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SANTA YNEZ STEELHEAD RESTORATION FEASABILITY STUDY
LOS PADRES NATIONAL FOREST
SANTA BARBARA RANGER DISTRICT
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Southern California steelhead populations have decreased to less than 5% of their historical size and range and are in immediate danger of extinction (Nehlsen et al., 1991). The Santa Ynez River once supported runs of 10,000-20,000 anadromous steelhead but numbers have dwindled to less than a few hundred (CDFG 1955). Sea-run steelhead currently have access to less than 40% of their historic habitat.

Steelhead are currently being reviewed by the National Marine Fisheries Service for listing under the Endangered Species Act. In preparation for a likely listing in August, many agencies are conducting analyses of ongoing or upcoming projects which could impact steelhead. A multi-agency "Technical Advisory Committee" has initiated a study of the feasibility of providing fish passage and restoring steelhead to the historical spawning and rearing habitat in the upper Santa Ynez River basin. The Forest Service manages the majority of these upper basin areas and has interest, issues, and concerns in the actions being considered.

The USDA Forest Service also is taking measures to conserve and restore steelhead in preparation for possible listing and under the interim National "PacFish" direction (USFS 1995), soon to be incorporated into the Forest Land and Resource Management Plan as part of a Riparian Conservation Strategy (USFS 1994). Los Padres National Forest is in the process of establishing "Riparian Habitat Conservation Areas" (special management zones), applying new standards to projects and ongoing activities, and managing to meet specified habitat objectives so as to lead to steelhead recovery. Watershed analyses are required in order to determine the most effective approach to managing for steelhead restoration. At this time, a full interdisciplinary watershed analysis is not possible. This report specifically addresses and summarizes what is know about the potential habitat that could be made available to steelhead trout in order to support a informed decision. This report is a techical fisheries report and does not constitute the only interests of the Forest Service. Additional input should be sought from Santa Barbara District personnel regarding the implications of any major proposed changes to local management of water, people, and/or fish.

THE HABITAT

The Santa Ynez River basin encompasses ____ acres of oak-woodland and chaparral. The Santa Ynez River flows 92 miles in a westerly direction from headwaters to the Pacific Ocean. The continuity of the river is punctuated by the three large reservoirs, Jameson about 4 miles from headwaters, Gibraltar about 8 miles further downstream, and Cachuma 12 miles more. The lower Santa Ynez below Cachuma Reservoir (Bradbury Dam) flows over 65 miles before reaching the ocean.

Downstream from Bradbury Dam, temperatures, flows, and a general lack of suitable rearing habitat are the primary limitations on steelhead production. Only the uppermost section from Bradbury Dam to Solvang (14 miles) is thought to be currently capable of supporting spawning and rearing steelhead. Riffles represent less than 5% of these reaches. Pools are common (>50% of the habitat) but may have adverse water quality for late summer holding habitat. The abundance of exotic and potentially predatory exotic bass and sunfish is also a concern. Of the tributaries to the lower Santa Ynez, Salsipuedes Creek currently has the highest potential for steelhead spawning and rearing. Rearing habitat and access to rearing habitat appears to be a greater limiting factor than spawning habitat within the lower Santa Ynez River. (Entrix 1994)

Cachuma Reservoir is managed as a stocked cold and self-reproducing warm water fishery. A component of self-reproducing trout may also inhabit the reservoir, spawning in the tributaries and inflowing Santa Ynez.

Cachuma Creek drains the south facing slopes of the San Rafael Mountains and flows 7 miles before reaching Cachuma Reservoir. Cachuma Creek is fished at a moderately intense level. The mainstem of Cachuma Creek and the lower end of Lion Creek support moderate densities of resident trout with a put-and-take stocked fishery established near the easy access roads. Several natural bedrock falls and mineral deposits may serve as barriers to upstream fish movements midway up the drainage. Habitat is characterized by cobble runs with small boulder pocket water and bedrock controlled pools. Water flows and temperatures may limit trout production during some years. Late summer siltation sometimes is evident, perhaps related to historic mining, grazing, and roads in the upper watershed. The high intensity burn over 10% of the steep surrounding slopes contributed to increased sedimentation and some additional downcutting after the Marre fire in 1993.

