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CURRENT STATUS OF SOUTHERN STEELHEAD/ RAINBOW TROUT IN SAN MATEO CREEK, CALIFORNIA

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The discovery of a small population (<70 individuals) of southern steelhead trout, *Oncorhynchus mykiss* in San Mateo Creek (SMC) and Devil Canyon Creek (DCC), a small tributary to SMC, in San Diego County, California in the spring 1999 represents the first multiple record account of trout in the creek in over 50 years. From August 1999 to December 2003, the California Department of Fish and Game (Department) conducted a total of 45 surveys along both creeks to monitor the status of the trout. Data on trout abundance, age analysis, water temperature, spawning behavior and genetic analysis were collected during the surveys. We observed that trout numbers on SMC began to decline shortly after the surveys began in 1999, and that the last trout was observed in August 2000. Juvenile trout were discovered on DCC in May and July 2000 and maturing fish were continually monitored on DCC through 2001 and 2002, with no new recruitment recorded during that time. A single adult holdover trout (DC2) was observed on the confluence as recently as December of 2003. Water temperature data collected on both creeks suggested that annual temperature profiles are more stable and suitable for southern steelhead survival in DCC than in SMC. We assume that this difference enhances trout survival in DCC. Spawning behavior was described on two different occasions on DCC, indicating the potential for resident reproduction. However, no actual spawning was ever recorded on SMC or DCC. Genetic and age analysis on specimens collected in 1999 and 2000 established that at least two pairs of anadromous steelhead entered the drainage in 1997 to spawn and that successful, resident reproduction (F1) occurred in DCC in 2000. Otolith age analysis of a single adult individual (DC1) collected in DCC in 2002 confirmed that maturing, second generation trout (F2) occupied that tributary, albeit in extremely small numbers (< 8 individuals). The numbers on DCC continued to drop until only a single adult trout (337 mm TL) was observed during a survey in December 2003. The higher water temperature and presence of non-native fish species likely contributed to the extirpation of adult trout on SMC in 2000. Conversely, the lack of non-native fish and the more stable water temperature in DCC enabled trout to survive on the tributary until the low water conditions impacted their numbers considerably.

INTRODUCTION

Southern steelhead trout historically occurred from Santo Domingo River in northern Baja California to Malibu Creek, California. Historic records also show that in

the early 1900's, San Mateo Creek may have been one of the most important southern steelhead spawning streams on the south coast (USFWS Report 1998[1]). At their peak, the San Mateo Creek steelhead runs were recorded as large and consistent, with the fish documented to attain a larger size than their relatives to the north. Despite the high numbers recorded in the early part of the Century, trout sightings dropped off in the 1940's and the 1950's and consistent trout abundance has not been present within San Mateo Creek or south of Malibu Creek in the last 50 years (USFWS Report 1995[2]). The last recorded sighting of multiple age-classes of southern steelhead on SMC was in 1950 during a Department stream survey. Since then, only anecdotal observations of trout on the creek have been recorded.

Since that time, inconsistent water availability due to an increase in ground water pumping beginning in the late 1950's and the negative influence of nonnative plants, (*Tamarisk* sp.), began to contribute to the alteration of stream habitat within SMC. Critical stream structures for trout reproduction, such as riffles and gravel beds now sit dry and useless due to altered flow dynamics. Inconsistent water levels also reduces the amount of time SMC remains open to the ocean, further limiting upstream migration of southern steelhead, as well as downstream emigration of resident fish.

Further effecting trout presence was the introduction of nonnative terrestrial and aquatic species (largemouth bass, *Micropterus salmoides*, green sunfish, *Lepomis cyanellus*, bluegill, *Lepomis macrochirus*, black bullhead, *Ameiurus melas*, mosquito fish, *Gambusia affinis*, swamp crayfish, *Procambarus clarkii*, and bullfrog, *Rana catesbeiana*) into San Mateo Creek. These species have been documented to increase competitive and predatory impacts on seasonal salmonid runs, as well as resident trout populations. Steelhead that were fortunate enough to find periodic available water to migrate upstream, often found their spawning grounds infested with nonnative fish species, heavily impacting reproductive success.

Due to these two factors (altered habitat and the introduction of aquatic, nonnative species), it was generally concluded that southern steelhead trout were extinct south of Malibu Creek, California.

The decline in quality, southern steelhead habitat and the absence of steelhead trout in southern California, prompted the National Marine Fisheries Service (NMFS) to list southern California's Evolutionarily Significant Unit (ESU) for anadromous steelhead as an endangered species in 1997 (Federal Registry 62 FR 43937). This listing, however, designated the current southern ESU boundary as Malibu Creek, California and protection was excluded for all potential waterways south of that boundary.

