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## SALMON PROTECTION AND WATERSHED NETWORK

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### **Relocation of stranded native fishes from isolated pools in the San Geronimo Creek System (2001).**

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#### Summary

In 2001, a total of 2,081 salmonids (1,804 steelhead and 277 coho) were successfully relocated in the San Geronimo Creek system within the Lagunitas Creek Watershed. This was the third year of SPAWN's salmonid rescue and relocation program, first begun in 1999 conducted under permit from National Marine Fisheries Service (NMFS) and California Department of Fish and Game (DFG)<sup>1</sup>. One steelhead mortality resulted from relocation efforts representing 0.0004 percent of fish handled.

Between April and October 2001, ten tributaries of San Geronimo Creek (Arroyo, Barranca, El Cerrito, Montezuma, Larsen, Creamery, Deer Camp, Bates Canyon, Woodacre Creek and Geronimo North Fork Creek as well as Roy's Pools) were examined for the presence of fish, stream flow and water temperature. Juvenile salmonids, stranded in isolated pools and riffles that were in imminent danger of drying up completely, were captured and transported a short distance downstream to areas of year round water flow from six of these creeks.

No juvenile salmonids were relocated from Montezuma, Creamery, Barranca, Bates, and Deer Camp Creeks in 2001. The latter two maintained year-round flow, and no salmonids were observed in Montezuma or Creamery Creek. Barranca Creek, which in previous years had salmonids present, dried up completely unusually early and was dry at the time of the first survey.

One non-native species, a bluegill (*Lepomis macrochirus*) was again discovered in Larsen Creek in summer 2001, for the second year in a row. Two captured coho that were stranded in the lowest pool of Roy's Pools were smolts. Since this program began in 1999, a total of 5,098 salmonids have been relocated.

The greatest risk to salmonids found in isolated pools was the rapid decline in water levels. The declining water table did not appear to cause a significant change in water temperature, which remained within the range necessary to support salmonid growth and survival. The exception was at Roy's Pools on San Geronimo Creek where direct sunlight elevated temperatures to near lethal limits for salmonids (19.5° C) and also caused alga blooms which consumed 90% of available space in the pools.

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<sup>1</sup> NMFS permit #1162 and a CDFG permit

## Introduction

California salmonid populations have experienced a significant decline in the past 150 years and most are now protected under the US Endangered Species Act. Coho salmon, for example, (*Oncorhynchus kisutch*) were historically noted in at least 582 streams from the Smith River near the Oregon border to the San Lorenzo River on the central coast and (Brown et al. 1994). Yet many populations have gone extinct or have been reduced to less than 100 individual spawning fish. By the 1950's and 1960's populations declined to 100,000 from what was believed to have numbered close to 1 million in the 1800's (DFG 1965 cited in Protecting California's Anadromous Fisheries, 1998). Brown et al (1994) estimated that an average of 13,000 native coho returned each year to spawn in California streams between 1987 and 1991. By 1994, they asserted the native coho population was "probably less than 5,000".

Coho salmon and steelhead trout (*Oncorhynchus mykiss*) are found in the Lagunitas Creek Watershed, Marin County (LCW). Both species in this region (Central California Evolutionary Significant Unit) are listed as threatened under the Endangered Species Act. The approximate 500 coho that return to this watershed annually are considered to be one of the more robust populations in the state. However, their numbers in this watershed are down 90% from 3000-6000 individuals 50 – 100 years ago.

Reasons for the historic decline in LCW are a microcosm of the problems faced by salmonids throughout California. Dams and water diversions have reduced available water supply and eliminated habitat. Urbanization have further degraded habitat by reducing or eliminating creeks, wetlands and riparian habitat, creating barriers to fish migration, lowering the water table through the creation of impervious surfaces and channelization, and through sedimentation and pollution of waterways. Overfishing in the marine realm may also have played a role in the demise of the local population, though specific data is not available.

San Geronimo Creek and its tributaries make up the headwaters of the LCW and are critical spawning and nursery habitat for coho and steelhead (Figure 1). In recent years, 30-50% of the LCW spawning coho population utilized the habitat of the San Geronimo system (MMWD 2001 and SPAWN in prep), despite significant anthropogenic impediments and barriers to (downstream, as well as upstream) migration in the system.