Santa Cruz Creek drains the south facing slopes of the San Rafael Mountains and flows 15 miles before entering Lake Cachuma. Much of the lower 5 miles of Santa Cruz Creek becomes intermittent by late summer although the upper reaches apparently retain water even in the driest of years. The East Fork supports better flow and habitat diversity than the West Fork. The West Fork flows from a upper moderate gradient mature Alder and Douglas Fir lined channel through a narrower boulder barrier sprinkled middle canyon and a 30 foot waterfall before the lower gradient pool rich but more open canopy lower section. Approximately 10% of the watershed burned in the 1993 Fire. Effects on the channels and biota were not substantial. Santa Cruz Creek is fished at low to moderate levels. Access is through private property by road in the lower sections and by trail into the upper watershed.

The lower reaches of Peachtree, a tributary to East Fork Santa Cruz Creek, often go dry and bedrock falls block upstream fish movement. Over 80% of the steep and unstable slopes of the Peachtree watershed burned with high intensity in the 1993 Marre Fire. Remnant sedimentation and channel scouring can still be seen today. Spawning, rearing, and summer holding habitat is good, but temperatures and flows may become prohibitive during drought years. The drainage is rugged and largely inaccessible to anglers.

Grapevine Creek, a tributary to East Fork Santa Cruz Creek retains water through most reaches and most years. Grapevine flows a total of two miles through an upper narrow but largely unshaded moderately steep valley and lower well shaded incised channel. Trout are found throughout in relatively high densities but small sizes. Grapevine may function well as a spawning and rearing area for Santa Cruz resident fish.

A number of smaller drainages also are tributaries to Cachuma Reservoir and the section of the Santa Ynez River between Cachuma and Gibraltar reservoirs.

Paradise and Oso Creeks are generally too small and quick to dry to support a significant number of spawning or rearing steelhead.

Between Cachuma and Gibraltar Reservoirs, the mainstem Santa Ynez flows over 8 miles through seepage maintained deep canyon bedrock pools in the upper section, through intermittent wide and open small boulder runs with occasional pools, and through a lower section of seasonally flowing sand and cobble riffles and glides. The lower section is on private lands and of unknown habitat quality and capability. The middle section is heavily stocked, fished, and used for recreation. Streambanks are disturbed, and no pool goes without fairly constant human disturbance in the summer. Riparian canopy is low and water temperatures are warm. All but the uppermost section usually goes intermittent by May or June. Wild trout are known to inhabit the upper more perennial reaches. Exotic Largemouth Bass, Smallmouth Bass, Greensunfish, and Mosquitofish are abundant. Carp, goldfish, and channel catfish are also present. Arroyo Chubs and Threespine Stickleback also inhabit this section.

Devil's Canyon flows off of north facing slopes approximately 3 miles before entering the Santa Ynez River almost immediately downstream of Gibraltar Dam. Devil's Canyon is densely shaded and well confined within steep Canyon walls. Gradients are more moderate than other North facing drainages. A small municipal water diversion 350 feet upstream as well as a concrete apron at a nearby bridge partially block fish movements at lower flows. All fish passage is blocked at a falls a mile upstream from the diversion.

Gibraltar Reservoir has supported a large trout and exotic warmwater fishery in the past. When the reservoir was drawn down and dredge in the late 1970's fish populations were reduced. No comprehensive surveys have been conducted to assess the present situation. It can be assumed, however, that Gibraltar like other Santa Ynez Reservoirs has a large component of exotic Greensunfish, Largemouth Bass, and Bullfrogs. Gidney Creek is the only tributary draining directly into the reservoir with opportunities for supporting spawning and rearing trout. Gidney flows a total of 3 miles through an extremely steep shaded upper section, past several partial barriers, through a moderate gradient narrow valley and through a lower steep rugged canyon reach with several boulder and plunge pool barriers. Trout are only found within the lower reach.

Camuesa Creek flows southeasterly through six fairly open moderate gradient miles. Camuesa only has seasonal and isolated pockets of intermittent flow, not enough to support a year-round fishery and limited access and qualities for spawning habitat.

