pools and cover was abundant and of very high quality. A 3-m high bedrock fall, located in the upper half of the creek, blocked upstream migration under low-flow conditions, but may have been passable at high flows. No diversions were seen. Juvenile steelhead/rainbow trout were scarce in abundance, but those observed ranged in length from about 5 to 15 cm and were noted to be wild progeny and in good condition. Willow Creek had been stocked with 5,000 each of juvenile steelhead and rainbow trout in 1940, and other plants had probably been made during the late-1930's and early 1940's for which records were not found.

Willow Creek was used as a test stream in the CDFG's development of brown trout fisheries in Monterey County during the 1950's and 1960's. Five 76-m sections were sampled by use of electrofishing during 27–28 April 1963 to determine the approximate size and structure of the wild trout population prior to making new plants of brown trout fingerlings (R. J. Hansen, CDFG, unpubl. memo. of 14 May 1963). All captured fish were juvenile steelhead/rainbow trout, which had section-specific mean lengths of from 9.4 to 17.5 cm, and an overall mean length of 11.4 cm (overall range, 2.8–25.4 cm). Conservative estimates of section-specific densities were low, and averaged 14 trout/100 m (range, 9–20 trout/100 m). There was no mention of smolting trout, although trout ≥ 18 cm long appeared to have relatively low condition factors, which is a typical smolting characterisitic. Alternatively, these fish may also have been post-spawners. Steelhead use of the stream at the time of this survey appeared to be light or non-existent, as the low population density was more indicative of a resident rainbow trout population, even assuming a high angler-harvest rate (e.g. M. L. Johnson, CDFG, unpubl. admin. report of 13 April 1964).

Following a plant of 5,000 brown trout fingerlings on 23 July 1963, the same five test sections of Willow Creek were electrofished again on 25 April 1964 (R. J. Hansen, CDFG, unpubl. memo. of 7 May 1964). Juvenile steelhead/rainbow trout had section-specific mean lengths of from 9.1 to 10.7 cm, and an overall mean length of 9.9 cm (overall range, 5.6–15.5 cm). Conservative estimates of section-specific densities averaged 24 trout/100 m (range, 12–33 trout/100 m). The overall estimated density of juvenile steelhead/rainbow trout in April 1965 was the same as in April 1963, about 14 trout/100 m (M. L. Johnson, CDFG, unpubl. memo. of 9 July 1965). This study showed that the survival of brown trout fingerlings was low, with a correspondingly low return to the creel, and no apparent impact on the wild steelhead/rainbow trout population.

The USFS surveyed the lowermost portions of Tassajara and Willow creeks on 5 November 1981, from the mouth at the Arroyo Seco to 1.2 km below Willow Springs

Campground. No significant change could be discerned in the characteristics or quality of the streams as steelhead/rainbow trout production areas, as compared with earlier CDFG surveys (see above). The visually-estimated density of juvenile steelhead/rainbow trout was greater in lower Tassajara Creek (about 66 trout/100 m) than in lower Willow Creek (about 16 trout/100 m). The trout were also longer on average in Tassajara (15 cm; range, 2.5–25 cm) than in Willow Creek (10 cm; range, 2.5–15 cm).

The Arroyo Seco and its tributaries may support the only persistent remnants of Salinas River steelhead (K. R. Anderson, CDFG, pers. comm. of 9 July 1992).

Atascadero Creek

The Salinas River tributary, Atascadero Creek in San Luis Obispo County, was used historically by steelhead. Juvenile steelhead/rainbow trout were abundant in Atascadero Creek when surveyed by Barclay (1975). The creek as well as Atascadero Lake, an impoundment on the creek, have been stocked with catchable rainbow trout over the years, which indicates that the system does indeed contain trout habitat. The Salinas River has become an increasingly unreliable migration corridor, and the creek itself has been altered by road/bridge construction and extraction of streambed materials, as evidenced by documents contained in the CDFG files. The status of the Atascadero Creek steelhead population has not been recently assessed, but steelhead use of the creek is likely very limited by the habitat degradation that has occurred throughout the system, including the creek itself.

Nacimiento River and Tributaries

The Nacimiento River was one of the most important spawning and rearing tributaries for Salinas River steelhead. Snyder (1913) found juvenile steelhead/rainbow trout at all of three sampling stations in the Nacimiento, from the foothill to mountainous portions of the drainage. He also noted observations of large steelhead carcasses along the river, and that fishing for juvenile steelhead/rainbow trout was especially good in the upper Nacimiento. There was apparently a “good run” of steelhead in the Nacimiento during the winter of 1950-51 (CDFG, unpubl. field notes of 24 January 1951).

The dam forming Nacimiento Reservoir on the Nacimiento River in San Luis Obispo

County was completed in the fall of 1956, and impoundment began that winter. The dam is located about 11.3 km upstream from the confluence with the Salinas River. With construction of the dam which lacked provisions for fish passage, steelhead no longer had access to historic spawning and rearing habitats in the upstream portions of the system.

No wild juvenile steelhead/rainbow trout were seen or captured during cursory surveys of the upper river (above the reservoir) during 1960–61, following rotenone treatment in 1956-57 to remove non-game fishes (M. R. Schreiber, CDFG, unpubl. intraoffice corr. of 28 June 1960; R. N. Hinton, CDFG, unpubl. intraoffice corr. of 2 January 1962). In addition to being stocked with catchable rainbow trout, the upper Nacimiento River was included in the CDFG's development of brown trout fisheries in Monterey County; for example, about 1,200 brown trout fingerlings were stocked in the upper river on 23 June 1963 (M. L. Johnson, CDFG, unpubl. memo. of 17 July 1963). When the upper river was fished between Redwood and ABC camps by CDFG personnel in 1971, brown trout were captured above a 7.6-m high waterfall barrier, and rainbow trout below (L. K. Puckett, CDFG, unpubl. memo. of 13 May 1971). Trout abundance was low, and low summer stream flow was mentioned as a likely limiting factor to population growth.

The upper Nacimiento River within the Los Padres National Forest was surveyed by the USFS during 2–3 September 1981. Stream flow was interrupted in the lower and middle portions of the survey area, where rainbow trout oversummered in perennial pools. These fish occurred in visually-estimated abundances of about 33 and 20 trout/100 m in the lower and middle sections, respectively, and averaged about 5 cm in length (range, 2.5–13 cm). Thus, most trout were young-of-the-year and natural reproduction was successful. Stream flow was very low but continuous in the upper survey section, where rainbow trout occurred at a visually-estimated abundance of about 39 trout/100 m, and averaged about 10 cm in length (range, 2.5–20 cm). Brown trout were again found only above the waterfall barrier mentioned above.

The CDFG surveyed by use of electrofishing nine sections of the upper Nacimiento within the Los Padres National Forest, during 21 July–20 August 1992 (K. D. Murphy, CDFG, unpubl. stream survey data). Mean (± SD) section length was 98 ± 8 m. Juvenile steelhead/rainbow trout had section-specific mean lengths of approximately 8 to 12 cm FL, and an overall mean length of about 8 ± 3 cm FL (n = 525). Section-specific densities averaged 59 ±

66 trout/100 m (range, 0–160 trout/100 m), based on abundance estimates made with the three-pass depletion method.

A catchable rainbow trout planting program in the lower river (below the dam) was initiated on a trial basis in 1963 (Johnson 1966) and continued through at least 1987. One resident rainbow trout, but no juvenile steelhead, were captured in the lower river during January–March 1977 (Corson and Simas 1977). The Nacimiento River was still mentioned as a viable steelhead water in CDFG file documents dealing with environmental impacts from 1986 and 1988. Steelhead use of the lower Nacimiento River is dependent upon the presence of a migration corridor in the main stem Salinas River, and the current presence/absence of steelhead is not known.

Prior to the construction of Nacimiento Reservoir, steelhead used the Nacimiento River tributary, Las Tablas Creek, for spawning and rearing. The creek currently flows into one of the main arms of Nacimiento Reservoir. Las Tablas Creek was surveyed by the CDFG in its entirety on 25 March 1966, for a distance of about 40 km. The creek contained suitable spawning gravels for steelhead/rainbow trout, and rearing habitat in the form of pools and cover, including undercut banks. Overall, the habitat was rated highly. No barriers or diversions were seen. The lower half or so of the stream was polluted with heavy metal effluents, from both active and abandoned mines of the Buena Vista Mining Company. This portion of the stream also became intermittent during the summer. Naturally-propagated rainbow trout, about 7.5–30.5 cm in length, occurred in the upper half of the stream, at a visually-estimated density of about 12 trout/100 m. Local residents reported that rainbow trout migrated from the reservoir into the lower stream area during spring. These fish either returned to the reservoir as summer approached, or died, due to the effects of reduced stream flow and pollution.

Old Negro Fork, a tributary in the extreme headwaters of the Nacimiento River in Monterey County, was also recognized as a steelhead production area prior to the construction of Nacimiento Reservoir (W. A. Evans, CDFG, unpubl. memo. of 14 June 1950). The stream was stocked with catchable rainbow trout at that time.

When surveyed by the CDFG following dam construction on 15 October 1961, the density of juvenile steelhead/rainbow trout was very low (visually estimated at about 49 trout/100 m), and their distribution was restricted to below a 3-m high bedrock barrier located about 1.6 km upstream from the confluence with the Nacimiento. The trout were about 6.5–15 cm long. Other bedrock and boulder barriers were found in the headwaters of the creek system. Spawning gravel may have been limited, but rearing habitat appeared to be adequate for juvenile steelhead and young rainbow trout. The stream was observed under very low flow conditions, following 3 yr of drought.

In addition to previous plants of catchable rainbow trout, the Old Negro Fork was included in the CDFG's development of brown trout fisheries in Monterey County; for example, about 1,200 brown trout fingerlings were stocked, both above and below the falls, on 23 June 1963 (M. L. Johnson, CDFG, unpubl. memo. of 17 July 1963).

The CDFG surveyed by use of electrofishing four sections of the Old Negro Fork, from the Ponderosa Campground to about 1.1 km upstream, during 18 August–10 September 1992 (K. D. Murphy, CDFG, unpubl. stream survey data). Mean (± SD) section length was 94 ± 2 m. Section-specific mean lengths of juvenile steelhead/rainbow trout had a small range (8–9 cm FL) as all sections were dominated numerically by young-of-the-year trout. The overall mean length was about 9 ± 4 cm (n = 502), and there were no juvenile steelhead/rainbow trout >25 cm FL. Section-specific densities averaged 144 ± 69 trout/100 m (range, 83–233 trout/100 m), based on abundance estimates made with the three-pass depletion method.

The CDFG re-surveyed the same four sections of the Old Negro Fork during 3–5 August 1993 (K. D. Murphy, CDFG, unpubl. stream survey data). Mean (± SD) section length was 95 ± 4 m. Section-specific mean lengths of juvenile steelhead/rainbow trout ranged from about 8 to 10 cm FL; thus, as in 1992, all sections were dominated numerically by young-of-the-year trout. The overall mean length was again about 9 ± 4 cm (n = 750), and only two juvenile steelhead/rainbow trout >25 cm FL were captured. Section-specific densities averaged about 1.5 times greater than in 1992 (c.f. above), at 217 ± 57 trout/100 m (range, 148–286 trout/100 m), based on abundance estimates made with the three-pass depletion method.

Paso Robles Creek and Tributaries

Although spawning areas were observed, no juvenile steelhead or other fishes were seen in Paso Robles Creek during a January 1957 CDFG survey. Insufficient flow for steelhead migration in the Salinas River was noted as a primary problem. Local residents reported that steelhead entered the Paso Robles drainage in 1955 and 1957-58. In a CDFG survey report from May 1960, juvenile steelhead, about 5 cm in length, occurred at an estimated minimum density of 4–10 trout/pool. Spawning success appeared to be high, and rearing occurred in shaded, isolated pools as stream flow receeded in summer. The sport fishery was minor due to limited access to private property, and a 69 cm steelhead was reportedly caught on hook-and-line the previous season. Catostomids and cyprinids were also present in the stream at very high densities. The stream has been altered as a result of bridge construction, diversions, and extraction of streambed materials, and various tributaries have been impounded. Juvenile steelhead/rainbow trout were abundant in Paso Robles Creek when surveyed by Barclay (1975).

Jack Creek is a main tributary to Paso Robles Creek which has historically also functioned as a steelhead spawning and rearing stream. Such mention was made in the report of a May 1960 CDFG survey of the stream. However, no juvenile steelhead were captured during a CDFG electrofishing survey in November 1973. It was reported that in the 1950's, large numbers of steelhead spawned in this stream, but not in recent years. One substantial migration barrier and several pumping stations were noted. Two adult steelhead were captured in Jack Creek in June 1975; one measured 71 cm FL and weighed nearly 4 kg, the other was about 41 cm in length (San Luis Obispo Telegram-Tribune, 18 June 1975). Juvenile steelhead/rainbow trout were limited in abundance in Jack Creek when surveyed by Barclay (1975). The stream has been altered by diversions, the construction of small reservoirs, and extraction of streambed materials, as evidenced by documents contained in the CDFG files.

Santa Rita Creek is another major tributary to Paso Robles Creek. It is comprised of flow from its north and south forks. When surveyed by the CDFG in May 1960, spawning areas were present in the main stem and both forks, one diversion pump was in operation, and no barriers were noted. Juvenile steelhead, 5 cm in length, were present in the main stem and lower north fork at a density of 4–5 trout/pool. Permanent, well-shaded pools provided summer rearing habitat. Catostomids and cyprinids were present in very high densities. The dam at the Santa Rita Ranch was completed in 1965, which blocked any potential upstream movement of steelhead spawners. By November 1973 when the stream was next surveyed by the CDFG, steelhead were unable to reach the Paso Robles drainage because of lack of a migration corridor by way of the Salinas River. No juvenile steelhead/rainbow trout were captured by use of electrofishing, although seven other species of fish were present. Apparently, hatchery rainbow trout were unsuccessfully stocked in the reservoir at the Santa Rita Ranch for several years. Juvenile steelhead/rainbow trout were limited in abundance in Santa Rita Creek when surveyed by Barclay (1975).

<u>San Antonio River and Tributaries</u>

The San Antonio River was one of the most important spawning and rearing tributaries for Salinas River steelhead. Snyder (1913) found juvenile steelhead/rainbow trout at both of two sampling stations in the San Antonio, near the mission and in the mountains. He also noted that fishing for juvenile steelhead/rainbow trout was especially good in the upper reaches of the San Antonio River system.

Rainbow trout were present in the upper San Antonio River when surveyed by the CDFG during the mid-1930's. Spawning grounds were scattered in distribution, and the presence of migration barriers was noted. Early CDFG records also showed that the San Antonio steelhead population was supplemented with 10,000 juveniles in each of 1931 and 1932, and 15,000 (@ 1,764/kg) from the Brookdale Hatchery in 1938. In addition, 60,000 hatchery rainbow trout were planted during 1930–32, and about 235,000 brown trout during 1930–36.

Evidently, the San Antonio River was used by local CDFG personnel as an index of the steelhead run in the Salinas River; a few steelhead entered the San Antonio during the winter of 1949-50, but none had been seen as of late January 1951 (CDFG, unpubl. field notes of 24 January 1951). A local resident reportedly saw four adult steelhead ascending the stream during the winter of 1957-58 at the Merle Ranch, near the boundary of the Los Padres National Forest and Hunter Liggett Military Reservation, in the upper San Antonio (S. C. Smedley, CDFG, unpubl. field notes of 4 September 1958). In addition, "trout water" was said to begin about 1.6 km upstream from that point. The CDFG had otherwise observed that steelhead ascended the San Antonio in all years when rainfall was sufficient to provide continuous stream flow to the Salinas River; and that resident rainbow trout occurred in the headwaters to within about 5 km above the ranch (W. A. Evans, CDFG, unpubl. intraoffice. corr. of 19 November 1958).

About 8 km of the lower San Antonio downstream from Pleyto Bridge was surveyed by the CDFG on 7 May 1959. Spawning and rearing habitats for steelhead were nonexistent, as the stream channel was braided, the substrate was mostly sand, and pool development was poor. No juvenile steelhead/rainbow trout were seen. Nor were any found on 10 May 1960 in the uppermost 6.5 km of the stream contained within the Hunter Liggett Military Reservation (M. R. Schreiber, CDFG, unpubl. intraoffice corr. of 13 May 1960).

The results of a CDFG survey conducted during 12–13 September 1961 confirmed earlier surveys, and provided a general overview of the distribution of steelhead/rainbow trout habitat in the San Antonio system, and its use by the species. The stream was surveyed from about 2.0 km upstream from Fresno Camp in the headwaters, downstream to Pleyto Bridge, for a total distance of about 74 km. Stream flow was minimal in the headwaters, and nonexistent downstream from the Merle Ranch. Essentially, gravel, pool, cover, and water quality conditions considered suitable for steelhead/rainbow trout spawning and rearing existed only in the headwaters, upstream from the Merle Ranch. A 1.2-m high flashboard dam at the ranch created a migration barrier; water was also diverted from the stream at this point. Rainbow trout and brown trout were present in the Fresno Camp area. In a related document, it was reported that the owner of the Merle ranch planted hundreds of hatchery rainbow and brown trout into the San Antonio River annually, upstream from the flashboard dam (R. L. Moore, CDFG, unpubl. memo. of 26 October 1961).

As on the Nacimiento and upper mainstem Salinas rivers, the San Antonio River was also developed for its water resources, and a dam was constructed in the lower river which began storing runoff during the winter of 1965-66. The pattern of flow releases from the dam was not predicted to provide perennial flow conditions in the lowermost river, and the CDFG decided against developing a fishery downstream from the dam (R. J. Hansen, CDFG, unpubl. memo. of 4 September 1963).

Prior to impoundment, the CDFG conducted a survey of the entire San Antonio drainage to determine the necessity of chemical treatment to eradicate non-game fish species. Stream surveys were made during July–September 1965 which resulted in a relatively detailed description of the distribution of steelhead/rainbow trout habitat and its use by the species (M. L.

Johnson, CDFG, unpubl. file report of 10 September 1965). The following areas lacked suitable spawning and rearing habitats, and were uninhabited by juvenile steelhead/rainbow trout: the mainstem San Antonio, from the confluence with the Salinas River upstream to the Merle Ranch; and the tributaries, Jolon Creek and Mission Creek, with its tributary, Coleman Creek. Two tributaries, Wizard Gulch and Forest Creek, may have supported some spawning but lacked the stream flow to provide juvenile rearing habitat, and no fish were seen in these streams.

The lowermost mainstem tributary to contain rainbow trout was Bear Canyon Creek, where these fish ranged in size from about 2.5 to 12.5 cm at a visually estimated density of about 10 trout/100 m. The main stem upstream from the Merle Ranch contained rainbow trout (2.5–25 cm long, @ ~82 trout/100 m), as did an unnamed headwater tributary (2.5–20 cm long, @ ~13 trout/100 m) and the tributary, Salsipuedes Creek (7.5–15 cm long, @ ~16 trout/100 m). The North Fork San Antonio River contained rainbow trout (2.5–20 cm long, @ ~13–16 trout/100 m) from the confluence with the main stem at the Merle Ranch, to the headwaters. Several North Fork tributaries also supported rainbow trout, including: Rattlesnake Creek (5–12.5 cm long, @ ~3 trout/100 m) and its tributary, Pinal Creek (7.5–12.5 cm long, @ ~16 trout/100 m); Sycamore Creek (5–7.5 cm long, @ ~26 trout/100 m); Carrizo Creek (2.5–25 cm long, @ ~16 trout/100 m); and an unnamed headwater tributary (7.5–15 cm long, @ ~16 trout/100 m). The North Fork tributary, Indians Creek, did not contain rainbow trout.

Stocking of hatchery-reared salmonids in the San Antonio River has continued over the years. For example, 2,000 rainbow trout (@ 551/kg) were planted in each of the upper and lower river on 7 June 1980.

Although the availability of steelhead spawning and rearing habitat was very limited in the lower San Antonio River even before dam construction (see above), the CDFG still identified steelhead as inhabitants of the San Antonio below the reservoir as of 1981 (R. Benthin, CDFG, unpubl. letter of 4 March 1981). Presumably, it was assumed that steelhead still entered the lower river from the Salinas when runoff was sufficient to provide a continuous migration corridor. However, lack of access to historic spawning and rearing habitats in the perennial headwaters greatly limits steelhead use of the San Antonio River.

Santa Margarita Creek and Tributaries

Juvenile steelhead/rainbow trout were abundant in Santa Margarita Creek when surveyed by Barclay (1975).

Juvenile steelhead/rainbow trout were present in the perennial Santa Margarita Creek tributary, Tassajara Creek, when surveyed by the CDFG during the mid-1930's. A lack of suitable spawning areas may have been a limiting factor for steelhead production. As of 1951, a few steelhead still entered Tassajara Creek when stream flow was sufficient (W. A. Evans, CDFG, unpubl. field notes of 5 April 1951). Juvenile steelhead/rainbow trout were abundant in Tassajara Creek when surveyed by Barclay (1975).

The Tassajara Creek steelhead population was supplemented with 10,000 juveniles in 1932, 8,000 in 1933, and 5,000 (@ 1,728/kg) from the Brookdale Hatchery on 29 June 1938.

Juvenile steelhead were present in the perennial Santa Margarita Creek tributary, Trout Creek, when surveyed by the CDFG during the mid-1930's. Spawning areas were common in the lower portion of the 6.4 km long stream, and scattered in the upper portion. No diversions or migration barriers were observed. Trout Creek was apparently regarded by local anglers as one of the best trout streams in San Luis Obispo County, although the surveyer thought that steelhead production was limited by a lack of flow and heavy fishing pressure.

Early CDFG stocking records showed that the Trout Creek steelhead population was supplemented with plants of 16,000 juveniles in 1933, and 5,000 (@ 1,728/kg) from the Brookdale Hatchery on 29 June 1938. Some 4,000 hatchery-reared rainbow trout were planted in 1932, and a total of 21,000 brown trout during 1932–1936.

Salmon Creek Drainage

Salmon Creek is the southernmost steelhead stream in Monterey County. It is a very high gradient creek in which a 30 m high waterfall, about 1.6 km upstream from the mouth, marks the upper limit for steelhead access (CDFG, unpubl. field note of 7 February 1961). The CDFG surveyed the lowermost 5.6 km of Salmon Creek during 3–4 August 1961. The approximate stream flow under late-summer conditions was strikingly low: the average at two stations in the upper creek was about 0.6 L/s. Spawning habitat in the lower creek for steelhead was very limited; the availability for resident rainbow trout above the barrier falls was generally greater. Despite the exceptionally low flow conditions, summer rearing habitat for juvenile steelhead/rainbow trout was apparently adequate as the high stream gradient and bedrock substrate resulted in the formation of many pools with boulder cover. There was only one small diversion of water, from the upper creek to the Salmon Creek Ranger Station. There were two partial bedrock barriers to steelhead migration below the falls, and both partial and complete barriers to resident rainbow trout movement above the falls. Rainbow trout in the upper creek were mostly about 2.5–15.0 cm in length (mean ≈ 5.0 cm), and occurred at a high visually-estimated density in one reach of about 230 trout/100 m. In the lower creek, juvenile steelhead/rainbow trout were 2.5–15.0 cm in length (mostly 5.0–10.0 cm) and the visually-estimated density from one pool count was about 178 trout/100 m. Fishing pressure was heavy in the lower creek during the beginning of the trout season in spring.

Salmon Creek was included in the CDFG's attempt to develop brown trout fisheries in Monterey County during the 1950's and 1960's. On 9 May 1962, 6,000 brown trout fingerlings were planted in the upper creek near the Spruce Creek Camp (CDFG, unpubl. field note of 9 May 1962). Conditions for trout were generally favorable as described in the 1961 CDFG survey, and many 10–15 cm long rainbow trout were observed. Another 600 brown trout fingerlings were planted in upper Salmon Creek on 23 June 1963. Neither of these plants was evaluated for their success, although brown trout survival in nearby streams was very low (M. L. Johnson, CDFG, unpubl. memo. of 14 October 1963).

Salmon Creek, along with Alder, Mill, Plaskett, and Prewitt creeks, is particularly interesting in that it seems to represent the lower dimensional threshold for drainages that can be utilized by steelhead along the steep Big Sur Coast.

San Jose Creek Drainage

San Jose Creek was surveyed by the CDFG in July–August 1962, from the mouth to the creek source, for a distance of about 13 km. A 2.4 m bedrock waterfall formed a partial migration barrier to steelhead, about 2.4 km from the mouth. In addition, a complete barrier was formed by a 6–7.5 m high earthfill dam, located another 2.4 km above the waterfall. Much of the stream bottom consisted of sand, but there were scattered beds of suitable spawning gravels for steelhead below the dam, and for resident rainbow trout above the dam. Rearing habitat for juvenile steelhead was adequate. Two small diversions were noted. The local warden estimated the annual run of adult steelhead at 50–100 fish. Resident rainbow trout densities were very low in the 8 km of stream above the dam; only two 12.5–15 cm fish were seen. In the 2.4 km section between the dam and waterfall, the density of 5–18 cm trout was about 30 fish/km. O. mykiss density was highest in the 1.6 km of flowing stream below the waterfall, where there were about 110 fish/km, 5–15 cm in length. O. mykiss in the middle and lower sections averaged 5–10 cm in length. In summary, reproduction and juvenile recruitment were successful in the creek sections accessible to steelhead. The low density of resident rainbow trout in the section above the dam was attributed to two successive years of nearly complete desiccation in that portion of the stream. These observations were in stark contrast to a 1961 CDFG document which stated that San Jose Creek was "of little use to fishlife" with regard to a proposed highway bridge replacement project (R. L. Jones, CDFG, unpubl. interdep. comm. of 29 June 1961).

In September 1962, the CDFG also made observations of several tributaries to San Jose Creek, and the following conclusions were made. Seneca Creek, Van Winkler Creek, and several small unnamed tributaries were judged to have low potential for O. mykiss production due to their steep gradient and intermittent flow. The North Fork San Jose Creek reportedly had limited salmonid production potential. Observations were also made of Williams Canyon Creek, the report of which is included below.

When San Jose Creek was surveyed again by the CDFG in May 1963, siltation of the stream bottom had intensified due to runoff from heavy winter and spring storms. The quality and quantity of both spawning and rearing habitat were reduced. No fish were observed above the waterfall, although several 15 cm juvenile steelhead were seen attempting to pass the falls.

As of August 1979, the earthfill dam had been temporarily removed to extract accumulated sediment. The damsite was now passable to steelhead and juveniles were observed in pools upstream from that point. San Jose Creek has apparently not been surveyed in recent years. However, in the report of a 1990 survey of Williams Canyon Creek (see below), it was mentioned that the creek had not reached the ocean during the drought that had begun in water year 1986-87, thus precluding steelhead migrations to and from the Pacific Ocean.

Williams Canyon Creek

When observed by the CDFG in September 1962, Williams Canyon Creek had perennial flow, and although none was seen during this survey, the local warden reported trout to 1.6 km above the mouth. The stream had limited spawning gravels and was heavily silted due to logging activities prior to 1900.

The CDFG surveyed Williams Canyon Creek in February and April 1990, from the confluence with San Jose Creek to the headwaters (F. Roddy, CDFG, unpubl. memo. of 30 April 1990). Generally, the creek was heavily silted, and consequently, no suitable spawning areas were observed. Pools were also filled in with sand. In a single 46 m reach in the lower creek, only two O. mykiss were captured by electrofishing. Lengths and weights were 149 and 170 mm FL, and 40 g and 60 g, respectively. Several partial and complete migration barriers were identified, created by logjams and culverts. In addition to siltation, the observed low abundance of O. mykiss was attributed to several successive years of drought. It was noted that, during the drought, San Jose Creek had not reached the ocean, thus precluding both adult and juvenile steelhead migrations.

Soberanes Creek Drainage

The very small yet perennial Soberanes Creek has not been accessible to steelhead within recent geological history due to a 2.4 m waterfall at the mouth. The stream may also be unsuitable habitat for resident rainbow trout, as none was found when the lowermost 3.2 km of the creek were spot-sampled with a dip net and electrofisher on 4 April 1989 (Rischbieter 1990b).

Soda Springs Creek Drainage

The lowermost 1.6 km of Soda Springs Creek were surveyed by the U.S. Forest Service on 17 September 1981. The creek was described as a very small, rocky, high gradient stream with poor riffle and pool development and little summer flow (~1.5 L/s during this survey). There was a 3 m fall just above the Highway 1 crossing which created a complete barrier for upstream migrating steelhead. No fishes were present in the stream and, overall, Soda Springs Creek may simply be too small for steelhead use.

Vicente Creek Drainage

The CDFG surveyed lower Vicente Creek on 7 September 1961. The stream was described as small and rugged. The creek had evidently not been populated by steelhead within recent geological history, because of an impassable bedrock fall near the mouth. However, resident rainbow trout were observed in pools beneath the Highway 1 bridge. A local resident reported that the trout population in the creek was small, and that the fish caught were seldom >15 cm in length. The stream was privately owned and closed to public access.

Villa Creek Drainage

Villa Creek is a small, rocky, high gradient stream that has evidently not been populated by steelhead within recent geological history. A CDFG survey of the lowermost 5.6 km of the creek on 4 August 1961 revealed the presence of a series of bedrock and logjam barriers, beginning near the mouth, which blocked steelhead access. No fish were seen in the lowermost third of the creek, nor in the extreme headwaters. The mid-portion of the stream was populated by resident rainbow trout, 5.0 –15.0 cm in length, at a visually-estimated density of about 230 trout/100 m. Spawning areas were very limited, but rearing habitat in the form of pools and cover seemed adequate. The survey report indicated that local residents had stocked the creek, presumably with rainbow trout, about 1900. Being undocumented otherwise, the reliability of this stocking record is unclear.

On 11 August 1969, the CDFG rechecked lower Villa Creek for steelhead access (CDFG, unpubl. field note of 21 August 1969). There was a natural boulder barrier about 90 m above the mouth that was deemed impassable by adult steelhead under high winter flow conditions. No fish were seen in the lowermost 180 m of the creek, although rainbow trout up to 18 cm long were seen at a low density above this reach.

The U.S. Forest Service surveyed the lowermost 2.4 km of the creek on 19 September 1981 and reaffirmed the presence of the 6 m high boulder barrier, about 90 m above the mouth, which blocked adult steelhead immigration. Overall, the character and condition of the creek seemed unchanged since the 1961 CDFG survey. The creek was morphologically stable through most of the survey area. Resident rainbow trout were common in abundance, and visual density estimates averaged 39 trout/100 m in the lower survey area, and about 49 trout/100 m in the upper survey area. Corresponding mean lengths were 14.6 cm and 16.0 cm (overall range, 2.5–25 cm).

Wildcat Creek Drainage

Wildcat Creek apparently has too high a gradient to provide access or habitat otherwise for steelhead or resident rainbow trout. This conclusion is based on the results of a CDFG reconnaissance of the stream in 1981 (as cited in Rischbieter 1990b).

Wild Cattle Creek Drainage

Wild Cattle Creek has apparently not been used extensively by steelhead, if at all, within recent geological history. The USFS surveyed the lowermost 800 m of the creek on 13 July 1981 and found that a 2.4 m boulder barrier would limit steelhead access to a point about 90 m above the Highway 1 crossing. No fish were seen below or above the barrier. Overall, the creek was deemed too steep, with too little pool development to support rainbow trout much less provide spawning and rearing habitat for steelhead. Rainbow trout presence/absence was not evaluated above the survey area where the stream ran through private property.

Willow Creek Drainage

Historically, Willow Creek was one of the most productive steelhead streams in southernmost Monterey County. Longtime visitors to the creek reported seeing adult steelhead in groups of 10–12 during most years, although none had been observed by early February of the 1960–1961 spawning season when low flow conditions prevailed (CDFG, unpubl. field note of 7 February 1961).

On 14 June 1961, the CDFG surveyed a 1.6 km reach of Willow Creek, near the confluence with the North Fork Willow Creek. Spawning gravel for steelhead was scarce in the survey reach, but rearing habitat in the form of pools and cover was abundant. Small diversions removed water from the stream for domestic use by local miners. Juvenile steelhead/rainbow trout occurred at a visually-estimated density of about 246 trout/100 m. The trout were about 7.5–25.0 cm long, although most were <13 cm. A part-time local resident since 1927 reported that steelhead used the drainage to about 5 km above the main stem/north fork confluence. He also reported that summer angling pressure had increased over the years and that few catchable-size trout remained in the stream after the early fishing season.

The CDFG surveyed the entire creek for a distance of about 18 km during 25 July–3 August 1961. Like the other streams in the area, Willow Creek was characteristically small, had a low summer flow and a high gradient, especially in the headwaters. Two small diversions were noted. The stream substrate was dominated by cobble, boulders, and bedrock. Suitable gravel for steelhead spawning occurred throughout the stream but in small quantities. The best spawning areas were in the upper half of the drainage, although their use by steelhead was limited because of bedrock and logjam barriers above the main stem/north fork confluence. Rearing habitat in the form of pools and cover was abundant throughout the stream. Visually-estimated densities of juvenile steelhead/rainbow trout ranged from 98 to 246 trout/100 m from upper to lower Willow Creek, and about 62 trout/100 m in the north fork. Annual steelhead runs had reportedly been well below normal during the previous 3 yr with low rainfall.

When surveyed by the USFS during 26–27 September 1981, the stream had apparently degraded somewhat from 20 yr earlier because of siltation from mining in and near the creek which resulted in pool filling. Numerous debris dams in the middle and upper stream were also causing erosion and migration barriers. The likely sources of woody debris were mining activity near the stream and the Los Burros fire of 1970. Water quality was reduced from the input of organics, possibly sewage. Yet, production of steelhead/rainbow trout and their invertebrate food items was still rated relatively highly. Visually-estimated densities in the lower, middle, and upper survey reaches were 49, 66, and 82 trout/100 m, respectively. The overall size range of trout was 2.5–30.5 cm, and the mean in each reach was about 13 cm. The largest individuals occurred in the mid- to upper stream.

SAN LUIS OBISPO COUNTY

Arroyo de la Cruz Drainage

The main stem Arroyo de la Cruz is formed by the confluence of two main headwater streams, Burnett and Marmolejo creeks. Burnett Creek is typically regarded as the headwater extension of the main stem, and is treated so here. The relatively small body of information on other tributaries is also included within this account on the main stem.

The Arroyo de la Cruz drainage lies on property owned by the Hearst Corporation, which limits access to the stream. CDFG observations beginning in 1937 described the intermittency of flow in the lower stream, but the persistence of the lagoon. Such observations were made both in summer and winter. Although records were not present, the steelhead population was evidently supplemented with juvenile plants made in the lagoon.