The discovery of southern steelhead/rainbow trout, *Oncorhynchus mykiss*, on SMC and Devil Canyon Creek (DCC) a small tributary to SMC, in San Diego County,

[1]U.S. Fish and Wildlife Service. 1998, Southern Steelhead Oncorhynchus mykiss Habitat Suitability survey of the Santa Margarita River, San Mateo and San Onofre Creeks on Marine Corps Base, Camp Pendleton. Coastal California Fish and Wildlife Office, Arcata, CA. Prepared for Assistant Chief of Staff, Environmental Security.

[2]U.S. Fish and Wildlife Service. 1995, Santa Margarita River and San Mateo Creek Salmonid Study. Progress Report prepared for Camp Pendleton Marine Corps. Base, January-September 1995. Coastal California Fish and Wildlife Office. Arcata, CA.

California during spring 1999, established a need to extend the newly designated ESU boundary. The population size, though never accurately determined, was extremely small (<70 individuals), which limited the number of samples that could be collected (10 adults in 1999 and 5 juveniles in 2000) for analysis. Despite this, successful analysis was conducted on genetics, age, and otolith microchemistry for the SMC population.

Genetic analysis conducted on a fin-clip collected from a single adult in 1999 (SM412199F) revealed that the specimen carried a unique haplotype that is most commonly found in southern California steelhead and has never been seen in any hatchery population of steelhead or rainbow trout (Nielsen et al. 1994). This information confirmed that the trout occupying SMC were wild fish. Otolith microchemistry performed on a single specimen collected from SMC in 1999 confirmed that the examined fish was the progeny of an anadromous female steelhead (CDFG steelhead report, 2000[3]; Rieman et al.1994) and that the cohorts occupying SMC were the offspring of ocean-going adults. Age analysis of a single otolith indicated that the fish were 2+ years of age when collected in 1999. Back calculating from the age at discovery, it was confirmed that the anadromous steelhead adults most likely entered the San Mateo drainage to spawn during a high water period in early spring 1997.

This information and additional monitoring observations were combined and submitted as an original report to the National Marine Fisheries Service (NMFS) by the California Department of Fish and Game (Department) in February 2000. It was hoped that this recent information on the newly discovered population of southern steelhead trout in SMC would require NMFS to re-evaluate the recently designated geographic boundary of the evolutionary significant unit (ESU) for this species. Due to the rarity of this occurrence, the Department also initiated a monitoring program to track the status of the steelhead/rainbow trout population on SMC immediately following the 1999 discovery. Continued monitoring began in August of 1999 and over the following 4-year period, additional information on genetics, age at growth, trout behavior, temperature conditions and population status was collected.

The objectives of this study are to: 1) describe the monitoring conducted and data gathered on the drainage since the re-discovery in 1999; and 2) to illustrate the factors affecting the survival and current status of the southern steelhead/rainbow trout in San Mateo and Devil Canyon creeks.

METHODS AND MATERIALS

A total of 45 stream surveys were conducted by the Department from August 1999 to December 2003. Surveys were conducted by Department personnel and volunteers, and started at the United States Geological Survey (USGS No. 11046300) gauging station on SMC to the Devil Canyon Creek confluence and included the entire Devil Canyon Creek drainage. Three large pools located on SMC, Pools 1, 2 and 3, (Fig. 1)

[3]California Department of Fish and Game (CDFG) 2000. Steelhead rainbow trout in San Mateo Creek, San Diego County, California. Report submitted to the National Marine Fisheries Services. 22 pp.

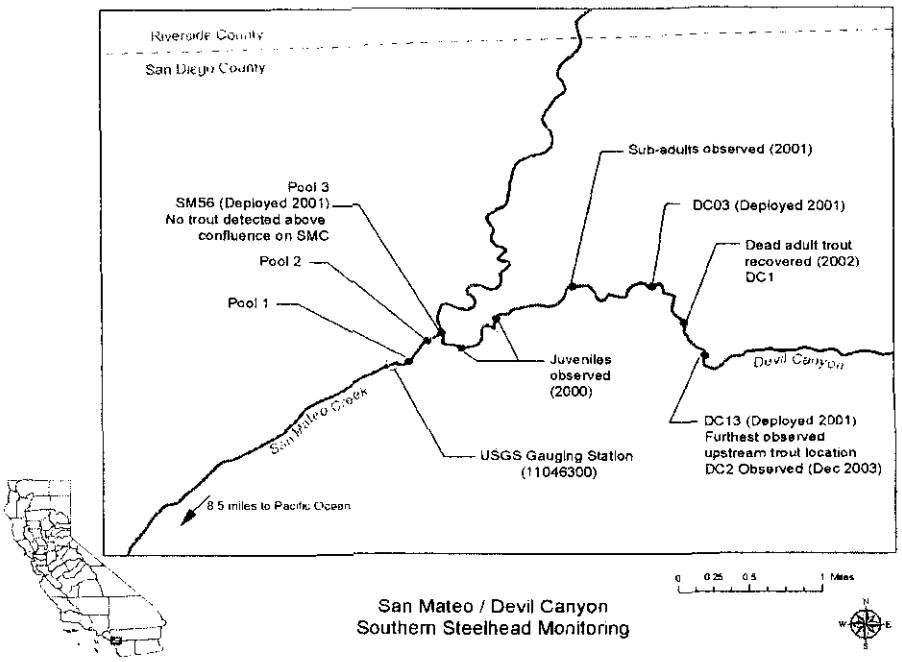

Figure 1. Map of survey area showing Pool 1, 2 and 3, temperature probe deployment areas, gauging station, and trout locations.