Indian Creek flows south a total of 12 miles through a steep narrow well shaded upper reach, through a short section of bedrock canyon, a more open warm water cobble reach, back through a steep boulder and bedrock canyon including a number of bedrock barrier falls, reopens into a lower gradient gravel section, meets with Buckhorn Creek, and meanders through a low gradient sand and gravel intermittant stretch with many isolated pools, and finally through a low gradient wide open arroyo type channel before merging with Mono Creek within the floodzone of the Mono Debris Dam. Trout abundance is moderate to moderately high particularly within the canyon reaches. Fish are found above all but the upper most barriers. Angling use is moderate within the lower middle sections and heavy at the spilling pool created at the Mono Debris Dam.

Buckhorn Creek, tributary to Indian Creek, flows almost five miles through upper narrow intermittant boulder and cobble reaches, through middle sections of more open gravel pool and riffle reaches, through a lower gradient open cobble run and corner pool section. Buckhorn supports rate to high densities of trout and medium angling use.

Mono Creek holds a good but lesser number of trout than Indian Creek. Mono Creek flows over 16 southwesterly miles through a moderate gradient open canopied cobble glide section, through a narrower shadier moderate gradient bedrock lined canyon ("the Narrows"), and lower open low gradient arroyo section before merging with Indian Creek at the Mono Debris dam. Most of the reaches are intermittent but retain fish within year-round isolated pools. Mono Creek receives moderately heavy dispersed angling use along the easy to reach segments.

Agua Caliente supports good year round flows and has suitable habitat within the upper reaches but water temperatures are too warm from the hot springs to support trout. Chubs are found in some sections.

Blue Canyon flows almost four miles in a westerly direction parallel and not far from the mainstem Santa Ynez. Escondido, the main tributary and contributor of water, flows northward 3 miles through an upper high gradient and fishless reach, past a large waterfall, through a moderate gradient boulder and bedrock step pool section, and through the lower moderate gradient riffle run habitat which merges with another tributary and turns sharply to become Blue Canyon. Blue Canyon is mostly a moderate to low gradient seasonal flow gravel dominated run and glide reach. Only the upper most section, and parts of the Escondido tributary support year-round flows, pools of any significance, and adult trout. Phenomenal numbers of fry are observed in the mid to lower reaches, however, and large size spawning trout have been seen utilizing the area. Unfortunately, no genetic samples have been taken from the Blue Canyon spawners. We can only assume that these fish represent a spawning migration out from Gibraltar Reservoir, perhaps of largely un-introgressed land-locked native steelhead.

Fox Creek flows in a northerly direction through a total of nearly 2 miles of mostly steep boulder bedrock step-pool type habitat. Flow is perennial and could support a low number of year-round trout, although adults seem to only be observed in and around the spawning season. A Diversion dam prevents fish movement about a half a mile upstream. A large waterfall is situated a short distance beyond the diversion.

Alder Creek flows a total of nearly three miles first in a northerly direction through an upper steep boulder bedrock lined densely shaded canyon, through a moderate gradient step-pool canyon walled reach with waterfall and man-made diversion structures, turns sharply to flow in a westerly direction parallel to what would be the Santa Ynez River (but is the flooded Jameson Reservoir) through a moderately low gradient more open gravel and cobble run and riffle reach. A 20 foot waterfall blocks upstream fish passage a quarter mile upstream from the man-made diversion barrier. Until recently (1995) a pipeline supporting gabion structure blocked all fish passage into the lower end of Alder Creek from the mainstem Santa Ynez River. Until that time, the lower reach was thought to be largely fishless. Within the last several years a number of fry have been observed within the lower reach. A short section below and immediately above the remaining man-made barrier supports year-round adult trout.

The 8 miles of mainstem Santa Ynez between Gibraltar and Jameson Reservoirs dries up in summer of most years leaving only a few stagnant pools and the plunge pools below Juncal Dam. Spawning habitat might be available but flows are likely not stable long enough to allow for successful development of eggs and fry movement into tributaries or down into Gibraltar Reservoir in order to survive. There have been numerous reports of stranded trout within this section. Arroyo Chubs are also common until flows subside.