The CDFG surveyed the Arroyo de la Cruz on 14 January 1960. Spawning areas were abundant in the lowermost 11 km of the stream, but scarcer above this point toward the headwaters. Rearing habitat was adequate throughout, but of highest quality in the upper stream area. No permanent diversions or barriers were noted. Cattle grazing caused streambank erosion in the lowermost 11 km of stream, but siltation was not extreme. No fish were seen in the stream during this survey, but they were when the CDFG made another brief survey on 29 June 1960. Juvenile steelhead, 5–10 cm long, occurred in approximate densities of 50–100 fish/pool. The Arroyo de la Cruz tributary, Green Canyon Creek, also contained 25–50 juvenile steelhead (4–7.5 cm long) per pool during this survey. A silt-filled 3 m high dam with a dysfunctional fish ladder was located about 8.4 km upstream from the confluence with Green Canyon Creek.

The stream was surveyed again by the CDFG, from the mouth to its headwater tributaries, in August 1973. The overall condition of the stream was apparently about the same as in 1960, although water extraction had increased due to the presence of two diversion weirs (inoperative at the time of the survey) and three wells in the system. Juvenile steelhead were observed throughout the drainage, except above impassable waterall barriers on Burnett Creek and its tributary, Spanish Cabin Creek. Aside from a high abundance of young-of-the-year in Green Canyon Creek, densities of young steelhead in the other tributaries were judged to be low, relative to the amount of available habitat. All juvenile steelhead found in the upper Arroyo de la Cruz, Burnett Creek, Spanish Cabin Creek, and Marmolejo Creek were covered with black spots thought to be encysted metacercaria of the monogenetic trematode, Neascus, such as those found on steelhead in San Carpojo Creek. Juvenile steelhead in Green Canyon Creek did not have the “black spot disease”.

The Arroyo de la Cruz was surveyed during September–October 1978 (G. J. Stone, unpubl. file report to the CDFG). Stream condition was similar to that in 1973. Juvenile steelhead were captured both with hook-and-line and by electrofishing. The lagoon supported a large number of steelhead, which were silvery and 15–20 cm long. From SKM 10.5 through 20 in Burnett Creek, trout as large as 35.6 cm were caught in large pools. About 75% of all steelhead observed were infected to varying degrees by the black spot disease. Observations made in the upper Arroyo de la Cruz and tributaries suggested that juvenile abundance was about 33 trout/100 m.

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in the Arroyo de la Cruz and five other San Luis Obispo County coastal streams. The Arroyo de la Cruz was selected to represent a steelhead production system approximating pristine conditions. Abundance and biomass were estimated using electrofishing and the two-pass removal method in six randomly-selected, 30.5 m long sections, in three 1.6 km long stream reaches. Most of the stream was dry below SKM 11.

Mean estimated juvenile density was 13 ± 15 trout/100 m (range, 0–46 trout/100 m). Estimates of population on a kilometer basis increased from downstream (70 trout in SKM 6.4–8.0) to upstream (439 trout in SKM 16.1–17.7). Many juvenile steelhead were also seen in the large lagoon and in large pools in SKM 17.7–19.3, but no abundance estimates were made at these locations. Apparently, juvenile recruitment in 1978 was poor as only 2% of sampled trout (n = 52) were likely young-of-the-year (50 –99 mm in length), 54% were 100–149 mm, and 44% were 150–199 mm. Most sampled trout were yearlings as average individual mass was 29 g.

Knable (1978) concluded that the Arroyo de la Cruz drainage remained basically unaltered, relative to the other creeks in his survey. Exceptions were conversion of the riparian corridor to grazing land to within 9 m of the stream, and fecal pollution from livestock.

In November 1978, the Hearst Corporation applied to the California State Water

Resources Control Board for a permit to pump water from the Arroyo de la Cruz. The CDFG and Jones & Stokes Associates conducted a cooperative study during August–October 1981 to collect baseline data on the life history and population size and structure of steelhead in the stream. The forthcoming synopsis of the results of this study are based on Jones & Stokes Associates and California Department of Fish and Game (1982) and data contained in the CDFG file (P. Chappell, CDFG, unpubl. data).

On 19 August 1981, 111 juvenile steelhead were captured in the Arroyo de la Cruz lagoon by electrofishing and hook-and-line. The steelhead had a mean (± SD) length of 15.3 ± 1.6 cm FL (range, 10.5–20.0 cm FL; Fig. 16) and were primarily age 1+. There was no significant difference in steelhead fork lengths among capture methods ($t = -0.26$, $p = 0.80$). The lagoon was isolated at this time, due to a lack of freshwater inflow and a sandbar which closed the mouth of the stream. One hundred of the captured fish were marked and released for future recapture and estimation of abundance. The lagoon population was sampled again by hook-and-line during 25–27 August 1981. Of 100 steelhead, only one was a recapture and the abundance estimate for the lagoon was 5,100 fish; confidence limits could not be calculated because of the extremely low recapture rate.

The second phase of this study was conducted during 20–22 October 1981 when two reaches of Burnett Creek were sampled by use of electrofishing to estimate juvenile steelhead abundances. Stream flow was continuous in Burnett Creek from the Van Gordon Creek confluence, to about 0.8 km below the Marmolejo Creek confluence in the main stem Arroyo de la Cruz. There was interrupted flow upstream and downstream from these points, respectively, although the main stem was completely dry downstream from the confluence with Long Canyon. The estimated density of juvenile steelhead in a 30.5 m reach about 0.4 km above the Van Gordon Creek confluence was 249 fish/100 m (95% C.L., 171–328 fish/100 m). In a 38 m reach about 0.8 km above the confluence with Spanish Cabin Creek, estimated density was nearly identical: 241 fish/100 m (194–289 fish/100 m). The fish averaged 7.1 ± 2.8 cm FL (range, 3.5–20.5 cm FL; $n = 140$), and 92% of the combined sample comprised age 0+ fish; 7% were age 1+ and 1% was age 2+. The black spot disease was prevalent among captured fish, and some individuals were smolting. The Arroyo de la Cruz was characterized by large bedrock pools where young-of-the-year steelhead were abundant. High concentrations of young steelhead in isolated pools were found as far upstream in the system as Burnett Creek near Burnett Camp. This stream area lacked a riparian understory, and stream banks were eroded due to heavy grazing pressure.

A complementary analysis was conducted to determine if there was a difference in size-at-age between lagoon-dwelling steelhead and those sampled from the perennial stream reach, as described above (W. M. Snider, CDFG, unpubl. memo. of 6 January 1982). One could predict that lagoon-rearing steelhead would have higher growth rates than creek-rearing steelhead. However, there was no significant difference ($t = -0.55$, $p = 0.59$) in average (± SD) backcalculated fork length at age 1 between lagoon-dwelling (89.4 ± 11.7 cm FL, n = 43) and stream-dwelling (91.9 ± 14.9 cm FL, n = 9) steelhead from the 1980 year-class; there were too few fish from the 1979 year-class to be statistically analyzed. This result indicated that all age 1+ steelhead had reared under similar conditions in the stream portion of the system through their first year of growth. Steelhead found in the lagoon apparently migrated downstream during their second year. It was concluded that the creek was used for spawning and as a young-of-the-year nursery, while the lagoon functioned primarily as a rearing area for ≥ 1+ steelhead.

The Hearst Ranch diversion was eventually approved with stipulations for a fish passage structure at the weir.

During the 1983-84 steelhead season, the Santa Lucia Flyfishing Club conducted a creel census of four San Luis Obispo County coastal streams, including the Arroyo de la Cruz (Santa Lucia Flyfishing Club, San Luis Obispo, newsletter of April 1984). Surveys occurred on 20 of the 50 legal fishing days, during which 83 anglers were interviewed and 112 steelhead were reportedly landed as a result of 239.25 hr of angling. Of these fish, 111 were juveniles ≤ 20 cm in length. One adult steelhead was taken on 15 January 1984 which measured 74 cm in length. Several other adult steelhead were observed in the stream throughout January, and one was seen on 22 March 1984 which was trapped in the creek as a sandbar had closed the mouth by 25 January 1984.

Jones & Stokes Associates (1986) collected additional baseline data on the Arroyo de la Cruz steelhead population in 1985. Juvenile steelhead abundance estimates were made by use of electrofishing and the three-pass removal method. One 30.5 m riffle in each of upper and lower Burnett Creek, and in the upper main stem Arroyo de la Cruz, was sampled in July and October. Abundance estimates (± SD) averaged 289 ± 98 trout/100 m in July, but when the same riffles were sampled again in October, abundances had decreased by an average of 55% when mean estimated abundance was 129 ± 46 trout/100 m. Similarly, juvenile steelhead abundances, determined by direct enumeration (snorkeling) in one shallow pool in each of upper and lower Burnett Creek, ranged from about 230–525 fish/100 m in July, and decreased to an average (± SD) observed abundance of 167 ± 69 fish/100 m in October. These losses may have been due in part to a reduction in both quantity and quality of habitat as stream flow decreased. The estimated abundance of juvenile steelhead in the lagoon in October was 424 fish, as determined by combined snorkeling and electrofishing counts. Juvenile population structure and distribution of age-classes were similar to those found in the 1981 survey. The population segment in Burnett Creek and the upper Arroyo de la Cruz was highly dominated by age 0+ steelhead. The mean length of these fish only increased from 55.1 mm FL in July to 61.3 mm FL in October, which was probably the result of not only poor growth as indicated by the authors, but perhaps also size-selective mortality and/or dispersal. Only 10–15 age ≥ 1+ trout, about 150–300 mm in length, were observed in the October creek samples, thus comprising a small proportion of the juvenile population in the stream portion of the system. Lagoon-dwelling steelhead in October ranged from about 120–250 mm FL. Age 1+ fish dominated in number and the mode in the length-frequency distribution was between 150 and 160 mm FL. There was a relatively small proportion of age 2+ and 3+ fish and young-of-the-year were absent. Nineteen of the 24 trout (79%) in the lagoon had morphological characteristics of smolts (absence of parr marks, silvery coloration, reduced condition factor); the mean condition factor (105[weight, g]/[fork length, mm]3) of smolt-like steelhead (1.16) was lower than that of all steelhead in the lagoon (1.33). As in earlier surveys, the black spot disease was prevalent among juvenile steelhead in the stream portion of the system, but <20% of lagoon-dwelling steelhead were infested with the parasite. Two adult steelhead were observed which had been trapped in fresh water since the previous spawning season: one in the lagoon estimated at about 4 kg; and one in upper Burnett Creek, a male which measured 635 mm FL and 2.2 kg. The skeleton of a third adult was found in Burnett Creek; the size of this fish was estimated at 510 mm, based on skeletal length. Interrupted surficial flow in the lower Arroyo de la Cruz separated the perennial stream from the lagoon typically for 3–5 months each year, depending on interannual differences in precipitation. The conclusions of this study were essentially the same as those of Snider, above: (i) the perennial stream was used for spawning and first year rearing of steelhead; and (ii) age 1 steelhead migrated downstream where possibly some smolted and continued to the ocean, while others reared for one or more years in the lagoon before emigrating to salt water.

In 1993, the CDFG assessed the stream habitat and associated steelhead population in the Arroyo de la Cruz (Nelson 1994d). This suite of studies consisted of stream surveys, emigrant trapping, and electrofishing surveys. Stream survey results are highlighted here first to provide an overview of the study area.

The main stem was surveyed on 6 July 1993 from the lagoon to the confluence of Burnett and Marmolejo creeks for a distance of 18 km. The lowermost 15.6 km were dry except for isolated bedrock and boulder-scour pools. There was perennial flow in the uppermost 2.4 km, and the lagoon was full. The channel in the low-gradient dry section was relatively broad with denuded, eroding stream banks. These conditions were associated with cattle grazing and numerous road crossings, primarily in the lower 8–10 km of stream. The perennial reach had a moderate gradient and more confined channel stabilized with riparian vegetation. Spawning areas were abundant. Most of the habitat was pools and step-runs with sufficient cover to provide perennial rearing habitat for juvenile steelhead. Age 0+, 1+, and ≥ 2+ steelhead were seen in isolated pools in the dry reach and throughout the perennial reach.

Burnett Creek was surveyed on 7 April 1993 from the Marmolejo Creek confluence to Spanish Cabin Creek for a distance of about 2.4 km. With regard to gradient, channel and streambank stability, Burnett Creek was basically a continuation of the mainstem perennial reach as described above. There were numerous small spawning areas, and an abundance of pools and runs with cover provided rearing habitat. The silt-filled weir with inadequate fish ladder seen in earlier surveys was still present. Apparently, the weir was only a partial barrier as age 0+ and 1+ steelhead were seen throughout the reach.

The lowermost 1.8 km of Marmolejo Creek were surveyed on 17 August 1993. About

0.64 km above the mouth, a series of boulders created a likely barrier to immigrating adult steelhead. Otherwise, the general character of the lower 1.1 km was much the same as at Burnett Creek, with regard to gradient, channel confinement, riparian canopy, and the presence of spawning and rearing habitats. Above the point, the channel was broad, riparian canopy was lacking, and flow was subsurface, perhaps the result of cattle grazing. There was surficial flow further upstream but this area was not surveyed extensively. Age 0+ through 2+ steelhead/rainbow trout were seen above and below the boulder series, and above the dry reach.

Overall, conditions in the drainage seemed little changed from earlier surveys, with the negative impacts of cattle grazing on stream habitat persisting.

Nelson (1994d) fished a downstream migrant trap on the main stem at SKM 1.1 from 5 April 1993 to 5 June 1993. During nine weeks of trapping, 44 steelhead parr, 24 partial smolts, 134 smolts, 11 rainbow trout, and 1 post-spawning adult were captured. Parr averaged 71.2 mm TL (range, 35–120 mm TL) and were thus dominated by age 0+ fish, while partial smolts, smolts, and rainbow trout averaged 180.0 mm TL (range, 105–335 mm TL) and were dominated by age 1+ and 2+ fish. The adult steelhead was 491 mm TL. About 75% of smolts were captured during the first two weeks of trapping, which indicated that many smolts emigrated prior to 5 april 1993.

Nelson (1994d) estimated the abundance of juvenile steelhead in the perennial reach of the Arroyo de la Cruz during 18–19 October 1993, using electrofishing and the multiple-pass removal method. The estimated abundance from composite catches in three 91 m long sections was 185 trout, or 67 trout/100 m. The expanded estimate for the 3.2 km perennial reach was 2,165 trout. The captured trout were 56–269 mm TL, but the catch was dominated by young-of-the-year 50–100 mm TL (54%) and yearlings 100–150 mm TL (36%).

Nelson (1994d) continued upstream with abundance estimates in two 91 m long sections in Burnett Creek. The estimated abundance from composite catches was 157 trout, or 86 trout/100 m. The expanded estimate for the 2.7 km perennial reach was 2,334 trout. The captured trout were 56–244 mm TL, but again the catch was dominated by young-of-the-year 50–100 mm TL (49%) and yearlings 100–150 mm TL (32%).

Marmolejo Creek only had 81 m of live stream, all of which was sampled. Nelson

(1994d) estimated abundance in this reach at 116 trout, or 144 trout/100 m. The captured trout were 53–224 mm TL, and highly dominated by young-of-the-year 50–100 mm TL (82%).

Nelson (1994d) concluded that the Arroyo de la Cruz provided an abundance of spawning habitat, but that high quality rearing habitat was limited because of interrupted flow conditions. She recommended that the Arroyo de la Cruz be protected as a steelhead production system by maintaining the perennial stream reaches and the lagoon. Removing the silt-filled weir on Burnett Creek would enhance stream channel function and steelhead access to the uppermost drainage. Further enhancement would be gained by increasing wetted stream length in reaches used by steelhead. Sedimentation from cattle grazing in the upper drainage was regarded as a negative impact needing attention.

Results from Knable (1978), Jones & Stokes Associates and California Department of Fish and Game (1982), Jones & Stokes Associates (1986), and Nelson (1994d) demonstrate the temporal variation in juvenile steelhead densities and age structure in the perennial reach of the Arroyo de la Cruz and Burnett Creek. Juvenile densities averaged 27 ± 10 trout/100 m in early fall 1978, 245 ± 6 trout/100 m in October 1981, 129 ± 45 trout/100 m in October 1985, and 76 ± 13 trout/100 m in October 1993. Most captured steelhead were yearlings in 1978, young-of-the-year in 1981 and 1985, and there was a relatively high proportion of yearling and older fish in 1993. Low densities of proportionately many yearlings observed in 1978 and 1993 may have reflected the impact of the 1976–77 and 1986–92 droughts on the steelhead population.

Arroyo Grande Creek Drainage

The Arroyo Grande Creek drainage area has been developed extensively for agriculture, and the stream is apparently heavily eutrophicated because of the discharge of nutrient-rich agricultural wastewater. Among other impacts, water is both diverted from the stream and pumped from the ground for irrigation. The lowermost portion of the stream, from the city of Arroyo Grande to the stream mouth, is channelized for flood control.

Historically, the Arroyo Grande system has supported steelhead, and rainbow trout in the mountainous headwaters (Jordan 1895). A mid-1930's CDFG survey report in the upper Arroyo Grande mentioned the presence of both rainbow trout and juvenile steelhead and that fishing

pressure was heavy. A January 1949 CDFG field note mentioned that steelhead entered the stream during high flow periods, in May 1950 many young-of-the-year and 5–15 cm juveniles were observed in the upper stream, and in October 1950 the stream was deemed unsuitable for rainbow trout stocking because of interrupted flow. Angling for juvenile steelhead, those of which occurred "by the hundreds" in the stream's lagoon, was reportedly good in May 1953. In a January 19
Juvenile steelhead were not observed during this survey. No migration barriers were seen. Fishing was reportedly heavy in both the winter steelhead season and the summer trout season. In June 1959, a low density of juvenile steelhead was observed in the upper stream above the confluence with the Arroyo Grande tributary, Lopez Canyon Creek.

The CDFG surveyed the stream again in May 1960. Low densities of rainbow trout and juvenile steelhead were seen, ranging in length from 5 to 30.5 cm. It was also reported that catchable rainbow trout were planted regularly each year when flow conditions permitted. The stream was noted as supporting one of the larger steelhead runs in the south coast region, which was estimated to be equal in magnitude to those found in Santa Rosa Creek, the Arroyo de la Cruz, San Simeon Creek, and San Carpojo Creek.

A coarse estimate of the long-term trend in the Arroyo Grande steelhead run was constructed by the CDFG in 1961 (Table 2), based on interviews of about 50 local landowners and sportsmen (R. N. Hinton, CDFG, unpubl. file report of 1 March 1961). Apparently, maximum estimated run size had decreased by a factor of about 50, from 5,000 adults in 1940 to less than 100 adults in 1960. Several hundred juvenile steelhead had been seen in the creek in each of the past few years.

A few adult steelhead were eventually seen later in the 1960-61 season. Two were reportedly taken by anglers on 4 March 1961 in the surf off the mouth of the creek. One of these fish was 54.5 cm in length and weighed about 1.4 kg. A 61 cm female and 12 smaller (23–25 cm) steelhead were seen in the lower stream in mid-March 1961. Juvenile steelhead/rainbow trout, 5–18 cm long, were observed on 21 March 1961 within a 3 km reach below the confluence with Lopez Canyon Creek. Stream flow was interrupted, and the trout were concentrated in pools. No adults were seen, although about 12 potential redds were located within this reach which otherwise lacked suitable spawning gravel.

By the time of a CDFG survey in September 1972, the Arroyo Grande had deteriorated substantially as a viable steelhead stream. Lopez Dam, constructed at the confluence with Lopez Canyon Creek during the mid-1960's (see below), blocked steelhead access to upstream spawning and rearing areas. Two small diversion dams were also noted in the lower stream. Numerous diversions had been installed along the stream course and various forms of pollution were noted. No juvenile steelhead were observed in the stream, but some adult steelhead were reportedly caught each year by local residents.

The Arroyo Grande was surveyed again in August 1978, from the mouth to Lopez Dam, an estimated 19 km (G. Stone, CDFG, unpubl. file report of 31 August 1978). The survey consisted of visual observations and electrofishing. Spawning areas were limited, and siltation was noted as a problem throughout much of the stream, with sediment depths of 2.5–15 cm. Rearing habitat, on the other hand, was adequate. Overall, the condition of the stream was unimproved since the 1972 survey, with the exception that willows were being allowed to grow back in the channelized lower stream. No juvenile steelhead were seen or captured.

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in Arroyo Grande Creek and five other San Luis Obispo County coastal streams. The Arroyo Grande was selected to represent a steelhead production system having undergone significant modification. No juvenile steelhead/rainbow trout were seen or captured by electrofishing in six randomly-selected, 30.5 m long sections, in four 1.6 km long stream reaches. Knable (1978) viewed the Arroyo Grande as the most severly degraded steelhead stream in his survey, primarily due to channelization, water diversions, and siltation.

The Arroyo Grande has apparently not been surveyed in recent years, yet the presence of a viable steelhead resource was mentioned in recent (through 1991) CDFG file documents in connection with a variety of proposed development projects.

Lopez Canyon Creek and Other Tributaries

According to Jordan (1895), Lopez Canyon Creek was "the best-known trout stream in San Luis Obispo County". Several Arroyo Grande Creek tributaries were surveyed by the CDFG in mid-March 1961. Juvenile steelhead, 10–15 cm in length, occurred in densities of about 2–5 fish/pool in Lopez Canyon Creek, and in its tributary, Vasquez Creek, at about 1–3 fish/pool. In contrast, no steelhead were observed in Corbett Canyon and Tar Springs creeks, although potential spawning substrate was present in Tar Springs which may have supported some spawning during winters of high precipitation.

Lopez Canyon Creek was fully surveyed by the CDFG on 10 August 1961. Some excellent spawning areas were observed, although they were limited in the bedrock headwaters. Rearing habitat was adequate for small juvenile steelhead. No barriers or diversions were seen. Stream flow became interrupted in the middle and lower portions of the stream. Young steelhead/rainbow trout, ranging in length from about 5 to 15 cm, occurred in visually-estimated densities of 26 trout/100 m in the upper section, 384 trout/100 m in the middle section, and 39 trout/100 m in the lower section. Overall, Lopez Canyon Creek was rated highly as a steelhead production area, with a comparable production potential of Santa Rosa and San Carpojo creeks.

The lowermost 3.2 km of Vasquez Creek was surveyed by the CDFG on 20 December 1961. Nearly all the stream bottom consisted of suitable spawning gravel. There were few pools and little cover to provide rearing habitat, however. A cement swimming pool with flashboard dam, built into the creek about 1.2 km above the mouth, created a steelhead migration barrier. A low density of 5–10 cm long juvenile steelhead was observed, and it was predicted that recruitment had been low during the past several dry years. There was little or no fishing. Vasquez Creek was recognized as a fair to good spawning tributary when steelhead were able to access Lopez Canyon.

The lowermost 1.6 km of Wittenburg Creek, the next Arroyo Grande tributary upstream from Lopez Canyon, was also checked by the CDFG on 20 December 1960. Stream flow was very low in this section and dry upstream from there. At least half the stream bottom contained suitable spawning gravel for steelhead. A local resident of 23 yrs reported that steelhead had not spawned in the creek since the winter of 1957-58, and "that there used to be lots of (steelhead) spawning" in the creek.

The lowermost 0.4 km of Vasquez Creek was walked by the CDFG on 22 February 1962 to look for spawning adult steelhead. None was seen, although a local resident reportedly saw two adults spawning just above the confluence with Lopez Canyon Creek and one spent adult moving downstream, the previous weekend.

Early fish stocking records showed that the Lopez Canyon steelhead population was supplemented with a plant of 10,000 juveniles in 1930, 25,000 in 1932, 24,000 in 1933, and 15,000 (@ 1,587/kg) from Brookdale Hatchery (Santa Cruz County) in 1938. The lower section of the creek was stocked annually with catchable rainbow trout as of the August 1961 CDFG survey.

The system was greatly altered when, during the mid-1960's, Lopez Dam was constructed on the Arroyo Grande at the confluence with Lopez Canyon Creek. The dam thus blocked steelhead access to upstream spawning grounds in Lopez Canyon, Vasquez, Wittenburg, and upper Arroyo Grande creeks . Partial mitigation for this loss was the development of a catchable rainbow trout fishery in Lopez Reservoir. Juvenile steelhead/rainbow trout, 5–23 cm long, were observed in Lopez Canyon Creek under low flow conditions in a CDFG electrofishing survey made during 27–28 August 1968 (CDFG, unpubl. data; E. V. Toffoli, CDFG, unpubl. memo. of September 1968). In contrast, none was found in the creek in a CDFG electrofishing survey conducted during 10–12 May 1978 (CDFG, unpubl. data).

Cayucos Creek Drainage

Cayucos Creek enters the Pacific Ocean along the north shore of Estero Bay. Four dams in the drainage were surveyed by the CDFG in January 1962 to determine steelhead passage; three were deemed impassable. Steelhead were apparently still present in the stream in 1989 (B. Hunter, CDFG, unpubl. memo. of 28 September 1989), yet historical records on the size and dynamics of this population are otherwise lacking.

Chorro Creek Drainage

Chorro Creek flows from dense chaparral in its headwaters, to a gently rolling grassland and oak woodland landscape, then through agricultural land until it enters Morro Bay. The dam at Chorro Reservoir, located about 4 km from the streams's headwaters, marks the upstream limit of 19 km of potential steelhead habitat.

The stream was surveyed by the CDFG in March 1958. At that time, there was an apparent abundance of high quality spawning and rearing habitat. Except for Chorro Dam, no migration barriers were noted, and no pollution sources were seen. Water was pumped from the stream in summer for agricultural irrigation. Flow was intermittent in some sections in the summer. Steelhead were not observed in Chorro Creek during this survey due to high flow and turbidity, although anecdotes mentioned in the survey report described observations of ascending adult steelhead (20–30 counted at one point within 0.5 hr as they proceeded upstream) and angling for steelhead near the creek mouth.

Some 3,167 catchable rainbow trout were stocked in the stream in 1960. A total of 208,436 catchable rainbow trout were planted in Chorro Reservoir from 1953 to 1968 to support a put-and-take fishery.

When Chorro Creek was surveyed by the CDFG in May 1973, several pollution sources, including the discharge of agricultural wastewater and chlorinated, secondarily treated sewage, were degrading the system. Water quality was apparently impacted and enhanced eutrophication was noted in the lower stream area. In addition, a number of culverts were noted as potential migration barriers, especially under low flow conditions, and one pumping diversion was sited. Local residents reported capturing juvenile steelhead/rainbow trout in both the main stem and tributaries, and observed spawning steelhead in the creek and its tributaries during the winter of 1973. So, despite habitat degradation, the stream still maintained at least a small run of steelhead.

Thirteen migration barriers of varying degree, caused mostly by dams and road crossings, were identified throughout the drainage by the CDFG in 1974 (W. M. Snider, CDFG, unpubl. file report of November 1974). Four of these barriers were on the main stem of Chorro Creek. It was concluded that elimination of these barriers would at least triple the available spawning and nursery area, and, in particular, would allow steelhead access to upstream areas with perennial flow. Poaching and predation would also be lessened because steelhead would not be concentrated behind these obstructions.

Western Outdoor News (8 March 1974 with photographic documentation) reported the catch of a 5.4 kg steelhead from Chorro Creek. Barclay (1975) found juvenile steelhead/rainbow trout in the creek, and "they were abundant in areas with clean, cool waters that flowed over gravel or other rock substrate."

Based on an extrapolation of data from Stenner Creek in the San Luis Obispo Creek drainage, the annual run of adult steelhead in Chorro Creek was estimated at 160 fish by the CDFG in 1976 (J. S. Leiby, CDFG, unpubl. memo. of 22 September 1976).

Since April 1979, up to 5,000 steelhead smolts have been stocked annually into Chorro Creek as mitigation for the California Department of Correction's Chorro Creek Dam which is a steelhead migration barrier. For example, 1,500 Mad River smolts (22/kg) were stocked in 1979, and 5,000 in 1980.

Dairy Creek

The Chorro Creek tributary, Dairy Creek, was surveyed in its entirety by the CDFG during 24–27 April 1973. High-quality spawning and rearing habitats appeared to be available to steelhead. Potential migration barriers may have blocked steelhead access to the headwaters. Cattle grazing in the watershed were a likely source of organic pollution in the stream. Juvenile steelhead/rainbow trout, 15–25 cm in length, occurred in low densities at two sampling stations in the lowermost 3.2 km of the stream. Steelhead juveniles up to 20 cm in length were captured by use of electrofishing during a CDFG survey in May 1973. A concrete apron at the Highway 1 crossing was identified as a low flow migration barrier by the CDFG in 1974 (W. M. Snider, CDFG, unpubl. file report of November 1974). In a grant proposal for a steelhead habitat improvement project, it was mentioned that San Luis Obispo County park personnel had observed steelhead in Dairy Creek as late as 1987.

San Bernardo Creek

The Chorro Creek tributary, San Bernardo Creek, was surveyed by the CDFG in February and June 1958, and January 1959 in connection with a proposed dam. Suitable steelhead spawning and rearing habitat was observed, although only one 13 cm juvenile was seen in the upper stream area. Algal growth inhibited visibility in the lower stream. Apparently, rainbow trout in the uppermost portion of the stream supported a small sport fishery. Local residents reported that adult steelhead entered the stream on two occasions during the winter of 1957-58, each time following an increase in stream flow. Four migration barriers were identified by the CDFG in 1974 (W. M. Snider, CDFG, unpubl. file report of November 1974). San Bernado Creek still reportedly supports a steelhead run (T. Tognazzini, CDFG, pers. comm. of

10 July 1992).

San Luisito Creek

The Chorro Creek tributary, San Luisito Creek, was surveyed by the CDFG on 12 May 1958, in a 3.7 km reach beginning about 1.9 km above the stream mouth. Spawning areas were rated as excellent, but rearing habitat in the form of pools and cover was lacking in this reach. Only one water diversion was observed but others were known to exist, and water for diversions was considered fully appropriated under summer streamflow conditions. No migration barriers were seen in this reach, but natural barriers were suspected to occur in the high-gradient headwaters. No pollution sources were identified. Even though no juvenile steelhead were positively identified during this survey, the stream was described as providing spawning and rearing habitat for Chorro Creek steelhead.

The CDFG identified two migration barriers on the creek in 1974 (W. M. Snider, CDFG, unpubl. file report of November 1974). Numerous adult steelhead were reportedly taken by poachers at the lowermost barrier.

Coon Creek Drainage

Coon Creek has apparently never been surveyed by the CDFG. The creek runs through the southern portion of Montana de Oro State Park. Juvenile steelhead/rainbow trout was the only fish species found in the creek by Barclay (1975). On 3 April 1986, a 13 cm long juvenile steelhead/rainbow trout was captured by dipnet about 1.2 km upstream from the mouth (T. L. Taylor, California Department of Parks and Recreation, unpubl. data). Local state park personnel have observed both adult and juvenile steelhead in the stream in recent years (R. Avant, California Department of Parks and Recreation, Montana de Oro State Park, pers. comm. of 4 May 1993).

Diablo Canyon Creek Drainage

Very little is known about the history of steelhead in Diablo Canyon Creek. Juvenile steelhead/rainbow trout was the only fish species found in the creek by Barclay (1975). With construction of the Diablo Canyon Nuclear Power Plant, the lower creek was greatly altered, including an extensive culvert system. These lower creek alterations probably block steelhead access to the stream, although resident rainbow trout should still be present in the upper drainage (W. M. Snider, CDFG, pers. comm. of 11 July 1994).

Islay Creek Drainage

Islay Creek lies within Montana de Oro State Park and has been closed to angling since 1968. The lowermost 4.8 km of the creek are available to steelhead, and 9.7 km of the creek upstream from a migration barrier support a resident rainbow trout population (M. L. Johnson, CDFG, unpubl. file letter of 24 February 1966). The creek has a very small and shallow lagoon. In a brief CDFG survey of the stream (M. L. Johnson, CDFG, unpubl. file letter of 1 April 1966), one adult steelhead was observed, and it was concluded that the creek supported only a small steelhead population. On 13 February 1986, juvenile steelhead were seen at the creek mouth (T. L. Taylor, California Department of Parks and Recreation, unpubl. data). Local state park personnel continue to see spawners and high densities of juvenile steelhead in lower Islay Creek, as well as rainbow trout in the upper drainage (R. Avant, California Department of Parks and Recreation, Montana de Oro State Park, pers. comm. of 4 May 1993).

Little Pico Creek Drainage

No formal record of an historical steelhead run was found for Little Pico Creek. During the 1983-84 steelhead season, the Santa Lucia Flyfishing Club conducted a creel census of four San Luis Obispo County coastal streams, including the Little Pico (Santa Lucia Flyfishing Club, San Luis Obispo, newsletter of April 1984). Surveys occurred on 20 of the 50 legal fishing days. Two anglers were interviewed who landed no steelhead during 3.00 hr of angling effort.

Reference was made, in several recent (1990) CDFG file documents, to a steelhead resource and its protection thereof in connection with lagoon alteration. Relative to nearby Pico Creek, the Little Pico apparently does not have as much deep pool habitat in which juvenile steelhead may oversummer. However, the dense riparian vegetation along the lower stream does provide good shelter for trout, and a few juvenile steelhead have been observed in the creek during snorkeling surveys since May 1992 (M. Jennings, USFWS, pers. comm. of 21 January

1993).

Morro Creek Drainage

A CDFG survey report combining field notes from February 1947 and April 1951 with observations made in December 1951 stated that steelhead runs in Morro Creek were small and that they were lightly fished because of limited access to private property in the lower stream area. Spawning substrate was present in the middle portion of the stream, and natural propagation was noted to have occurred in the lower mid-section. Upstream migration was blocked by cascades and a waterfall about 12 km from the mouth. Fishing for resident rainbow trout in 1951 was reportedly successful (medium to heavy fishing pressure) following a plant of 5,000 catchable-size fish. Some 990 rainbow trout catchables were stocked in 1953 and 1,540 in 1955.

In a January 1962 CDFG survey, the stream habitat was somewhat degraded due to pollution from an abandoned dump in the lower stream, and because of reduced flow due to extensive pumping. No migration barriers were observed, except as mentioned above. Drought conditions had prevailed since 1957-58, thus preventing breaching of the sandbar and adult steelhead immigration. No steelhead were observed and local residents reported that they had not seen any in the stream since 1959. Yet, the creek was still regarded as a viable steelhead production area.

When surveyed again by the CDFG in June 1973, silt was armoring spawning gravel in the lower stream, but gravel quality was still high in the upper and middle areas. Flow conditions were improved from 1962 due to increased precipitation, but pollution of various sorts had apparently increased, including siltation, dumping of garbage, urban and highway runoff, as well as discharge of agricultural wastewater. Several rainbow trout were captured above the barrier falls, which averaged 15.7 cm in length (SD = 5.6 cm; n = 15). These fish were believed to be descendants of catchable rainbows planted in 1953 and 1955. Steelhead juveniles were seen, but not captured for positive identification, in sections below the falls. Overall, the steelhead stock may have been negatively impacted by (i) diversion dams lacking optimal fishways in the lower and middle stream, which would block access to spawning areas, and (ii) unstable flow conditions because of water diversions.

Two adult steelhead, about 43 and 58 cm in length, were observed by the CDFG in the middle portion of the stream on 14 April 1974. On 4 May 1974, two steelhead measuring 30.5–33.0 cm in length, and one spent female at 51.5 cm FL, were captured by electrofishing in the same area. No redds were observed.