remained isolated for much of the survey period and was examined during each department survey. An additional 3.4 km of San Mateo Creek above the Devil Canyon Creek confluence were infrequently surveyed.

Survey techniques used were drainage mapping, back pack electro-shocking (Smith-Root 12-B), snorkeling, seining, and passive observation.

Drainage mapping involved hiking the DCC drainage to evaluate habitat and to identify individual trout locations. Data was collected on fish barriers, quality of habitat, and fish presence.

Electro-shocking surveys were conducted for exotic species removal and juvenile trout detection in areas where seining was not possible. Data were collected on species observed, water temperature, and effort (seconds) for each electro-shocking survey. The use of the back pack electro-shocker was limited during the survey period to reduce the possibility of injury to resident trout.

Presence/absence snorkel surveys were conducted in pooled areas where effective seining was difficult and where electro-shocking was ineffective. Snorkel surveys were conducted by a single observer using an underwater dive light. Each survey covered the entire pool and all fish species were recorded. When trout were observed, size (total length) was estimated and over all health assessed.

Two different types of seines were used to sample the drainage: a 3-m beach seine and a 12-m pole seine. Seines were used for exotic species removal and to determine if trout were present.

Passive presence/absence shore observations were conducted on several occasions to record trout sightings and abundance. Data were collected on the length of observation and the species encountered. All trout sightings obtained by passive shore observations were visually confirmed with follow-up snorkel surveys the same day.

A total of 15 fin-clips were collected for genetic purposes from March 1999 to June 2000 (Table 1). Each sample comprised of a 1-cm square piece of fin tissue excised from the upper lobe of the caudal fin and placed on filter paper to dry. All dried samples were placed in small envelopes for analysis. A single genetic sample was sent for mitochondrial DNA (mtDNA) analysis in 1999 and verified the resident trout as wild fish. This specimen is designated as SM412199F in Table 1. The remaining 14 samples were sent out for mitochondrial DNA (mtDNA) analysis in March of 2001 and we report on the findings of that analysis in this study (Table 1).

Three temperature loggers (two Onset Optic StowAway model number WTA08-05+37 and one Onset Optic StowAway Tidbit model number TB132-05+37) were deployed (two on DCC and one on SMC) in August 2001. Each probe gathered temperature data every 15 minutes for a period of over 11 months. Data logger No. 471213 (DC13) was deployed in a small pool at GPS N 33.47665, W 117.45485 on DCC, approximately 1.6 km from SMC (Fig. 1). Tidbit data logger No. 364203 (DC03) was

Table 1. Trout genetic samples collected on San Mateo Creek and Devil Canyon Creek

Sample	Date Collected	Length mm TL	Collection Location	Date Analyzed
SM412199F	4/21/99	217	Devil Canyon	May 1999
SM1F	5/13/99	204	San Mateo Creek	March 2001
SM2F	5/13/99	202	San Mateo Creek	March 2001
SM3F	5/13/99	245	Devil Canyon	March 2001
SM4F	5/13/99	233	San Mateo Creek	March 2001
SM5F	5/13/99	198	San Mateo Creek	March 2001
SM6F	5/13/99	196	San Mateo Creek	March 2001
SM7F	5/13/99	193	San Mateo Creek	March 2001
SM8F	5/13/99	164	San Mateo Creek	March 2001
SM11F	5/13/99	180	San Mateo Creek	March 2001
SM15F	5/26/00	60	Devil Canyon	March 2001
SM16F	5/26/00	65	Devil Canyon	March 2001
SM17F	7/7/00	81	Devil Canyon	March 2001
SM18F	7/7/00	74	Devil Canyon	March 2001
SM19F	7/7/00	60	Devil Canyon	March 2001

deployed in a larger pool at GPS N 33.47453, W 117.45926 on DCC, approximately 0.8 km from SMC (Fig. 1). Data logger No. 471256 (SM56) was deployed in Pool 3 on SMC (Fig. 1).

A single adult trout was collected in June 2002 on DCC (designated DC1) and examined to determine age. The fish was weighed, measured, and dissected. The sagittal otoliths were removed, cleaned, and age determination, using a dissecting scope, was confirmed by four readers (Fig. 2).