However, juvenile coho and steelhead in San Geronimo Creek and its tributaries become stranded when rains cease and surface flows become intermittent, causing pools and riffles to become isolated. As summer progresses, water levels in some areas decrease and often disappear resulting in certain death for stranded fish.

High temperatures caused by a lack of canopy cover also threaten salmonid survival. Sandercock (1991) cites the upper lethal temperature for juvenile coho at 25°C, and Barnhart (1991) from his study cites lethal temperature for juvenile steelhead at 23.6°C.

The absence of canopy cover also results in algae and aquatic plant blooms, which inundate pools consuming nearly all available space needed by juvenile salmonids. Furthermore, eutrophication may occur as decomposing algae consume the available oxygen needed by stranded salmonids.

**The Need For Fish Rescue**-- Fish rescue and relocation is attempting to mitigate for some of the human activities that have reduced juvenile salmonid survival in the San Geronimo Creek system. These anthropogenic changes include:

- reduced or eliminated summer creek flows from lowered water table caused by increased winter run-off from creation of non-permeable surfaces (roads, structures), elimination of wetlands, channelization of creeks and direct removal of aquifer water from wells (42 registered and an unknown amount of unregistered) and direct pumping from creeks;
- increased sedimentation of pools that eliminate available habitat;
- creation of barriers and impediments to downstream migration (culverts, large reservoir dams, small check dams, etc.)
- importation of non-native predatory fish (large mouth bass, *Micropterus salmoides* and bluegill, *Lepomis macrochirus*) and pets;
- habitat modification including removal of woody debris, reduction of riparian habitat, etc.

Since LCW salmonid populations are greatly reduced (~90 percent) from historical levels and are presumably below available carrying capacity for these species, it is unlikely that these modest relocation efforts will negatively impact already present fishes in relocation sites, all of which maintain year-round stream flow.

In addition, this permitted activity has incorporated local residents previously involved in ad-hoc fish rescue operations into a scientifically-based program that has provided instruction and supervision in proper capture, handling and collection of valuable scientific data.

### **Methods**

Streams were surveyed to determine presence and absence of salmonids and monitored to determine water flow, pool depth and temperature in pools from April - October 2001. As it became apparent that pools would dry completely and based on current monitoring and previous years observations at known sites, fish rescue and relocation efforts were begun. Every attempt was made to delay relocation efforts until the latest possible time in effort maximize resident time in their natal stream habitat.

Fish were dip-netted out of pools and placed in insulated coolers equipped with a battery operated aerator. Approximately every 15-45 minutes, captured fish were transported to a perennial flow section downstream on their natal tributary or to the San Geronimo Creek at or near the confluence where they would have passed had they not become stranded. The exact release location was dictated by the availability of nearby pool habitat and issues of access on private property.

Upon capture of fish, individuals were identified and lengths measured and stream conditions were recorded. In some cases, measurements were done on a random sample of fish, especially if hundreds were caught at a single site. On occasion,

particularly when air temperature was 32° C or higher, fish were identified but not measured in order to rapidly relocate fish with minimum stress

To further minimize disturbance and stress to fish, pools were netted for no more than 30 minutes. Netting was done by gently but swiftly sweeping a net through the water. If fish mortalities occurred, individuals were collected and frozen for delivery to NMFS. Notes were made of how each incident occurred and efforts were modified to prevent further mortalities.

## **Results**

Ten tributaries to San Geronimo Creek were surveyed for salmonids and habitat conditions between (Figure 1) April and October 2001 (Arroyo, Barranca, El Cerrito, Montezuma, Larsen, Creamery, Deer Camp, Bates Canyon, Woodacre Creek, and San Geronimo North Fork as well as Roy's Pools). Relocation efforts were conducted on all tributaries surveyed except Montezuma, Creamery, Deer Camp and Bates Canyon Creeks. Deer Camp and Bates Canyon Creeks maintained year-round flow and no relocation efforts were deemed necessary. No fish were located on either Montezuma, Creamery or Barranca Creek. In the case of the Barranca, this creek went dry unusually early and neither fish nor water was present at the time of the first survey. Montezuma Creek supports spawning fish in some years (Todd Steiner, pers. obs.), and Creamery Creek historically had a significant population of spawning salmonids (Elgin Orcutt, pers. comm.), but the culvert at the Creamery - San Geronimo confluence may be a complete barrier to upstream migration.