Barclay (1975) found juvenile steelhead/rainbow trout in Morro Creek, and "they were abundant in areas with clean, cool waters that flowed over gravel or other rock substrate."

Morro Creek was surveyed visually and by electrofishing during 1–9 September 1978, from the mouth through km 19 upstream (G. Stone and R. Adams, CDFG, unpubl. file report). Suitable spawning gravels were located between stream km 13 and km 18. Gravel beds in the lower stream were covered with silt. Diversion dams in the lower and middle stream still needed fishway improvements as noted in the 1973 survey. Two irrigation pumps were seen taking water directly from the lower creek. The lower and middle creek areas were polluted with urban debris; agricultural wastewater was identified as a potential pollution source in the lower area. Small juvenile steelhead/rainbow trout were most common from SKM 11 through SKM 15, and two trout were captured within each of SKM 1–2 and SKM 6–7. Local residents interviewed during the survey indicated that Morro Creek had historically supported a productive steelhead/rainbow trout fishery, but that fishing was no longer worth pursuing there, presumably because of a greatly reduced population.

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in Morro Creek and five other San Luis Obispo County coastal streams. Morro Creek was selected to represent a steelhead production system having undergone significant modification. Abundance and biomass were estimated using electrofishing and the two-pass removal method in six randomly-selected, 30.5 m long sections, in four 1.6 km long stream reaches. The uppermost stream was dry, in SKM 17.7–19.3.

Mean estimated juvenile density was 14 ± 19 trout/100 m (range, 0–52 trout/100 m). Estimates of population on a kilometer basis were generally low in the lowermost 8 km (18 trout in SKM 1.6–83.2) and much higher above SKM 11.3 (average, 343 trout/km). Apparently, juvenile recruitment in 1978 was fairly low as only 25% of sampled trout (n = 51) were likely young-of-the-year (50 –99 mm in length), 43% were 100–149 mm, 25% were 150–199 mm, and 6% were 200–349 mm. Most sampled trout were yearlings as average individual mass was 21 g.

Knable (1978) concluded that lower portions of Morro Creek were evolving toward a state of advanced degradation. Spawning in the lower creek was compromised by siltation from adjacent agricultural activities. Pollution from urban debris and reduced flow from water diversions also decreased habitat quality in the lower creek. Dams at SKM 3.2 and SKM 14.5 still lacked adequate fishways.

The addition of numerous diversions and pumping wells over the years has continued to deplete the amount of flow in the Morro Creek drainage, although no recent assessment has apparently been made to ascertain impacts on the steelhead resource.

Little Morro Creek

The Morro Creek tributary, Little Morro Creek, was surveyed by the CDFG in January 1962. It was deemed unsuitable as steelhead habitat because of extremely low and unstable flow, and a lack of spawning gravel. Local residents reported that they had never seen or heard of fish in the creek.

Old Creek Drainage

Prior to the impoundment of Whale Rock Reservoir in 1961, Old Creek and its tributary, Cottontail Creek, supported a steelhead run of unknown magnitude. Early CDFG stocking records indicated that the Old Creek steelhead population was supplemented with 15,000 juveniles in 1932, and 10,000 in 1933. Fingerling steelhead (5–7.5 cm) were common in several stream sections when surveyed by the CDFG in January 1957. Suitable spawning areas were present throughout the survey area, including below the proposed dam site. The results of a July 1957 CDFG survey suggested that the run might be relatively small. Juvenile steelhead were scarce at that time, ranging in length from about 5 to 20 cm, and were observed at a diversion dam with a dysfunctional fish ladder about 6 km upstream from the mouth. Some fishing for adult steelhead occurred at the stream mouth in winter.

With completion of the dam at Whale Rock Reservoir, the CDFG placed management emphasis on the landlocked steelhead in the reservoir system, as only about 1.6 km of Old Creek is available to sea-run fish below the dam. The CDFG (1982) conducted studies during the late 1970's–early 1980's during which they found that spawning occurred in late winter, and the juvenile steelhead entered the reservoir from the spawning tributaries mostly at age 1, although some emigrants were also age 2. It was not indicated if the fish smolted when they entered the reservoir. Mean backcalculated length at formation of the first annulus was 90 mm FL. Second-year growth in the reservoir was very good (mean length at annulus 2 = 260 mm FL) but apparently approached an asymptote beginning in the third year (mean length at annulus 3 = 310 mm FL). No age 4 or older steelhead had been collected from Whale Rock since 1979; the largest of these fish had exceeded 500 cm FL. The apparent attenuated growth and low survival of age-3 and older steelhead may have been due to a reduction in suitable forage organisms (mainly Dipterans and prickly sculpin, Cottus asper), and possibly direct foraging competition with Sacramento sucker (Catostomus occidentalis), which were introduced to the reservoir sometime between 1971 and 1978. Some older steelhead also left the reservoir via the spillway, although the dam spilled infrequently during the study period.

The CDFG (1982) found that about 4 km of high quality spawning and rearing habitat was accessible to steelhead in Old Creek between the reservoir and a natural barrier. About another 5 km of potential habitat existed above the barrier. Only about 1.6 km of Cottontail Creek was accessible to steelhead spawners because of barriers, and, otherwise, the creek comprised poor quality spawning and rearing habitat because of the effects of agricultural development, including depleted riparian vegetation from grazing, siltation, and water diversion.

Whale Rock Reservoir has not been stocked with exotic rainbow trout; supplementation plants have only been made with progeny of Whale Rock broodstock. The landlocked steelhead in Whale Rock Reservoir may serve as a broodstock for use in stock enhancement efforts in other San Luis Obispo County stream systems as well (K. R. Anderson, CDFG, pers. comm. of 9 July 1992). It is not known if adult steelhead still enter Old Creek below the reservoir.

Pico Creek Drainage

Pico Creek is comprised of its north fork and south fork which converge to form the main stem about 2.4 km upstream from the mouth. In a CDFG survey in January 1960, suitable spawning and rearing habitats were observed, the former especially in the south fork, but no steelhead were seen. Migration barriers were not present, except possibly one in the upper north fork. Grazing was noted as heavy in the drainage which may have resulted in some siltation in the stream due to erosion. A local resident reported that the main stem and portions of the south fork were dry in summer, leaving the north fork as the most reliable steelhead producing portion of the stream. This source had also counted between 50 and 100 adults on occasion in a single pool in spring. A local CDFG warden estimated the size of the run to be about 3,000 adult steelhead.

On 25 January 1974, a 64 cm adult steelhead was observed in Pico Creek, about 2.4 km upstream from Highway 1. According to a local resident, only one other adult had been seen earlier that season, and that more fish were expected in the stream at that time of year (CDFG, unpubl. field notes). Western Outdoor News (6 August 1976 with photographic documentation) reported the catch of three 3.6 kg steelhead from Pico Creek.

During the 1983-84 steelhead season, the Santa Lucia Flyfishing Club conducted a creel census of four San Luis Obispo County coastal streams, including Pico Creek (Santa Lucia Flyfishing Club, San Luis Obispo, newsletter of April 1984). Surveys occurred on 20 of the 50 legal fishing days. Nine anglers were interviewed who landed no steelhead during 7.75 hr of angling effort, although there were rumors of steelhead being taken.

Pico Creek continued to be a popular steelhead fishing location. Adult steelhead were seen entering the lagoon during the late 1980s – early 1990s (K. Worcester, CDFG, pers. obs.), although no steelhead were seen in the stream during a survey on 12–13 June 1989 (Par Environmental Services, Inc. 1991). The 1987–92 drought undoubtedly had a significant negative impact on the small Pico Creek steelhead stock. From May 1992, however, juvenile steelhead were observed during monthly snorkeling surveys in the lagoon and lowermost 200 m or so of the creek (M. Jennings, USFWS, pers. comm. of 21 January 1993).

Pismo Creek Drainage

Pismo Creek discharges into the Pacific Ocean at Pismo Beach after flowing about 8.5 km through Price Canyon. Its headwater tributaries, East and West Corral de Piedra creeks, converge near the community of Edna to form the main stem. When Pismo Creek was surveyed by the CDFG in September 1972, spawning gravel was present but not very abundant. No juvenile steelhead or any other fishes were observed from the mouth to Edna. Siltation and chemical pollution were noted as problems, and one 1-m high diversion dam functioned as a barrier to fish movements.

Yet, juvenile steelhead were observed in the upper half of Pismo Creek during a CDFG electrofishing survey on 26 June 1974. This distribution was essentially confirmed in another survey conducted during the summer and fall of 1974 (Rohde 1975); juvenile steelhead were found in lowermost West Corral de Piedra Creek and in the lower mid-portion of Pismo Creek, but not in the lowermost main stem or estuary.

Based on a cursory review of CDFG file documents regarding a variety of development projects in and around Pismo Creek, it is likely that steelhead habitat has continued to degrade in especially the lower portion of the creek. Steelhead apparently still enter Pismo Creek, as based on their mention in recent (1990) CDFG file documents.

East and West Corral de Piedra creeks. Both East and West Corral de Piedra creeks have historically supported rainbow trout and at least small runs of steelhead (e.g. Jordan 1895). As of 1985, a dysfunctional fish ladder on East Corral de Piedra Creek, built by the railroad in about 1927, blocked adult steelhead immigration to the upper stream (P. Chappell, CDFG, unpubl. memo. of 24 June 1985). This barrier was judged to have a "serious deleterious effect on the population."

Steelhead reportedly spawned in the vicinity of a proposed dam site in West Corral de Piedra Creek during the winter of 1961-62, and juveniles (5–10 cm in length) were common in the 1.6 km section of live stream below the dam site the following September (R. N. Hinton, CDFG, unpubl. memo. of 4 October 1962). In addition, rainbow trout were observed in 3.2 km of live stream in the canyon above the dam site. The dam application was not protested by the CDFG, and a fishway on the dam was deemed unnecessary, but a minimum release flow was secured in the agreement. The last observation of juvenile steelhead was in lowermost West Corral de Piedra Creek in 1974 (Rohde 1975). Resident rainbow trout, up to 20 cm long, have been observed in the tributaries above the reservoir as recently as December 1989 (K. Worcester, CDFG, pers. obs.). Two upper tributaries provided excellent salmonid habitat for at least 1.3 km, even at the low flow stage observed. Much of the stream below the reservoir was dry or otherwise degraded, and no fish were observed.

Salinas River Drainage (see Monterey County)

San Carpojo (San Carpoforo) Creek

Most of the San Carpojo Creek drainage lies on property owned by the Hearst Corporation, and as of 1948 was noted as having a self-sustaining steelhead population. Public access to the stream is restricted. Surficial flow is normally interrupted in the lower stream in summer. Juvenile steelhead, ranging in length from 5 to 20 cm, were seen in the lower stream in June 1948, July 1952, and January 1960 when observations were made. In June 1960, the visually-estimated density of 7.5–15 cm juvenile steelhead at two locations in the lower stream was about 3.3 trout/m. The 7.5 cm fish were apparently greater in abundance than the 15 cm fish.

The CDFG surveyed the lowermost 6.5 km of the San Carpojo during 24–25 January 1961. Stream flow was intermittent in the lowermost 1.6 km. Suitable spawning areas were found throughout the stream, and were of excellent quality in the lower stream. High quality rearing habitat, in the form of pools and cover, was available in the upper creek area. Two small diversions were present, and several potential migration barriers near Windy Point were noted. Juvenile steelhead were noted as scarce in the upper stream where excellent cover may have hid them, but common in the lower 1.6 km of stream (estimated visually at 31–62 trout/km). One adult was reportedly seen in the stream’s lagoon. A local resident reported that fingerling steelhead were common throughout the stream in summer, but most emigrated during the first rain of the season. In addition, he reportedly counted 155 adult steelhead in three holes in the lower stream, and claimed that the largest adults entered the stream to spawn in January and February, and smaller (30–51 cm), more silvery adults in March. Fishing intensity was heavy at the mouth but light upstream because of restricted access. Overall, the San Carpojo appeared to be a good steelhead spawning and nursery area.

In July 1972, 23 adult (53–84 cm) and 350 juvenile steelhead were rescued from a drying pool in the stream and released further upstream in an area with perennial flow (J. Schuler and K. Boettcher, CDFG, unpubl. memo.)

The CDFG surveyed the San Carpojo during 23–24 July 1973. Stream flow was interrupted at that time. Spawning gravels were present throughout the stream, and rearing habitat, in the form of pools and cover, was abundant. No water diversions were observed. There may have been minor pollution in the lower creek area from livestock feces, but siltation was not a problem. Juvenile steelhead/rainbow trout, 5–25 cm in length, were captured by electrofishing. The trout were very abundant, both above and below a 2+ m high waterfall in the mid-section of the stream. Up to 20–25 trout occurred in 28 m2 pools. All trout observed were infested with encysted metacercaria of the monogenetic trematode, Neascus, a condition commonly referred to as "black spot disease". A local resident reported that he had seen black spot disease on the trout since about 1932. He also mentioned that the steelhead population had been supplemented with juvenile plants during the late 1930's or early 1940's, which corresponds with the time that rescued steelhead from the Santa Ynez River were being planted in San Luis Obispo County streams. The waterfall was judged to be a barrier to immigrating adult steelhead, at least under low flow conditions. It was assumed that resident rainbow trout occurred above the waterfall and probably into the lower portion of the stream below the fall where juvenile steelhead were also present. Again, fishing for adult steelhead was noted as heavy in the lagoon; fishing for juvenile steelhead and resident rainbow trout in upstream areas was probably light. The stream at this time was rated as one of the best steelhead streams in San Luis Obispo County.

Some 27 adult steelhead were counted in three pools by a local resident in April 1974. Follow-up observations were made of seven adult steelhead in the pools in question; the fish ranged in length from 43 to 76 cm and several redds were observed in a nearby riffle (M. Seefeldt, CDFG, unpubl. field report).

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in San Carpojo Creek and five other San Luis Obispo County coastal streams. The San Carpojo was selected to represent a steelhead production system approximating pristine conditions. Abundance and biomass were estimated using electrofishing and the two-pass removal method in six randomly-selected, 30.5 m long sections, in two 1.6 km long stream reaches, between the mouth and the waterfall barrier at SKM 8.2. Portions of the lower creek were dry.

Mean estimated juvenile density was 187 ± 344 trout/100 m (range, 0–1,063 trout/100 m), although this was an overestimate due to poor depletions with the two-pass removal method. Juvenile recruitment in 1978 was relatively good as 50% of sampled trout (n = 150) were likely young-of-the-year (50 –99 mm in length), 45% were 100–149 mm, and 4% were 150–249 mm. Most sampled trout were young-of-the-year as average individual mass was 3.5 g.

Knable (1978) concluded that San Carpojo Creek remained basically unaltered, relative to the other creeks in his survey. The most significant impacts were from extensive vegetation clearing, channelization, and gravel mining within the lowermost 1.6 km of the creek.

San Carpojo Creek is reportedly still in prime condition (J. Nelson, CDFG, pers. comm. regarding results of 1993 stream survey) and, along with the Arroyo de la Cruz, continues to be among the most important steelhead streams in San Luis Obispo County.

Estrada Creek

The lowermost 0.4 km of the San Carpojo tributary, Estrada Creek, was surveyed by the CDFG on 25 January 1961. Spawning substrate occurred only in scattered patches, but rearing habitat, in the form of pools and cover, was adequate and juvenile steelhead (5–10 cm) were present at a low density. No migration barriers, diversions, or pollution were observed in this reach.

San Luis Obispo Creek Drainage

Historically, the San Luis Obispo Creek system has supported steelhead, and rainbow trout in the mountainous headwaters (Jordan 1895). The upper mid-portion of the creek flows through the city of San Luis Obispo. Agricultural lands border the creek, both upstream and downstream from the city. The CDFG surveyed the lowermost 11 km of the creek during 2–3 September 1958. Spawning gravel was mostly lacking in this lower area, but rearing habitat in the form of pools and cover was abundant. There were no barriers to migration. Agricultural diversions occasionally caused interrupted flow conditions. Urban runoff, effluent from the San Luis Obispo Sewage Treatment Plant, and an oil pipeline leak were pollution sources. No steelhead were seen, although this area was regarded as steelhead rearing habitat. Angling pressure for steelhead was reportedly heavy in the winter.

When surveyed again by the CDFG during 12–16 December 1960, conditions in the lowermost 11 km of the creek were apparently much the same. Spawning habitat was generally more abundant in the remaining 13 km of stream to the headwaters. Rearing habitat, in the form of pools and cover, was generally available throughout, but still of highest quality in the lower stream. There was a 1.5 m waterfall just upstream from the confluence with Reservoir Canyon Creek which may have posed a barrier to upstream migration under low-flow conditions. There were no diversions or pollution in the headwaters, whereas pollution from urban debris and runoff, and effluent from the sewage treatment plant may have limited steelhead use of the middle and lower stream areas. Several pumps and storage tanks were present along the lower creek where water was diverted for agricultural irrigation. Juvenile steelhead/rainbow trout, 2.5–20 cm long, occurred in the headwater section at a low population density. No trout were captured in net samples farther downstream. Angling pressure for steelhead was still reportedly heavy during the winter and early spring.

During May–August 1966, the CDFG investigated the effect of waste discharges on the biologial resources of San Luis Obispo Creek, with emphasis on steelhead (Nokes 1966). Along a 3.2 km reach within the city of San Luis Obispo, about 90 pipes, culverts, and drains were observed which opened to the creek. A variety of chemical and organic pollutants were discharging directly into the stream, including chlorinated swimming pool effluent and food-laden kitchen drain effluents. Urban debris also heavily littered the stream.

Discharge from the San Luis Obispo Sewage Treatment Plant appeared to have the greatest single effect on the distribution and site-specific abundance of aquatic organisms. Effluent from the treatment plant sustained a continuous stream flow in the lower creek during the summer–fall low flow period, when stream flow upstream from that point became interrupted. Nokes (1966) found that the creek was relatively void of clean-water indicator species of algae, invertebrates, and fishes along a 2.4 km reach downstream from the point of discharge. Densities of juvenile steelhead on 5 May 1966, as determined by cresol sampling in blocked-off stream sections, were low (13–26 trout/100 m) at three stations in the middle to lower creek. These fish ranged in length from 6.5 to 30.5 cm. In an instream bioassay conducted during 24–28 August 1966, all rainbow trout held in the treatment plant discharge which contained a high concentration of residual chlorine, and in the creek just downstream from the point of discharge, died within 0.5 hr. Those held in the creek just upstream from the point of discharge survived the 96 hr trial.

Overall, about 6.4 km of San Luis Obispo Creek, through the city of San Luis Obispo and downstream from the sewage treatment plant discharge, were adversely affected by waste discharges. Nokes (1966) predicted that the pollution effect would be even more widespread as stream flow continued to decrease and waste discharges made up an even greater proportion of the flow.

During the 1972-73 steelhead season, the CDFG in collaboration with students at the California Polytechnic State University conducted a study to (i) estimate the adult steelhead run size in San Luis Obispo Creek, and (ii) determine the approximate distribution of steelhead spawning in the drainage (Schuler 1973). A trap to capture adult steelhead on their upstream migration was operated at Marre’s dam, located about 1.6 km from the creek mouth, from 27 November 1972 through 10 February 1973. Adults were captured from 21 December 1972 through 6 February 1973, although 85% of adults were captured during 9–13 January 1973; high flow displaced the trap during 17–26 January 1973. A total of 45 steelhead was captured, of which 40 were tagged and released to estimate the adult run using the Lincoln-Petersen mark-and-recapture method. Only trout ≥ 46 cm FL were considered steelhead, although this was later considered a mistake. Apparently, the trap was ineffective in capturing steelhead spawners between 35 cm and 46 cm, and so these smaller, younger adults were underestimated in the catch. Captured males averaged (± SD) 66.9 ± 4.4 cm FL (range, 55.9–73.7 cm FL, $n = 14$), females averaged 66.5 ± 5.0 cm FL (range, 55.9–76.2 cm FL, $n = 13$), and steelhead of undetermined sex averaged 63.2 ± 7.2 cm FL (range, 45.7–73.7 cm FL, $n = 13$). There was no significant difference in fork lengths among these three groups (ANOVA, $F = 1.687$, $p = 0.199$). Two estimates of adult run size, 102 and 117 (95% C.L., 22–212), were derived using electrofishing and creel census as recapture methods, respectively. Both numbers were considered underestimates, and Schuler guessed the run was closer to 200 fish during a good year. The San Luis Obispo Creek tributaries, See Canyon, Stenner, and Brizziolari creeks, were judged to be the areas used most by steelhead spawners, based on observations of young-of-the-year steelhead made during electrofishing surveys.

The study was repeated during the 1973-74 season (Schuler 1974). Trapping was conducted at Marre's dam for 86 days, ending 2 March 1974. Only 13 adult steelhead were captured, tagged, and released. In recapture efforts, 18 adults were captured by electrofishing of which two were recaptures, and 17 adults were seen in a creel census of which three were recaptures. The Petersen run size estimate corresponding to each recapture method was 117 (95% C.L., 9–223) and 58 (12–104), respectively, the latter being a partial estimate since the fishing season ended before the adult upstream migration was completed. The 18 adults captured by electrofishing were distributed as follows: six in San Luis Obispo Creek, 10 in See Canyon Creek, and two in Stenner Creek (c.f. young-of-the-year steelhead observations in 1972-73 study, above). Males observed in this study tended to be smaller on average (49.5 ± 10.7 cm FL; range, 38.1–71.1 cm FL; n = 19) than females (55.5 ± 11.0 cm FL; range, 36.8–68.6 cm FL; n = 19) but this difference was not statistically significant (Mann-Whitney U test, p = 0.09). Based on ageing from scales, the total ages of spawners were 3–5 yr, with an overall average of 3.84 yr (calculated as in Fahy 1978). Males on average (3.63 yr) tended to be younger than females (4.05 yr), but this difference was not statistically significant ($X^2 = 4.255$, DF = 2, p = 0.12). Scale reading also showed that most juveniles emigrated to sea at age 1(+), and that five of 19 (26%) females and one of 19 (5%) males were repeat spawners. Age 3 spawners averaged (± SD) 40.8 ± 2.8 cm FL (range, 36.8–45.7 cm FL; n = 11), age 4 spawners averaged 54.8 ± 8.7 cm FL (range, 39.4–68.6 cm FL; n = 22) and age 5 spawners averaged 68.3 ± 1.9 cm FL (range, 66.0–71.1 cm FL; n = 5). The sport fishery was poor; there was an estimated 19 steelhead caught by 540 anglers who fished about 1,555 hr (0.012 fish/angler hr, 0.035 fish/angler). The decline in the San Luis Obispo Creek steelhead population was primarily attributed to (i) a lack of juvenile steelhead rearing habitat in the form of pools and overhead cover (e.g. riparian vegetation, undercut banks); (ii) poor water quality in the lower creek downstream from the discharge point of the San Luis Obispo Sewage Treatment Plant (see summary of Nokes 1966, above); and (iii) man-made migration barriers that blocked access to spawning and rearing habitats in tributaries.

Barclay (1975) reported juvenile steelhead/rainbow trout in San Luis Obispo Creek, and "they were abundant in areas with clean, cool waters that flowed over gravel or other rock substrate." Rutten (1975) gave a more detailed presentation of the data collected under Barclay's direction. Sampling occurred between 17 June 1975 and 1 July 1975. Juvenile steelhead/rainbow trout occurred in the lowermost main stem near Marre's dam and just upstream from the confluence with See Canyon Creek, and at nine mainstem stations from about 180 m above the sewage treatment plant outfall to the headwaters. Observed densities in the main stem up to the confluence with Stenner Creek averaged (± SD) 13 ± 16 trout/100 m, while those in upper San Luis Obispo Creek and the tributaries, See Canyon, Stenner, Brizziolari, and Reservoir Canyon creeks, averaged 174 ± 148 trout/100 m. This difference in juvenile steelhead/rainbow trout densities was highly significant (Mann-Whitney U test, $p<0.001$), and reflected the disparity in trout habitat quality between the impacted main stem and relatively undeveloped tributaries and headwaters. For example, the adverse effect of the treatment plant effluent on juvenile steelhead distribution in the lower creek persisted.

The CDFG evaluated the steelhead resources of San Luis Obispo Creek in relation to a proposed flood control project (Snider and Gerdes 1975). It was noted that mainstem steelhead habitat was already degraded by existing flood control improvements such as bank revetment, channelization, and tunneling. The juvenile steelhead population was studied during the late summer–fall low flow period in 1975, when rearing habitat quantity and quality were presumably most limited. Steelhead had access to suitable spawning habitat in the upper main stem (above the confluence with Stenner Creek), and in the tributaries, See Canyon, Stenner, Brizziolari, and Reservoir Canyon creeks. Qualitative surveys revealed the presence of juvenile steelhead in nearly all stream areas with surficial flow. Abundance estimates were made, by use of electrofishing and the two-pass depletion method, in six 30.5 m stream sections per 1.6 km reach of each major steelhead rearing area identified in the qualitative survey. The highest densities of juvenile steelhead corresponded to the main spawning areas. The average density in upper San Luis Obispo Creek was 269 trout/100 m, while those in See Canyon, Stenner, and Reservoir Canyon creeks ranged from 249 to 981 trout/100 m (see below for details on each tributary). The average length and biomass of juvenile steelhead were 87 mm FL and 1.8 kg/100 m, respectively, in the upper main stem, and had ranges of 56 –95 mm FL and 0.6–4.2 kg/100 m, respectively, in the tributaries. In upper San Luis Obispo Creek, 77% of sampled trout were age 0+, 22% were age 1+, and 1% was age 2+. Corresponding percentages in the tributaries averaged 91.3%, 8.3%, and 0.3%, respectively. Based on age-class specific survival rates from Shapovalov and Taft (1954), observed juvenile production in upper San Luis Obispo Creek would correspond to an adult steelhead production on the order of 179 fish, while those in the tributaries averaged 275 fish, resulting in an estimated drainage production of about 1,000 adult steelhead. Snider and Gerdes (1975) noted that the most significant factor affecting steelhead production in the San Luis Obispo Creek drainage was the availability of suitable juvenile rearing habitat.

Eckle (1978) reaffirmed the negative impact of the San Luis Obispo Sewage Treatment Plant on juvenile steelhead rearing habitat quality in lower San Luis Obispo Creek. Chloramine toxicity rendered between 1.6 and 6.4 km of stream below the point of waste discharge unsuitable as steelhead rearing habitat, as determined by instream bioassays conducted under low flow conditions in August 1978. It was also suggested that chloramines could be a deterrent to upstream migrating adult steelhead in low flow years, when a water quality barrier might persist in the absence of sufficient dilution from rain runoff.

As of 1985, the best spawning and rearing habitats in the drainage were still in the tributaries, See Canyon, Stenner, and Reservoir Canyon creeks, and upper San Luis Obispo Creek above the urban area. Juvenile steelhead densities in the main stem above the San Luis Obispo Sewage Treatment Plant ranged from 186 to 311 trout/100 m, while those in the tributaries ranged from 435 to 808 trout/100 m (P. Chappell, CDFG, unpubl. data from a 1985 electrofishing survey, as cited in Western Ecological Services Company, Inc. 1987). No juvenile steelhead were found at three locations on San Luis Obispo Creek below the treatment plant, as far downstream as the Highway 101 bridge near Avila Road.

Cannata (1989) conducted a survey of San Luis Obispo Creek to determine if steelhead still used the stream as spawning and rearing habitat within the San Luis Obispo city limits. Young-of-the-year (<75 mm TL) and older (≥ age 1+; >75 mm TL) steelhead were counted while walking along the streambank during April–May 1989, thus providing a conservative juvenile population count. About 800 young-of-the-year and 20 older steelhead were counted. Thus, spawning was successful in at least two consecutive years. Steelhead occurred in all sections of the survey area except below the point of discharge of the San Luis Obispo Sewage Treatment Plant. When surveyed again during September–October 1989, stream flow was interrupted and only a short section of stream within the San Luis Obispo city limits continued to provide habitat for juvenile steelhead. Cannata (1989) concluded that, as of 1989, San Luis Obispo Creek continued to support a steelhead population, but that the population was likely depressed due to the effects of three consecutive years of drought (1986-87 through 1988-89). Steelhead used the portion of the creek within the San Luis Obispo city limits as a migration corridor, and as spawning and rearing habitats.

Young-of-the-year steelhead were observed in pools in lower San Luis Obispo Creek, downstream from the city's sewage treatment plant, during an electrofishing survey on 4 May 1994 (J. Nelson, CDFG, pers. comm. of 12 May 1994).

Castro Canyon Creek

Castro Canyon Creek is a very small, 2.4 km long tributary that enters lower San Luis Obispo Creek about 6.4 km upstream from the Pacific Ocean. The creek was surveyed in its entirety by the CDFG on 14 December 1960. Stream flow was very low at the time of the survey, but suitable spawning and rearing habitats would be available to steelhead under higher flow conditions. No barriers, diversions, or pollution were observed. The local CDFG warden reportedly rescued large steelhead from the creek in some years. Local residents reported that adult steelhead ascended the creek in wet years, but that none had been seen in several years. Nor were any juvenile steelhead seen during this survey.

Harford Canyon Creek

Harford Canyon Creek is a very small, 3.2 km long tributary that enters the tidal zone of lower San Luis Obispo Creek about 180 m upstream from the mouth. The creek was surveyed in its entirety by the CDFG on 13 December 1960. Spawning habitat was only fair as the substrate contained much sand and silt. Rearing habitat in the form of pools and cover was adequate. No barriers, diversions, or pollution were observed. Juvenile steelhead, 2.5–10.0 cm in length, were seen, and local residents reported that the creek had “always” supported numerous small trout.

Prefumo Creek

Prefumo Creek is a main tributary that enters the mid-portion of San Luis Obispo Creek. The entire 8 km of the creek was surveyed by the CDFG on 14 December 1960. Stream flow was interrupted at the time of the survey. High quality spawning grounds were available in the lower creek, and steelhead rearing habitat, in the form of pools and cover, occurred throughout the stream. No diversions, barriers, or pollution were observed. Although no fish were captured in net samples, the local CDFG warden indicated that adult steelhead did run in the creek in wet years.

Schuler (1973) captured no adult steelhead by electrofishing in Prefumo Creek above Laguna Lake during the 1973-74 season. Evidently, a concrete spillway and culvert under Los Osos Road blocked the upstream migration of adult steelhead above Laguna Lake. Rutten (1975) also found no juvenile steelhead in Prefumo Creek during the latter half of June 1975, at an electrofishing station in the lowermost creek.

In contrast, young-of-the-year steelhead were inhabiting all available habitat in Prefumo Creek when observed by the CDFG in October 1980 (P. P. Chappell, CDFG, unpubl. memo. of 14 October 1980). Every pool contained trout with densities ranging from 10 to 50 fish/pool, depending on pool size.

Cannata (1989) saw no juvenile steelhead in lower Prefumo Creek while walking along the streambank during April–May 1989. Apparently, the overpass structure at Highway 101 created a barrier that prevented adult steelhead from migrating to upstream spawning habitat.

Steelhead and rainbow trout were mentioned as fishery resources to be protected in a recent (1990) CDFG file document, in connection with a proposed development project in the creek drainage.

Reservoir Canyon Creek

Reservoir Canyon Creek is an extreme headwater tributary to San Luis Obispo Creek. Steelhead were present in the creek during a mid-1930's CDFG survey. Spawning grounds were described as patchy. The stream was regarded as the best steelhead production area in the San Luis Obispo Creek system. Although no records were discovered, plants of juvenile steelhead had apparently been made, the origin of these fish unknown. Brown trout had been introduced to the creek (4,000 planted in 1933), but with poor results. Angling pressure on the creek was rated as very heavy.

The report of a CDFG survey conducted on 16 December 1960 provided an impression of how a dam in the system affected historical steelhead production. The earth-fill dam creating a small reservoir restricted potential steelhead production to only about 0.8 km of the lower stream area. Most of the water in the stream was diverted by the City of San Luis Obispo for domestic use. At the time of the survey, stream flow was intermittent, rearing pools were small and scattered, but cover from overhanging vegetation was abundant. A very sparse population of small rainbow trout, 2.5–10 cm long, occurred in the upper canyon above the reservoir. The reservoir was stocked with 12,000 catchable rainbow trout annually.

Rutten (1975) determined juvenile steelhead/rainbow trout abundance at three electrofishing stations on the creek, two below and one above the big falls in Reservoir Canyon, between 17 June 1975 and 1 July 1975. The density of juvenile steelhead below the falls averaged (± SD) 294 ± 21 trout/100 m, while the density of rainbow trout at the one station above the falls was 26 trout/100 m.

The CDFG also made juvenile steelhead abundance estimates in Reservoir Canyon Creek downstream from the falls in 1975, by use of electrofishing and the two-pass depletion method (Snider and Gerdes 1975). During June 1975 when stream flow in the creek was continuous, the average density was 348 trout/100 m. By fall 1975, however, only 0.4 km of surface water persisted in the creek and the average density of juvenile steelhead nearly tripled to 981 trout/100 m, apparently due to crowding as a result of the reduction in rearing habitat availability. The average length and biomass of these fish in fall were 70 mm FL and 4.2 kg/100 m, respectively, and 94% of sampled trout were young-of-the-year and the remaining 6% were yearlings. Based on age-class specific survival rates from Shapovalov and Taft (1954), the observed juvenile production in Reservoir Canyon Creek corresponded to an adult steelhead production on the order of 91 fish.

As of 1985, some of the best spawning and rearing habitats in the drainage still occurred in Reservoir Canyon Creek. At that time, the creek supported >435 trout/100 m (P. Chappell, CDFG, unpubl. data from a 1985 electrofishing survey, as cited in Western Ecological Services Company, Inc. 1987), which was a similar production level as in 1975.

See Canyon Creek

See Canyon Creek is an important, 7 km long tributary that enters the tidal zone of San Luis Obispo Creek about 3.4 km upstream from the Pacific Ocean. Steelhead were present in the creek during a mid-1930's CDFG survey. Spawning grounds were "common" and overhanging riparian vegetation and an abundance of insects apparently provided good rearing conditions for juvenile steelhead. No barriers or diversions were seen. Angling pressure was noted as heavy. The steelhead population had been supplemented with a plant of 8,000 juveniles in 1932.

When surveyed in its entirety by the CDFG on 12 December 1960, there was still high quality spawning gravel throughout the creek. Suitable rearing habitat, in the form of pools and overhanging vegetation, was also widespread. There were several agricultural diversions, and urban debris polluted the stream. "A fair size population" of juvenile steelhead was observed. These fish were visually estimated to be 2.5–20.0 cm in length. Local residents reported that as many as several hundred adult steelhead ascended See Canyon Creek in wet years, but only a few in dry years. The creek was regarded as the most important spawning tributary in the San Luis Obispo Creek drainage.

Schuler (1973) captured six adult steelhead in See Canyon Creek by electrofishing during 22–25 February 1973. Observations of young-of-the-year steelhead made during this survey also supported the view that the creek was an important spawning and rearing tributary for San Luis Obispo Creek steelhead. During the 1973-74 season, 10 adult steelhead were captured by electrofishing (Schuler 1974), thus demonstrating the continued persistent use of this stream as a steelhead production area.