RESULTS

Figure 2. Otolith micrograph of trout collected on Devil Canyon Creek in June 2002. Age was determined to be 2 + years of age. Specimen was 273 mm TL. Photo by R. Titus

Observations during the survey period (August 1999 to December 2003) revealed that the trout located in SMC declined in numbers, with no trout being observed after August 2000. In May and July 2000, a total of 22 juvenile trout, ranging in size from 60-81 mm TL, was discovered occupying the first 1.2 km of DCC. Continued observations of juvenile trout on DCC lasted through September 2000. No juvenile trout were located in SMC during the survey period. In August 2001, several adult trout (200-250 mm TL) were observed in two separate pools on DCC, approximately 0.8 and 1.6 km from the SMC confluence (Fig. 1). These were assumed to be cohorts of the juveniles found in 2000. Observations of adults occupying DCC approximately 1.6 km up from the confluence continued through December 2003. Trout were frequently observed in DCC occupying pools during the spring where they were previously absent, indicating possible downstream migration.

While the age at size of the juveniles found on DCC could not be confirmed, the measurements of the individuals are well within the maximum first year growth rate of size-at-time data collected by the Department of known-age juvenile steelhead trout in south-central and southern California coast (CDFG Steelhead Report 2000).

Reproductive activity was observed on DCC in August 2001 and January 2002. Three adult trout were observed participating in brief spawning episodes on Devil Canyon Creek, in a pool approximately 0.8 km from the San Mateo Creek confluence. Individuals were using a central boulder as a staging area and conducting reproductive posturing directly upstream of the boulder. A redd had been constructed adjacent to the boulder and individuals were observed approaching the redd and rubbing themselves on the gravel bottom. The redd was approximately 45-60 cm in diameter and appeared as a circular, sandy area where all the leaf litter had been either removed or covered. One observation was recorded while the pool was being snorkeled and another was recorded from a rock outcropping directly above the pool. Both episodes were brief and activity ceased once the observers were detected by the trout. While this was encouraging, no actual spawning was observed and no new recruitment was documented for 2001 or 2002.

Mitochondrial DNA (mtDNA) was successfully extracted from all fin-clip specimens and analyzed according to established analytical methods (Nielsen et al. 1997). Five of the 1999 samples (SM3, SM4, SM7, SM8, and SM11) showed a lack of differentiation between the trout collected, indicating that these fish were cohorts of the previously analyzed SM412199F (F1)(Fig. 3). The remaining four adults (SM1, SM2, SM5, and SM6) differed in relatedness from SM412199F and were probably descended from a separate pair of anadromous adults that entered the Creek in early 1997. Analysis of the juvenile samples showed that three of the fish (SM15, SM16, and SM18) were of direct descent (F2) from SM412199F (F1). The remaining two juveniles (SM17 and SM19) had very divergent haplotypes, suggesting that more than one resident spawning pair bred successfully in DCC in 1999 (Nielsen and Sage 2001[4]) (Fig. 3). No useable material was obtained from SM14 and this sample was excluded from analysis.

The temperature probes were recovered in July 2002. All three probes successfully

[4]Nielsen J.L and G.K. Sage. 2001 Microsatellite and mtDNA analyses of San Mateo Creek trout, 2001. A progress report. 17 pp.