Water temperatures in the creeks ranged from 8.5 -18.0 C, except in Roy's Pools, where temperatures reached 19.5° C. At this site, high temperatures in combination with direct sunlight exposure caused alga and aquatic plant blooms inundating available habitat. As the algae and plants decayed, pool temperatures increased and oxygen levels likely dropped potentially compromising salmonid survival. Temperatures in all other creeks remained moderate until the point surface flow disappeared.

A total of 2,081 salmonids (277 coho and 1804 steelhead) were successfully relocated from pools to flowing stretches of creek (Figure 2, Table 1). One steelhead mortality resulted from relocation efforts on Arroyo Creek representing a fraction of a percent (0.0004%) of total fish rescued. Examination of the individual indicated that injury was likely caused by a dip net pinning fish to the substratum during capture efforts. One other dead fish was seen in one pool on Larsen Creek unrelated to netting activities. Both carcasses were collected for deposition with Carlos Garza, Geneticist at the NMFS Laboratory in Santa Cruz.

Specific description of relocation efforts for each site are listed below:

El Cerrito- A total of 471 steelhead were relocated from this tributary between May and July 2001 (Figure 2, Table 1). The creek passes through a culvert under Arroyo Road located ~30m upstream of the confluence with Arroyo Creek. A second culvert under El Cerrito Road is located ~15m further upstream. By early June the lower 300m of this creek went dry. Flow continued in the upper portion throughout the summer.

Deer Camp - This tributary is located in a small steep wooded canyon, which has several potential future home sites (roads and utilities in place). The creek passes through a culvert under San Geronimo Valley Drive. While no fish were seen there and the stream did not go dry in 2000 or 2001, salmonids have been sighted both north and south of the culvert in recent years by Steiner and several times over the past 40 years (Willis Evans, pers. comm.). No salmonids were relocated from this tributary in summer 2001.

Bates Canyon - This creek is also located in a small relatively undeveloped canyon and it also passes through a culvert under San Geronimo Valley Drive. Flow in this creek has not ceased since 1999 when relocation efforts began. In spring and summer 2001 several juveniles, likely steelhead, were spotted in the tributary but no rescue was conducted since they were not in imminent danger and were able to move downstream on their own. However, by June researchers noted that water flow was passing underneath the cement box culvert that passes under San Geronimo Valley Drive. Apparently the culvert has eroded such that water flow percolates underground and re-surfaces on the other side of the culvert. After this discovery, SPAWN surveyed this tributary to determine if any salmonids were stranded upstream of the culvert but none were found.

Montezuma - The majority of this tributary passes through a heavily developed portion of Forest Knolls. No relocation activities occurred on this tributary since no spawning salmonids were noted in winter 2000/01 and the tributary went dry in late May. However, in recent years, coho salmon have been observed spawning in this tributary and juvenile steelhead have been seen at various locations along the first ~1,000 meters (Todd Steiner and Reuven Walder, pers. obs.).

Larsen - This tributary passes through the Lagunitas School District and the San Geronimo Golf Course and Roy's Redwoods (Marin County Open Space). Between May and August 2001 a total of 198 salmonids (37 coho and 161 steelhead) were relocated from pools to the confluence with San Geronimo Creek. One exotic species, a bluegill (*Lepomis macrochirus*) was again discovered in Larsen Creek in summer 2001. In the previous summer 2000, researchers discovered 4 large mouth bass (*Micropterus salmoides*), 8 bluegill (*Lepomis macrochirus*), 17 mosquitofish (*Gambusia affinis*) and 2 bullfrog tadpoles (*Rana catesbeiana*). Before winter rains resumed, all but 2 pools went completely dry in the lower reach where fish were rescued. Other pools reached low levels (<20cm) which warranted rescue since dogs and humans were commonly found wading in remnant pools. Researchers noted that the creek lost connectivity in late May yet for a brief period in June, flow increased and connectivity was re-established. A similar phenomenon was noted in summer 2000 and it was believed that this was due to water discharged into the creek from a pond that Larsen Creek drains through on the golf course. Researchers also determined that this pond is the likely origin of non-native species discovered in this tributary.