Rutten (1975) sampled six stations throughout See Canyon Creek by electrofishing, between 17 June 1975 and 1 July 1975. Densities of juvenile steelhead were relatively high and averaged (± SD) 277 ± 163 trout/100 m (range, 161–584 trout/100 m). Juvenile population density remained essentially the same into fall 1975 when the CDFG found an average of 302 trout/100 m, by use of electrofishing and the two-pass depletion method (Snider and Gerdes 1975). The average length and biomass of these fish were 56 mm FL and 0.6 kg/100 m, respectively, and 97% of sampled trout were young-of-the-year and the remaining 3% were yearlings. Based on age-class specific survival rates from Shapovalov and Taft (1954), the observed juvenile production in See Canyon Creek corresponded to an adult steelhead production on the order of 486 fish, making this stream the area of greatest steelhead production in the San Luis Obispo Creek drainage.

As of 1985, some of the best spawning and rearing habitats in the drainage still occurred in See Canyon Creek. At that time, the creek supported 435 –808 trout/100 m (P. Chappell, CDFG, unpubl. data from a 1985 electrofishing survey, as cited in Western Ecological Services Company, Inc. 1987), which at least equalled the production seen in 1975.

Stenner Creek

Stenner Creek is a major, 9.7 km long headwater tributary that enters San Luis Obispo Creek within the city limits of San Luis Obispo. The creek was surveyed in its entirety by the CDFG on 16 December 1960. Suitable spawning substrate occurred throughout the creek, and was of highest quality in the middle portion just outside the city limits. Rearing habitat quality was limited by a scarcity of pools throughout, and lack of riparian cover in the middle portion of the creek. No barriers, diversions, or pollution were observed. Although no fish were observed, the creek was regarded as potentially “a fair producer of steelhead especially during wet years.”

Schuler (1973) captured one adult steelhead in Stenner Creek during an electrofishing survey on 9 March 1973. Young-of-the-year steelhead were also observed in both Stenner and its tributary, Brizziolari Creek, during this survey. Schuler suggested that the Stenner Creek system was one of the areas used most by San Luis Obispo Creek steelhead.

During 16–18 May 1973, the CDFG surveyed a reach of Stenner Creek from 1.6 km below to 1.6 km above its confluence with the tributary, Brizziolari Creek. The upper 1.6 km section flowed through agricultural land, while the lower 1.6 km section flowed through an urbanized area. An estimated third of the streambed within the survey sections consisted of suitable spawning gravel. Rearing habitat in the form of pools, undercut banks, and overhanging riparian vegetation was abundant. Perennial flow maintained pools and other low-velocity rearing habitat even in dry years. Several migration barriers were observed, including summer dams, but none appeared to affect adult steelhead movements. No diversions were seen. Storm drains entering the creek were a potential pollution source. Agricultural waste water appeared to enhance eutrophication of the stream, and resultant algal growth limited steelhead rearing habitat utility. Silt entered the stream from Brizziolari Creek and extended downstream as far as 275–365 m. Young-of-the-year and yearling steelhead were sampled by electrofishing. Estimated abundance of both age classes combined, using the two-pass removal method, was low, about 10 trout/100 m. There was an estimated 6.4 km of stream habitat suitable for steelhead production. The stream supported a minor trout fishery, with most pressure from youngsters.

During the 1973-74 season, two adult steelhead were captured by electrofishing (Schuler 1974), thus demonstrating the continued persistent use of this stream as a steelhead production area.

Rutten (1975) found only 16 trout/100 m at one electrofishing station in lower Stenner Creek during the latter half of June 1975, but 131 trout/100 m in the upper creek. In fall 1975, juvenile population density averaged 249 trout/100 m in several 30.5 m stream sections, as determined by electrofishing and the two-pass depletion method (Snider and Gerdes 1975). The average length and biomass of these fish were 95 mm FL and 2.5 kg/100 m, respectively, and 83% of sampled trout were age 0+, 16% were age 1+, and 1% was age 2+. Based on age-class specific survival rates from Shapovalov and Taft (1954), the observed juvenile production in Stenner Creek corresponded to an adult steelhead production on the order of 249 fish.

As of 1985, some of the best spawning and rearing habitats in the drainage still occurred in Stenner Creek. At that time, the creek supported up to 435 trout/100 m (P. Chappell, CDFG, unpubl. data from a 1985 electrofishing survey, as cited in Western Ecological Services Company, Inc. 1987), which at least equalled the production seen in 1975.

Cannata (1989) counted eight young-of-the-year and one yearling steelhead while walking along the streambank on the lowermost 180 m of Stenner Creek, during April–May 1989.

The Stenner Creek tributary, Brizziolari Creek, was surveyed by the CDFG on 15 May 1973, from its confluence with Stenner Creek upstream through the California Polytechnic State University campus. This portion of the drainage was highly developed and the creek passed through agricultural land, and through several culverts beneath and along roadways, including the construction site for a new road. There were some suitable spawning grounds in the upper survey area, but silt covered suitable gravel downstream from the road construction site. Man-made pools occurred downstream from the culverts and these, along with undercut banks and overhanging riparian vegetation, provided rearing habitat for juvenile steelhead, even under interrupted flow conditions. Such pools, though, were silted in below the construction site. No diversions were seen. Silt polluted the stream from the construction site, and this siltation apparently extended well into Stenner Creek (see above). Cattle fecal material was also a pollution source which likely enhanced primary production in the stream. Resultant algal growth limited steelhead rearing habitat utility through physical occlusion. Young-of-the-year and yearling steelhead were sampled by electrofishing. Estimated abundance of both age classes combined, using the two-pass removal method, was very low, about 5 trout/100 m. Rutten (1975) found no trout at an electrofishing station in lower Brizziolari Creek during the latter half of June 1975, but about 10 trout/100 m at a station in the upper creek.

As of 1985, a dysfunctional fish ladder on Brizziolari Creek on the California Polytechnic State University campus blocked upstream migration of adult steelhead (P. Chappell, CDFG, unpubl. memo. of 6 June 1985). There was an estimated reduction of about 7,000–10,000 juvenile steelhead annually over a 3–5 yr period. The barrier problem was apparently rectified by the University as of 18 December 1985 (R. A. Tartaglia, California Polytechnic State University, San Luis Obispo, unpubl. letter of 23 December 1985).

STATUS: Mention Froom Creek, the Buckley Road tributary, and other minor tributaries that may have supported steelhead production but no longer do so because of barriers, etc. (see Schuler 1974).

San Simeon Creek Drainage

San Simeon Creek has historically supported a steelhead population. Early records show that steelhead were present in the creek when the CDFG surveyed the stream during the mid-1930's. Spawning grounds for steelhead were common except in the upper areas. The middle and lower portions of the stream had apparently dried up in late summer over several years, resulting in a loss of rearing habitat. No barriers or diversions were seen. Natural propagation among migrant adults was noted to occur, but survival of progeny was predicted to be low, presumably because of stream desiccation and heavy fishing pressure on steelhead juveniles. Although the steelhead population had been supplemented with 10,000 juveniles in 1932 and 8,000 in 1933, the surveyors recommended against further stocking because of interrupted flow conditions in late summer.

When San Simeon Creek was surveyed by the CDFG in June 1948, spawning substrate was plentiful, and juvenile steelhead, 2.5–5 cm in length, were abundant and occurred at visually estimated densities of 160–250 trout/100 m. A few planted rainbow trout were also observed. Based on infor 1950), the creek was planted with hatchery reared trout during 1947–1950 to support a stream trout fishery. Fingerling plants were most often indicated but it was unclear if the fish planted were from steelhead or rainbow trout stock. Planting of catchable rainbow trout was also mentioned. There was much attention paid to the success of these plants relative to stream flow, and the 1949 and 1950 plants in the North Fork San Simeon Creek were considered unsuccessful because of interrupted flow conditions in late summer–fall. However, this headwater area contained perennial pools with ample shading capable of providing over-summering habitat for juvenile steelhead.

When the CDFG surveyed the lower creek area in September 1948 (H. D. Hoefelmeier, CDFG, unpubl. field correspondence of 10 September 1948), the creek was completely dry for at least 2.4 km upstream from the Highway 1 bridge. Isolated pools occurred above that point which supported surviving fish. The lagoon at the mouth of the creek, downstream from the Highway 1 bridge, contained the only water in the lower creek area. The local fish and game warden participating in the survey indicated the lagoon would persist until winters rains began. Hoefelmeier also noted that all the creeks from Morro Bay to Piedras Blancas Point had similar streamflow conditions at that time.

The lowermost 11 km of San Simeon Creek were surveyed by the CDFG on 19 January 1960. The lowermost 7 km contained a very high proportion of spawning gravel, visually estimated at 80%–90% of the streambed. In the uppermost 4 km of the survey area, <30% of the streambed overall contained suitable spawning gravel. The distribution of high quality rearing habitat for juvenile steelhead, in the form of pools and cover (rootwads, fallen trees, overhanging riparian vegetation, boulders), was essentially the opposite of that for spawning habitat, in that the best rearing areas were in the uppermost 5 km of the survey area. A bedrock fall, about 320 m downstream from the confluence of the north and south forks, was a potential barrier to upstream migration. However, it was apparently passable to adults under high flow conditions because the local fish and game warden had seen steelhead in the south fork above the fall. There were no diversions, and no pollution was seen although there was extensive cattle grazing in the watershed. No fish were observed in the stream during this survey, but the stream was characterized as providing "some of the better steelhead fishing for the San Luis Obispo area."

In 1965, the CDFG investigated the effect of siltation from the Stewart Warren Mine on juvenile steelhead production in Steiner and San Simeon creeks (M. L. Johnson, CDFG, unpubl. memo. of 4 October 1965 and attached unpubl. file report on subject). Steiner Creek is a major tributary that enters San Simeon Creek about 7 km upstream from the mouth. The mine contributed silt to Steiner Creek which then carried it to San Simeon Creek below the confluence with Steiner. On 8 June 1965, juvenile steelhead abundance was determined by creosol sampling in one 20 m long section each in San Simeon Creek above the Steiner Creek confluence, in Steiner Creek, and in San Simeon Creek below the confluence. (Visual streambank counts were also made but it was later decided that creosol sampling gave the most accurate results). The density estimate for the San Simeon Creek section above the confluence was 994 trout/100 m, while those in Steiner Creek and San Simeon below the confluence were 114 and 94 trout/100 m, respectively. Thus, the data suggested that steelhead production in the silted areas was lower than that in the unsilted area by a factor of nearly 10. Johnson expanded the data for the entire 8 km section of Steiner Creek, and the 7 km of San Simeon Creek below the confluence, and estimated a loss in juvenile steelhead production (at that recruitment stage) of about 137,500 fish.

The CDFG conducted a follow-up survey on 27 September 1965. The most significant change in conditions was that San Simeon Creek was dry from the lagoon to 1.6 km upstream from the Steiner Creek confluence, as was the lowermost 2.4 km of Steiner Creek. Juvenile steelhead density in San Simeon Creek above the confluence was 809 trout/100 m, as determined by creosol sampling in one 23 m long section. Thus, there was about a 20% reduction in density since the June 1965 sampling occasion. Assuming the same density reduction rate in Steiner Creek, and taking into consideration the rearing habitat loss in all of San Simeon Creek below the confluence and in lower Steiner Creek due to desiccation, the estimated loss in juvenile steelhead production (at this recruitment stage) because of siltation was calculated to be about 41,000 fish.

In 1970, the CDFG estimated the abundance of juvenile steelhead by electrofishing several randomly-selected 30.5 m reaches in three 1.6-km sections (L. K. Puckett, CDFG, unpubl. memo. of 30 December 1971). Abundance was estimated using the two-pass removal method. Juvenile steelhead abundance ranged from 113 trout/100 m in the uppermost km to 653 trout/100 m in SKM 8 (SKM 3–5 were dry), and averaged 376 ± 270 trout/100 m among the three sections.

San Simeon Creek was next surveyed by the CDFG during 13–14 August 1973, from the headwaters to the lagoon for a distance of 14.5 km. The distribution of spawning and rearing habitats was essentially the same as that described in the January 1960 survey (see above). No new barriers to adult immigration or diversions were observed on the main stem, although farm ponds withheld the water of some tributaries. The gravel quarrying operation of Morro Rock and Sand disturbed the streambed at three locations downstream from Steiner Creek. Not only was about 3.2 km of steelhead spawning habitat disturbed or eliminated, but the quarrying also caused siltation. In addition, the gravel operations blocked the spring-time migration of young-of-the-year steelhead from the desiccating lower stream to perennial rearing habitat upstream. An abandoned mercury mine on a small tributary polluted the stream with silt and possibly mercury, cattle fecal material contaminated the upper stream areas, and a public dump on the lower San Simeon Creek tributary, Van Gordon Creek, contributed silt and trash to the drainage.

Despite the relatively degraded condition of the creek, juvenile steelhead/rainbow trout, 4.0–15.0 cm in length, were captured by electrofishing and netting in all sections of the main stem, including the lagoon and above the bedrock barrier near the headwater forks. There were many young-of-the-year in pools in the lower and middle creek areas, and the upper creek contained both young-of-the-year and age 1+ fish but in relatively lower densities. San Simeon Creek was still viewed as a valuable steelhead production area, but that its potential was compromised by especially the gravel extraction activity.

Degradation of lower San Simeon Creek persisted in connection with gravel removal. In discussing the problem, Chappell (1976) wrote that the loss of gravel and cobble, compaction of the streambed, loss of riparian vegetation, road construction, and resultant sedimentation from both instream sources and erosion of streamside soils would preclude the continued use of lower San Simeon Creek as steelhead spawning and rearing habitat. Chappell also made two points of broader interest: first, that juvenile steelhead in central California coastal streams, such as San Simeon Creek, typically remained in the stream for only one year before smolting and emigrating to the sea; and second, that small tributaries becoming intermittent in summer often support steelhead spawning in winter, with resultant juveniles escaping downstream in spring to perennial rearing areas.

During the 1983-84 steelhead season, the Santa Lucia Flyfishing Club conducted a creel census of four San Luis Obispo County coastal streams, including San Simeon Creek (Santa Lucia Flyfishing Club, San Luis Obispo, newsletter of April 1984). Surveys occurred on 20 of the 50 legal fishing days. Seven anglers were interviewed who landed no steelhead during 6.50 hr of angling effort, although there were rumors of steelhead being taken.

Approximately 200 steelhead, ranging in size from 9 to 60 cm, died in the San Simeon Creek lagoon on 9 August 1988, because of low water levels and resultant high temperature and low dissolved oxygen concentration. Generally, though, the lagoon is used as rearing habitat by juvenile steelhead when water quality is suitable (D. W. Alley, D. W. Alley and Associates, pers. comm. of 21 January 1993). A few juvenile steelhead were observed in the lagoon and lowermost 200 m or so of the creek during monthly snorkeling surveys beginning in May 1992, although abundances of juvenile steelhead/rainbow trout were generally higher in upstream areas

(M. Jennings, USFWS, pers. comm. of 21 January 1993).

The CDFG surveyed San Simeon Creek during 15–16 September 1992, from the confluence of the north and south forks to a point 8 km downstream. Only the uppermost 3.2 km of the survey area had surface flow and of this about 0.8 km was above the bedrock fall described in earlier surveys (see above). The remainder of the stream in the survey area contained only isolated pools of water. Contrary to stream survey reports through 1973, the lowermost 3.2 km of the survey area contained extensive (≥ 30 m long) deposits of sand along with boulders and cobble. This lower section still contained more spawning areas, relative to the upstream area with water, but there was clearly a significant reduction in abundance of suitable spawning gravel from previous surveys. Physical conditions for the provision of rearing habitat were still intact but stream flow limited rearing habitat quantity and quality. No new barriers were seen, nor were there any surface diversions, but there were several streamside wells that pumped water from the underflow. Cattle polluted the stream with fecal material. Low densities of young-of-the-year, age 1+, and possibly age 2+ juvenile steelhead/rainbow trout were seen in the uppermost 3.2 km section with surface flow.

This stream survey was followed by an assessment of the stream habitat and juvenile steelhead population in San Simeon Creek in 1993 (Nelson 1995). This work was conducted in the perennial reach of stream from the Steiner Creek confluence at 6.4 km above the mouth, to the bedrock fall at 9.3 km above the mouth. Stream flow within the perennial reach decreased from 0.156 m3/s on 5 May 1993 to 0.013 m3/s on 1 November 1993; the lowermost 6.4 km of the creek went dry during the latter half of July 1993. The perennial reach was habitat typed in June 1993, and as a percentage of the total length, 46% was flatwater habitat (pocket waters, glides, runs, step runs), 43% was pools, 7% was riffles, and 4% was cascades. Spawning areas were sparse, small in size, and the substrate was either embedded or consisted of sand. Rearing habitat was relatively abundant but not of high quality. Cover was adequate, but pools were shallow as a result of the combined effects of low stream flow and sedimentation. The reach contained one surface diversion. Sediment sources may have been a landslide on the north fork, a construction site below the bedrock fall, five road crossings, and four cattle crossings. The sediment problem had been exacerbated by a lack of flushing flows for 5 yr.

Nelson (1995) sampled the juvenile steelhead population by use of a downstream migrant trap and electrofishing. The downstream migrant trap was located at the upstream end of the lagoon, and was fished from 7 April 1993 to 19 May 1993. Only 10 steelhead smolts were captured during seven weeks of trapping, nine of which were captured during the weeks of 19 April 1993 and 26 April 1993. More smolts may have emigrated prior to the trapping period. Captured smolts averaged (± SD) 181 ± 11 mm TL (range, 170–204 mm TL). Electrofishing was conducted in 10-30.5 m long sections in the perennial reach during September 1993. A total of 205 juvenile steelhead was captured, and the composite abundance estimate determined by the multiple-pass removal method for all 10 sections was 218 trout. The expanded estimate for the 2.4 km long perennial reach was 1,726 trout, or about 72 trout/100 m. Captured steelhead averaged 130 mm TL (range, 69–314 mm TL), and the length frequency distribution of the catch (Nelson 1995) suggested that at least three consecutive year classes were represented, with the 1993 age 0+ group dominating in relative abundance. Nelson (1995) concluded that the San Simeon Creek steelhead population was primarily limited by lack of stream flow during spring–fall, and secondarily by sedimentation.

The habitat and juvenile steelhead population in the perennial reach of San Simeon Creek were assessed again in September 1994 by Alley & Associates (1994). The perennial reach in 1994 was only 1.5 km long. Habitat typing affirmed the dominance of flatwater habitats and pools, and the negative influence of sediment, as seen by Nelson (1994) in 1993. Using the multiple-pass removal method, and weighing habitat-type specific densities of each age class by the cumulative length of each habitat type in each of three reaches, there was a summed estimate of 2,003 juvenile steelhead in the 1.5 km perennial reach, or 134 trout/100 m. Thus, the estimated total number of juvenile steelhead in the perennial reach was very similar in September 1993 (~1,700) and September 1994 (~2,000), but density in 1994 was nearly twice that in 1993 (~130 trout/100 m vs. ~70 trout/100 m, respectively). The length of the perennial reach was also about 38% shorter in 1994 than in 1993. Based on observed densities of juvenile steelhead in September 1994, the corresponding number of adult steelhead that would be produced was estimated at 65 fish, using a model developed by Kelley et al. (1987).

Steiner Creek

Observations by biologists over the last 30 yr demonstrate the persistent use of the San Simeon Creek tributary, Steiner Creek, as a steelhead production area. On 8 June 1965, the CDFG estimated juvenile steelhead abundance in one 20 m long reach at 114 trout/100 m, in the investigation of a siltation problem in the drainage (M. L. Johnson, CDFG, unpubl. memo. of 4 October 1965 and attached unpubl. file report on subject; see above for complete synopsis). Juvenile steelhead, 5.0–12.5 cm in length, were observed in the creek near the dam site of the proposed Cambria Meadow Reservoir when surveyed by the CDFG on 21 December 1989. In September 1994, Alley & Associates (1994) assessed the habitat and juvenile steelhead population in one 435 m long reach in the perennial portion of Steiner Creek. Perennial water began about 5.6 km upstream from the confluence with San Simeon Creek. About 92% of the surveyed reach was composed of step-runs and bedrock pools. Using the multiple-pass removal method, and weighing habitat-type specific densities of each age class by the cumulative length of each habitat type in the reach, there was a summed estimate of 1,145 juvenile steelhead in the reach, or 263 trout/100 m. Based on observed densities of juvenile steelhead in September 1994, the corresponding number of adult steelhead that would be produced was estimated at 31 fish, using a model developed by Kelley et al. (1987).

Santa Rosa Creek Drainage

Santa Rosa Creek is among the most well-known steelhead streams in San Luis Obispo County. The CDFG surveyed the creek under low-flow conditions during the mid-1930's. Stream flow was perennial in the upper creek but became interrupted in the middle and lower portions. No migration barriers were observed, and spawning grounds were common along the stream. The steelhead population had apparently been supplemented with earlier plants, but a stocking summary covering the early 1930's showed only a plant of 4,000 brown trout made in 1933. The surveyors recommended against further stocking under low-flow conditions. They also predicted that the success of natural spawning was limited because of low stream flow. Fishing pressure had been heavy on the stream.

The CDFG stream survey files contained several miscellaneous notes about steelhead and their habitat in Santa Rosa Creek from the 1950's. The opening of the summer trout season on 1 May 1950 included the take of many limits of juvenile steelhead/rainbow trout, about 12.5–23.0 cm in length. Some 3,000 rainbow trout were planted in the stream in April 1951. A creel census conducted during January 1955 revealed that an estimated 650 angler days were spent to catch over 600 steelhead at Santa Rosa Creek. Angling was confined to the tidewater portion of the stream, and most captured fish were presumably juveniles, based on the magnitude of the catch. During a brief check of the creek on 18 January 1957, suitable spawning gravel was seen at the Highway 1 crossing. Several adult steelhead had reportedly been taken in the lagoon during the previous week. On 29 April 1959, the CDFG observed a high abundance of 2.5–5.0 cm long steelhead fry and 10.0–18.0 cm long yearlings in the upper stream. For example, there were a visually-estimated 150–200 fry and 30 yearlings in one 17 m3 pool.

A more comprehensive view of Santa Rosa Creek as a steelhead production area was provided when the CDFG surveyed the lowermost 18 km of the stream on 18 January 1960. Spawning areas were abundant and in good condition throughout the lowermost 10.6 km of stream, and scattered further upstream. Rearing habitat, in the form of pools and cover, was of high quality in the uppermost 3–5 km of the survey area. In contrast, pool development was poor and cover lacking in the lowermost 14.5 km. Surface water was diverted to adjoining ranches, and cattle grazing caused much erosion in the upper stream area. No juvenile steelhead/rainbow trout were seen in the creek during this survey.

In a letter of concern to the CDFG (W. C. Weiss, Cambria, CA, unpubl. letter of 23 January 1960), a local resident described how ranchers in the upstream creek area built small dams in summer each year for irrigation diversions. Stream flow, in the otherwise perennial creek, became interrupted as a result. This problem occurred reportedly about four times between 5 July 1959 and mid-October 1959, each time for 1–2 weeks. Many juvenile steelhead and stocked rainbow trout were apparently killed as their oversummering pools dried up.

Similarly, on 24 June 1960, the CDFG found that stream flow in Santa Rosa Creek, downstream from 4.7 km above the Highway 1 crossing, became interrupted as the result of a surface diversion in that reach (M. R. Schreiber, CDFG, unpubl. field notes of 24 June 1960). Young-of-the year steelhead, 2.5–7.5 cm long, were observed at high visually-determined densities in pools at each of 10 stations from the perennial upstream area, 15.8 km above Highway 1, to isolated, desiccating pools in the lowermost creek within the town of Cambria. In 1961, these seasonal, interrupted flow conditions persisted through late fall when the CDFG observed the stream on 19 December 1961, and saw six 5.0–10.0 cm long juvenile steelhead in a pool about 4.5 km upstream from Highway 1.

In 1970, the CDFG evaluated the impact of summer trout fishing on the juvenile steelhead population inhabiting the Santa Rosa Creek lagoon (L. Puckett, CDFG, unpubl. memo. of 2 November 1970). The study consisted of (i) a mark-and-recapture estimate of the lagoon-dwelling juvenile steelhead population; and (ii) an estimate of the number of steelhead removed from the population by angling during the summer trout season as determined by a creel census. Beginning in mid-February 1970 and continuing periodically through April 1970, juvenile steelhead were seined in the lagoon, marked with an adipose fin clip and released. Juvenile steelhead entering the lagoon were intercepted at a downstream migrant trap 1.6 km above the lagoon. These fish too were marked and released. Trapping continued through July 1970, although <50 trout were trapped over the entire period. Thus, most downstream movement must have occurred prior to early March. Overall, 1,800 juvenile steelhead were marked and released.

The lagoon population was estimated to be 6,800 juvenile steelhead by the opening of the trout season on 2 May 1970. An estimated 2,290 juvenile steelhead, or 34% of the lagoon population, were captured during 2 May–31 August 1970, as determined by the creel census. These fish averaged 13.0 cm in length. On a monthly basis, 1,960, 268, 61, and 0 trout were caught in May, June, July, and August, respectively. The seasonal decrease in harvest reflected a decline in use rather than catch rate, as catch rates throughout the period that fishing occurred remained above 1.3 trout/hr. No angling took place in August 1970, yet at least several hundred juvenile steelhead remained in the lagoon, as determined by seining.

Thus, of the estimated 6,800 steelhead present at the start of the trout season, roughly 50% were accounted for in the fishery (~2,300 trout) and as fish surviving the summer in the lagoon (perhaps as many as 1,000 trout). The other half of the original population either escaped to the ocean before the sandbar formed in early May, was lost to predation, or died as a result of decreasing water quality with water temperature peaking at 25.6° C on warm calm days.

Puckett concluded that the data did not support the need for a closure on summer trout fishing in lagoons south of San Francisco, as the observed level of fishing mortality was not thought to have a significant influence on adult run size, which he noted was about 500 fish. However, current regulations prohibit summer trout fishing from San Francisco through San Luis Obispo counties on coastal streams or portions thereof accessible to steelhead, including lagoons.

Bailey (1973) estimated the population size and biomass of juvenile steelhead in Santa Rosa Creek during June–August 1970. The study area included the lowermost 19.3 km of the stream. During this study period, stream flow in the creek was interrupted which resulted in three dry sections, the most significant of which extended from about 11 to 13 km upstream from the mouth. This dry section was used as a boundary zone between the upper and lower creek for which post hoc comparisons were made. The lower creek lacked riparian vegetation, and was relatively warm and eutrophicated. In contrast, the upper creek had dense riparian vegetation, an abundance of riffles, and was relatively cool and oligotrophic. Juvenile steelhead/rainbow trout abundance was estimated, by use of electrofishing and the two-pass removal method, in typically four, randomly selected 30.5 m long sections in each of 11 contiguous, 1.6 km stream reaches.

Juvenile steelhead densities in individual sections were highly variable (range, 0–1,020 trout/100 m; c.v. = 88%), and averaged 345 ± 302 trout/100 m. Densities in the upper creek averaged 535 ± 286 trout/100 m, while those in the lower creek averaged 202 ± 229 trout/100 m, and this difference was highly significant (Mann-Whitney U test, $p<0.001$)[4]. Individual section density estimates were averaged and expanded for each 1.6 km reach, and it followed that reach densities in the upper creek (5,336 ± 1,874 trout/km) were significantly greater (Mann-Whitney U test, $p<0.02$) than those in the lower creek (2,117 ± 1,071 trout/km). Average individual masses of trout in upper creek reaches (179 ± 48 trout/kg) were significantly

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[4] **Note that sampling occurred from June to August, the period during which the size of the age 0 cohort is typically regulated the most proportionately (reviewed by Titus 1990). Thus, the overall picture provided by Bailey (1973) may have been somewhat confounded in that abundance and biomass estimates made at different locations and times likely corresponded to different recruitment stages.**

lower (Mann-Whitney U test, $p<0.03$) than those in lower creek reaches (83 ± 47 trout/kg). Thus, juvenile steelhead were typically more abundant per unit area and smaller in the upper creek relative to the lower creek. With an average individual mass in the upper and lower creek of 5.6 g and 12.0 g, respectively, most fish in the upper creek were young-of-the-year while yearlings were proportionately more abundant in the lower creek. Interestingly, average total biomass in upper creek reaches (29 ± 15 kg/km) did not differ significantly (Mann-Whitney U test, $p>0.85$) from that in lower creek reaches (28 ± 18 kg/km). The total population estimate and biomass for the study area was 63,378 trout and 504 kg. Bailey (1973) concluded (i) that Santa Rosa Creek, on a per km basis, was the most productive among several central coast steelhead streams surveyed during 1970–71 under the direction of the CDFG (L. K. Puckett, CDFG, unpubl. memo. of 30 December 1971); and (ii) that water development posed the greatest threat to the Santa Rosa Creek steelhead run.

On 2 February 1974, the CDFG observed three adult steelhead in the creek, about 6–8 km above the mouth. The visually-estimated lengths of these fish were 41 cm, 64 cm, and 76 cm. On 23 February 1974, the CDFG captured two spawning pairs of adult steelhead in Santa Rosa Creek by electrofishing: the first pair consisted of a 79.8 cm female and 72.9 cm male, and the second pair of a 61.0 cm female and a 51.3 cm male. On 24 February 1974, a 50.8 cm female was captured on hook and line in the lagoon.

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in Santa Rosa Creek and five other San Luis Obispo County coastal streams. Santa Rosa Creek was selected to represent a steelhead production system subject to a moderate level of human-induced degradation. Similarly to Bailey (1973), abundance and biomass were estimated, by use of electrofishing and the two-pass removal method, in six randomly-selected 30.5 m long sections in each of five 1.6 km long stream reaches. Two reaches each corresponded to the lower and upper creek areas described by Bailey (1973; see above), and the fifth reach was in the boundary zone from about 11 to 13 km above the mouth.

As seen by Bailey (1973), individual section densities varied greatly (range, 0–105 trout/100 m; c.v. = 151%), but the average of 22 ± 33 trout/100 m was an entire order of magnitude lower than that estimated by Bailey (1973) and this difference was highly significant

(Mann-Whitney U test, $p<0.001$). As in 1970, densities in the upper creek (41 ± 40 trout/100 m) tended to be higher than those in the lower creek (6 ± 11 trout/100 m), and this difference was nearly significant (Mann-Whitney U test, $p = 0.0525$). Also consistent with Bailey (1973), average individual masses of juvenile steelhead in upper creek sections (111 ± 68 trout/kg) were significantly lower (Mann-Whitney U test, $p<0.007$) than those in lower creek sections (25 ± 7 trout/kg). Again, juvenile steelhead were typically more abundant per unit area and smaller in the upper creek relative to the lower creek. With an average individual mass in the upper and lower creek of 9.0 g and 40.0 g, respectively, most fish in the upper creek were young-of-the-year while most of those in the lower creek were yearlings. Overall, of 161 trout sampled, 52% were 50–99 mm in length, 31% were 100–149 mm, 16% were 150–199 mm, and 1% was 200–249 mm. Also consistent with Bailey (1973) was the finding that average total biomass in upper creek sections (446 ± 539 g/100 m) did not differ significantly (Mann-Whitney U test, $p>0.58$) from that in lower creek reaches (330 ± 429 g/100 m).

Knable (1978) found that lower Santa Rosa Creek was evolving toward a state of advanced degradation. The stream channel in the lower creek was eroding and broadening as a result of streamside vegetation loss, caused by intense livestock grazing, urbanization, and agricultural development. The quality of rearing habitat for juvenile steelhead was limited because of the lack of cover. Spawning gravel occurred in the lowermost 13 km of the creek but its utility was considered questionable because of insufficient cover. Suitable spawning gravel and cover existed in the upper creek area, which had not been severely modified. The lower creek, especially near Cambria, was polluted with urban debris which also reduced rearing habitat quality. Stream flow was interrupted in many areas above stream kilometer 9.6. In addition, the 1976–1977 drought likely exacerbated these negative impacts on steelhead habitat and therefore the population.

Rathbun et al. (1991) presented a brief summary of up-to-date observations on steelhead in Santa Rosa Creek, and indicated that juveniles were abundant in the drainage through the early 1980's, based on CDFG unpublished reports and field logs. Sport fishing effort for returning adult steelhead was reportedly still intense at the mouth of the creek through 1986. Angler observations and reports indicated that the number of adult steelhead entering the creek declined significantly from 1987 through 1991. During a qualitative survey in 1988, rainbow trout were noted as "fairly numerous" in the upper watershed, but absent in lower Santa Rosa Creek. Only a few juvenile steelhead were seen in one pool during a survey from the mouth to the Main Street bridge in Cambria in March 1990. During 1988–1991, the CDFG received only a few reports of spawning adults. No steelhead were seen during a survey of the lowermost 3.2 km of the creek in mid-July 1991. As of 1991, steelhead still spawned and reared in the upper drainage, but the lagoon no longer functioned as important rearing habitat, especially during the summer, as no steelhead had been seen there for years. It was apparent to Rathbun et al. (1991) that overall steelhead abundance was "drastically reduced from historic numbers." These authors attributed the decline primarily to reduced habitat quality and quantity from loss of instream flow and perennial holding pools in the lower creek, and to loss of flow to the lagoon, as a result of increased agricultural and urban use of the water. The 1987–1992 drought undoubtedly exacerbated the problem.

The lowermost 21 km of Santa Rosa Creek were surveyed by the CDFG from 28 April 1992 through 1 May 1992. The lowermost 4 km of the creek, where it flows through Cambria, was somewhat urbanized, including pollution from urban debris. The next 9.7 km upstream flowed through land developed for cattle grazing and crop production; cattle wastes were a source of organic pollution and cattle use of the stream channel also caused streambank erosion and sediment pollution as did poor agricultural practices. Many homes were built adjacent to the creek. Extensive stretches of high quality spawning grounds, some over 30 m long, existed throughout the drainage. Rearing habitat, in the form of pools and cover, also occurred throughout the drainage. Steelhead had access to the lowermost 18 km of Santa Rosa Creek as cascade falls in the headwaters blocked upstream migration of adult spawners. There was a log jam about 13 km upstream from the lagoon but there was no indication if it was a migration barrier. An elevated culvert at the mouth of the Santa Rosa Creek tributary, Curti Creek, blocked upstream migration into that stream. Many surface water diversions were seen throughout the drainage, in addition to wells on the stream banks which pumped from the underflow. Juvenile steelhead/rainbow trout were present throughout the drainage, with the exception of the uppermost 2.4 km of the study area. Young-of-the-year were abundant at only three locations in the upper creek. Yearling steelhead, ≥ 12.5 cm in length, were seen throughout the system but not in great abundance. Santa Rosa Creek was still recognized as having been one of the best steelhead production areas in San Luis Obispo. Lack of instream flow during the summer and fall was considered the factor which most prevented the steelhead production potential of the system from being met. Otherwise, restoration potential was high with regard to problems associated with cattle grazing, crop production, and other development.