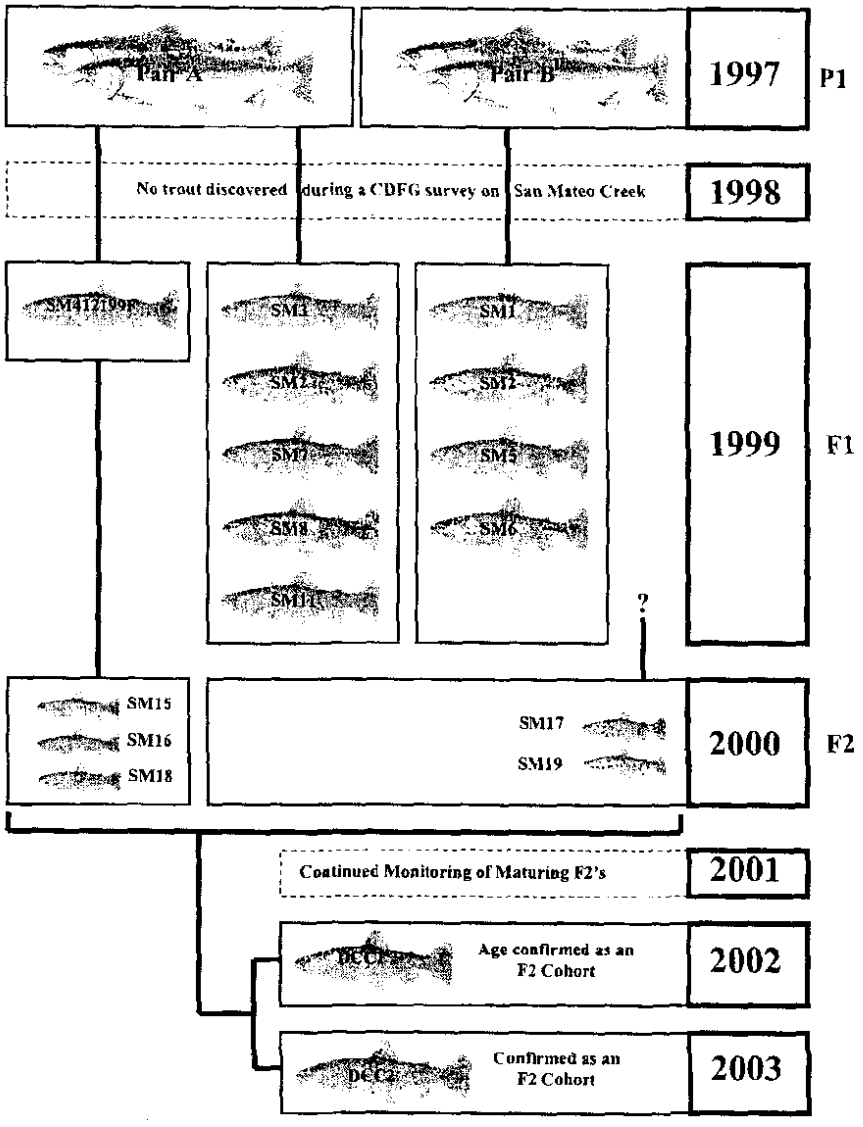

Figure 3. Chronology of trout presence on San Mateo Creek and Devil Canyon creek using genetic analysis, aging and observational data. 1997. Connected boxes indicate a confirmed genetic relationship. 1997:(P1) adults enter the San Mateo Creek drainage to spawn. 1998: No trout detected on San Mateo Creek during Department of Fish and Game Survey. 1999: A small population of 2 + year old, resident trout (F1) is detected on San Mateo Creek and Devil Canyon Creek. 2000: A small group of juvenile trout (F2) is discovered on Devil Canyon Creek in May and July. 2001: Continued monitoring of maturing F2 population on Devil Canyon Creek. 2002: The aging of a recovered adult on Devil Canyon Creek confirms individual is part of the 2000, F2 juveniles. 2003: The observation of a 3 ½ year old holdover fish on Devil Canyon Creek provides evidence of an uninterrupted fish presence on the San Mateo Creek drainage from 1997 to present.

collected data for the 11-month period of deployment. Two of the probes (DC13 and DC03) recorded very similar readings from August 2001 to March 2002. They recorded maximum temperatures of 21.8° C (DC13) and 23.1° C (DC03) and minimum temperatures of 7.8° C and 5.8° C, respectively (Fig. 4). The ranges within the first 7 months of deployment were almost identical between DC13 and DC03. For the last 4 months of deployment, DC13 recorded more consistent temperatures, with an increase from 10.1°