Jameson Reservoir retains a good population of resident trout. Exotic bass and sunfish are likely not present in numbers comparable to those of Gibraltar and Cachuma. Spawning runs of good sized fish are observed into the tributaries. The North Fork Juncal flows over 2 miles in a southerly direction through steep upper bedrock and boulder cascades through moderate gradient boulder cobble step runs and through a short lower section of low gradient gravel glides and riffles. The upper Santa Ynez (Main Fork Juncal) flows in a westerly direction through almost two miles of steep boulder cascades followed by moderate gradient boulder/cobble step runs and riffles. Spawning trout and fry have been observed moving up this drainage.

HISTORICAL CONDITIONS

Historically, steelhead (Oncorhynchus mykiss) were a common inhabitant of California coastal streams as far south as Baja. An estimated 10,000-20,000 steelhead once ran over 50 miles up the mainstem Santa Ynez and additional distances into most of the major tributaries to spawn (Shapovalov 1944). Although the exact figures for steelhead production are arguable, there are many historical accounts of how the Santa Ynez River Basin produced larger runs and sized fish (20 lbs) than many other southcoast rivers. It is odd, however, that there are not the numerous historical accounts praising the Santa Ynez for it's rich resident trout angling like there are for other southcoast drainages. This may be just a matter of the accessibility and nearby human populations, or it may be a reflection that the Santa Ynez was a ideal producer for anadromous fish but could not support high numbers of fish into adulthood.

The best historical spawning habitat was concentrated in the mid to upper third of the Santa Ynez basin. The best quality mainstem spawning habitat was noted as from around present day Solvang up to Oso Creek in 1946 field observations (post Gibraltar Dam) (Shapovalov 1946). Cachuma and Santa Cruz were noted as significant spawning tributaries. Other upstream tributaries and mainstem areas also likely supported spawning steelhead but by the time steelhead began to decline and people took notice (ie the 1940's) reservoirs had already blocked access further upstream.

Historically, a substantial run of steelhead extended up into the lower part of Cachuma Creek. Natural bedrock falls provided at least partial blockage of fish passage into the upper basin. A "land-locked" run of steelhead continued to run up out of Cachuma Reservoir and utilizing lower reaches of Cachuma Creek to spawn but there were concerns with poaching and predators and a fish barrier (gabion??) was constructed at the outlet and several miles inland as a protective measure against poaching of spawners!

From what few accounts are available, steelhead appeared to begin their most precipitous decline in the late 1940's. The construction of Gibraltar Dam in the 1920's, Juncal Dam in 1930, and Bradbury Dam in 1953, blocked steelhead from accessing the upper Santa Ynez River and began to greatly affect habitat quality. Debris basins and water diversions further fragmented the habitat. During 1940-1950's steelhead were "rescued" from stranding in drying reaches and moved up and over many natural and artificial barriers. Over 175,000 steelhead were rescued from prematurely drying reaches and stocked into Peachtree Creek in the late 1940's.

Within the last 50 years, stocking of non-native rainbow trout has resulted in dilution of native genes although most of the stocking has occurred in the lower portion of the Santa Ynez River below Gibraltar Reservoir. Stocking or inadvertent introductions of other exotic species has likely also had effects on steelhead. The reservoirs contributed to expansion and continued presence of exotics, as even in floods and droughts the reservoirs serve as a refuge. Largemouth Bass, Smallmouth Bass, Greensunfish, and bullfrogs, are of particular concern. Tamarisk continues to be a problem that will need ongoing efforts at control.

Dams also cut-off much of the supply of sand and gravels and began a process which has drastically altered the downstream channels and floodplains. Road building, maintenance, and use, has also had an effect on steelhead and stream corridors, although probably less so than many other watersheds. Most of the present day access roads were built around the turn of the century. The retention of much of the upper River basin as semi-primitive and more recently designated wilderness, has protected it from some human disturbances.