This stream survey was followed by a CDFG assessment of the juvenile steelhead population and stream habitat in 1993 (Nelson 1994b). The study area included the lowermost 23 km of the creek. Stream flow at stream kilometer 16 in the upper creek area decreased from 0.214 m3/s on 5 May 1993 to 0.012 m3/s by 1 November 1993. At stream kilometer 3.2 in the lower creek area, stream flow decreased from 0.301 m3/s on 5 May 1993 to 0.011 m3/s by 20 September 1993, at which time measurements were discontinued at that station due to interrupted flow conditions.

Steelhead were sampled by use of a downstream migrant trap and electrofishing. The downstream migrant trap was located at stream kilometer 1.9, and was fished from 26 April 1993 to 5 June 1993. Only one steelhead parr (76 mm TL), five smolts (158–247 mm TL), 13 rainbow trout (174–300 mm TL), and three post-spawner adults (421–496 mm TL) were captured. More smolts may have emigrated prior to the trapping period.

The electrofishing survey repeated the stratified random sampling method used by Bailey (1973) and, to a lesser extent, Knable (1978). During 16 August–9 September 1993, abundance and biomass were estimated, by use of the multiple-pass removal method, in six randomly-selected 30.5 m long sections in each of 14 contiguous, 1.6 km long stream reaches. Seven reaches corresponded to the lower creek area described by Bailey (1973), while six corresponded to the upper creek area. As seen previously, individual section densities varied greatly (range, 0–433 trout/100 m; c.v. = 168%), and the average of 56 ± 94 trout/100 m represented the same lower, order-of-magnitude difference in densities seen by Knable (1978), and this difference relative to Bailey (1973) was highly significant (Mann-Whitney U test, $p<0.001$). Consistent with earlier results, densities in the upper creek (123 ± 112 trout/100 m) were significantly higher (Mann-Whitney U test, $p<0.001$) than those in the lower creek (4 ± 9 trout/100 m), and average individual masses of juvenile steelhead in upper creek sections (75 ± 50 trout/kg) were significantly lower (Mann-Whitney U test, $p<0.001$) than those in lower creek sections (15 ± 20 trout/kg). These results reaffirmed the drainage use pattern observed earlier where the upper creek consistently provided suitable spawning and young-of-the-year rearing habitat, while the lower creek supported only relatively few yearling and older juvenile steelhead/rainbow trout. Overall, of the 1,172 trout sampled, 64% were <100 mm TL, only 8% were 100–200 mm TL, and 28% were >200 mm TL.

Nelson (1994b) also presented the results of an exhaustive habitat typing effort made on the creek during July–October 1993. No attempt will be made here to summarize the very detailed reach-by-reach descriptions. The results clearly corroborate earlier, more qualitative observations regarding overall habitat quality for steelhead spawning and rearing between the upstream and downstream creek areas. Habitat quality in the lower creek was negatively impacted by the proximate effects of cattle grazing, crop production, and urbanization, and the diversion of water for both agricultural and domestic use. These effects included loss of riparian vegetation, excessive erosion, increased sediment load, and reduction of instream flow which led to extensive desiccation of the stream and lagoon. With little suitable spawning substrate, minimal vegetative cover, poor pool development, and a lack of instream flow, there was little or no successful spawning and little rearing in the lower creek, as evidenced in the electrofishing survey. In contrast, as seen in previous surveys, there was greater diversity and complexity in physical habitat in the upper creek, along with mostly perennial flow conditions. These high quality habitat attributes continued to support adult spawning and year-round rearing habitat for at least three year classes of juvenile steelhead and rainbow trout. Nelson's (1994b) primary recommendation was to maintain the favorable spawning and rearing habitats for steelhead in the upper creek and to re-establish adequate flow conditions in the lower creek. The negative impacts of the various land uses in the lower creek would then be secondarily addressed once instream flow requirements were determined and implemented.

The juvenile steelhead population and stream habitat in Santa Rosa Creek were assessed again in fall 1994 by Alley & Associates (1994). The study area extended from the fish ladder at SKM 5.4 to SKM 20.9, and consisted of seven study reaches (1.3 ± 0.7 km long; range, 0.35–

2.4 km) interrupted by one 6.3 km long dry section. Two reaches corresponded to the lower creek area described by Bailey (1973), while five corresponded to the upper creek area. In contrast to earlier population surveys at Santa Rosa Creek, study reaches were not selected randomly but were instead selected to represent the portion of the stream providing highest quality rearing habitat for juvenile steelhead. For example, the lowermost 5.4 km of stream below the fish ladder was not included in the survey because "(s)ampling in previous years indicated very low steelhead densities" in that section. Another departure from earlier methodology was that abundance estimates were made on a mesohabitat-specific basis (i.e. pool, riffle, run, etc.), and pools were sampled most comprehensively as they were the most heavily utilized habitat type under the prevailing low-flow conditions. Abundance estimates were made using the multiple-pass removal method, where habitat-type specific densities of each age class were weighed by the cumulative length of each habitat type in each reach. As such, only one comprehensive density estimate (no. trout/km) could be determined for each reach.

Comparison with earlier surveys, especially on a stream-wide basis, was compromised in that the study design used by Alley & Associates (1994) lacked replication of randomly-selected sections within reaches, and sampling was biased toward higher density reaches and mesohabitat types. Yet, an attempt is made below to present the results within the context of the earlier, more similarly designed studies.

Alley & Associates (1994) determined that reach densities averaged 1,737 ± 582 trout/km (range, 1,299–2,669 trout/km) and although this average was on the same order of magnitude as that seen by Bailey (1973; 3,580 ± 2,192 trout/km), it was still significantly lower (Mann-Whitney U test, $p \approx 0.03$). Densities in the upper creek (1,892 ± 634 trout/km) tended to be higher than those in the lower creek (1,351 ± 74 trout/km) but, contrary to previous studies, this difference was not significant (Mann-Whitney U test, $p>0.12$). When the data of Alley & Associates (1994) are plotted along with those of Knable (1978) and Nelson (1994b), depicting the results of all three fall population surveys (Figure X), it becomes apparent that spawning and subsequent rearing have been most heavily concentrated in the upper creek area. Alley & Associates' (1994) density estimates for the two lower creek reaches appear anomalous relative to Knable (1978) and Nelson (1994b), and are likely a result of the bias introduced in the selection of reaches and individual habitat units sampled, as described above and further in their report. Based on observed densities of juvenile steelhead in fall 1994, Alley & Associates (1994) estimated the corresponding number of adult steelhead that would be produced at 405 fish, using a model developed by Kelley et al. (1987). Alley & Associates (1994) concluded that low stream flow in summer was the factor that most limited the number of juvenile steelhead in Santa Rosa Creek, by rendering step-run and glide habitats unuseable and by reducing the amount of escape cover in pools.

Overall, the most noticeable change that has occurred in this drainage is the pattern of use by steelhead, as reflected in the results of the similarly designed studies of Bailey (1973), Knable (1978), and Nelson (1994b). Using average densities of juvenile steelhead in the upper and lower creek areas as an indication, the percentage of the population using the upper creek has increased from about 73% in 1970, to 87% in 1978, to 97% in 1993, corresponding to a decrease in the lower creek from 27% to 13% to 3%, respectively. This change in frequencies in use between the two stream areas over this 23 yr period was highly significant ($X^2 = 38.8$, df = 2, p = 0.0001). These results strongly suggest that the degraded physical habitat and reduced instream flows in the lower creek have progressively rendered this area less and less suitable for steelhead production.

Toro Creek Drainage

Toro Creek, a tributary to Estero Bay, has historically supported a steelhead population. When surveyed by the CDFG in the mid-1930's, spawning grounds were noted as common along the stream. No diversions or barriers were observed. Toro Creek was otherwise described as "a small brushy stream (that) contains a 'goodly' number of small fish because of the shade and pools". Apparently juvenile steelhead did not reach a large size in the creek, which would suggest that they smolted and emigrated at an early age and small size. Angling pressure was reportedly heavy in spring, and then light during May–July. Because of low flow conditions late in the season and a prevailing dry cycle, Toro Creek was not highly regarded for its summer trout fishing. The surveyors recommended that only a few steelhead be stocked in wet years. Early stocking records showed that the Toro Creek steelhead population had been supplemented with 10,000 juveniles in 1932 and 8,000 in 1933.

The CDFG surveyed the lowermost 16 km of Toro Creek on 17 January 1962. The upper 8 km of the survey area contained the high-gradient headwater and canyon sections of the stream, while the lower 8 km of stream flowed through a low-gradient coastal valley developed for agriculture. Spawning areas were scarce in the headwaters where much of the rubble and gravel were cemented by calcareous deposits, but abundant and of high quality throughout the lowermost 8 km of stream. Rearing conditions for juvenile steelhead were poor because of extremely low flow conditions. Under normal flow conditions, rearing habitat in the form of pools and cover was of high quality, especially in the canyon section. Although there were no natural migration barriers in the stream, there was a flashboard dam in the headwaters which blocked adult steelhead migration. One domestic diversion was seen in the headwaters, and many pump diversions for irrigation in the lower creek section. No pollution was seen in the headwater or canyon sections, but in the lower section, grazing cattle polluted the stream with sediment and excrement. The lagoon area was polluted with an oily-brine outfall from the Standard Oil Company's El Estero pumping station. No juvenile steelhead/rainbow trout were seen in the lower creek section, and only a few in the canyon section. Low trout abundance was attributed to several years of persistently low flow conditions resulting from drought, exacerbated by agricultural diversions. Local residents reported good adult steelhead runs in past years, including fish that reached the absolute headwaters during the 1957-58 season. Angling pressure was probably only heavy at the stream mouth during steelhead season when the adults were running. The surveyors regarded Toro Creek as a steelhead production area with high potential. They also recognized that increased pumping for irrigation would lower steelhead production.

Toro Creek was surveyed in its entirety by the CDFG during the weeks of 25 June and 2 July 1973. The uppermost 4 km of the headwaters were dry, although they were included in addition to the upper and lower 8 km sections described in the 1962 CDFG survey. Suitable spawning areas occurred not only in the lowermost 8 km as in 1962, but also in the uppermost 4 km headwater section. Spawning areas were described as both readily accessible and of very high quality. Rearing habitat in the form of pools and cover was especially good in the canyon section, although some pool habitat was also available in the lower section. There were no barriers to migrating adult steelhead. Two diversions were observed. Juvenile steelhead abundance was estimated at seven stations throughout the survey area, by use of electrofishing and the two-pass removal method. Trout were found at all but one station. The expanded estimate for the 16 km of wetted stream was about 16,000 trout, 6.5–25.5 cm in length. The relatively large juvenile population was attributed to observed high quality habitat conditions, including an abundance of aquatic insect prey. The adult steelhead run supported a popular sport fishery. A local resident reported that no stocking had occurred during the previous 15–18 yrs, and that at least three spawners migrated successfully past SKM 16 the previous winter where five redds had also been observed.

The CDFG monitored for adult steelhead at Toro Creek on seven occasions from 14 January–7 April 1974 (M. Seefeldt, CDFG, unpubl. field reports of 14 January–7 April 1974). No adults were seen on the first occasion, although there has been substantial rainfall and the sandbar at the creek mouth had been breached for more than a week. A total of 10 adult steelhead was captured by electrofishing from the second occasion on 10 February 1974 through the final occasion. These fish averaged 50.1 ± 5.9 cm FL (range, 41.9–61.6 cm FL). Many juvenile steelhead/rainbow trout were observed during these surveys; these fish ranged in length from about 10 to 35.5 cm.

In fall 1974, the CDFG investigated the juvenile steelhead population in Toro Creek (Snider 1974). The character of the upper and lower 8 km sections of the creek was apparently the same as described in the 1962 CDFG survey (see above). The area of primary concern was the lowermost 3.2 km of the stream, where Standard Oil proposed an expansion of their onshore oil storage facility. Juvenile steelhead abundances were determined in 12 randomly-selected 30.5 m sections by use of electrofishing and the two-pass removal method. For comparison, juvenile steelhead abundances were also determined in six randomly-selected 30.5 m sections by the same method in the upper 8 km section.

Mean estimated juvenile density in the lower creek was 30 ± 3 trout/100 m, which gave an estimate of about 2,400 trout for the entire lower 8 km section. Mean density in the upper creek was an order of magnitude higher, 390 ± 128 trout/100 m, and corresponded to about

31,200 trout for the entire upper 8 km section. Age 0+ trout averaged about 80 mm TL, age 1+ about 157 mm TL, and age 2+ about 227 mm TL. In the lower creek, 14% of sampled trout were age 0+, 69% were age 1+, and 17% were age 2+, while corresponding figures in the upper creek were 78%, 17%, and 5%, respectively. Overall, 68% of the juvenile steelhead population were young-of-the-year, 26% were 1+, and 6% were 2+. Based on age-class specific survival rates from Shapovalov and Taft (1954), observed juvenile production in Toro Creek corresponded to an estimated adult steelhead production of about 1,400 fish. Snider (1974) related the relatively large steelhead run at Toro Creek to the lack of development in the drainage.

Barclay (1975) found juvenile steelhead/rainbow trout in Toro Creek, and "they were abundant in areas with clean, cool waters that flowed over gravel or other rock substrate."

The CDFG surveyed Toro Creek in its entirety during 11–15 September 1978. Of its 30 seasonal tributaries and springs, 11 contributed significant flow to the creek. The distribution and quality of spawning and rearing habitats were essentially the same as described in the 1973 CDFG survey (see above). A heavy concentration of spawning reportedly occurred at about SKM 14.5 the previous winter. Juvenile steelhead/rainbow trout were observed from SKM 6 through SKM 15. The greatest density and largest individuals were associated with the high quality rearing habitat in the canyon section. Angling pressure was light, and the 1976–77 drought apparently had a noticeable, negative impact on the juvenile population (see Knable 1978, below). One diversion was observed, although it was not in operation. There was a potential barrier to adult immigration at a culverted road crossing in SKM 11. Localized heavy grazing pressure, especially in the lower section, resulted in removal of riparian vegetation and fecal pollution. The creek was also polluted with urban debris.

During 17 August–22 October 1978, Knable (1978) estimated juvenile steelhead abundance and biomass in Toro Creek and five other San Luis Obispo County coastal streams. Toro Creek was selected to represent a steelhead production system subject to a moderate level of human-induced degradation. Abundance and biomass were estimated using electrofishing and the two-pass removal method in six randomly-selected, 30.5 m long sections, in three 1.6 km long stream reaches. Two reaches occurred in the lower 8 km section, while a third was in the upper 8 km section; the stream was dry above this point.

Mean estimated juvenile density in the lower creek was 3 ± 5 trout/100 m which was an order of magnitude lower than that seen by Snider (1974); mean upper creek density was 7 ± 8 trout/100 m, two orders of magnitude lower than that seen by Snider (1974). There was no significant difference between lower and upper creek densities (Mann-Whitney U test, p>0.18). Observations indicated that greatest trout abundance was in SKM 8.0–9.7, but this reach was not sampled. Apparently, juvenile recruitment in 1978 was poor as only 7% of sampled trout (n = 28) were likely young-of-the-year (50 –99 mm in length), 75% were 100–199 mm, and 18% were 200–299 mm. Most sampled trout were yearlings as average individual mass was 38.5 g.

Knable (1978) concluded that the lower section of Toro Creek was evolving toward a state of advanced degradation, primarily because of grazing effects on riparian vegetation and water quality as described in the 1978 CDFG survey (see above). In the upper 8 km section, two flashboard dams, a short channelized section, and a natural 1.2 m waterfall were noted but not as significant problems for steelhead production. The exception was the road crossing with blocked culverts in SKM 11 mentioned above.

Steelhead were still mentioned as a viable fishery resource in Toro Creek in recent (through 1988) CDFG file documents, in connection with proposed development. Adult steelhead have reportedly been seen in Toro Creek as recently as the late 1980's (D. W. Alley, D. W. Alley and Associates, pers. comm. of 21 January 1993).

Villa Creek Drainage

Little documentation was found regarding the history of steelhead in Villa Creek, a small tributary to northern Estero Bay. When surveyed by the CDFG during 13–14 August 1969, stream flow was interrupted along its entire course of about 13 km. There were suitable spawning areas in the central and upper stream, given winter flow conditions. Suitable rearing habitat occurred in the upper 5 km of stream where pools had sufficient cover; pools in the lower 8 km were silted and lacked cover. There were two low-flow barriers in the upper 5 km; both were considered passable under winter flow conditions. Juvenile steelhead/rainbow trout were found from 1.6 km above the mouth to the headwaters, including above the barriers. Visually estimated densities of 6.5–10.0 cm long trout were about 490 trout/100 m in SKM 1.6–8.0, and about 220 trout/100 m in the uppermost 5 km. The population supported a winter fishery at the creek mouth for adult steelhead with moderate to heavy pressure. Summer fishing for juveniles was light because of restricted access to private lands.

In 1980, the CDFG determined the abundance of juvenile steelhead/rainbow trout by electrofishing at three stations on the uppermost 3.2 km of Villa Creek (P. P. Chappell, CDFG, unpubl. memo. of 14 October 1980). The exact date of sampling was not indicated but it is assumed that sampling occurred sometime during late summer–early fall. There was an average of 392 ± 124 trout/100 m. The uppermost 5 km appeared to provide most of the spawning and rearing habitat in the stream, although this conclusion was based on limited observation.

SANTA BARBARA COUNTY

Arroyo Hondo Drainage

Canada del Corral Drainage

No formal records of an historical steelhead population were found for Canada del Corral. However, this small stream did receive CDFG plants of juvenile steelhead rescued from the Santa Ynez River during the 1940's. In addition, documents contained in the CDFG file expressed concern for the steelhead resource in this creek in relation to pollution from oil extraction operations in the lower stream area.

Cañada Honda Creek Drainage

No information was discovered regarding an historical steelhead population in Cañada Honda Creek, which is contained within the boundaries of Vandenburg Air Force Base. However, in a brief survey conducted recently by the CDFG, the stream appeared highly suitable as a steelhead and/or resident rainbow trout production area; no apparent migration barriers existed at the Highway 1 or Southern Pacific railroad crossings, and the physical instream habitat and riparian vegetation provided favorable spawning and rearing conditions. A local authority indicated that much of the creek was dry during the 1987–92 drought except for isolated pools, and it was concluded that an electrofishing survey should be conducted to assess the trout population (S. Parmenter, CDFG, pers. comm. of 31 March 1993).

Carpinteria Creek Drainage

No information was discovered regarding steelhead in Carpinteria Creek. However, the following Carpinteria tributaries, which apparently comprise trout habitat, have received CDFG plants of O. mykiss: Dark Canyon Creek was stocked with 3,000 juvenile steelhead rescued from Santa Cruz Creek in the Santa Ynez River system in 1939; Deer Creek has received hatchery rainbow trout; and Gobernador Creek was planted with juvenile steelhead rescued from the Santa Ynez River in 1939, and has received hatchery rainbow trout.

Dos Pueblos Canyon Creek Drainage

No record of steelhead was found for Dos Pueblo Canyon Creek. However, the creek apparently comprises O. mykiss habitat as it has received CDFG plants of hatchery rainbow trout.

Gaviota Creek (Cañada de la Gaviota) Drainage

There is little formal record regarding the steelhead in Gaviota Creek. In the report of a mid-1930's CDFG stream survey, it was mentioned that steelhead entered the creek in winter. Steelhead have continued to run in Gaviota Creek (Swift et al. 1993), at least as recently as 1986 (S. Sasaki, CDFG, unpubl. file report of 3 October 1986). Adult steelhead were reported, nearly annually, attempting to ascend the stream at the Gaviota State Park road crossing. Sasaki had also observed and sampled juvenile steelhead and/or rainbow trout in sections of the creek adjacent to Highway 101. The creek still had perennial flow, and spawning areas and rearing pools were available to steelhead. Sasaki predicted that run sizes were very small. The 1987–92 drought may have had a significant negative impact on this small population, as Nehlsen et al. (1991) listed the native Gaviota steelhead stock as extinct. No steelhead were captured when a 30 m section, downstream from a Highway 101 grade stabilization structure, was electrofished during 21–23 January 1992 (D. McEwan, CDFG, unpubl. memo. of 26 March 1992).

The Gaviota Creek tributary, Canada de las Cruces, was planted with juvenile steelhead rescued from the Santa Ynez River in 1939.

Mission Creek Drainage

No detailed records of an historical steelhead run were found for Mission Creek. According to Cooper et al. (1986), it is probable that steelhead more fully exploited the Mission Creek system and other small Santa Barbara County coastal streams before dams were built by Spanish colonists. Steelhead still attempt to ascend these streams; one was caught in lower Mission Creek in the late 1950's (Cooper et al. 1986). Swift et al. (1993) indicated that steelhead have continued to run in Mission Creek in recent years. Juvenile steelhead were present in the stream in 1984 (Santa Barbara News-Press of 3 June 1984). Habitat loss and migration barriers, both as a result of flood control structures, and reductions in water quality and quantity have probably contributed to the decline of the Mission Creek steelhead population.

Rattlesnake Creek

Resident rainbow trout are present in Rattlesnake Creek, a Mission Creek tributary to which steelhead may have had access at one time. Cooper et al. (1986) presented a detailed description of this stream. Local residents claim that Rattlesnake Creek has historically supported a native rainbow trout population. The CDFG stocked 1,000 juvenile rainbow trout into the creek in 1975. Natural propagation does occur as young-of-the-year have been observed. The size of the population is highly variable and probably regulated by density-independent factors such as floods and droughts. For example, trout density decreased in a 1.3 km reach from >31 trout/km in 1982 to 1.5 trout/km in 1984. Although no details were given on the structure of the population, rainbow trout used in field experiments have ranged from 10.2 to 32.5 cm TL (Cooper 1984).

Refugio Creek (Canada del Refugio) Drainage

Although Refugio Creek is a known steelhead stream, no details were found regarding the history of its population. The creek received plants of juvenile steelhead rescued from the Santa Ynez River during the 1940's, and hatchery rainbow trout. CDFG file documents made reference to observations of adult steelhead ascending the stream in winter to spawn, especially in "wet years". Steelhead presence in the stream was documented as late as 1958. Man-made structures in the lower creek area, including a low water crossing built in the 1960's, have created barriers for immigrating adult steelhead. A description of Refugio Creek is presented by

Fox (1975; as cited in Hemphill and Cooper 1983). The current status of the steelhead population is not known.

Rincon Creek Drainage, Including Portions in Ventura County

Although known historically as a steelhead stream, few details were discovered regarding the steelhead in Rincon Creek. When surveyed by the CDFG in 1934, the creek had recovered from an input of sediment that resulted from an earlier fire in the watershed. The upper watershed was described as not being prone to erosion. It was also indicated that local anglers did not value the steelhead runs, as the fish "would return to the sea". The creek received plants of juvenile steelhead rescued from the Santa Ynez River during the 1940's, and hatchery-reared rainbow trout.

Within the lower creek area, rubble drop structures on two bridges and a long, inclined concrete culvert at the U.S. 101 crossing effectively prevent immigration of steelhead from the ocean (M. H. Capelli, California Coastal Commission, unpubl. project review of 22 March 1989 to C. Cesena, Caltrans). The input of fine sediment from agricultural operations has also degraded the stream below the confluence with Casitas Creek. Yet, the headwaters still maintain perennial flow and other habitat attributes necessary for successful spawning and rearing of steelhead. Nehlsen et al. (1991) listed the Rincon Creek steelhead stock as extinct. It is not known if resident rainbow trout remain in the headwaters.

San Antonio Creek Drainage

No information was discovered regarding an historical steelhead population in San Antonio Creek. However, the creek did receive a plant of juvenile steelhead rescued from the Santa Ynez River in 1944. Warmwater fishes and stickleback apparently inhabit this stream, based on information contained in the CDFG file. The CDFG recently made a casual survey of general conditions in the lower creek, and concluded that the observed low gradient and soft-sediment substrate did not give the stream a high priority status for further investigation with regard to steelhead assessment and restoration (S. Parmenter, CDFG, pers. comm. of 31 March 1993).

San Jose Creek Drainage

San Jose Creek received a plant of juvenile steelhead rescued from the Santa Ynez River in 1944, and has also been stocked with hatchery rainbow trout. A 3.2 kg steelhead was caught in the creek in 1975. The lowermost portion of San Jose Creek is channelized with a concrete lining for flood control. This structure may function as a migration barrier because it lacks resting areas for immigrating adult steelhead.

Atascadero Creek

Swift et al. (1993) indicated that steelhead have continued to run in the San Jose Creek tributary, Atascadero Creek, in recent years. Two adult steelhead were captured in the Atascadero Creek tributary, Maria Ygnacio Creek, in March 1982 (Santa Barbara News-Press of 23 March 1982). These fish measured 76 cm, 4.5 kg and 69 cm, 2.5 kg. A dense growth of emergent vegetation in Atascadero Creek, at the confluence with the Maria Ygnacio, may create a barrier to upstream migrating adult steelhead (M. Cardenas, CDFG, pers. comm. of 22 April 1993).

Santa Maria River Drainage, Including Portions in San Luis Obispo and Ventura Counties

Shapovalov (1944b) described the Santa Maria River drainage, and its steelhead population and fishery, through 1944. The Santa Maria is formed by the confluence of the Cuyama and Sisquoc rivers, about 40 km upstream from the river mouth. Stream flow in most of the drainage was intermittent or interrupted each year, especially during the dry summer season. Some headwater tributaries of the Sisquoc River, such as Manzana Creek and its tributaries, and the South Fork Sisquoc River, maintained perennial flow over long stream reaches. Other streams, such as the Cuyama River tributary, Kelly Canyon Creek, had perennial pools in their upper reaches. In addition to natural drought conditions, stream flow was reduced by groundwater extraction for agriculture, especially in the Santa Maria and upper Cuyama valleys, and by several surface water diversions. Forest fires, especially during the preceding 22 years, had removed ground cover and increased erosion. Consequently, runoff occurred more rapidly during the wet season, and less water was available for stream flow during the summer as more of it was absorbed in the stream bed where the eroded materials were deposited. No dams were present in the system as of 1944.

In addition to the migratory steelhead, resident rainbow trout were also present in the drainage, especially in headwater areas (Shapovalov 1944b). The resident rainbows probably comprised indigenous populations, progeny of introduced hatchery fish, and hybrids of the various genotypes.

Steelhead used the Santa Maria River primarily as a migration corridor to and from the Cuyama and Sisquoc rivers, where reproduction and nursery areas existed. Adult steelhead entered the river following the first heavy rains of the wet season (Shapovalov 1944b). The greatest proportion of the run entered during December–March. No estimate of run sizes was available. Few details were known about spawning area locations, although the Sisquoc system was apparently used more heavily by steelhead than the Cuyama system (see below). The Sisquoc tributary, La Brea Creek, was known as a reproduction area for steelhead. In general, spawning and rearing conditions had greatly deteriorated as a result of the aforementioned forest fires; sediment had smothered spawning gravels and filled rearing pools. Prior to the fires, some Sisquoc River tributaries were famous for their steelhead and rainbow trout fishing.

Hatchery-reared steelhead and rainbow trout were stocked in the Sisquoc River, and in tributaries to both the Sisquoc and Cuyama, at least as early as 1930–33 (Shapovalov 1944b). No records were found for stocking which may have occurred before 1930. Juvenile steelhead rescued from the Santa Ynez River were planted in the Santa Maria system during 1940–44; more may have been planted in 1945 and 1946, the last years of fish rescues in the Santa Ynez, but no records were found. Stocking details for which documentation was found are given below.

As of 1950, there appeared to have been no adult steelhead fishery for 10–15 years in the Santa Maria River, and very few steelhead were reported to have entered the Cuyama River for a decade (W. A. Evans, CDFG, file letter regarding the proposed Vaquero Dam project on the Cuyama River). Most steelhead entered the Sisquoc River system and spawned in the headwaters. Juvenile steelhead/rainbow trout measuring 23–36 cm were reportedly abundant in the inaccessible tributaries of the Sisquoc in years following large steelhead runs. The last sizeable steelhead run in the Santa Maria system occurred in 1941, few entered in 1942 and 1943 during brief periods when river flow reached the ocean, and no runs were thought to have occurred during the ensuing 7 years of drought. In addition to the naturally inconsistent flows in the Santa Maria River, completion of the Vaquero Dam project in the late 1950's made flow conditions for steelhead even more unreliable. Vaquero Dam, which creates Twitchell Reservoir, is located on the Cuyama River about 11 km upstream from the confluence with the Sisquoc River. The dam was built for flood control and replenishment of ground water in the Santa Maria Valley.

Steelhead use of the Santa Maria River system has not been assessed recently. Steelhead may still have access to the Sisquoc system when flow conditions allow, but extensive habitat degradation throughout the system, and lack of access to the upper Cuyama River (see below), greatly limit steelhead use.

Cuyama River and tributaries

Virtually no details were discovered regarding the historic steelhead resource in the Cuyama River. Steelhead migrations to and from most of the Cuyama system became obstructed when Vaquero Dam was completed in the lower river in the late 1950's. It can be assumed that the opportunity for steelhead to use the Cuyama River was gone by 1960.

The Cuyama River tributary, Alamos Creek (San Luis Obispo County), was planted with a total of 28,000 juvenile steelhead rescued from the Santa Ynez River during 1940–42 (Shapovalov 1944b), and has also been stocked with hatchery rainbow trout. The creek has perennial stream flow and now runs into one of the main arms of Twitchell Reservoir.

The Cuyama tributary, Kelly Canyon Creek, was planted with 6,000 hatchery rainbow trout in 1932 (Shapovalov 1944b). The creek's watershed was destroyed by forest fires during the 1920's.

The following are headwater tributaries to the Cuyama River in Ventura County that have been managed for catchable trout fisheries and stocked with hatchery rainbow trout but whose CDFG files lack any mention or record of an historical steelhead run: Alamo Creek, with a stocking record back to 1947; Beartrap Creek with a stocking record back to 1944 and 1947; Reyes Creek with stocking records dating back to 1933 and 1941–48, and with wild juvenile rainbows observed in 1949.

Sisquoc River and tributaries

In addition to having been an important spawning and rearing area for Santa Maria River steelhead, the Sisquoc River has also been managed for a resident rainbow trout fishery. Documented CDFG plants of hatchery-reared rainbow trout date back to 1932 (8,000 fish), 1939, and 1944–47. Some 20,000 hatchery-reared steelhead were also planted in 1930.

In the CDFG files, pools in the main stem Sisquoc River were noted as providing good habitat for rainbows up to 36 cm which were well-fed on chubs (*Gila* sp.). In a 1959 CDFG stream survey (W. M. Richardson, CDFG, unpubl. file report), a self-sustaining rainbow trout population was found with all size-classes present ranging from young-of-the-year to adults 34 cm in length. A high abundance of chubs was also noted. Thus, the Sisquoc River still provided a functioning system for natural production of O. mykiss, although there was no mention of a contemporary steelhead run. A similar survey was conducted in August 1964 but under low flow conditions (M. J. Whalls, CDFG, unpubl. memo.). Several size-classes of naturally propagated rainbow trout were still present although in lower abundance than in 1959 due to poor water conditions. It was also mentioned that upstream movement of anadromous fishes in the Santa Maria system had been all but eliminated because of intensified water use. In a CDFG survey in the lower Sisquoc River in April 1984, rainbow trout were reportedly common with several size-classes present (S. Sasaki, CDFG, unpubl. memo.).

The Sisquoc tributary, La Brea Creek, was a known spawning area for steelhead (Shapovalov 1944b). The creek was also a famous fishing stream before forest fires in the 1920's destroyed the watershed. Eroded materials were washed into the stream over the years, and by the time of a mid-1930's CDFG survey, sediment covered the spawning gravels and filled the pools. La Brea Creek was stocked with 6,000 hatchery rainbow trout in 1932.

The Manzana Creek drainage, in the headwaters of the Sisquoc, had perennial flow, unlike most portions of the Santa Maria system (Shapovalov 1944b). CDFG stocking records for Manzana Creek date back to 1930 when 15,000 hatchery-reared steelhead were planted. Some 10,000 hatchery rainbow trout were also planted in 1930, and about 4,500 during 1941–42. The creek also received a total of 47,240 juvenile steelhead rescued from the Santa Ynez River during 1940–44. The Manzana tributary, Davy Brown Canyon Creek, received about 1,900 hatchery rainbow trout during 1941–42, and 103,600 Santa Ynez steelhead during 1940–44. In June 1956, CDFG personnel found a high abundance of 15–20 cm rainbow trout in Manzana Creek.

The South Fork Sisquoc River received a plant of 10,000 hatchery-reared steelhead in 1933, and 3,200 hatchery rainbow trout in 1942 (Shapovalov 1944b).

The Sisquoc River tributary, Tepusquet Creek, was planted with a total of 73,800 juvenile steelhead rescued from the Santa Ynez River during 1940–44 (Shapovalov 1944b). The creek has also been stocked with hatchery rainbow trout.

Santa Ynez River Drainage

The Santa Ynez River probably supported the largest steelhead run in southern California, and was famous for its steelhead sport fishery (e.g. Mears 1947). In an early account, Holden (1910) related the popularity of the lower Santa Ynez for catching steelhead as large as 9 kg, and how these fish would ascend the stream 65–80 km to spawn in the upper drainage where resident rainbow trout were also abundant (see also Fry 1938).

Gibraltar Dam, located about 116 km upstream from the river mouth and built in 1920, was the first man-made obstruction to block steelhead access to the upper Santa Ynez drainage. Landlocked steelhead, 13–39 cm long and 2–4 years old, were captured when Curtis (1937) gill-netted Gibraltar Reservoir in November 1937. These fish included females with developing ova. No young-of-the-year steelhead were observed in the reservoir. In the tributary streams above the reservoir, Curtis (1937) identified suitable spawning grounds in the Santa Ynez River below the confluence with Mono Creek; in Mono Creek up to the debris dam; and in Gidney Creek. Although no juveniles were observed in the Santa Ynez or Mono Creek, both reportedly received spawning runs of steelhead. Spawning reportedly occurred in February, although the 1937 spawning run was apparently small. Siltation and desiccation were mentioned as potential problems for successful spawning in Mono Creek and the upper Santa Ynez River. Gidney Creek was unsilted and contained surficial flow later into the season. Camuesa Creek was apparently not used by steelhead spawners for some unknown reason.

In addition to supporting landlocked steelhead native to the drainage, the Gibraltar Reservoir stock was also supplemented with 25,000 hatchery-reared steelhead in 1932; 87,000 in 1933; 30,000 in 1934; 50,000 in 1935; and 40,000 in 1936. Some 10,000 hatchery rainbow trout were stocked in 1932. Shapovalov (1944a) also indicated that 9,000 juvenile steelhead, rescued from the Santa Ynez River, were stocked in the reservoir in 1939, 195,000 in 1940, and 25,440 in 1944.

During the mid-1930's, the CDFG conducted a cursory survey of 120 km of the Santa Ynez River to evaluate the system's suitability for stocking of hatchery-reared trout. The survey report indicated that spawning grounds for steelhead and rainbow trout were common along the entire stream, but that flow was a limiting factor for spawning habitat quantity. During spring freshets, steelhead were observed spawning in all tributaries and in the mainstem river below Gibraltar Dam. Natural propagation produced the principle supply of harvestable juvenile steelhead and rainbow trout in the stream. Planting was not recommended for the river or tributaries because of high mortality due to intermittent flow conditions in summer. Fish rescues were conducted every summer and fish losses were typically heavy after 1 June.