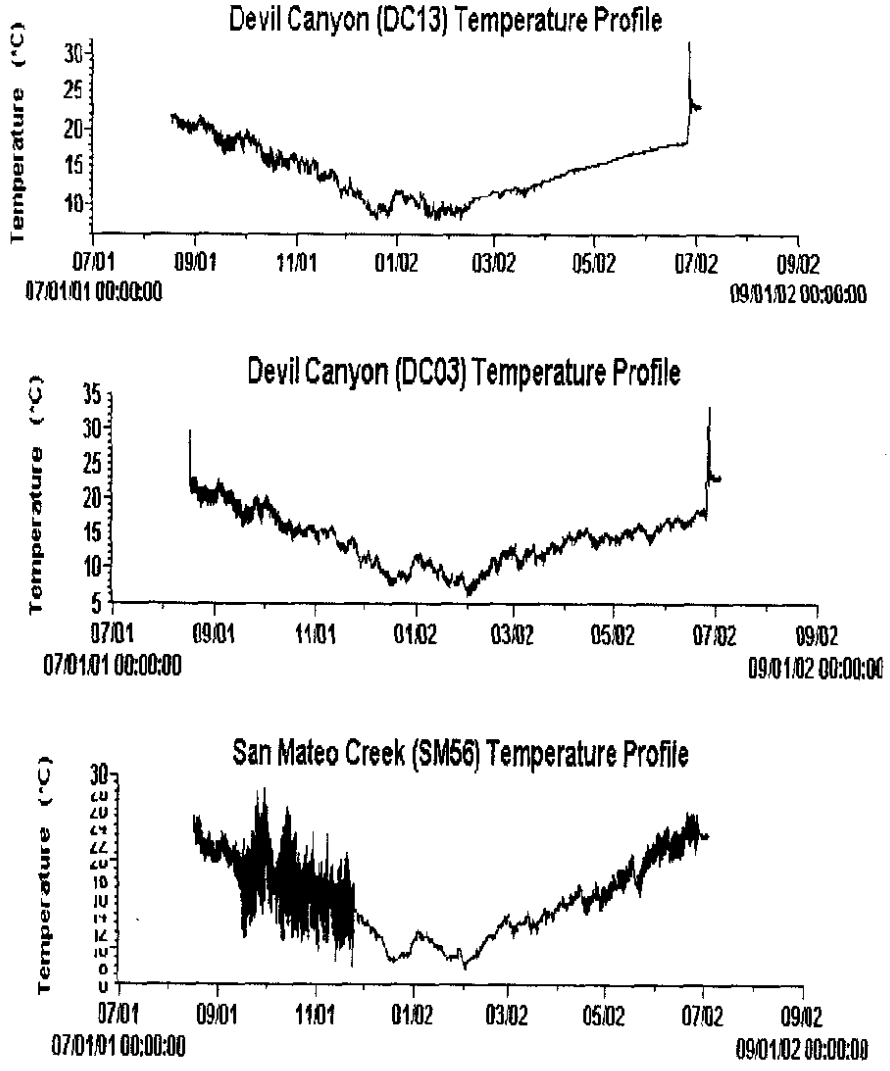

Figure 4. Temperature profiles for Devil Canyon Creek and San Mateo Creek from August 2001 to July 2002.

C to 18.1° C, with a daily range of +/- 0.9° C (Fig. 4). DC03 recorded an increase in temperature in that same period from 11.2° C to 18.9° C, with daily ranges of +/- 2.5° C (Fig. 4).

The SM56 temperature probe recorded severe temperature variations from August 2001 to December 2001, with readings from 28.4° C to 7.9° C, with some daily ranges shifting +/- 7.5° C (Fig. 4). Beginning in May 2002, SM56 recorded a steady increase in temperature, with daily ranges shifting +/- 1.4° C and topping out at time of retrieval at 25.8° C. This was in sharp contrast to the temperature maximums for DC13 and DC03 of 18.1° C and 18.9° C, respectively at time of probe retrieval (Fig. 4).

Age-at-growth calculations were performed on a single adult fish (DC1) collected in June 2002. The fish was recently expired and a complete work-up was performed. Both the right and left sagittal otoliths were removed and a single otolith was aged by four readers using a dissecting microscope (Fig. 2). The fish was determined to be 2+ years of age, and was a 273-mm TL female (gonad wt. 16.38 g), with a body weight of 213.5g. The eggs of the fish were partially hydrated upon removal and appeared of high quality. Both lobes of the ovaries were ruptured and the stomach was empty. Genetic material was collected, but has yet to be analyzed. No parasites were observed, internally or externally.

A single adult, holdover trout (DC2) was observed on the confluence as recently as December 2003. This specimen was determined to be a F2 holdover fish due to its size, coloration, and location on the creek. This observation established an uninterrupted fish presence on the drainage since 1997.

DISCUSSION

Almost immediately following the discovery of southern steelhead on San Mateo Creek, Department surveys began to record a decline in trout numbers towards the end of 1999. Observations of trout in an apparent emaciated condition strongly suggested that resource competition with exotics was impacting trout survival. Additionally, the recorded water temperature within SMC during trout presence strongly favored the exotic species over the trout, and probably contributed greatly to their eventual extirpation.

The discovery of juvenile trout in the lower reaches of DCC in May and July of 2000 became a pivotal observation during the survey period. This illustrated that even with infrequent and intermittent steelhead trout migration into the drainage, successful resident (F1) reproduction could result. These observations also confirmed that adequate resident spawning habitat does exist in DCC, and given the proper conditions, resident spawning could occur. This tributary is completely free of exotic fish species and holds promising trout habitat only a short distance from the SMC. Additionally, temperature stratified pools, deep enough and cold enough to support trout year-round are readily available in the drainage.

The genetic analysis was crucial in not only establishing the lineage of the sampled trout within the drainage, but also proving a connection between the trout located in both drainages. The trout first analyzed (SM412199F) was collected in DCC and the

confirmed cohorts (SM4, SM7, SM8, and SM11) were all collected in SMC, indicating either upstream or downstream migration of the residents. Since we observed trout in declining health, co-occurring with exotics in SMC, the survey observations provide strong evidence that downstream migration of the residents from DCC to SMC likely occurred.

The positive identification of direct descendents (Samples SM15, SM16, and SM18) from the previously sampled SM412199F indicates that the trout population size on the drainage is extremely small. This is also the first evidence supporting successful reproduction and survival of F2 offspring from this F1 cohort (SM412199F)(Table 1).