Fire and post-fire floods and debris slides have been a significant disturbance processes in the upper Santa Ynez River basin. Chaparral fires occur every 30-60 years (Davis et al., 1988) and seem to burn hot over large areas of the landscape. In normal water or wet years the incidence of fire is low, it burns only at low intensities, and rarely burns through the moister riparian zones. The riparian network thus is protected from fire and may contain fires within smaller patches of the watershed. Such is also the case if nearby hillslopes have recently burned and lack the fuels to carry the fire. Many recent fires have originated in or near streams in areas of greatest concentration of fire causing human activity (campfires, vehicles, etc.).

People have also directly disturbed the Ventura River watershed and the riparian corridors. Downstream from Bradbury Dam, historical channelization and bank revetment work has straightened and constricted mainstem channels to the detriment of fish and other aquatic life. Channel clearing continues within the lower River basin but has not been substantial within the Forest. Woody debris has been cleared from channels after fire. Known locations of past channel clearing projects include Cachuma and Santa Cruz drainages.

CURRENT CONDITIONS

Steelhead and Rainbow Trout

The Santa Ynez River steelhead population continues to be severely depressed. While it is likely that steelhead pass upstream without detection it is certain that their numbers are low (<100?; Entrix 1994), below the 200 fish threshold associated with a high risk of extinction (Franklin 1980). There have been no confirmed reports of anadromous adult steelhead in the Ventura River since 1993 and only a few scattered reports since the 1960's.

Southern steelhead and rainbow trout are of the same species and potentially intermixing populations. As has been observed in other steelhead populations (Shapovalov and Taft, 1954) resident populations may coexist and geographically overlap with the anadromous form. Steelhead and rainbow trout eggs, fry, and juveniles can not easily be differentiated. They can conclusively be identified as "steelhead" when they go through the smoltification process which prepares their system for salt water and gives them the characteristic silvery appearance. Smoltification probably occurs when fish achieve a length of 15 cm within the first or second year (Moore, 1980). Smolts move downstream with receeding storm flows in April-June (Shapovalov and Taft, 1954).

Southern steelhead have adapted to the unpredictable climate by retaining the flexibility to remain landlocked through many years or even generations before returning to the ocean when conditions allow (Titus et al., 1994). Such traits and behaviors appear to be inherited and there could very well be differences in the extent of anadromy between different river basins and even within a single drainage (Waples, 1991). Research into the movements of inland trout has also shown that different populations have vastly differing degrees of mobility ranging from a few feet to 50 miles within a year (Schmal and Young, 1994). Both anadromous and resident trout have likely adapted to move upstream to counter effects of periodic flood extremes and droughts. Success of restoration may be dependant on retaining the appropriate genetics for physiology and behaviors adaptive to local situations.

Stocking of non-native rainbow trout may be detrimental to native trout and hamper the restoration of anadromous steelhead. Filmore Hatchery rainbow trout are stocked in Cachuma Creek and the mainstem Santa Ynez below Gibraltar Dam. Many tributaries have been stocked in the past but have not been stocked for over 10-20 years.

It is not clear to what extent overstocking with non-native rainbow trout may have caused introgression in the Santa Ynez steelhead. Genetic analysis of rainbow trout from Alder, Juncal, Fox, and Indian Creeks has suggested that these populations retain much of the genetic make-up of their southern steelhead ancestry (Nielsen et al. 1997). More recent genetic analysis has revealed that Devil's Canyon also may harbor a large component of fish with native steelhead genes (4 out of 5 fish sampled) (USFS data files 1997). Jameson Reservoir seems to maintain a mixture of the southern California and non-native stocks. It is not known if the progeny of resident trout with steelhead ancestry will ever be able to smolt and regain the anadromous life-style.

Until recently, the regular five fish limit without gear restrictions was applied throughout the Ventura River basin. Since 1993, only catch and release fishing with barbless artificial flies is allowed from May through December below Cachuma Reservoir in order to protect anadromous steelhead trout. The five fish limit continues in upstream reaches. Most angling activity is concentrated in Cachuma and the mainstem Santa Ynez below Gibraltar Dam and mostly takes place in spring extending into the early summer. The extent that angling has impacted wild trout populations is not clear. Steelhead populations have been shown to be highly susceptible to angling in the northwest (Pollard and Bjornn, 1973). Even catch and release angling can impact populations, especially later in summer when fish are already stressed by high water temperatures and reduced flows (Wright, 1992).