Shapovalov (1944a) described the Santa Ynez River drainage, and its steelhead population and fishery, through 1944. Tributary streams typically went dry in their lower reaches during the summer, but maintained perennial flow or series of pools in their upper reaches. Much of the main stem Santa Ynez below Gibraltar Reservoir also became desiccated during May–July, except for several kilometers of stream in the vicinity of Solvang; at the lagoon, which was also several kilometers long (see Shapovalov 1940b); and occasionally at large pools elsewhere. Stream flow during the dry season in the lower Santa Ynez had been reduced by the effects of forest fires, water storage and diversion in the upper drainage at Gibraltar Reservoir and Jameson Lake, and groundwater pumping for irrigation. There was a saltwater intrusion barrier near the mouth of the Santa Ynez River which included a reportedly satisfactory fishway. Yet, despite unstable flow conditions, water discharges at Lompoc on the lower Santa Ynez during 1928–44, were great enough to allow immigration of adult steelhead to upstream spawning grounds in all years except probably 1929 and 1931, which were very dry (Moffett and Nielson 1945).

Steelhead, most of which entered the river during December–March following the first heavy rains of the season, still spawned as far upstream as Gibraltar Dam. Landlocked steelhead, and possibly various strains of rainbow trout and hybrids of the different genotypes, persisted in Gibraltar Reservoir and in the creeks upstream from there. Steelhead progeny, which were rescued annually from the drying Santa Ynez below Gibraltar Dam, were planted in creeks both above and below the dam. No counts were ever made of the adult steelhead run in the Santa Ynez, but as Shapovalov (1944a) indicated, the 1,036,980 juvenile steelhead rescued from the drying main stem in 1944 suggested a very large run. This count would serve as the basis for an underestimate of the adult run size as an additional proportion of the juvenile population went uncounted: fish which migrated to the lagoon before rescues began, those which survived in the remaining live portions of the river system, and those which presumably died in the desiccated lower reaches of tributaries. A local CDFG employee believed that the 1943-44 adult steelhead run in the Santa Ynez at least equalled the 1938-39 and 1939-40 runs at Benbow Dam on the South Fork Eel River in northern California, which he had personally observed. Adult steelhead runs at Benbow Dam had ranged from 12,995 to 25,032 fish from 1938-39 to 1943-44. Forest fires during the preceding 20 years had reduced steelhead/rainbow trout populations, especially above Gibraltar Reservoir, either by direct mortality or through the destruction of spawning and rearing habitat by erosion and siltation. Among the upper tributaries affected were Alamar, Indian, and Buckhorn creeks where trout had survived the summer dry season in perennial pools.

Shapovalov (1944a) reported that, at that time, most mainstem spawning by steelhead occurred upstream from Buellton to Gibraltar Dam. Steelhead also spawned in nearly all accessible tributaries below the dam, including Alisal, Santa Cota, Cachuma, Tequepis Canyon, and Santa Cruz creeks. Alamar and Indian creeks were among the tributaries above Gibraltar Reservoir which were known to have been utilized by steelhead before the dam was constructed (see also the above summary of Curtis 1937).

Fish rescue operations were conducted by the CDFG each summer for several years in the Santa Ynez drainage below Gibraltar Dam. No records were available prior to 1939, but during 1939–44 (excluding 1941 when sufficient flow persisted), a total of about 2,850,000 juvenile steelhead was rescued from the lower mainstem Santa Ynez River (Shapovalov 1944a). The fish ranged in batch sizes from about 212 to 1,411 fish/kg (nearly all rescued steelhead were young-of-the-year). On average, about 73% of each year's rescue was replanted in perennial water within the Santa Ynez River system, the majority in the lagoon (see below). In addition, a combined total of about 1,450,000 juvenile steelhead was rescued in 1945 and 1946; no rescues were conducted after 1946 due to a lack of fish (CDFG, unpubl. file data; see also below). As an example of the magnitude of juvenile steelhead production in the Santa Ynez River, Shapovalov (1944a) presented approximate numbers of steelhead rescued from three river reaches in 1944; corresponding densities were 11,298, 32,219, and 51,781 steelhead/km. That nearly all rescued steelhead were young-of-the-year indicates that main stem Santa Ynez steelhead smolted and emigrated to the ocean primarily at age 1.

During 1940–1947, nearly 2,550,000 juvenile steelhead were planted in the lower Santa Ynez River, primarily in the lagoon and in perennial water at Solvang (Shapovalov 1944a; CDFG, unpubl. file data). With the exception of 1947, these fish were rescued steelhead from within the Santa Ynez River drainage. In addition, a total of 133,000 hatchery-reared juvenile steelhead were planted in the Santa Ynez River during 1930–35 (Shapovalov 1944a). Some 5,000 hatchery-reared rainbow trout were stocked in the river in 1930 (Shapovalov 1944a), 650 in the lower river in 1945, and 35,160 in the lower river during 1950–53 (CDFG, unpubl. file data).

On 28–29 March 1946, a party of state and federal fishery biologists conducted a visual survey of steelhead spawning in the Santa Ynez River (L. Shapovalov, CDFG, unpubl. field correspondence of 2 April 1946). In addition to observations of recently completed redds, adult steelhead were seen moving upstream and actually spawning among four river locations from Alisal Creek to Oso Canyon, where high quality spawning grounds occurred. In contrast, no live steelhead or spawning activity were observed from the saltwater intrusion barrier near the river mouth to the Highway 150 crossing at Lompoc. The substrate in this river reach was dominated by shifting silt, sand, and fine gravel. Shapovalov concluded that spawning habitat quality for steelhead was very poor from the mouth to the Salsipuedes Creek confluence, of doubtful quality from Salsipuedes Creek to Solvang (a conservative judgement since no observations were documented for this reach), and excellent from Solvang to Gibraltar Dam. He also noted that high quality spawning grounds existed in tributaries but that the flow in these streams was too low at the time of the survey to allow the ascent of adult steelhead. Finally, many adult steelhead carcasses were observed in the lower river between the mouth and Lompoc; apparently high adult mortality had occurred in this area during the previous 2 weeks when water temperature peaked at ≥ 21° C.

The winter of 1946-47 was relatively poor for steelhead due to little precipitation and low flow. There was no steelhead run in the fall of 1951 (W. A. Evans, CDFG, unpubl. field notes). Cachuma Dam, known now as Bradbury Dam which creates Lake Cachuma about 76 km upstream from the river mouth, was completed in early 1953. The last substantial steelhead run occurred in 1945-46 (H. L. Lantis, CDFG, unpubl. file letter). In 1946-47, large numbers of steelhead were observed outside the mouth of the river, waiting for the sandbar to breach to make their ascent. This never occurred due to lack of precipitation and consequently there was no spawning run that year. Observations or catches of steelhead in the Santa Ynez after 1946 were relatively rare. For example, about 25 fish were taken in the river in 1952. Adult steelhead were otherwise taken by anglers in the ocean surf near the river mouth during 1947–52; too little freshwater outflow prevented these fish from entering the river system. Juvenile steelhead had been planted in the lagoon in an effort to reestablish the run, but low precipitation and reduced river outflow due to Bradbury Dam were cited as causes for the failure of these plantings. Some 20–40 adult steelhead, reportedly up to 5.5–6.5 kg, were observed at the head of the Santa Ynez lagoon in March 1956. Steelhead were also observed in the lower Santa Ynez tributary, Salsipuedes Creek. Some steelhead were also reportedly taken in the river during the spring of 1962.

Lake Cachuma has been heavily stocked with hatchery-reared rainbow trout. The CDFG stocked the reservoir with 199,250 rainbow trout fingerlings (Arrowhead, Hot Creek, and Mt. Shasta strains @ 55–317/kg) from 24 February 1953 through 16 October 1953 in preparation for the 1 May 1954 opening of angling at the reservoir (CDFG, unpubl. file data). Some 10,271 catchable-sized rainbow trout (@ about 11/kg) from a private hatchery were stocked on 6 August 1954, under purchase by the County of Santa Barbara (S. M. Soule, CDFG, unpubl. intraoffice correspondence of 7 October 1954). The CDFG planted an additional 2,277,767 fingerlings during 1954–1958 but, overall, survival and thus creel returns were low because of poor water quality for trout in summer. Fingerling plants were discontinued in 1959, and the management recommendation of stocking only catchable-size rainbow trout during cool-water months (H. L. Huddle, CDFG, unpubl. file report of 23 October 1958) has been followed since 1960. The extent to which these planted trout disperse up- and downstream in the system, and the effect they may have on native steelhead and rainbow trout, is not known.

No wild rainbow trout were found in the Santa Ynez River between Lake Cachuma and Gibraltar Reservoir during a survey in November 1972 (S. Sasaki, CDFG, unpubl. memo.). Steelhead were reportedly caught in the lower Santa Ynez during 1972-73, a high water year, although these catches were unverified (S. Sasaki, CDFG, unpubl. memo.).

By 1975, Bradbury Dam had all but eliminated the Santa Ynez steelhead run from its estimated average annual size of 20,000 migrant adults, as reported by the CDFG (California Department of Fish and Game 1975). Insufficient water releases from Lake Cachuma, to provide flow for migrations, spawning, and rearing, and a lack of adult steelhead salvage facilities at the dam, were cited as the primary causes for the demise of the run.

In 1986, the CDFG indicated that excellent spawning areas still existed in the main stem Santa Ynez below Bradbury Dam (S. Sasaki, CDFG, unpubl. file report of 3 October 1986). However, it was also indicated that even in years of high rainfall when adults could conceivably enter the river and spawn, flow below the dam would not be maintained through the summer and fall to allow for juvenile survival.

In 1989, the California Sportfishing Protection Alliance (CSPA) submitted a petition to the California Fish and Game Commission to list the Santa Ynez River steelhead as an endangered species under the California Endangered Species Act (R. J. Baiocchi, CSPA, petition of 25 August 1989). The basic tenet of the petition was that the Santa Ynez steelhead was unique because of the maximum size of 9 kg attained by adults, and because of the size of the estimated average adult run, which historically was on the order of 20,000 fish. The CDFG rejected the petition based on the conclusion that these characteristics were not uncommon in California steelhead populations (P. Bontadelli, CDFG, unpubl. memo. of 7 December 1989).

See “Discussion” for more on this issue.

Nehlsen at al. (1991) listed the Santa Ynez River steelhead stock as being at a high risk of extinction.

Santa Ynez River Lagoon. During late spring and summer 1940, the CDFG rescued more than 525,000 young steelhead from the drying Santa Ynez River (Shapovalov 1940b). Nearly all of these fish were young-of-the-year, and 191,700 were planted in the Santa Ynez River lagoon. One lot of about 8,700 steelhead was retained at the Fillmore Hatchery in Ventura County, to be used in a lagoon stocking experiment and in brackish water challenge tests. The steelhead were marked by clipping both ventral fins, and reared through September 1940. On 5 October 1940, when the fish had reached an average size of nearly 9 cm and 9 g, the young steelhead were planted in the freshwater portion of the Santa Ynez lagoon, apparently with success as no signs of stress or mortality were seen over the next several hours of observation. A short-term experiment had also been made at the hatchery on 26 September 1940 of transferring small samples of marked steelhead (3 and 12 fish in two trials) from fresh hatchery water to brackish lagoon water and back to fresh water. The fish in both trials showed no signs of stress. The combined results of both experiments suggested that young steelhead could be planted directly in brackish water lagoons from fresh water with little or no mortality.

Hundreds of thousands of juvenile steelhead rescued from the Santa Ynez River were planted in the lagoon during 1940–1947 (see above). In February 1954, 16,500 catchable rainbow trout were planted in the lagoon with apparently poor returns to the creel (H. L. Huddle, CDFG, unpubl.intraoffice correspondence of 3 December 1957). During 17–18 June 1954, the CDFG seined both shallow (1 haul) and deep water (4 hauls) habitat in the lagoon to cursorily evaluate the retention of these rainbow trout (P. E. Giguere, CDFG, unpubl. intraoffice correspondence of 9 July 1954). Several marine and euryhaline fishes were captured but no rainbow trout or juvenile steelhead. However, one each hatchery rainbow trout (26.0 cm) and juvenile steelhead (15.0 cm) were seined from small freshwater pools upstream from the saltwater intrusion barrier. On 14 July 1954, two rainbow trout (~17.0–18.0 cm) were seined from the most seaward extension of the lagoon but not at any of three other lagoon stations

(CDFG, unpubl. field report of 14 July 1954).

During 12–13 March 1958, one group of 10 of each 7.5–10.0 cm long and 20.0–23.0 cm long hatchery rainbow trout were placed in live cages at two lagoon locations where surface salinity ranged from 2.5 to 4.0 ppt (H. L. Huddle, CDFG, unpubl. intraoffice correspondence of 21 March 1958). All trout survived after 24 h, as had rainbow trout fingerlings tested at 12 ppt salinity in aquaria. These results seemed to corroborate the results of Shapovalov's (1940b) seawater challenge tests, as reported above.

Agua Caliente Creek

Although no historical record was discovered, steelhead probably spawned in Agua Caliente Creek prior to the construction of Gibraltar Dam, as they did in other tributaries in the upper Santa Ynez River drainage. Agua Caliente Reservoir, created by a debris dam completed on the creek in 1937, was planted with 13,000 juvenile steelhead rescued from the Santa Ynez in 1939, and 27,000 in 1940 (Shapovalov 1944a). The reservoir basin was completely filled with sediment by 1944.

Alisal Creek

Alisal Creek, which enters the Santa Ynez below Bradbury Dam, has been used historically for spawning by steelhead (Shapovalov 1944a). Some 26,000 juvenile steelhead were rescued from the creek in 1940. An adult O. mykiss about 38 cm in length, which was presumably a steelhead, was captured in the creek by an angler during the 1992-93 steelhead season (M. Cardenas, CDFG, pers. comm. of 5 April 1993).

Ballard Creek

Steelhead probably spawned in Ballard Creek, a Santa Ynez tributary below Bradbury Dam, as they did in most accessible tributaries (Shapovalov 1944a). The creek received a plant of 1,500 juvenile steelhead rescued from the Santa Ynez in 1943.

Cachuma Creek

Steelhead spawned in Cachuma Creek (Shapovalov 1944a), prior to the construction of Bradbury Dam. The creek received a plant of 7,000 juvenile steelhead rescued from the Santa

Ynez in 1942. Steelhead runs occurred at least as late as 1948, and the creek, which now flows into one of the main arms of Lake Cachuma, has also historically contained resident rainbow trout (CDFG, unpubl. file data).

Gidney Creek

Steelhead probably spawned in Gidney Creek prior to the construction of Gibraltar Dam; it now flows into one of the main arms of Gibraltar Reservoir. Curtis (1937) identified favorable spawning grounds in the creek, where juveniles (5–12.5 cm long) of landlocked steelhead from the reservoir were seen at a density of about 30 trout/pool. Gidney Creek was unsilted and contained surficial flow late into the season.

Hilton Canyon Creek

O. mykiss adults were observed spawning in Hilton Canyon Creek, the uppermost tributary to the Santa Ynez below Bradbury Dam, during mid- to late February 1993 (C. Fusaro, Santa Barbara City College, pers. comm. of 9 March 1993). One spawning pair comprised fish which were 46–51 cm in length. Some 22 adult trout, at visually estimated weights of 1.8–2.7 kg, were observed in the creek on one day. It was not known if these fish were actual steelhead or large rainbow trout which had moved downstream out of Lake Cachuma, although this problem was being investigated. Adult fish continued to be observed in the creek through late April 1993 (M. Cardenas, CDFG, pers. comm. of 22 April 1993).

Mono Creek and Tributaries

Steelhead spawned in Mono Creek, a tributary to the upper Santa Ynez, prior to the construction of Gibraltar Dam. Curtis (1937) identified suitable steelhead spawning grounds in Mono Creek up to the debris dam, and although no juveniles were observed, the creek reportedly received spawning runs of landlocked steelhead from the reservoir. Siltation and desiccation were mentioned as potential problems for successful spawning in the creek.

Sea-run steelhead also spawned in the Mono Creek tributaries, Alamar and Indian creeks, before the dam was built (Shapovalov 1944a). Forest fires since the 1920's had reduced O. mykiss populations in these tributaries, and in the Indian Creek tributary, Buckhorn Creek, either by direct mortality or through the destruction of spawning and rearing habitat by erosion and siltation. Trout had survived the summer dry season in perennial pools in these streams. Indian Creek received a plant of juvenile steelhead rescued from the Santa Ynez in 1945.

Salsipuedes Creek and Tributaries

As of 1974 (P. R. Gantt, Goleta, CA, unpubl. correspondence in the CDFG file) and 1986 (S. Sasaki, CDFG, unpubl. file report of 3 October 1986), Salsipuedes Creek and its tributary, El Jaro Creek, reportedly continued to support natural steelhead propagation. According to Sasaki, the Salsipuedes, which enters the lower Santa Ynez River about 24 km above the mouth, had suitable steelhead spawning areas, perennial flow, and an intact riparian canopy which sheltered the stream. Although the presence of spawning adult steelhead had not been investigated, Sasaki did observe many O. mykiss fingerlings in the creek in some of the 17 years he had worked in the area.

Electrofishing surveys were conducted in Salsipuedes and El Jaro creeks in March 1987 and 1988 (Harper 1988), in which both juvenile and adult steelhead were observed. Four adult trout were captured on 11 March 1987 in the lowermost 5 km of Salsipuedes Creek: (i) a 48 cm FL female steelhead which was age 4+ and had spent 2 years each in fresh and marine water; (ii) a 34.5 cm FL ripe male which could not be distinguished as a resident or migrant trout; (iii) a 30.5 cm FL female which appeared to be a migrant; and (iv) a 30 cm FL ripe male which could not be distinguished as a resident or migrant trout. Another large trout, about the same size as the 48 cm FL female steelhead above, was seen but not captured. Some 10–15 juvenile trout, >10 cm FL, were also captured on this date. On 12 March 1987, two adult trout were captured in El Jaro Creek: a 22.5 cm FL male which appeared to be a stream resident, and a 28.5 cm FL female which appeared to be a migrant that had grown in the lagoon or ocean. On 17 March 1988, several juvenile trout about 16 cm in length were seen but not captured in lower Salsipuedes Creek. On 31 March 1988, eight juvenile trout, 9.5–18.5 cm FL, were captured by electrofishing; these fish appeared to be stream residents as they displayed no signs of smolting. Thus, Salsipuedes Creek supported a small, self-sustaining O. mykiss population, which appeared to include both steelhead and resident rainbow trout.

Several adult O. mykiss were reportedly caught by anglers in Salsipuedes Creek during February–March 1993 following heavy precipitation (M. Cardenas, CDFG, pers. comm. of 5

April 1993). The catches were to have included about a dozen 30 –33 cm fish, and about five fish which were nearly 46 cm in length. These catches were not verified by the CDFG, however.

Santa Cota (Zanja de Cota) Creek

Santa Cota Creek, which enters the Santa Ynez below Bradbury Dam, has been used historically for spawning by steelhead (Shapovalov 1944a). The creek was stocked with 10,000 hatchery-reared rainbow trout in 1932.

Santa Cruz Creek and Tributaries

Steelhead spawned in Santa Cruz Creek (Shapovalov 1944a) prior to the construction of Bradbury Dam. The creek now flows into one of the main arms of Lake Cachuma. The creek was planted with 10,000 hatchery-reared juvenile steelhead in 1932, and received 3,000 juveniles rescued from the Santa Ynez in 1939. Some 10,000 juvenile steelhead were rescued from the creek in each of 1939 and 1940 (Shapovalov 1944a).

Steelhead could not access the Santa Cruz Creek tributary, Peach Tree Creek, because of impassable waterfalls on Santa Cruz Creek. However, the creek received a total of nearly 125,000 juvenile steelhead rescued from the Santa Ynez River during 1939–44 (Shapovalov 1944a). There was no indication whether the plants were made to take advantage of a favorable but inaccessible rearing area in Peach Tree Creek, or if the fish were to support summer trout fishing there.

Tequepis Canyon Creek

Tequepis Canyon Creek was used historically by spawning steelhead, where 3,660 juveniles (@ 970 fish/kg) were rescued in May 1941 (Shapovalov 1944a). Steelhead access to the creek is now blocked by Bradbury Dam.

Zaca Creek

No records were discovered of historical steelhead use of Zaca Creek, although the stream was planted with juvenile steelhead rescued from the Santa Ynez River. This stream enters the Santa Ynez downstream from Bradbury Dam.

Tecolote Creek Drainage

In a report to the CDFG, Gantt (1973) presented the efforts of a local property owners association to restore the steelhead/rainbow trout resource of Tecolote Creek. Included in the report appendix were photographs of juvenile steelhead/rainbow trout caught by anglers during the 1930's. Historically, steelhead had access to about the lowermost 10 km of the stream, at which point a 6 m natural waterfall blocked upstream passage to the remaining 5 km of stream contained within Los Padres National Forest. The original steelhead/rainbow trout population was apparently decimated when early landowners pumped the creek dry.

As of 1973, two flood control dams, 1.8 m and 3.7 m in height, respectively, created migration barriers downstream from the waterfall. A 23 m long, inclined concrete culvert was also a potential barrier to upstream migration of steelhead under high flow conditions. Otherwise, high quality spawning and rearing habitats existed along most of the stream. Exceptions were a 1.6 km long section of the lower stream which had interrupted surficial flow during the summer dry season, and another lower stream reach that was silted due to construction activities and associated erosion. There was a small lagoon at the creek mouth, and a sandbar often closed the stream during the summer.

No estimates were given regarding the size of historic steelhead runs or natural juvenile population densities. As part of their restoration effort, the group represented by Gantt stocked the creek with 4,200 juvenile steelhead and rainbow trout in mid-April 1973. The fish were purchased from SilverKing Oceanic Farms in Santa Cruz County (see Waddell Creek). Some 3,900 of these fish were the progeny of wild Waddell Creek steelhead, while the remaining 300 were resident rainbow trout. The plant was made about 8 km upstream from the ocean, and most fish were observed migrating toward the ocean within 2 weeks after release. About 700 were rescued from pools in the interrupted flow section of the creek in July 1973, and released downstream. Fish remaining in the stream apparently grew well. No follow-up documentation on this operation was discovered in the CDFG files. The current status of this population is not known, although groundwater extraction and surface diversions at Tecolote Creek after 1973, as well as two drought periods, most likely depleted the stream flow, which would be predicted to negatively impact the steelhead population.

VENTURA COUNTY

Big Sycamore Canyon Creek Drainage

Keegan (1990b) concluded that Big Sycamore Creek had a relatively low potential for steelhead restoration because of a lack of perennial stream flow. Yet, Swift et al. (1993) indicated that steelhead have run in Big Sycamore Canyon in recent years.

Calleguas Creek Drainage

There is no formal record of steelhead inhabitation of this stream. A 1973 U. S. Fish and Wildlife Service (USFWS) document stated that a proposed flood control project would have no impact on fishery resources because the stream was intermittent and did not support fish populations. Keegan (1990b) judged Calleguas Creek as having little potential for steelhead restoration because of degraded habitat from sedimentation, and poor water quality from agricultural runoff. The stream otherwise had a relatively constant stream flow, no known barriers to fish passage, and an extensive and protected (Mugu) lagoon.

Arroyo Conejo Creek is an intermittent tributary to Calleguas Creek which contained no salmonids in a 1948 CDFG survey.

Santa Clara River Drainage, Including Portions in Los Angeles County

The Santa Clara River system once supported a popular winter steelhead sport fishery based on its apparently “large and consistent runs” (Hubbs 1946; see also Kreider 1948). The average annual run in the Santa Clara may have been on the order of about 9,000 adult steelhead (Moore 1980a). Steelhead migrated upstream through the lower Santa Clara River to reach spawning grounds in Santa Paula, Sespe, and Piru creeks, and perhaps in other tributaries and reaches of the upper Santa Clara itself (see below). However, the steelhead stock has declined precipitously since the mid-1950’s, primarily due to an increase in surface water diversion in the lower Santa Clara by the United Water Conservation District. The unscreened diversion near Saticoy has historically blocked upstream migration of adult steelhead, entrained emigrating smolts into percolation basins, or eliminated fish movements to and from the ocean altogether by dewatering the river channel during critical migration periods. The current diversion structure, the Vern Freeman Diversion Dam, was equipped with a fish ladder and intake screens in 1989 to enhance fish passage, and the effectiveness of these features are being evaluated (ENTRIX reports). The steelhead decline has also been attributed, in part, to altered flow patterns and blocked access to historic spawning grounds by upstream dams (see below). Nehlsen et al. (1991) listed the Santa Clara River steelhead stock as having a high risk of extinction.

The following is a chronological rundown of information from CDFG files regarding the presence or stocking of steelhead and rainbow trout in the main stem Santa Clara River. Early CDFG records showed that 5,000 juvenile steelhead were stocked in 1938 in the "River of Doubt" area, and 21,600 were planted in the lagoon in 1944, the latter being steelhead which were rescued from the Santa Ynez River. In a CDFG survey in the River of Doubt area in 1949, no rainbow trout were found despite stocking of hatchery rainbows in 1939 and during 1942–48. The main stem river was apparently not surveyed again for O. mykiss for many years. Bell (1978) found no O. mykiss by seining in the main stem Santa Clara from its mouth, although hatchery escapees of rainbow trout which live in the tailwater of the Fillmore Fish Hatchery were observed. Areta and Willsrud (1980) also captured no O. mykiss by seining the main stem during 8–24 May 1980. In both of these surveys, most of the fishes captured reflected an assemblage of warmwater and euryhaline species.

In a two-year CDFG study of steelhead in the lower Santa Clara River system, Puckett and Villa (1985) reported the steelhead captures presented in Table 3. In addition, 25 other O. mykiss were captured during the study ranging in fork length from 20.3 to 45.7 cm, and in age from 1 to 3 years old. Some of these fish may have been pre-smolted steelhead, and others resident rainbow trout. No emigrating smolts were captured in a fyke net set in the Vern Freeman Diversion canal at Saticoy during both years. Eleven other species of fish were captured during the study, including both emigrating juvenile and spent adult Pacific lampreys (Lampetra tridentata). Most adult lampreys were captured at the Sespe Creek weir although a few were also caught at Saticoy. Puckett and Villa (1985) concluded that the lower Santa Clara River served primarily as a migration corridor for both adult and juvenile steelhead, and was less important as a spawning and rearing area, with the exception of the estuary as potential rearing habitat. Fish movements, both upstream and downstream, were coincident with flow pulses following major storm events.

Piru Creek and Tributaries, including Portions of the Creek System in Los Angeles County

Piru Creek was historically a major steelhead spawning tributary in the Santa Clara River system. Steelhead reportedly ascended Piru Creek occasionally as far as Buck and Snowy creeks (W. A. Evans, CDFG, unpubl. field notes from 1946). However, since 1955, Santa Felicia Dam at Lake Piru has blocked steelhead access to Piru Creek beyond the lowermost 9.7 km of the stream. The dam at Pyramid Reservoir blocks fish migration further upstream as well.

Upstream portions of the stream are currently managed for both catchable and wild rainbow trout fisheries (e.g. Deinstadt et al. 1990). Hatchery rainbow trout stocking records date back to 1931. A mid-1930's CDFG survey mentioned the presence of both rainbow trout and juvenile steelhead. Some 5,000 juvenile steelhead were stocked in 1938, and an anecdote indicated the presence of steelhead spawners in 1944–45 as far upstream as the Gold Hill area.

No trout were seen in the stream below Frenchman's Flat in a 1946 survey, nor in a 1949 survey. Low summer flow and correspondingly high water temperature, and siltation were cited as problems in the suitability of this section of Piru Creek as salmonid habitat. The exception was some large, deep pools which held trout, such as in 1951 when several 31–36 cm rainbows were observed. Bell (1978) found no O. mykiss in Piru Creek below Lake Piru during a seining survey. However, this portion of the stream may have some potential as a steelhead spawning and rearing area since a flow of 5 cfs is guaranteed below Santa Felicia Dam.

Agua Blanca Creek flows into Piru Creek upstream from Lake Piru. A mid-1930's CDFG survey indicated the presence of resident rainbow trout and juvenile steelhead, although the stream was not considered a valuable resource because of low late-summer flows which reduced available salmonid habitat. The stream had been stocked with 20,000 steelhead in each of 1930 and 1931. There was no mention of steelhead in a 1949 survey, and few rainbow trout were seen despite stocking in 1939, 1942, 1944, and 1946.

Buck Creek enters Piru Creek above Pyramid Reservoir. Steelhead apparently entered this stream on occasion (W. A. Evans, CDFG, unpubl. field notes from 1946). It is a small, intermittent tributary stream which has been stocked with hatchery rainbow trout at least as early as 1942.

Lockwood Creek is a headwater tributary to Piru Creek upstream from Pyramid Reservoir with a record of presumably wild rainbow trout being present in 1946. These fish could have also been juvenile steelhead although there is no mention of an historical steelhead run. Seymour Creek is a tributary to Lockwood Creek for which stocking records of rainbow trout date back to 1943–44. Catchable size trout were observed in the stream in 1946 but no young-of-the-year.

Snowy Creek is a tributary to Piru Creek above Pyramid Reservoir which was apparently used by steelhead on occasion (W. A. Evans, CDFG, unpubl. field notes from 1946). Rainbow trout stocking records for this stream date back to 1942.

Santa Paula Creek and Tributaries

Santa Paula Creek is known historically as a major spawning tributary for Santa Clara River steelhead, but there is no formal record on stock size. It is the first major tributary above the Vern Freeman Diversion available to steelhead spawners returning from the Pacific Ocean. About 6.4 km upstream from the confluence with the Santa Clara River, the Santa Paula Diversion greatly reduces or eliminates stream flow below the dam during much of the year. During periods of high runoff, steelhead may gain access to the base of the dam but lack of an operable fishway blocks access to several (≥ 8) kilometers of suitable steelhead spawning habitat upstream from the diversion.

Juvenile steelhead and rainbow trout were noted as being present in the stream in a mid-1930's CDFG survey. Since the 1940's, Santa Paula Creek above the diversion has been managed intensively as a catchable rainbow trout fishery, the activities of which included a stocking and creel census experiment in 1947 (W. A. Evans, CDFG, unpubl. file report). The presence of naturally propagated O. mykiss juveniles was noted during the experiment, and it was indicated that these fish were probably the progeny of both resident rainbow trout and steelhead. The steelhead population was supplemented with 5,000 juveniles in each of 1930 and 1931, 15,000 in 1938, and 3,500 in 1943. Stocking records for rainbow trout date back to 1930.

In March 1987, the USFWS conducted an electrofishing survey in Santa Paula Creek below the diversion site which produced two adult steelhead (37.5 and 38.0 cm FL) and two adult resident rainbow trout (30.0 and 31.0 cm FL). These fish were captured in the pool at the base of the diversion dam, which is where an angler had also caught two adult steelhead. In addition, one 16.0 cm FL steelhead smolt was captured. The pool below the dam was also electrofished in March 1988 and one, possibly two, adult steelhead was seen but not captured. These surveys (B. Harper, USFWS, unpubl. file report) demonstrated that adult steelhead still occurred in Santa Paula Creek but only in low numbers. Decimation of the population to this level was primarily due to operational changes in the Vern Freeman Diversion, the inoperable fishway at the Santa Paula Diversion, and drought. However, with the construction of fish passage facilities at the Vern Freeman Diversion in 1989, the lower Santa Clara River should be functional as a migration corridor for steelhead during periods of sufficient flow, and restoration of the fishway at the Santa Paula Diversion would allow steelhead to take advantage of the spawning and rearing habitat in upper Santa Paula Creek. The CDFG electrofished a 100 m reach immediately below the Santa Paula Diversion Dam during 21–23 January 1992, but no steelhead or rainbow trout were captured or observed (D. McEwan, CDFG, unpubl. memo. of 26 March 1992).

Sisar Canyon Creek is a headwater tributary to Santa Paula Creek. There was no mention of steelhead using the stream historically via Santa Paula Creek although 5,000 steelhead (@ 847/kg) were planted in the stream in 1938. Rainbow trout stocking records date back to 1939, 1943–47, and suitable spawning habitat and young-of-the-year O. mykiss were noted in a 1947 CDFG survey.

Sespe Creek and Tributaries

Sespe Creek is the only major steelhead spawning tributary in the Santa Clara River system which remains unregulated. Access to the Sespe by steelhead spawners returning from the Pacific Ocean has been impeded by the Vern Freeman Diversion in the lower Santa Clara River (see main heading for Santa Clara River Drainage). There is no formal record of the steelhead population size at Sespe Creek.

Much of the stream has been managed for a catchable rainbow trout fishery. Rainbow trout stocking records date back to 1930–31, 1939, and 1942–48. A 40 km section of Sespe Creek was added to the California Wild Trout Program in 1986, a measure which protects the stream's free-flowing status.

The steelhead population was supplemented with 40,000 juveniles in 1930, 38,000 in 1931, and 20,000 in 1938. In 1944, 35,000 juvenile steelhead rescued from the Santa Ynez River were planted in upper Sespe Creek.

Juvenile steelhead and rainbow trout were present during a mid-1930's CDFG survey. Juvenile steelhead were seen in the stream in 1937 although young-of-the-year were reportedly rare. Steelhead were mentioned as being present in 1947. Juvenile rainbow trout or steelhead (10–15 cm), but no young-of-the-year, were present in a 1949 CDFG survey. Steelhead reportedly occurred in the upper Sespe during the winter of 1953–54.

Bell (1978) reported the presence of O. mykiss in the middle and upper Sespe during a seining survey. Puckett and Villa (1985) reported small numbers of both juvenile and adult steelhead captured during 1982–84, and a fair abundance of juvenile and adult Pacific lampreys (see synopsis under the main heading for Santa Clara River Drainage). CDFG fish surveys, conducted during 1983–86 in preparation of the Sespe Creek Wild Trout Management Plan, also demonstrated the presence of wild rainbow trout (possibly including juvenile steelhead as well) and juvenile Pacific lamprey (Sasaki 1986; S. Sasaki, CDFG, unpubl. file report). In both of these cases, the presence of lampreys confirmed that anadromous fishes had access to Sespe Creek via the lower Santa Clara River. No adult or juvenile steelhead were observed or captured during a walk-through survey in April 1988 from Alder Creek to the West Fork Sespe Creek, although several year classes of rainbow trout occurred in abundance including several fish ≥ 35 cm in length. Suitable steelhead spawning and rearing habitat was noted as being abundant, and no barriers to adult migration were seen (M. Moore, Calif. Dept. Trans., unpubl. file report). About 80 km of Sespe Creek remains available to steelhead for spawning and rearing.

Abadi Creek is a headwater tributary to Sespe Creek for which there are stocking records for rainbow trout dating back to 1942 and 1946, but for which there is no record of an historical steelhead run.