Since the two remaining juvenile samples were shown to be derived from a yet unsampled resident pair, we concluded that additional, undocumented resident fish may still occupy the drainage, further elevating population numbers.

The temperature data obtained from the probes clearly shows that Devil Canyon maintains a more consistent and preferential temperature profile for southern steelhead/rainbow trout survival than portions of San Mateo Creek (Fig. 4). Southern races of steelhead have evolved a much higher tolerance to high temperatures and low dissolved oxygen levels than is generally thought suitable for juvenile salmonids (Greenwood 1988), and the preferred water temperature for various life stages of steelhead is well documented (Bovee 1978: Reiser and Bjornn 1979[5]: Bell 1986). While this adaptation to adverse water conditions may assist in southern steelhead survival, temperature stability and reduced daily range shifts would be more favorable for trout occupying this drainage.

Both SMC and DCC exhibit ideal southern steelhead life history temperatures (McEwan and Jackson 1996[6]) for a portion of the year, but, during the summer, sections of the drainage experience surface water temperatures in excess of 26.7° C, well above suitable salmonid preference. Temperature stratification occurs throughout the SMC drainage and has been documented in pools occupied by trout. However, during dryer years, pool stratification and survivable temperatures for salmonids becomes limited. The probe data suggests that the over-summering habitat available in Devil Canyon provides a more stable temperature environment for steelhead sustainability and survival.

The collection of the single dead individual (DC1) on DCC during the summer of 2002 enabled us to not only confirm the age of the individuals that were currently being monitored on DCC, but also allowed us to examine the reproductive status of the collected specimen. The fish was 2 + years of age, confirming that the like-sized individuals occupying DCC were indeed cohorts of the 2000 juvenile group discovered in the lower portion of the drainage in May and July of that year. Upon dissection, no anomalies were discovered. The weight of the two ovaries made up over 7.5% of the

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[5]Reiser, D.W., and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. USDA, Forest Service, Pacific Northwest Forest and Range Experimentation Station, Portland, Oregon, General Technical Report PNW-96, 54 pp.

[6]McEwan, D. and T.A. Jackson 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Sacramento, CA.

body weight of the fish and the eggs looked to be partially hydrated in life. This indicated that this fish could have participated in spawning activity during spring 2002, given the opportunity. There was no outward indication of why the fish died. However, the pool in which the fish was collected, had a water temperature of 25°C at the time of collection, and it is likely the fish succumbed to depleted dissolved oxygen levels in the shallow, overheated pool.

The additional genetic, age, and monitoring information collected during this survey period clarifies the sequence of events for the population of steelhead/rainbow trout on the San Mateo Drainage (Fig. 3). Back calculations of the individuals aged in 1999 confirm that the anadromous adults (P1) entered the drainage in the early spring 1997 to spawn. Genetic analysis of samples SM1, SM2, SM5, and SM6 confirm the presence of an additional anadromous pair in the drainage in 1997. No fish were detected during a Department survey on San Mateo Creek in 1998. In the following year, a small population of trout (F1) was discovered occupying San Mateo Creek. All trout observed were of a single age class (2+ years), indicating they were the offspring of a single, reproductive event. In 2000, juvenile trout (F2) were discovered in the lower reaches of Devil Canyon Creek. Genetic analysis linked these fish to the F1 population, some directly descended from the first fish analyzed (SM412199F). The presence of sub-adults on the drainage in November 2000 suggests that they were maturing F2's. Age analysis of a single adult (DC1) collected in June 2002 confirms that a few of the adult fish currently occupying DCC are mature F2's (Fig. 3). Surveys conducted on SMC and DCC in 2001 and 2002 revealed no new recruitment during that time. The discovery of a 3.5-year-old holdover fish (DC2) in DCC in December 2003 provides evidence that there has been an uninterrupted trout presence on the drainage since the anadromous adults entered SMC during the spring of 1997 to spawn.

While the timeline of trout presence on the drainage can be firmly established with the evidence gathered during the study period, some question can be raised on where the original steelhead adults spawned in 1997. Surveys conducted in 1995, 1996, and 1997 by the United States Fish and Wildlife Service (USFWS) and a Department survey conducted in 1998 failed to detect trout on SMC. If anadromous adults entered the drainage and spawned in San Mateo Creek in 1997, young-of-the-year individuals should have been detected in fall 1997 by USFWS personnel and yearling individuals should have been detected in 1998 by Department personnel. All surveys included the stream portion from the USGS gauging station to above the DCC confluence, but did not include DCC. Since the age of the 1999 individuals has been confirmed at 2+ years of age and the fish were all cohorts, they had to be present on the drainage during the 1997 and 1998 surveys. Since the upstream migration opportunities from SMC to DCC have been extremely limited since 1999, and trout were absent in SMC when those opportunities existed, we can conclude that all trout observed during the original discovery in 1999, migrated downstream from DCC into SMC. We can also conclude that the individuals discovered in 1999 were attempting to emigrate out of DCC at the time of discovery, as several of them were observed in the silvery, smoltification stage when captured.