Arroyo - A total of 229 salmonids (163 coho and 66 steelhead) were dip-netted from a series of drying pools located along the downstream 1000m of this creek between May and September 2001. Water temperatures remained relatively cool (11.0-18.0° C). Many pools went dry unusually early (early June) and nearly all pools went completely dry before winter rains commenced. However, researchers noted that water levels temporarily increased in some pools near the confluence with San Geronimo Creek in August. No rain event was associated with this phenomenon.

Barranca - Pools where rescue had been conducted in years past were found to be completely dry at the time of the first survey on April 1.

Woodacre - Flow continued year-round in the lower 500m of this tributary and no relocation occurred there. Yet, a total of 779 salmonids (all steelhead) were relocated from two upper branches of Woodacre Creek between May and July 2001. Temperatures ranged from 8.0 - 17.0° C. In late September, researchers again noted a stretch of creek that was completely dry was again flowing. A local landowner, indicated that seasonal pumping activity has been occurring by a neighbor upstream of this site for years.

Creamery - No fish were located. The culvert at the Creamery - San Geronimo confluence may be a complete barrier to upstream migration.

Roy's Pools, San Geronimo - This site was formerly a dam with an adjacent fish ladder. In 1999 the creation of three jump pools immediately downstream of the dam was built to improve fish passage. Water continued to flow year-round through the adjacent fish ladder but ceased cascading through the pools in late May isolating fish in all three pools. The upper and middle pools maintained sufficient water level all summer, while the lowest pool lost more than 75 percent of its water volume by October.

Visual surveys in the upper 2 pools indicated that hundreds of steelhead (YOY through 2+), coho (YOY and smolts), roach and stickleback were trapped within them. Water temperatures in pools ranged between 11.8 - 18.0° C.

Temperatures were highest in the lowest pool (19.5° C), exceeding threshold temperatures reported necessary to maintain growth for coho and approaching or exceeding sublethal temperatures reported in some studies (Hines and Ambrose unpublished data, Welsh et al. 2001).

Due to the direct sunlight exposure at the site, all three pools developed large quantities of alga growth in all three pools. The possibility of low oxygen levels impacting survival of juveniles caused by a decay of algae in mid summer became a concern. Therefore, every 2-3 weeks decaying algae was removed from pools to prevent anoxic conditions. No relocation efforts were conducted on the upper two pools since salmonids appeared to be out of danger. However, the low water level and elevated temperature in the lowest pool in combination with alga blooms warranted rescue. A total of 120 salmonids (34 coho and 86 steelhead) were relocated from this pool between June and August. Most coho discovered ranged in size between 52 and 70mm. However 2 of the coho trapped in the pool appeared to be smolts measuring 110 and 116 mm respectively.

North Fork San Geronimo (Upstream of Woodacre - San Geronimo Confluence) - Fish were relocated from this stretch between the confluence of Woodacre Creek a 10' tall dam located ~400m upstream on Dixon Ranch. Before the entire stretch went dry in September, SPAWN crews relocated 284 salmonids (43 coho and 241 steelhead). Water temperature remained low until pools went dry.

## Discussion

Because of the lowered water table and other impacts to the creek ecosystem in the Lagunitas Watershed, relocation of salmonids is a necessary measure to protect and enhance the remaining populations of coho and steelhead, which have declined by 90% in the last 50-100 years. Since 1999, SPAWN has relocated 5,098 juvenile salmonids from tributaries in the Lagunitas Watershed, a record 2,081 of those in summer 2001 alone. As noted in previous years, most fish relocated did not appear to be endangered by elevated water temperatures. Yet, a steady and early decline of water levels in isolated pools, relative to years past, would have resulted in 100 percent mortality without relocation efforts.