In the Sespe tributary, Bear Canyon Creek, juvenile steelhead and rainbow trout were present during a mid-1930's CDFG survey of this seasonal stream. Some 5,000 Mt. Whitney steelhead (@ 847/kg) were stocked in the stream on 30 September 1938. Juvenile O. mykiss were observed in the stream in 1949.

Howard Creek is a seasonal tributary to Sespe Creek and in a mid-1930's CDFG survey, juvenile steelhead and resident rainbow trout were present. Steelhead use of the stream was mentioned in field notes from 1949, and what were listed as 10–15 cm rainbow trout were seen in the same year. Rainbow trout (15–25 cm) were seen in 1951. Howard Creek has been managed primarily as a catchable rainbow trout stream. Stocking records date back to 1940, 1948, 1953, and 1956 for rainbow trout.

Rose Valley Creek is a seasonal tributary to Howard Creek. Although there is no explicit mention of it in CDFG files, steelhead probably used this stream as they did Howard Creek. Stocking records for rainbow trout date back to 1948. Dams have blocked steelhead access to the upper portion of the stream since 1955.

Lion Canyon Creek is a tributary to Sespe Creek. In mid-1930's CDFG stream survey, juvenile steelhead and resident rainbow trout were listed as present. After this time, the stream was managed primarily for a catchable trout fishery with rainbow trout stocking records dating back to 1948. Juvenile O. mykiss were seen in the stream in 1949. Stream flow accelerators were constructed in 1956 to increase pool habitat.

Lords Creek is a tributary to Sespe Creek. Stocking records for fingerling rainbow trout date back to 1945 and 1947, but there was no mention in the CDFG file of steelhead in this stream.

Piedra Blanca Creek is a tributary stream located in the upper Sespe drainage. Stream flow in the Piedra Blanca is intermittent after late spring. Some 5,000 steelhead (@ 847/kg) were stocked into the stream in 1938, but there was no mention in the CDFG file about an historical steelhead run. Rainbow trout stocking records date back to 1942 and 1945, and presumably wild rainbows were observed in the stream in 1949 and 1963.

Pine Canyon Creek is a tributary to Sespe Creek which has been stocked with rainbow trout since at least 1946. No record was discovered of steelhead use of this stream.

Tule Creek is a headwater tributary to Sespe Creek. In a mid-1930's CDFG survey, juvenile steelhead and resident rainbow trout were listed as present. Spawning habitat was noted as being common but the stream was not considered to be of much value because of its seasonal flow. No formal record of steelhead use in this stream was discovered, although it was likely when flow conditions were suitable. Rainbow trout stocking records date back to 1942.

Minor Mainstem Santa Clara River Tributaries

Lost Creek is a Santa Clara River tributary for which there is mention of steelhead. W. A. Evans (CDFG, unpubl. field notes) wrote on 30 April 1947, "Steelhead enter this stream." Bell (1978) found no O. mykiss in Todd Barranca, a tributary to the main stem below Santa Paula Creek, during a seining survey.

The following are other minor tributaries to the main stem Santa Clara River that have been stocked with hatchery rainbow trout, but whose CDFG files lack any mention or record of an historical steelhead run: Hopper Canyon Creek, for which there are rainbow trout stocking records dating back to 1942, 1944, and 1946, and its tributary, Tom Creek, which was planted with fingerling rainbow trout in 1946 and contained 10–15 cm trout in 1947; Pole Creek with stocking records dating back to 1940 and 1941, and as recently as 1984 (both Hopper Canyon and Pole Creek are southward flowing streams which enter the Santa Clara between Sespe and Piru creeks); and Willard Creek where 10 cm rainbow trout were seen in 1949 but no natural propagation was thought to have occurred.

Santa Clara River Headwater Tributaries in Los Angeles County

CDFG records show that hatchery rainbow trout were stocked and present in the upper sections of Bouquet Canyon Creek during the 1940's and 1950's, but there was no mention of an historical steelhead run. The dam creating Bouquet Reservoir would now block steelhead access to the most upstream portion of this stream.

Bell (1978) found no O. mykiss in Castaic Creek below Castaic Lake during a seining survey.

No O. mykiss were seen in Elizabeth Lake Canyon Creek in a 1948 CDFG survey, and there was no mention of an historical steelhead run. Steelhead access to the upper portion of this stream would now be blocked by the dam at Castaic Lake.

Fish Canyon Creek is a tributary to Castaic Creek, above Castaic Lake. This is a highly intermittent stream for which there are hatchery rainbow trout stocking records dating back to

1945 and 1948. There is no mention of an historical steelhead run in the CDFG file. Steelhead access to this stream would now be blocked by the dam at Castaic Lake.

San Francisquito Canyon and Soledad Canyon creeks are two streams for which there are CDFG records for rainbow trout presence and/or stocking dating back to c. 1930, but for which there is no mention of historical steelhead runs. Bell (1978) found no O. mykiss in these streams during a seining survey.

Ventura River Drainage

An excellent account on the history of the Ventura River and its steelhead fishery is provided by Capelli (1974; see also Ventura County Fish and Game Commission 1973). The Ventura River supported “large and consistent runs” of steelhead (Hubbs 1946) up until the late 1940’s when prolonged drought and the construction of Matilija Dam (completed in 1948) on Matilija Creek decimated the population. Apparently, up until this time, steelhead weighing 3 to 4 kg were commonly taken by anglers.

In a 1934 CDFG survey, steelhead and resident rainbow trout were listed as present in the river system. At this time, the river below the mouth of Matilija Creek, where diversions greatly reduced stream flow, was considered to be of no value except during the winter when steelhead used the river as a migration corridor to reach the abundant spawning grounds upstream, especially in Matilija Creek.

The steelhead population was supplemented with 40,000 juveniles in 1930, 34,000 in 1931, and 15,000 in 1938. About 27,200 juvenile steelhead rescued from the Santa Ynez River were planted in the Ventura in 1943, about 20,800 in 1944, and about 45,440 in 1945. Stocking records for rainbow trout date back to 1936 and 1939.

CDFG personnel in 1946 (D. A. Clanton and J. W. Jarvis, CDFG, unpubl. file report of 8 May 1946) estimated that in normal water years, a minimum of 4,000–5,000 adult steelhead spawned in the Ventura River system, about half of them in Matilija Creek. The observation of several hundred yearling steelhead, 10–15 cm in length, in Matilija Creek was also noted in this report.

In March 1947 under drought conditions, an estimated 250–300 adult steelhead were observed in scattered pools from the river mouth to the Foster Park bridge located about 5 miles upstream (W. A. Evans, CDFG, unpubl. file report of 29 March 1947). The steelhead averaged about 61–66 cm in length and 2–3 kg. Several adult steelhead which had become stranded in shallow water and died were also noted. Redds were observed within this reach and it was estimated that 3.2 km of available spawning habitat below the Foster Park bridge would support a maximum of 1,000 steelhead spawners. Under these low flow conditions, upstream movement of adults was impeded by a sandbar at the river mouth and several shallow riffles upstream. The City of Ventura diversion dam above the Foster Park bridge blocked any further upstream movement under low flow conditions. Yearling steelhead juveniles (23–25 cm in length) were seen in the lagoon and in most pools observed.

A few steelhead reportedly entered the river in April 1950. No significant steelhead run was reported again until January and February of 1953 when anglers reported the capture of several individuals ranging in length from about 30–56 cm. Scales from the largest of these, a female, showed that this fish had spent 3 years in fresh water and its last year in the ocean. According to local fishermen, 1955 was the most productive steelhead season on the Ventura River between the late 1940's and 1973 (Ventura County Fish and Game Commission 1973). In February and March 1958, anglers reported the presence of adult steelhead in the Ventura River and two of its tributaries, Coyote Creek and Matilija Creek. However, a CDFG seining survey in August 1958 in the river and tributaries including San Antonio Creek produced no young-of-the-year steelhead. The apparent lack of spawning success was attributed to siltation problems in Coyote Creek and the Ventura River due to construction of Casitas Dam on Coyote Creek, and a general lack of suitable spawning grounds in San Antonio Creek. With completion of Casitas Dam and the Robles Diversion Dam in 1958, the latter of which transfers water from the Ventura River via the Robles-Casitas Canal for storage in Casitas Reservoir, flow conditions favorable for Ventura River steelhead would become even more infrequent. In addition, both of these structures were built without fish passage facilities.

In the early 1970's, an organized effort was begun to promote the restoration of the Ventura River and its steelhead population (Ventura County Fish and Game Commission 1973). The Ventura County Fish and Game Commission's proposal called for an end to pollution and development within the river and its floodplain, and for an increase in both quantity and quality of instream flows to maintain aquatic resources.

Despite rather tenuous conditions for Ventura River steelhead following the construction of dams and diversions and other development during the 1940's and 1950's, local anglers continued to report the capture of small numbers of steelhead nearly annually into the early 1970's (Ventura County Fish and Game Commission 1973), and thereafter based on a variety of accounts in the CDFG file which included information on steelhead and resident rainbow trout captures in the lower Ventura River and San Antonio Creek during March and October 1974, February–April 1975, November–December 1978, and January 1979.

A number of minor studies has been conducted over the years to evaluate water quality in the lower Ventura River as a component of the steelhead and resident rainbow trout habitat, and to determine the status of the steelhead population. In August 1976, the CDFG conducted a bioassay to determine acute impacts of effluent from the Oak View Sanitary District Treatment Plant on rainbow trout. High mortality rates of rainbow trout suggested that water quality was negatively impacted by the effluent for several kilometers downstream from the point of discharge. Trout losses were associated with low dissolved oxygen concentrations, and high ammonia and residual chlorine concentrations.

Based on the results of a field study conducted during the winter of 1976-77 near Casitas Springs (Tippets 1979; Kelley 1982), it was concluded that a small remnant steelhead run existed in the lower Ventura River; the size of the run was limited by the number of smolt-sized fish remaining at the end of the first year; and the run size could only be enhanced if water quality downstream from the Oak View Sanitary District Treatment Plant was improved. Densities of rainbow trout and/or steelhead in five river reaches near Casitas Springs in December 1976 ranged from 249 to 1,262/ha. No adult steelhead were observed in this study, probably due to extremely low freshwater outflow conditions which would block upstream migration. However, run size was estimated to average about 100 adults.

The condition of the river and status of the steelhead population it supports remain essentially the same at present. Nehlsen at al. (1991) listed the Ventura River steelhead stock as being at a high risk of extinction. The 1987–92 drought was probably unfavorable for the steelhead, both in terms of pre-smolt survival in the stream, and in terms of allowing upstream migration of adult spawners returning from the Pacific Ocean. Ventura River tributaries which still produce steelhead are San Antonio Creek, which has about 19 km of habitat, and Coyote Creek below Lake Casitas (Minutes of southern California steelhead meeting, USFWS, Ventura, CA, 22 January 1991). Observations of small numbers of steelhead annually have continued, including the sighting of between 14 and 25 adults on 5 May 1991 in the upper Ventura River Estuary (R. A. Leidy, Wetlands Science and Field Program Manager, EPA, unpubl. memo. of 8 May 1991). The range of estimated total lengths of these fish was 350–625 mm. A short (≈ 15 m) section was electrofished at the SP Milling gravel extraction site during 21–23 January 1992; this brief survey produced no steelhead or resident rainbow trout (D. McEwan, CDFG, unpubl. memo. of 26 March 1992). However, heavy rains in early February 1992 should have created a good opportunity for any remnant of the stock, as well as steelhead from other stocks, to enter the river and spawn. The lagoon remained open to the Pacific Ocean in early June 1992 (M. Capelli, California Coastal Commission, pers. comm.). The most recent documented sighting of steelhead in the Ventura River occurred on 4 January 1993 when two adults, both about 51 cm in length and between 2.3 and 2.7 kg, were observed beneath the Shell Road bridge, which is located about 4.8 km above the estuary (M. Bennett, Oak View, CA, unpubl. letter of 7 January 1993 to M. Cardenas, CDFG). These fish had apparently entered the river following heavy rainfall.

<u>Coyote Creek and Tributaries</u>

A CDFG stream survey from the mid-1930's states that both resident rainbow trout and juvenile steelhead were present in Coyote Creek at that time. The natural stocks of resident rainbows and steelhead had been supplemented with hatchery plants, and were doing well prior to a 1932 fire in the area. Coyote Creek was still identified as a steelhead stream in 1946 (D. A. Clanton and J. W. Jarvis, CDFG, unpubl. file report of 8 May 1946), and it was indicated that juvenile steelhead were rescued in the lower portion of the creek in dry years. In another 1946 report, CDFG personnel estimated that the 1945 steelhead run in the Coyote–Santa Ana Creek system comprised at least 2,500 adults, and that the average was about 3,000 in normal water years, which made steelhead use of these streams comparable to that in Matilija Creek (D. A. Clanton and J. White, CDFG, unpubl. file report). Spawning habitat was listed as being poor downstream from a proposed (El Rancho Cola) dam site, 4.8 km above the confluence with the Ventura River. About 11 km of Coyote Creek and 6.4 km of Santa Ana Creek above Highway 150 comprised the spawning areas in this system. In 1951, the CDFG reported anecdotes which stated that steelhead were seen as far upstream as the El Rancho Cola Dam site, and that the creek was considered as one of the important remaining spawning tributaries for Ventura River steelhead (W. A. Evans, CDFG, unpubl. file report). Casitas Dam, 10.5 km above the confluence and completed in 1958, prevented any further steelhead access to suitable spawning grounds in this stream, as the dam was built without a fish passage facility. Some steelhead production continues to occur in Coyote Creek below Lake Casitas (Minutes of southern California steelhead meeting, USFWS, Ventura, CA, 22 January 1991).

Matilija Creek and Tributaries

According to CDFG personnel in 1946, Matilija Creek comprised one of the most productive spawning grounds for steelhead in the Ventura River system (D. A. Clanton and J. W. Jarvis, CDFG, unpubl. file report of 8 May 1946). Its 19 km of spawning area made up about one-half of the entire stream area of the Matilija-Ventura section. Completion of Matilija Dam in 1948 blocked steelhead access to this important spawning and nursery area. A little used fish passage facility built in 1947 was removed in 1965 in connection with dam modification work.

The Matilija Creek steelhead population was supplemented with 10,000 juveniles (@ 847/kg) in 1938. In 1944, 53,000 juvenile steelhead rescued from the Santa Ynez River were planted into the creek, and 21,120 in 1945. Records for rainbow trout plants date back to 1939 and 1942–48.

North Fork Matilija Creek and Tributaries

CDFG personnel in 1946 estimated that <2% of the Ventura River steelhead run used the north fork for spawning, despite the removal of a waterfall 2 years earlier which added about 5.6 km of available stream (D. A. Clanton and J. W. Jarvis, CDFG, unpubl. file report of 8 May 1946). Low flows and a lack of suitable spawning habitat were cited as causes of low steelhead use. The steelhead population was supplemented with 10,000 juveniles (@ 847/kg) from Mt. Whitney in 1938, 1,000 juveniles rescued from Santa Ana Creek in 1944, and 3,900 of unspecified origin in 1954. Stocking records for catchable rainbow trout date back to 1939 and 1942–47. Stream improvement work, which consisted of the construction of 40 flow constrictors, was carried out in 1955. Wild fingerling and sub-adult rainbow trout, as well as a few recently planted catchables, were sampled and noted to be abundant during an electrofishing survey on 16 April 1985 (S. Sasaki, CDFG, unpubl. memo.). Rainbow trout were also stocked in the Upper North Fork Matilija Creek in 1948, and in Murietta Canyon Creek in 1942.

San Antonio Creek and Tributaries

No formal record was discovered of an historical steelhead run in San Antonio Creek, although 525 rescued juvenile steelhead from Gridley Canyon Creek and 1,500 from Howard Creek in Ventura County were planted in the stream in 1944. Rainbow trout stocking records date back to the period 1943–47. O. mykiss of two size classes (15–20 cm and 30–40 cm) were sampled in the lower creek in a January 1982 CDFG survey (S. Sasaki, CDFG, unpubl. file report). There was no mention of resident rainbow trout or steelhead following surveys in the lower creek in April 1984 and April 1985 (S. Sasaki, CDFG, unpubl. file reports). Yet, San Antonio Creek, which has about 19 km of habitat, reportedly continues to function as a steelhead production area (Minutes of southern California steelhead meeting, USFWS, Ventura, CA, 22 January 1991).

Lion Creek, a tributary to San Antonio Creek, was stocked with hatchery-reared steelhead (5,000 @ 847/kg) and rainbow trout in 1938. No record was discovered of an historical steelhead run in this intermittent stream. Steelhead access would now be blocked by a dam on the stream, about 6–8 km east of Ojai, as mentioned in a 1949 CDFG field note.

Another tributary to San Antonio Creek, Senior Canyon Creek, was stocked with hatchery rainbow trout at least as early as 1945.

LOS ANGELES COUNTY

Arroyo Sequit Drainage

Small runs of steelhead have reportedly occurred in the Arroyo Sequit historically. The CDFG surveyed this stream in mid-November 1979 by use of electrofishing, in a reach extending about 3.2 km upstream from Leo Carillo State Beach campground (D. P. Drake, CDFG, unpubl. memo. of 4 February 1980). At that time, stream flow was intermittent, and water temperature ranged from 14.5° C in shaded areas to 16.0° C in exposed areas. O. mykiss was present ranging in length from 5 to 16.5 cm. The 5–7 cm trout were very abundant (>200 in a 5 m3 pool).

Both juvenile and adult steelhead have been observed in recent years (Keegan 1990b; M. Capelli, Friends of the Ventura River, pers. comm. in 1992). Several trout, about 33–41 cm in length, were observed in an upstream reach in November 1992 (M. Cardenas, CDFG, pers. comm. of 30 March 1993). Based on their size and the fact that the creek mouth was not open to the ocean, these fish were probably steelhead that were trapped in the creek from the previous spawning season. Also, a very high density of young-of-the-year was observed. The watershed appeared to be in good condition. No stocking records were discovered for the stream, so the stock may be relatively unaffected genetically by introduced hatchery trout.

Five trout, 19.5–29.5 cm TL, were captured in the Arroyo Sequit by use of electrofishing on 9 April 1993 (M. Cardenas, CDFG, pers. comm. of 22 April 1993).

Keegan (1990b) concluded that the steelhead run in the Arroyo Sequit Creek would be enhanced with increased stream flow and improvements for fish passage. Apparently, a notch has now been cut into a small check dam which will enhance fish passage to and from upstream areas (M. Capelli, Calif. Coastal Comm., pers. comm.).

Los Angeles River Drainage

No formal record of an historical steelhead run was found for the Los Angeles River, although steelhead apparently did occur here once because Nehlsen et al. (1991) listed this native stock as being extinct. No steelhead were observed in a CDFG survey in the upper Los Angeles River in 1945, nor during an overnight set of a 30 m gill net and three minnow traps by CDFG biologists on 13–14 February 1975 in the river near Western Avenue (V. C. Bleich, CDFG, unpubl. memo. of 14 February 1975). In the latter case, the only capture was three specimens of bigmouth buffalo (Ictiobus cyprinellus), an introduced species to California which is generally not associated with steelhead waters (see Moyle 1976). Steelhead access and use of the Los Angeles River is precluded by the presence of flood control structures throughout much of the lower river course, such as a concrete lining of the river channel and the dam at the Sepulveda Flood Control Basin.

Arroyo Seco Creek and Tributaries

Arroyo Seco Creek, a tributary to the Los Angeles River, is managed for rainbow trout, and is stocked with catchables although wild trout are apparently also present. CDFG records dating back to c. 1941 mention nothing about a previous steelhead run. Tributaries to the Arroyo Seco which also contain rainbow trout are Bear Canyon Creek and Little Bear Creek.

Big Tujunga Creek and Tributaries

Big Tujunga Creek is a major tributary to the Los Angeles River that originates in the San Gabriel Mountains. No historical record or mention of steelhead was discovered for the creek. However, early CDFG records showed that rainbow trout were planted in this stream during 1942–46, as they were in the Big Tujunga tributaries, Mill Creek and Trail Canyon Creek. Upstream migration of steelhead into the Big Tujunga would now be blocked by dams at Hansen Lake and Tujunga Reservoir.

Other Tributaries

In a 1948 survey by the CDFG, O. mykiss was not seen in the Rio Hondo River although a tributary, Mission Creek, was stocked with rainbows during the 1940's, as were other Los Angeles River tributaries such as Murray Creek and Pacoima Canyon Creek. No mention of historical steelhead runs was found for these streams.

Malibu Creek Drainage

At present, Malibu Creek is the southernmost Pacific coast stream known to support a self-propagating run of steelhead. The 30 m tall Rindge Dam was built in 1924, thus blocking upstream migration of steelhead spawners beyond 4.2 km above the stream mouth. Prior to this, 6.5 kg steelhead were reportedly caught as they migrated upstream to the lower reaches of Las Virgenes Creek and Cold Creek to spawn. Since the late 1960's, releases of treated wastewater from the Tapia Water Reclamation Facility have maintained a perennial surface flow in Malibu Creek, even during the May–October dry season (Edmondson 1991). Nehlsen et al. (1991) listed the Malibu Creek steelhead stock as having a high risk of extinction.

CDFG records indicate that there was a relatively large steelhead run in 1947 when the sandbar across the mouth of the stream was opened manually, and steelhead were still noticably present in 1952, although no quantification of the runs was given in either case. No O. mykiss were observed during CDFG surveys in June 1969 and August 1972, in the 10 km from Tapia Park to the Pacific Ocean. However, local residents reportedly caught steelhead below Rindge Dam in 1968, and found two steelhead which had washed ashore during a February 1969 storm. In mid-November 1979, the CDFG electrofished a 183 m reach of the creek, about 2 km upstream from the Pacific Coast Highway (D. P. Drake, CDFG, unpubl. memo. of 4 February 1980). Stream flow was low (0.9–1.5 m3/s), and water temperature varied between 15.0° and 17.5° C. Ten O. mykiss were captured ranging in length from 12.7 to 19.0 cm. Drake also reportedly observed 61 adult steelhead just below Rindge Dam in 1980 (Manwaring and Edmondson 1986). A 1.2 km reach of lower Malibu Creek above Cross Creek Bridge was electrofished on 24 May 1985 (W. E. Tippets, Calif. Dept. Parks Recreation, unpubl. memo. of 29 May 1985). No O. mykiss were seen or captured, although several other fish species were present.

The "Malibu Creek Steelhead Watch" (Manwaring and Edmondson 1986) was conducted on Saturdays from 4 January 1986 to 19 April 1986. A total of about 158 salmonid observations was made, comprised of counts in the following classifications: resident rainbow trout, fish with parr marks, steelhead smolts, and steelhead adults. Among these, 26 observations were of smolts which were seen from 8 March to 5 April 1986. Only one adult steelhead was observed, a spent female captured on 23 March 1986, which measured 69 cm in fork length and weighed 3 kg. The results of this study led to the protective angling regulations currently in effect on Malibu

Creek.

Minor reconnaissance surveys have continued over the years. The following fish were observed in late 1986–early 1987 as reported by Manwaring and Edmondson (1987): (i) A female which measured 50 cm FL and weighed 2.35 kg was captured in a trap near Cross Creek Road on 14 February 1987. A second female measuring about 61 cm was lost from the trap. (ii) Three females measuring about 50 cm and 3 kg were captured on hook-and-line; two below Rindge Dam in late December 1986, and one about 0.8 km below the dam on 28 February 1987. (iii) Three mature O. mykiss males, 33 to 46 cm in length, were caught at Rindge Dam in mid-December 1986. The CDFG and USFWS also electrofished the creek downstream from Rindge Dam in April 1987, and although O. mykiss was apparently captured, the observed fish could not be conclusively identified as steelhead (Fisheries Management Activities in CDFG Region 5 for April 1987). The CDFG electrofished a 100 m reach immediately below Rindge Dam during 21–23 January 1992 (D. McEwan, CDFG, unpubl. memo. of 26 March 1992); several O. mykiss, ranging in length from about 20 to 41 cm, were observed but not captured.

No formal records were discovered of hatchery rainbow trout stocking in Malibu Creek below Rindge Dam, although hatchery rainbows were planted at Malibu Creek State Park in 1984, and evidently these plants are made regularly (Manwaring and Edmondson 1986).

Steelhead habitat availability and use has been evaluated in recent years. Franklin and Dobush (1989) determined that about 504 m2 of spawning habitat was available in Malibu Creek. The highest quality spawning habitat was located in narrow gorge sections between the mouth of Cold Creek (above Rindge Dam) and 2.0 km below Rindge Dam. Nearly 5 km of rearing habitat was available; the highest quality habitat was also located in narrow gorge sections, both below Cold Creek and above Las Virgenes Creek. Thus, about 86% of available spawning habitat, and 65% of rearing habitat was inaccessible to steelhead because of upstream migration barriers which included: (i) Rindge Dam; (ii) a waterfall near the Malibu Canyon Road tunnel; (iii) a concrete apron at the stream gage near Cold Creek; and (iv) a concrete road crossing in Century Ranch State Park. Franklin and Dobush (1989) concluded that spawning and rearing habitat would increase by 590% and 180%, respectively, if fish passage was provided at these sites. Evaluations are currently underway regarding a fish passage facility at

Rindge Dam.

In a companion study to that by Franklin and Dobush (1989), Keegan (1990a) evaluated habitat use of juvenile steelhead in August 1989, from the mouth of Malibu Creek to Rindge Dam. This 4.2 km study area was divided into an upper (0.8 km), middle (1.0 km), and lower (1.2 km) reach. Juvenile steelhead were most abundant (22.4 trout/100 m) in the upper gorge reach, which contained the highest quality spawning and rearing habitat below Rindge Dam, as determined by Franklin and Dobush (1989). Steelhead abundance decreased in the middle (17.5 trout/100 m) and lower (3.5 trout/100 m) reaches where abundances of introduced warmwater species increased. Steelhead use of pools (75% of 145 trout observed) was significantly greater ($X^2 = 7.507$, DF = 2, $p = 0.0234$) than that of runs (25%). Three or more age-classes were present: 0+, which were <10 cm; 1+, 10–18 cm; and 2+ and older, >18 cm. Age 1+ trout were more abundant (44% of 145 trout observed) than 0+ (32%) or ≥ 2+ (24%) trout, although differences in relative abundance among 0+ and 1+ trout may have primarily reflected differences in relative year-class strength. These results demonstrated that (i) successful reproduction had occurred in at least 3 consecutive years, despite low flow conditions; (ii) juvenile steelhead distribution was linked to quality of spawning and rearing habitat; and (iii) summer flow and water temperature conditions were acceptable for juvenile steelhead rearing. It was concluded that steelhead production in the Malibu Creek drainage could be at least tripled if passage was provided for spawning adults over Rindge Dam.

San Gabriel River Drainage

The San Gabriel River system once supported steelhead although little historical information was discovered. In a personal communication to Ewy (1945), Commissioner L. F. Payne of the Los Angeles Branch of the CDFG stated that “steelhead run up the San Gabrial River in December, January and February to spawn”. Steelhead were mentioned in connection with San Jose Creek, a tributary to the lower main stem San Gabriel River. This perennial foothill stream supported steelhead and other native fishes through at least the 1940’s–50’s (L. Pardy, CDFG, unpubl. memo. of 13 December 1991). Nehlsen et al. (1991) listed the native San Gabriel River steelhead stock as extinct.

The San Gabriel River is highly urbanized in its lower reaches in the Los Angeles Basin, and is impounded further upstream. The first major dams form Morris Reservoir followed by San Gabriel Reservoir. The San Gabriel system, especially its tributaries both upstream and downstream from these reservoirs, has been intensively managed for catchable trout fisheries since the 1930–40's, and more recently for wild trout as well (Deinstadt et al. 1990). The CDFG files did contain considerable information on rainbow trout stocking and associated observations dating back to c. 1930. This information is briefly summarized below to indicate the approximate historical distribution of suitable habitat for steelhead/rainbow trout in the system.

Hatchery rainbow trout have been stocked in the main stem San Gabriel River below Morris Reservoir with records dating back to 1930. A main stem tributary, Little Dalton Creek, was stocked with rainbow trout in 1945. Fish Canyon Creek is a tributary to the San Gabriel below Morris Reservoir. Wild rainbow trout were present in the headwaters of this stream during CDFG surveys conducted in 1949, 1956, and 1973. Robert's Canyon Creek is also tributary to the main stem below Morris Reservoir. Rainbow trout were present here in a 1947 survey and into the 1950's. Rainbow trout have occurred in San Dimas Canyon Creek, a main stem tributary, as determined by CDFG surveys. Finally, rainbow trout have also been stocked in Winter Creek, which flows into Big Santa Anita Canyon Creek, a tributary to the San Gabriel River below Morris Reservoir.

The various forks of the San Gabriel River are located upstream from Morris and San Gabriel reservoirs. The CDFG files contained information on rainbow trout presence and stocking dating back to c. 1930, but lacked any record of historical (pre-reservoir) steelhead runs, for the following San Gabriel forks and their tributaries. The East Fork San Gabriel River and two tributaries, Cattle Canyon Creek and Devil's Canyon Creek, have been stocked with rainbow trout since at least 1930. Rainbows were observed in Cattle Canyon Creek during a 1933 CDFG survey. Coldwater Canyon Creek, a tributary to Cattle Canyon Creek, has also been stocked with rainbows since 1930, and rainbows were present during a 1981 CDFG survey (D. Drake, CDFG, unpubl. memo.).

The North Fork San Gabriel River and one of its tributaries, Soldier Creek, have also contained resident rainbow trout since at least 1930. Rainbow trout were present in another tributary, Bichota Creek, during a 1949 CDFG survey, but not in Cedar Creek in a 1948 CDFG survey.

The West Fork San Gabriel River has also contained and been stocked with resident rainbow trout since at least 1930 (see also Deinstadt et al. 1990), as has Bear Creek. A tributary to the latter, the West Fork Bear Creek, also contained resident rainbow trout when surveyed by the CDFG in 1948. Below the falls in Chileno Creek, 5–15 cm rainbow trout have been observed in high abundance by the CDFG. Rainbow trout were present in Devil's Canyon Creek during a 1947 CDFG survey.

The Fish Fork, Iron Fork, Prairie Fork, and South Forks of the San Gabriel River have also contained resident rainbow trout and been planted with hatchery rainbows since at least 1930.

Topanga Creek Drainage

The CDFG electrofished Topanga Creek in mid-November 1979 (D. P. Drake, CDFG, unpubl. memo. of 4 February 1980). Flow was intermittent at this time, and habitat quality was variable. O. mykiss was present, with individuals ranging in length from 10 to 32 cm. Twelve trout measured from 25 to 32 cm, but apparently no young-of-the-year (trout <10 cm) were found.

Keegan (1990b) concluded that Topanga Creek had a relatively high potential for steelhead restoration, based on observed flow, substrate, stream morphology, and riparian conditions. The stream's high-gradient aspect, and a wide beach at the stream mouth, may result in steelhead passage problems under low flow conditions. Adult steelhead were reportedly present in pools upstream of the lagoon in March 1990. Swift et al. (1993) also indicated that steelhead have run in Topanga Creek in recent years.

Various Smaller Coastal Drainages

The CDFG conducted an electrofishing survey of the following smaller coastal drainages (listed from north to south) in Los Angeles County during mid-November 1979, primarily to determine the presence or absence of O. mykiss (D. P. Drake, CDFG, unpubl. memo. of 4 February 1980): Arroyo Sequit, Willow Creek, Unnamed stream 0.8 km south of Willow Creek, San Nichola Canyon, Los Alisos Canyon, Lachusa Canyon, Unnamed stream 0.47 km south of Lachusa Canyon, Encinal Canyon, Steep Hill Canyon, Unnamed stream 0.77 km south of Steep Hill Canyon, Trancas Canyon, Unnamed stream 1.25 km south of Trancas Canyon, Zuma Canyon, Ramirez Canyon, Escondido Canyon, Latigo Canyon, Solstice Canyon, Unnamed stream 1 km south of Solstice Canyon, Puerco Canyon, Marie Canyon, Winter Canyon, Malibu Creek, Unnamed stream 0.92 km south of Malibu Creek, Unnamed stream 2.27 km south of Malibu Creek, Carbon Canyon, Las Flores Canyon, Unnamed stream 0.35 km south of Las Flores Canyon, Piedra Gorda Canyon, Lena Canyon, Tuna Canyon, and Topanga Canyon. Fish were found only in Arroyo Sequit, Malibu, and Topanga creeks (see above). Most of the other drainages were dry.

Zuma Creek was also dry when surveyed by Keegan (1990b). Lack of stream flow was cited as the primary factor which would limit steelhead restoration in this stream. In contrast, Keegan (1990b) concluded that Solstice Creek had steelhead restoration potential because of its adequate base flow, high invertebrate production, suitable substrate, and intact riparian vegetation. Its potential could be increased, however, with pool enhancement and removal of at least two barrier falls.

Swift et al. (1993) indicated that steelhead have run in Mullholland Creek in recent years.

ORANGE COUNTY

San Juan Creek Drainage

Steelhead have historically populated San Juan Creek. Juvenile steelhead were collected from the lower creek by the University of Michigan in the summer of 1939 (Swift et al. 1993). Adult steelhead were reported, and resident rainbow trout and/or juvenile steelhead, were seen in a CDFG survey of the stream in 1946. Hubbs (1946) reported an anecdote regarding angler catches of steelhead in the San Juan Creek estuary. The lowermost 3.2 km of the creek are channelized for flood control, at least one major migration barrier exists in the lower creek (see below), and water is diverted from the stream. Apparently, 1969 was the last year adult steelhead entered the creek (Woelfel 1991), and the population is currently considered extinct. Rainbow trout stocking records for San Juan Creek dated back to 1941.

More recently, plans for a fish passageway (Hinson 1989), at the downstream channel stabilizer at Calmat Lake in lower San Juan Creek, have been approved by the CDFG and implemented (M. Giusti, CDFG, pers. comm. of 13 May 1992). In addition to facilitating fish passage, the baffled culvert structure is also predicted to sustain a base flow in the lower creek during runoff periods, thus enhancing steelhead movements to and from the Pacific Ocean.

The CDFG files contained information on resident rainbow trout in the following tributaries to San Juan Creek, but made no mention of steelhead. Wild rainbow trout were observed in Falls Creek by CDFG personnel. Rainbow trout were present in Hot Springs Canyon Creek during a 1946 CDFG survey, and rainbow trout stocking records dated back to 1943. Wild rainbow trout were seen in Trabuco Creek in 1946, and rainbow trout stocking records dated from 1942 to 1975. Holy Jim Creek, a tributary to Trabuco Creek, is managed as a catchable rainbow trout stream with stocking records dating back to 1949.

Santa Ana River Drainage

CDFG fish sampling surveys in 1951 and 1955 in main stem sections of the Santa Ana River below Prado Dam produced no fish, although warmwater species were thought to be present. In 1957, the CDFG indicated that steelhead had occurred in the Santa Ana River drainage but that they were no longer found there; however, resident rainbow trout were still found in mountain headwaters (R. R. Bell, CDFG, unpubl. file letter of 16 October 1957; see also Swift et al. 1993). Flow in the lower Santa Ana is composed primarily of effluent from water treatment facilities except during the rainy season. Because of this, in addition to restricted releases from Prado Dam, fish occurrence in the lower Santa Ana is limited (C. Marshall, CDFG, unpubl. file letter of 30 August 1984). Nehlsen et al. (1991) listed the native Santa Ana River steelhead stock as extinct.