The impacts of exotic fish competition and predation on native fish is well

documented and while direct competition is difficult to quantify, the observation of resident trout on SMC in an unhealthy state co-occurring with nonnatives suggests that trout survival is severally hindered by the constant presence of exotic fish species. Exotic fish species (largemouth bass, green sunfish, bluegill and black bullhead) have been present in great numbers within the San Mateo Creek drainage for many years (USFWS status report, 1998; Woelfel 1991[7]) and have been shown to have a strong competitive edge over resident trout. Green sunfish have been found to feed on juvenile trout and out-compete adult steelhead for benthic food (Swift 1975[8]; Greenwood 1988). Largemouth bass take over as top predator in the habitat they occupy and can directly predate steelhead (Stouder et al. 1997).

Other studies have found that competition between introduced, warm water exotics and juvenile steelhead, when water conditions are warm, favored the exotics (Reeves 1985[9]). Later studies inferred that competition between exotic species and steelhead was limiting production of steelhead in some Umpqua River, OR.tributaries (Fontaine 1988[10]). While exotic fish presence may have played some role in steelhead trout decline on SMC, the combination of a higher water temperature and limited water supply likely contributed.

A portion of the information collected during this 4-year monitoring program provided NMFS with enough data to re-evaluate the ESU geographic unit for the endangered southern steelhead trout established in 1997. On May 2002, NMFS published their final rule for the range extension for endangered steelhead in southern California. Citing the extensive monitoring information collected by the Department and the new genetic analysis conducted by Dr. Jennifer Nielsen, the NMFS concluded that the *O. mykiss* population in San Mateo Creek is part of the listed southern California steelhead population and worthy of protection. Also citing the San Mateo Creek population, NMFS decided not to delineate a specific stream as the southern boundary as it had in 1997. Instead, the final rule states that the listed *O. mykiss* population extends from the Santa Maria River to the southern extent of its range. This provides additional protection for future discoveries within the entire endangered southern steelhead range. The individuals currently occupying the San Mateo Creek drainage represent the southern most documented population of *O. mykiss*.

It is clear that two definitive processes combine to influence the survival of the southern steelhead trout population on the San Mateo Drainage; water availability and

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[7]Woelfel, D. 1991. The restoration of San Mateo Creek: A feasibility study for a southern California steelhead fishery. MS. Thesis, California State University, Fullerton

[8]Swift, C.C., A.W. Wells, and J.S. Diana. 1975. Survey of the freshwater fishes and their habitats in the coastal drainages of southern California. Natural History Museum of Loa Angeles County. Final Report to California Department of Fish and Game, Inland Fisheries Division. 364 pp.

[9]Reeves, G. 1985. Competition between redside shiners and steelhead trout juveniles in the Umpqua River. Dissertation, Oregon State University, Corvalis, Oregon

[10]Fontaine, B. 1988. An assessment of habitat enhancement measures and factors limiting production of steelhead trout in tributaries to the Umpqua River. M.S. Thesis, Oregon State University, Corvalis, Ore.

the presence or absence of exotic fish species. For the last 60 years, Marine base Camp Pendleton has been pumping ground water from the aquifer beneath the SMC drainage. While stream conditions are currently capable of supporting a steelhead population, alternatives to reduce or eliminate this pressure on the resource can only benefit the trout. Additional efforts are needed to seek an acceptable and effective method for controlling exotic fish species on the drainage. Regardless of the methods employed, this undertaking cannot be successful in the long-term unless re-infestation from the source is controlled, if the source still exists. Currently, the populations of exotic fish species within the drainage are self-sustaining and annual repopulation of the creek occur from adults within the creek.

Even though the San Mateo drainage steelhead/rainbow trout have extremely low population numbers based on Department surveys, their continued survival in extremely harsh conditions makes their preservation even more important. All juvenile coastal rainbow trout have the potential to emigrate from their coastal stream and become steelhead irrespective of their parentage, and therefore are extremely important to the persistence of the population (Behnke 1992). This polymorphic population structure allows persistence in an environment that is frequently suboptimal and populations of this type may be necessary for the long-term persistence of the population (Johnson 1985, Titus and Mosegaard 1992, Northcote 1997). Often species occupying the margins of their range benefit from a polymorphic life history where conditions may be unstable. This life-history plasticity, in a drainage that experiences unreliable stream flow for immigrating adults and emigrating smolts, and a constant exotic presence, is undoubtedly the reason southern steelhead/rainbow trout continue to occupy the San Mateo Creek drainage.

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