Impacts of existing and new development of riparian habitat have and will continue to cause excessive runoff, compaction of riparian habitat and insufficient infiltration of water into aquifers. Reduction of water quantity is further exacerbated by the occasional resident and business along these tributaries that actively pump water either directly from the creek or from wells nearby. This is an issue of great concern since these activities further lower the water table especially during the summer months when flows are critical to juvenile salmonid survival. SPAWN will continue educational activities in the watershed to seek voluntary cessation of pumping activities.

We noted an occasional mid-summer increase in water levels and resumption of stream flow that was not associated with any rain event. We believe that this may be linked to releases of water from nearby ponds as noted on Larsen Creek (San Geronimo Golf Course) or from cessation of pumping activities by local residents either directly from the creek or nearby wells. This phenomenon may also be linked to natural fluctuation in transpiration of trees and water uptake rates throughout the summer. Further study is necessary to further ascertain the cause of this phenomenon.

Greater spawning activity in the upper tributaries (associated with timing and size of winter rainfall events that allow spawners to migrate into upper tributaries) in combination with the irregular and below average total rainfall likely resulted in the record number salmonids relocated in 2001. In the winter prior to relocation efforts (2000/01), 74 of the 204 coho redds found in the LCW were discovered in the San Geronimo system and SPAWN crews counted 22 of those redds in the upper tributaries. This was a relative increase from the prior season (1999/2000) where 61 of 203 total coho redds counted were in the San Geronimo system. We predict a high number of juveniles will be in need of relocation in summer 2002 since 145 of the 285 coho redds discovered in winter 2001/02 were found in San Geronimo system. Over 40 of these coho redds were discovered in the tributaries to San Geronimo Creek alone.

The continued presence of exotic species on Larsen Creek is still of concern. Non-native predatory species pose a serious threat to already fragile populations of salmonids. Moyle and Light (1996) assert that successful species invasions are more likely when native assemblages have been depleted or disrupted. While fewer exotics were seen in Larsen Creek in 2001, the source of introduction still remains. SPAWN is working with the golf course to prevent any further introductions. Bass and bluegill were also sighted in summer 2000 in Lagunitas Creek just below Peter's Dam and within S.P. Taylor Park (Reuven Walder pers. obs., Leslie Ferguson pers. comm.). It is possible that these fish spill over Peter's Dam and pass through drainage pipes. Apparently spillways and

pipes on Seeger Dam, which forms Nicasio Reservoir, were originally equipped with gear to prevent non-native fish introduction, but were removed because hundreds of tiny fish would clog screens preventing drainage (Willis Evans Pers. comm.). We recommend that all drain pipes be re-equipped with screens and spillways modified to prevent non-native fish from moving into the creek system. In addition, green sunfish (*Lepomis cyanellus*) were discovered in spring 2002 within out-migrant traps operated by Point Reyes National Seashore in the Olema Creek sub-watershed. These fish were removed from the system.

Restoration of Roy's Dam to Roy's Pools improved adult fish migration upstream of this site. However, the project has resulted in a downstream migration barrier for juvenile salmonids. SPAWN's discovery of coho smolt (100+ mm) in these pools also demonstrates the immediate need to address this problem and we are seeking funding to address this issue. We anticipate convening a meeting of interested parties in summer 2002 to discuss possible solutions. SPAWN also anticipates providing shading to pools in summer 2002 by placing tree branches over the pools and planting appropriate native trees at the site to provide future canopy cover.

SPAWN also anticipates conducting out-migrant studies next year on some the tributaries where fish relocation is now occurring in part to better understand juvenile out-migration patterns in order to more fully assess the value and need for fish rescue.

While SPAWN's efforts to relocate salmonids is aimed at mitigating for anthropogenic impacts to protect the remaining salmonid populations of the Lagunitas Watershed, our long term goals are to restore natural functioning systems where salmonid rescue and relocation are unnecessary. SPAWN is currently investigating strategies to increase groundwater recharge and educating residents and seeking voluntary elimination of pumping activities. Furthermore we are engaged with a number of organizations and agencies to improve and re-open habitat through reduction of sedimentation, remove barriers to migration, identify and reduce pollution and restore and protect riparian habitat.



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