Among the mountain headwater tributaries mentioned above, Santiago Creek, which originates in the Santa Ana Mountains, is highly managed for a resident rainbow trout fishery. Rainbow trout stocking records for this stream dated back to 1943. In Silverado Canyon Creek, a tributary to Santiago Creek, no fish life was observed during a 1952 CDFG survey. Rainbow trout were observed in Ladd Canyon Creek, a tributary to Silverado Canyon Creek, when surveyed in 1948. Note also that other Santa Ana headwater tributaries in Riverside and San Bernadino counties also support both cultured and wild resident rainbow trout (see e.g. Deinstadt et al. 1990).

SAN DIEGO COUNTY and BAJA CALIFORNIA

Otay River Drainage

Behnke (1992) citing Barnhart (1986) stated that steelhead occurred in the Otay River, which enters the Pacific Ocean just north of the Baja California border. No other reference to historical steelhead use of this river was discovered. The dam at Lower Otay Reservoir currently blocks steelhead access to the upper drainage where spawning and rearing areas presumably would have occurred. If a steelhead population did indeed occur here, it is now extinct. Resident rainbow trout may still persist in perennial headwaters, such as Pine Valley Creek (see Swift et al. 1993), formerly a tributary to the Tijuana River via Cottonwood Creek.

San Diego River Drainage

No formal records of steelhead use were discovered for the San Diego River, although steelhead were reportedly caught there by anglers (Hubbs 1946). The lower river is now channelized for flood control, and steelhead access to historical spawning and rearing areas farther upstream is blocked by the dam that forms El Capitan Reservoir. Nehlsen et al. (1991) listed the native San Diego River steelhead stock as extinct.

Resident rainbow trout may still persist in perennial headwater tributaries to the San Diego River above El Capitan Reservoir, such as Boulder Creek (see Swift et al. 1993). Cedar and King creeks have received CDFG plants of hatchery rainbow trout.

San Dieguito River Drainge

Hubbs (1946) mentioned the report of a potential steelhead catch by an angler in the estuary of the San Dieguito River. No other reference to historical steelhead use of this river was discovered. Dams at San Dieguito Reservoir and Lake Hodges currently block steelhead access to the upper drainage. If a steelhead population did indeed occur here, it is now extinct.

The San Dieguito River below Lake Hodges has received CDFG plants of hatchery rainbow trout, as has Black Canyon Creek, a tributary to Santa Ysabel Creek (thence San Dieguito River).

San Luis Rey River Drainage

No formal records of steelhead use were discovered for the San Luis Rey River, although steelhead were reportedly caught there by anglers (Hubbs 1946). The dam that forms Lake Henshaw reduces the downstream river flow, and blocks steelhead access to the uppermost portion of the drainage. The native San Luis Rey steelhead stock is extinct (Nehlsen et al. 1991), although resident rainbow trout persist in headwater tributaries such as Pala and Pauma creeks (Behnke 1992; Swift et al. 1993).

The main stem San Luis Rey has received hatchery rainbow trout, as have tributaries such as Pauma Creek (CDFG, unpubl. file records; see also Behnke 1992).

San Mateo Creek Drainage

San Mateo Creek was at one time an important steelhead-producing stream in San Diego County to the extent that it supported significant local sport fisheries of both juveniles and adults (e.g. Hubbs 1946). The steelhead-producing capacity of the stream, and thus the population, are now greatly reduced as a result of habitat degradation. The following account on the history of the drainage and its steelhead/rainbow trout fisheries is based on Higgins (1991) and Woelfel (1991), except as otherwise noted.

According to local newspaper articles from March and May of 1916, the steelhead/rainbow trout population in San Mateo Creek was larger and consisted of larger fish than in neighboring Orange County streams. Fishing success was apparently high. Woelfel (1991) assumed that these descriptions included catches of both adult and juvenile steelhead, as well as resident rainbow trout. In May 1939, the Univeristy of Michigan took a sample of juvenile steelhead/rainbow trout from the San Mateo Creek lagoon and about 13 km upstream for its zoological museum collection (see also Swift et al. 1993). The local CDFG warden reported to Hubbs (1946) that steelhead ran consistently in San Mateo Creek, and that he had personally observed the runs for 20 years. Apparently, adults were as large as 9 kg. The steelhead run was under annual observation by the CDFG at that time, and juvenile steelhead rescues were made. For example, on 7 August 1939, the CDFG rescued about 9,800 steelhead from isolated stream sections and planted them in the San Mateo Creek lagoon. The CDFG also observed marines rescue juvenile steelhead from desiccating pools in the Camp Pendelton section of the creek in May 1946. About 3,100 hatchery rainbow trout were planted in the creek by the CDFG during 1945–46.

Woelfel (1991) also interviewed local residents and retired CDFG personnel who provided a variety of anecdotes based on their personal observations made between 1900 and 1950. Descriptions of adult steelhead included visually estimated lengths up to 76 cm and weights up to 7 kg, although most recollections were of fish <50 cm in length. These anecdotes also gave an impression of the variability of stream flow in the creek system, and how juvenile steelhead/rainbow trout survived summer drought conditions in isolated pools; fish losses occurred in some cases when water temperature and dissolved oxygen became too high and low, respectively. Steelhead/rainbow trout, including adult steelhead, were also observed in the San Mateo Creek tributary, Devil Canyon Creek.

The headwaters, from 1.6 km above the Devil Canyon Creek confluence to just below a waterfall in the upper drainage, was surveyed by the CDFG in October 1950. Apparently, there was no continuous flow in the creek from the mouth to the headwaters. Bedrock pools and basins provided habitat in which juvenile steelhead/rainbow trout could survive until winter rains created continuous flow conditions again. Natural reproduction had been successful that year based on the observation of young-of-the-year trout.

There were fewer observations of juvenile steelhead/rainbow trout in San Mateo Creek after 1950. Trout were found from the lagoon to the headwaters at Los Alamos Canyon during a CDFG survey on 1 September 1979. Woelfel (1991) reported anecdotes of juvenile steelhead/rainbow trout presence in pools in the upper drainage during the early 1980's, and of a few steelhead adults around 50 cm long being captured by a local resident in the lower creek in 1986. However, no juvenile steelhead/rainbow trout were found in San Mateo Creek by Woelfel during surveys in 1987 and 1988.

The San Mateo Creek steelhead population was probably reduced periodically by natural episodes of sediment input from within the watershed. However, increased groundwater extraction in the lower creek area since the mid-1940's is responsible, both directly and indirectly, for the inability of steelhead to use the system as they have historically (Lang *et al.* 1998). Riparian vegetation has been lost, stream channel width has increased, and surficial flow has been eliminated during most of the year. Thus, the migration corridor for immigrating adult steelhead and emigrating smolts has become very unreliable. Recent human-caused fires farther upstream resulted in large sediment inputs which filled in pools and the lagoon, both of which are important rearing habitats for juvenile steelhead/rainbow trout. Fish faunal surveys in San Mateo Creek in 1995, 1996, and 1997 failed to detect the presence of steelhead/rainbow trout (Lang *et al.* 1998).

Nehlsen *et al.* (1991) classified the San Mateo Creek steelhead population as extinct. While we agree that conditions in the lower creek system, as described above, have made the creek less conducive to anadromy than it was prior to extensive groundwater pumping and development, the CDFG recognizes the upstream spawning and rearing areas as functional for steelhead production, and that they are still used when sufficient flow allows passage of immigrating adults (CDFG 2000).

San Onofre Creek Drainage

San Onofre Creek is contained within the boundaries of Camp Pendelton. A local CDFG warden reported to Hubbs (1946) that steelhead ran consistently in San Onofre Creek, and that he had personally observed the runs for 20 years. The adult steelhead in San Onofre Creek were apparently smaller on average than those observed in nearby San Mateo Creek, the latter of which is a larger stream (Woelfel 1991). In CDFG field notes from 1950, Fletcher Creek, a tributary to the north fork of San Onofre Creek, was described as a steelhead nursery stream. Rainbow trout and/or juvenile steelhead were present in San Onofre Creek during a CDFG survey on 1 September 1979. Groundwater extraction and associated effects have probably led to the extinction of the San Onofre Creek steelhead population, as at San Mateo Creek (see above).

Santa Margarita River Drainage

Higgins (1991) presented a description of the Santa Margarita River as part of a report on a steelhead recovery assessment. The lowermost portion of Santa Margarita River is contained within the boundaries of Camp Pendelton where much of the river flow is diverted into O'Neill Lake, the water supply for the camp. Impoundment and diversion of river flow begins in the headwaters, however, at Skinner Reservoir and Vail Lake. With groundwater pumping also occurring, there is no surficial flow in the lower river during much of the year. These conditions were exacerbated during the 1987–92 drought.

Few details were discovered regarding the history of the steelhead in the Santa Margarita River. In May 1939, the Univeristy of Michigan took a sample of juvenile steelhead/rainbow trout from the lower river for its zoological museum collection (Swift et al. 1993). Adult steelhead may have ascended the Santa Margarita River into the 1970's (Swift 1975 as cited in Higgins 1991). In 1980, Camp Pendelton increased the height of the diversion at O'Neill Lake, which probably created a complete barrier to immigrating adult steelhead. In addition, water quality in the river decreased during 1970–80 because of pollution inputs from several sources. Erosion has apparently increased in the watershed; as of 1990, much of the river bottom was silted, and the depth and area of the lagoon were reduced. No steelhead spawning habitat exists below the diversion dam at O'Neill Lake, so several successive years of unsuccessful reproduction has apparently led to the extinction of the population (Nehlsen et al. 1991). The CDFG planted hatchery rainbow trout in the Santa Margarita as recently as 1984, but Higgins (1991) saw no evidence of a naturalized population resulting from these plants. De Luz Creek, a tributary to the Santa Margarita, has also received CDFG plants of hatchery rainbow trout.

Santo Domingo River Drainage

The southernmost extension of the historical steelhead range in fresh water is most often given as the Rio Santo Domingo in northern Baja California, Mexico (Moyle 1976; Barnhart 1986; but see Behnke 1992), based on the work of Needham and Gard (1959). Collecting expeditions to the Rio Santo Domingo took place during 1936–38, and as of that time, steelhead still reportedly entered the river from the ocean during periods of high runoff in winter. A more recent publication about the status of, or conditions for, steelhead in the Rio Santo Domingo was not discovered, although resident rainbow trout are still known to be present in the drainage

(Behnke 1992).

Sweetwater River Drainage

Nehlsen et al. (1991) listed the native Sweetwater River steelhead stock as extinct. No other reference to historical steelhead use of this river was discovered. The dam forming Sweetwater Reservoir in the lower river currently blocks steelhead access to the upper drainage where spawning and rearing areas presumably occurred. Stream flow is also impaired farther upstream where Sweetwater Falls Dam creates Loveland Reservoir. A steelhead population would indeed have difficulty persisting in the Sweetwater River under current conditions.

Resident rainbow trout may still persist in perennial headwaters such as Cold Creek (see Swift et al. 1993), a tributary to Green Valley Creek (thence Sweetwater River). Green Valley Creek has received CDFG plants of hatchery rainbow trout. Small juvenile steelhead/rainbow trout were seen in the Sweetwater tributary, Noble Creek, by the CDFG in 1946.

Tijuana River Drainage

A CDFG warden in San Diego County reported to Hubbs (1946) that, in about 1927, he had seen two adult steelhead that were taken by anglers in the lower flowing portion of the Tijuana River. No other reference to the historical presence of steelhead in the main stem Tijuana River was discovered.

However, there was mention of steelhead in the report of a mid-1930's CDFG survey of Cottonwood Creek, a major Tijuana River tributary in San Diego County. Apparently, the native juvenile steelhead/rainbow trout population had been successfully supplemented with CDFG plants of both resident rainbow trout and juvenile steelhead. Steelhead access to most of the Cottonwood Creek drainage was blocked by the dams forming Barrett Lake and Morena Reservoir. The Cottonwood Creek tributary, Kitchen Creek, has also received CDFG plants of hatchery rainbow trout.

It is assumed that the Tijuana River in Mexico has been developed for water resources and otherwise degraded, as seen in San Diego County steelhead streams, thus blocking steelhead access to upstream spawning and rearing areas. Because no reports suggest otherwise, the native steelhead population in the Tijuana River drainage, including Cottonwood Creek and its tributaries, is considered extinct.

OVERALL TRENDS FROM DRAINAGE-BY-DRAINAGE ACCOUNTS

The history and current status of steelhead were reviewed for 91 coastal drainages, comprising 276 streams. The information for 177 main stem streams and primary tributaries was used as a subsample for further analysis (Table 4). The steelhead stock in each stream was conservatively assigned one of four status ratings, based on professional judgement of available information (see footnote 2 in Table 4 for an explanation of each status rating). The availability of reliable data on juvenile sizes, densities, and adult sizes; the known presence of wild resident rainbow trout; and the stocking history of juvenile steelhead and rainbow trout, were determined on a drainage-by-drainage basis. In addition, a combination of documented evidence and professional judgement was conservatively applied to identify each of nine man-related factors that has negatively impacted the steelhead population size and persistence in each stream.

Overall, steelhead are present, without any discernible, significant change in production from historical levels, in 14% of 168 streams for which a status rating could be assigned (Table 5). Assignment of this rating to a population was usually based on the persistence of habitat quality through time. In another 31% of these streams, steelhead are present but production is clearly reduced from historical levels, or likely so, based on the nature of the impacts on the production area. In many cases, these reductions are extreme and include populations which are often referred to as remnants of historical runs, and are near extinction (e.g. Salinas, Carmel, Santa Ynez, Ventura, and Santa Clara rivers and tributaries, and Malibu Creek). Steelhead are extinct in about 24% of the 168 streams where they occurred historically, and the current presence or absence of steelhead is not known in the remaining 32%. The latter category may well include several extinct populations in degraded streams where surveys have not been conducted for many years. Reliable estimates are lacking with which to describe steelhead population declines in actual numbers. However, estimates of historical average annual runs were 20,000 adults for the Santa Ynez River, 4,000–5,000 in the Ventura River, and 9,000 in the Santa Clara River. The current average annual run in these rivers is probably <100 adults each, which indicates that populations in the highly impacted southern counties have declined by at least two orders of magnitude.

Various trends were revealed when the status data were considered on a latitudinal continuum, with counties or county groups serving as data blocks (Table 5). For example, the proportion of streams in each county with steelhead present at or near historical levels varied significantly, and generally decreased from north to south, while the proportion of extinct populations increased over the same gradient (Fig. 17a; Table 5 for X^2 statistics for among-county differences). The proportion of extinct populations ranged from 0 in San Mateo and Santa Cruz counties in the north, to 0.92 in the Orange/San Diego county block in the south. Within the latter block, the Tijuana River steelhead stock was included as extinct, while that in the Santo Domingo River was classified as unknown, due to a lack of information regarding contemporary steelhead use of the stream.

The proportion of reduced populations also varied significantly among counties, and generally decreased from north to south (Fig. 17b). The average (± SD) proportion of remaining but reduced populations was greater in the four northern counties (0.38 ± 0.12) than in the blocks representing the five southern counties and northern Baja California (0.13 ± 0.12). This pattern reflects the fact that, on average, a greater proportion of streams in the southern blocks was already reduced to extinction. The proportion of streams for which status was not known did not vary significantly among county blocks ($p>0.05$; Table 5).

The proportion of streams in each county block planted with exotic strains of hatchery-reared steelhead varied significantly (Table 5), and while there was no clear latitudinal trend (Fig. 17c), the proportion ranged from 0.52 in San Mateo County in the north to <0.10 in the Orange/San Diego county block in the south. Overall, 25% of the 177 streams analyzed received plants of hatchery steelhead. The proportion of streams in each county block planted with hatchery rainbow trout also varied significantly (Table 5), and generally increased from north to south (Fig. 17c). About 35% of streams reviewed were stocked with hatchery rainbow trout, and the frequency reached 80% in the Ventura/Los Angeles county block.

About 35% of 165 steelhead populations reviewed were negatively impacted by water diversions. Frequencies varied significantly among counties, although there was no clear latitudinal trend (Table 5). The proportion of steelhead populations affected by water diversions in San Mateo County (0.37) approached that of some of the southern county blocks (Table 5), because of both domestic and agricultural water demands. The proportion of streams in each county block containing dams that lack functional fishways also varied significantly (Table 5), and generally increased from north to south (Fig. 17d). Overall, 24% of the 165 populations reviewed were negatively impacted by the presence of dams in the drainage. The proportion of streams in each county block, where the quantity and quality of spawning and rearing habitats for steelhead were reduced by siltation, varied significantly (Table 5), and generally decreased from north to south (Fig. 17d). Nearly half the steelhead streams reviewed in each of San Mateo and Santa Cruz counties were affected by silt inputs. Siltation of streams in San Mateo, Santa Cruz, and Monterey counties was most often associated with logging operations, where steelhead production was also negatively impacted by the effects of logjams and slash in the stream channels (Table 5).

The proportion of streams where channelization eliminated steelhead habitat varied significantly among county blocks (Table 5). Even though there was no clear latitudinal pattern, the proportion of channelized streams in the Orange/San Diego county block (0.27) was higher than in all county blocks to the north (≤ 0.08).

The proportion of streams where steelhead populations have been negatively impacted by barriers and pollution did not vary significantly among county blocks, and no latitudinal trends were apparent (Table 5). Overall, 18% of 165 streams reviewed had barriers, and 10% were affected by pollution. Barriers included impassable culverts and bridge support structures, for example, but not logjams and dams, the frequencies of which were analyzed separately. Natural barriers, such as bedrock falls, were also not included because they are natural components of a river system that influence the distribution and abundance of steelhead and resident rainbow trout.

Finally, the proportion of spawning and rearing tributaries to which steelhead access has been blocked by main stem impediments (e.g. dams, major diversions) varied significantly among county blocks (Table 5). The overall proportion among 165 streams reviewed was 0.21. No latitudinal pattern was evident; instead, the results reflect the fact that steelhead are no longer able to reach important upstream reproduction and nursery areas in most of the major coastal river drainages south of San Francisco Bay (e.g. the Salinas, Carmel, Santa Maria, Santa Ynez, Ventura, Santa Clara, Los Angeles, San Gabriel, Santa Ana, San Diego, and Tijuana river drainages, among others).

DISCUSSION

This review has clearly demonstrated the precipitous decline of California steelhead in coastal drainages south of San Francisco Bay. Assuming the 168 main stem streams and primary tributaries used in the status analysis were a representative subsample, steelhead populations are either extirpated or reduced in size from historical levels in at least half the steelhead streams in the study area. The status of nearly another third of the populations reviewed could not be determined based on available information; some of these populations are also probably reduced or extirpated. Only 14% of the streams reviewed still had steelhead present where there was no discernible, significant change from historical production levels.

Nearly all historical steelhead populations are extirpated in Orange and San Diego counties. The effect of these extinctions is that within a few decades, the known southern limit of steelhead in North American fresh waters has shifted northward from the Santo Domingo River in northern Baja California (Needham and Gard 1959), to Malibu Creek in Los Angeles County. Local extinctions continue to creep northward (Fig. 17a) and are concomitant with urban expansion and an increasing human demand on freshwater resources. Indeed, among the developmental activities negatively affecting steelhead populations, water diversions were proportionately most common overall (0.35), and especially common in the San Luis Obispo (0.44), Ventura/Los Angeles (0.40), and Orange/San Diego (1.00) county blocks (Table 5). Dams were often present in conjunction with water diversion, especially in larger drainages, and were third most common proportionately among the factors affecting steelhead abundance and persistence (Table 5).

The 1976–77 and 1987–92 droughts certainly exacerbated unfavorable conditions for steelhead in streams where water resource development had already impacted the populations. Steelhead in the study area, though, have evolved with periodic drought cycles as part of long-term climatological conditions. However, the relatively recent and drastic increase in human use of water is rendering an increasing proportion of these steelhead production systems dysfunctional, or nearly so, and populations are disappearing.

As documented in the drainage-by-drainage status accounts, the Santa Ynez River drainage is among these dysfunctional systems. Santa Ynez steelhead runs were on the order of 13,000–25,000 adults prior to the construction of Bradbury Dam in 1953, and the beginning of an intensive water management program in the lower river area. The steelhead population declined to a remnant by the late 1980's, which prompted the California Sportfishing Protection Alliance (CSPA) to petition the California Fish and Game Commission to list the Santa Ynez River steelhead as an endangered species under the California Endangered Species Act (R. J. Baiocchi, CSPA, petition of 25 August 1989). The basic tenet of the petition was that the Santa Ynez steelhead was a unique subspecies or strain of migratory rainbow trout because of the maximum size of 9 kg attained by adults caught in the past, and because of the estimated magnitude of the historical runs.

Following the recommendation of its staff (E. Gerstung, CDFG, unpubl. memo. of 22 November 1989), the CDFG in its official response to the CSPA (P. Bontadelli, CDFG, unpubl. memo. of 7 December 1989) rejected the petition based on the conclusion that these characteristics were not uncommon in California winter steelhead populations. The CDFG recommended instead that it would be more appropriate to reformulate the petition to encompass all southern California steelhead populations because of similar life histories (presumed short freshwater residence as juveniles, protracted ocean residence during droughts), and similar problems with regard to availability and quality of freshwater habitat.

This approach was pursued by Moyle and Yoshiyama (1992) in their synopsis of supporting information for listing of "southern steelhead" as endangered or threatened. Southern steelhead were roughly defined as being ecologically and physiologically adapted to the seasonally warm and intermittent coastal streams from San Luis Obispo County and southward. The authors indicated that the line of demarcation was vague, due to a lack of detailed knowledge regarding southern steelhead life history, physiology, and genetics, and that the distribution of southern steelhead could reach as far north to include Monterey County steelhead as well.

Let us now take an even broader spatial scale and consider the potential uniqueness of steelhead for the entire coastal region south of San Francisco Bay. These populations are unique from a zoogeographic standpoint simply by virtue of the fact that they represent the southernmost portion of the native steelhead range in North America, which extends as far north as the north side of the Alaska Peninsula (Burgner et al. 1992). Coincident with this aspect is that these populations inhabit a unique continuum of stream environments, one completely different from any found north of San Francisco Bay. This continuum consists of a gradation of streams originating in the relatively moist and cool coniferous forest-dominated drainages in San Mateo and Santa Cruz counties, to streams southward that are dominated by arid chaparral and grassland landscapes not usually associated with steelhead.

This collection of populations is also unique from at least one key life history aspect in that smolting and emigration to the ocean at age 1 becomes the norm, at least in main stem population segments (c.f. Life History Analysis). Smolting at this relatively early age for steelhead is most likely a consequence of one or both of the following. First, because smolting is a function of an individual salmonid's physiological performance (Thorpe 1986), which we measure as growth and express as size/age, steelhead in central and southern California coastal drainages are able to develop as smolts by the end of their first year because of overall higher average annual water temperature and a longer growing season with regard to photoperiod. Both temperature and photoperiod are basic determinants of growth rates in fishes.

Second, smolting at age 1 may have also been selected for as an advantageous life history characteristic, especially in smaller streams with unreliable stream flow during late summer and fall; with emigration to the ocean, the instream mortality risk due to stream desiccation is eliminated (Borgstrø m and Heggenes 1988; Titus and Mosegaard 1989, 1992). The trade-off is, of course, that ocean survival of age 1 smolts may be lower than that of the larger age 2 smolts, presumably because of the greater predation risk experienced by smaller individuals. When present, some fish also spend their second year in the lagoon or estuary of a stream system before smolting and emigrating to the ocean (e.g. Jones & Stokes Associates 1986; Smith 1990).

The significance of small, intermittent tributaries as steelhead production areas has not always been appreciated. The CDFG conducted stream surveys to locate planting sites during the expansion of their catchable trout management program, beginning in the 1930's but especially after World War II. In the stream survey files for Santa Barbara County and southward, it was often noted that small headwater streams lacking perennial flow were unsuitable habitat for catchable trout. Because these small streams had no apparent fishery value, applications to develop their water resources were seldom protested. When dams were proposed, the loss of wild resident rainbow trout and steelhead was mitigated by the opportunity to develop warmwater reservoir fisheries, which was in a major experimental phase during the post-war period (Jenkins 1970). The use and importance of seasonally intermittent streams for spawning of both steelhead (Everest 1973) and resident rainbow trout (Erman and Hawthorne 1976) were not documented until much later. It is known now that, in dry years, newly-emerged fry escape mortality by moving downstream to permanent water in the main stem, but remain in the tributary in wet years when stream flow persists (Everest 1971; Erman and Leidy 1975).

Considering the hydrological variability in steelhead streams south of San Francisco Bay, some populations probably experience major reductions approaching extinction during drought cycles, and then rebuild again by an influx of founder individuals from other populations during normal and wet years. For example, only 14 adult steelhead returned to the Carmel River fish ladder during the 1991-92 season following 6 successive years of extreme drought. But hundreds of adults returned during the very wet 1992-93 season. It is likely that this run included individuals spawned in other drainages, as an abundance of adult spawners would not be expected after several years of poor recruitment.

The pervasive view on the spawning migrations of anadromous salmonids is that a very high proportion of adults home strictly to their natal stream to spawn (e.g. Taft and Shapovalov 1938). Although this strategy may work well in regions where streams are typically stable, it may not be selectively advantageous where access to the natal spawning and rearing area may be highly unpredictable because of stochastic meteorological conditions. The degree of homing in steelhead south of Santa Cruz County has not been explicitly studied. However, it has been suggested, for example, that adult steelhead in southern California may tend to be larger and older on average than elsewhere in California because frequent droughts may prevent them from entering their natal stream during their first year(s) of maturity (E. Gerstung, CDFG, unpubl. memo. of 22 November 1989). Basic research questions on this problem should ask whether it is more advantageous under such conditions to simply delay spawning and resorb the gonads if unable to enter the natal stream (winter steelhead are ripe upon entry to fresh water), or to simply enter any accessible stream in the region and proceed with spawning. It can be argued that the risk of mortality and not passing on one's genes is greater if the energetic investment in gonad production is made in one or more successive years but spawning is not completed, than if entry is made into an, albeit, "unfamiliar" and therefore riskier reproduction area, but spawning is completed and progeny may be produced which can carry one's genes to the next generation.

A body of concepts and models has been consolidated recently under the rubric of metapopulation dynamics (Gilpin and Hanski 1991) that provides a framework within which this general problem may be approached. Broadly put, a metapopulation is a set of local populations that interact via individuals moving among populations (Hanski and Gilpin 1991). The metapopulation concept is related to MacArthur and Wilson's (1967) theory of island biogeography in that there are two essential elements in common: extinction and (re-)colonization. Island biogeography represents one extreme on a continuum where the mainland population (the source of colonists) is immune to extinction while the surrounding island populations are not. Theoretically, all populations in the set comprising the metapopulation have a risk of extinction which is dependent on the size of the habitat patch and thus the population. Most real world metapopulations appear to fall between these opposite ends of the continuum as based on empirical evidence (Harrison 1991).

Under natural conditions, where the effect of periodic drought on population persistence is not exacerbated by human extraction of water, steelhead/rainbow trout populations probably seldom go completely extinct, even in southern California. Except in some very small first-order coastal streams lacking perennial refugia, at least a fraction of the resident component of the population, as well as juvenile steelhead which fail to escape to the ocean, probably persist through drought cycles, as evidenced in the drainage-by-drainage material reviewed herein. What leads observers to the conclusion that a population is truly extinct is the absence of adult steelhead spawners in the stream because of blocked entry. The presence of resident rainbow trout had been identified in about 36% of the populations listed in Table 4; their actual frequncy is probably much higher but simply not explored and documented.

A related aspect with regard to persistence, especially in small streams with small populations, is the significance of life history variation (see Life History Analysis). This characteristic has probably been the saving grace for steelhead, considering the highly unpredictable conditions under which they exist throughout much of the study area. Representatives of each generation may potentially be present in both fresh water and the ocean, which reduces the risk of extinction from direct mortality. Resistance to extinction from reduced heterozygosity and associated effects of inbreeding in small populations is enhanced by the presence of overlapping generations in the spawning population (Saunders and Schom 1985). This is facilitated by (i) the presence of mature male parr or a full resident-population component in fresh water; (ii) variation in steelhead age at emigration; (iii) variation in steelhead age at maturity; and (iv) repeat spawning among steelhead (see Titus and Mosegaard 1992 for a related example). The interchange of individuals among populations in a metapopulation would also help maintain genetic diversity.

RESEARCH AND MANAGEMENT RECOMMENDATIONS

In conclusion, the following recommendations are made to assist in the development of future research and management programs.

Relative to several other salmonid species, little is documented about steelhead mating systems. The composition of spawning aggregations should be studied in the field, and the proportionate gametic contributions of all male forms, including mature male parr, should be determined. The frequencies of mature female parr should also be investigated, and the relationship of these individuals to the migratory component of the population determined.

The genetic and/or environmental determinants of individual life histories should be explored by following individually marked fish through time and space. One specific research question is whether mature parr remain in fresh water after spawning and functionally assume a resident life-style, or if they eventually smolt and leave the stream to continue growth in the ocean, and return to spawn again as large migrant spawners. Life history information at the population level is also lacking over much of the study area; for example, mean smolt and sea ages, and the relative survival rates of different smolt-age groups to first spawning.

Management activities should be directed toward the conservation of both the resident and migratory forms of the species within a stream or drainage. For example, minimum stream flows should maintain growth conditions that allow for the development of the average natural frequencies of all physiologically-based life history characteristics, such as smolting and parr maturation. As discussed earlier, life history variation appears to be important for steelhead persistence in a number of ways.

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Table 1 (in prep). Summary of adult steelhead angler catch statistics from early 1970's creel census' on the San Lorenzo River, Santa Cruz County. Source: CDFG data.

Table 2. Estimates of adult steelhead run size in Arroyo Grande Creek, San Luis Obispo County, based on interviews of local landowners and anglers (from R. N. Hinton, CDFG, unpubl. file report of 1 March 1961).

Winter season(s)	Estimated no. of adult steelhead in spawning run
1939-40 and earlier	500–5,000 annually
1940-41	3,000–5,000
1941-42 through 1948-49	<200 annually
1949-50	200–300
1950-51 through 1953-54	<100 annually
1954-55	100–200
1955-56	300–500
1956-57	<100
1957-58	100–300
1958-59	<100
1959-60	<100
1960 through 1 March 1961	0

Table 3. Summary of steelhead captured in lower Santa Clara River system by Puckett and Villa (1985).

Capture date	Adult	Smolt	Capture method & site
2 Apr 1983	Male, 61.5 cm FL, 2.0 kg, age 1/2*	—	Hook & line, Sespe Creek
4 Apr 1983	—	Potential steelhead, 15 cm FL	Fyke net in Sespe Creek
26 Apr 1983	Spent female, 70.4 cm FL, 2.95 kg, age 1/2	—	Weir in Sespe Creek
mid-Mar 1984	c. 61 cm	—	Hook & line, Sespe Creek
17 Mar 1984	Dead female, 45.0 cm FL, age 2/1	—	Weir in Sespe Creek
21 Mar 1984	—	15.7 cm FL	Fyke net in Sespe Creek
23 Mar 1984	—	17.8 cm FL	Fyke net in Sespe Creek

* Age A/B: A = no. years in freshwater, B = no. years in ocean.

Fig. 1. The study area, comprised of coastal California south of San Francisco Bay, and northern Baja California, Mexico.

Fig. 2. Variation in (a) mean smolt age (·) and mean sea age at maturity (_), and (b) mean adult length, as functions of increasing latitude among steelhead populations from central California (Waddell Creek) to southern British Columbia. Data are from Withler (1966) where mean ages at smolting and maturity are calculated as in Fahy (1978).

Fig. 3. Mean (± SD) monthly upstream (a) and downstream (b) migration of adult spawners at Waddell Creek, Santa Cruz County, 1933-34 through 1941-42. Data are from Shapovalov and Taft (1954).

Fig. 4. Total age frequency distributions of male and female steelhead spawners at Waddell Creek, Santa Cruz County. Data are from Shapovalov and Taft (1954).

Fig. 5. Frequency distributions of (a) ages of male and female steelhead smolts, and (b) sea ages of male and female steelhead at first spawning, at Waddell Creek, Santa Cruz County. Data are from Shapovalov and Taft (1954).

Fig. 6 (in prep). Mean (± SD) monthly downstream (a) and upstream (b) migration of juvenile steelhead at Waddell Creek, Santa Cruz County, 1933-34 through 1941-42. Data are from Shapovalov and Taft (1954).

Fig. 7. Negative density-dependent relationship between stock (estimated number of eggs produced) and recruits (estimated number of first-time spawners) for steelhead at Waddell Creek, Santa Cruz County. Data are from Shapovalov and Taft (1954).

Fig. 8. Positive relationship between the age of steelhead at initial downstream migration at Waddell Creek, Santa Cruz County, and the proportion in each age-class surviving to return from the ocean as first-time spawners. Data are from Shapovalov and Taft (1954).

Fig. 9 (in prep). Juvenile steelhead population structure at Gazos Creek, San Mateo County. Source: unpublished CDFG file data.

Fig. 10 (in prep). Juvenile steelhead population structure at San Pedro Creek, San Mateo County, the northernmost steelhead population in the study area. Source: unpublished CDFG file data.

Fig. 11 (in prep). Length-frequencies of angler-caught adult steelhead at the San Lorenzo River, Santa Cruz County. Source: CDFG data.

Fig. 12 (in prep). Steelhead spawning run at Scott Creek, Santa Cruz County, 1908–1940. Source: CDFG egg-taking data.

Fig. 13. Total estimated number of adult migrant spawners at Waddell Creek, Santa Cruz County, 1933-34 through 1941-42. Data are from Table 35 in Shapovalov and Taft (1954).

Fig. 14. Structure of (a) the resident rainbow trout population in the upper portion of the Big Sur River tributary, Juan Higuera Creek; (b) the mixed resident rainbow trout/juvenile steelhead population in lower Juan Higuera Creek; (c) the predominantly juvenile steelhead population in the mainstem Big Sur River, Monterey County, in November 1992. Data are from Titus (unpubl. data).

Fig 15 (in prep). Length-frequency distribution of adult steelhead returning to the Carmel River, Monterey County. Source: CDFG data.

Fig 16. Juvenile steelhead population structure in (a) the perennial creek portion and (b) the lagoon of the Arroyo de la Cruz, San Luis Obispo County, during late summer–fall 1981. Based on unpublished CDFG data.

Fig. 17. The proportion of streams in each county block with (a) steelhead present with no discernible change in production from historical levels (·), and steelhead extinct (_); (b) steelhead

present but at reduced levels; (c) hatchery steelhead planted (·), and hatchery rainbow trout planted (_); and (d) dams (·) and siltation (_) affecting steelhead abundance and distribution.