Angling as well as other recreational activity may be affect trout and their habitat. Recreationists concentrate their activity along fragile streambanks and wading in the prime shallow water spawning areas. Research has indicated that a single wading across salmonid spawning redds can kill 40% of the eggs. Mortality increases to over 90% with multiple wadings (Roberts and White, 1992). Recreationists build flimsy and yet channel altering small boulder and cobble dams for ponding water for summer soaking. At lower flows these small dams act as barriers to fish movements and create additional pool habitats that may favor exotic species such as bass, mosquitofish, sunfish, and bullfrogs to the detriment of native species and trout. Recreationists potentially have the greatest impacts on stream fish and biota from May through August with the highest potential impacts on steelhead and resident trout during April and May when the eggs and fry are sensitive to damage or habitat loss.

Resident rainbow trout are well dispersed throughout the upper Santa Ynez River basin, inhabiting all sections of the mainstem and tributaries where there is good perennial water and stream gradients are not too steep (generally less than 10%). In drought years their distribution shrinks and in high water years their distribution expands where falls, boulder cascades, or man-made barriers do not block their upstream migration. The highest densities of juvenile trout are found within seasonal intermittent reaches such as Blue Canyon and Alder Creek.

Santa Ynez River basin supports low to moderate ("good" according to Smith 1982) overall trout densities (0.3-2.0 fish per m^2), comparing favorably to more northerly coastal streams (Burns 1971; Shapovalov and Taft 1954) and of similar densities to other south coast streams (USFS data files). Adult population densities are estimated at 300-1000/mi which is lower than densities encountered in other southern California coastal streams. Juvenile densities ranged from 0.1-5.0 per m^2 with the average around 1.2, higher than documented in many other southcoast streams, including the lower Santa Ynez River (0.18/m^2; Entrix 1994). These differences in productivity may be related to morphological, geological, and hydrological differences between watersheds but could also indicate that human influences have taken a toll. The discrepancy between high juvenile but low adult populations may indicate that the Santa Ynez River basin has the capability to produce large numbers of steelhead smolts that go to sea to complete their growth but is not ideal for supporting year-round high resident trout production.

Among the tributaries, Blue Canyon holds the greatest potential to produce a large number of fry. There seems to be something particularly productive about the lower gradient east-westerly reaches of Blue Canyon and Alder Creeks. Access of fry to continued late summer rearing habitat may be a problem, however. Other areas of high observed fry densities include Juncal Creek above

Jameson Reservoir, Fox above Gibraltar Reservoir, and sections of Santa Cruz Creek and it's tributaries above Cachuma Reservoir.

Projecting fry densities across the potential fish producing reaches within the Santa Ynez River basin, Forest lands would yield roughly 92,000 juvenile trout on the whole or equivalent smolts to support an adult steelhead run of approximately 1,800 (Table 1). A similar but higher estimate of potential steelhead production (4,000 adult spawners) can be derived from the quantity and quality of spawning habitat which could be made accessible to spawning steelhead within the Forest Service System lands. These estimates are within the realm of the historical projections of over 10,000 steelhead historically utilizing the Santa Ynez River basin (Shapovalov 1944) but rather low. The discrepancy may be due to present-day habitat alterations and differences in productive capabilities of anadromous steelhead and the current resident trout.

Projected spawning capacities reinforces the premise that Blue Canyon, Santa Cruz and Alder Creeks are the prime potential steelhead smolt producers. Because of extensive and/or high quality available habitat, Mono/Indian Creeks, Devil's Canyon, and the lower mainstem Santa Ynez emerge as additional contenders as major production areas (Figure 1).

Other Aquatic Species:

Pacific lamprey (Lampetra tridentata) share many of the same habitat requirements as steelhead and may spawn and rear within similar areas and within the same season. Lamprey larvae are not easily detected, however, and although they were not observed in Forest Service surveys they may be there. Lamprey are also hampered in their upstream migrations by natural and artificial barriers, but possibly to a lesser extent than steelhead.

Arroyo chub (Gila orcutti) are found in abundance (10-20 fish per 100 feet) throughout much of the mainstem Santa Ynez and many of the lower gradient reaches of tributaries. Chubs appear to be associated with low gradient riffles and runs (USFS, 1995). Three spine stickleback (Gasterosteus aculleatus aculleatus) are not as abundant but are common in the middle Santa Ynez above Gibraltar Reservoir. Stickleback habitat includes small pools with constant flow and low water velocities (Baskin and Bell, 1975). Both species are known to coexist with steelhead and resident trout and may serve as a food source for migrating adult steelhead.

Several species of sculpin (staghorn sculpin Leptocottus armatus, prickly sculpin Cottus asper) and tidewater goby (Eucyclogobius newberryi) co-existed with steelhead and were native to the Santa Ynez lagoon and estuary. Sculpin may also have inhabited the mainstem but were not likely to have extended far into the upper basin and tributaries. Sculpins have been observed in Cachuma Reservoir and may extend into Cachuma and Santa Cruz Creek. Neither of these species interacted with steelhead to any great degree except possibly as a food source for migrating adults.

Exotic species that are abundant in the upper Santa Ynez River basin include Largemouth Bass (Micropterus salmoides), Smallmouth Bass (Micropterus dolomieui), Greensunfish, (Lepomis cyanellus), Bluegill (Lepomis macrochirus), and Pacific Crayfish (Procambarus clarki). Less abundant exotics include Fathead Minnows (Pimephales promelas), and Mosquitofish (Gambusia affinis). Highest densities of the exotics are found in the reservoirs, mainstem, and lower gradient sections of some of the tributaries. Crayfish are scavengers that readily feed upon eggs and fry in gravel spawning beds (Hobbs et al. 1989; Page 1985). Periodic floods likely limit upstream expansion of these species. Droughts may limit populations but can also increase the impacts of exotics on native species as there is increased competition for shrinking habitat.

Native species which may impact trout and steelhead include western pond turtles (Plemmys marmorata pallida) and two striped garter snakes (Thamnophis hammondii). Turtles prey upon fish but only if the fish are stranded, dead, or sluggish. Two-striped garter snakes are highly effective predators, taking juvenile salmonids of up to five inches in length. Their impacts on local fish populations can be substantial during dry summers when fish are concentrated in limited habitat.

Other native aquatic species that appear not to negatively impact trout or steelhead included Red-legged Frogs (Rana aurora), California Treefrog (Hyla cadaverina), Pacific Treefrog (H. regila), Western Toads (Bufo boreas), Arroyo toads (Bufo microscaphus), and California Newt (Taricha torosa). All of these species except California newts overlap with trout in the use of stream channel types, reaches, and to some extent instream habitat. California newts generally inhabit perennial stream reaches where trout densities are low to non-existant. Newts are not common in the Santa Ynez River basin. Arroyo toads requires shallow open pools, with little to no flowing current, and open banks, usually the low gradient reaches with only seasonal water flow. Red-legged Frogs typically utilizes dense shrubby riparian vegetation associated with deep pool habitats (>1 meter deep) in still or slow moving perennial water (Christopher 1994, Stebbins 1954, Hayes and Jennings 1988).

Habitat Quality -- Migrations

Southern California steelhead/rainbow trout move upstream to spawn during the tail-end of winter storm events between January and March (Shapovalov and Taft 1954). Usually, several successive winter storms would allow for multiple spawning migrations and assist with the movements of steelhead smolts downstream to the ocean.

Landlocked resident rainbow trout may also move great distances as a mechanism to survive the typical flood and drought cycle (Schmal and Young 1994). If upstream movements are blocked, trout survival and reproduction may be drastically reduced. Entire year classes may be lost as the lower and mainstem channels go dry; Adult spawners may not be able to reach suitable spawning habitat and return safely to good summer holding water. Trout strandings are common. Natural falls and concrete dams with a drop of over four feet are generally complete barriers to upstream fish movements.

Migrating steelhead can generally navigate upstream against flows up to 6 feet per second and leap over 4-6 foot heights (Evans and Johnston, 1972). Deep water (>half of the vertical jump) is necessary to gain the leaping momentum. Resting pools (>6") are necessary in long sections of high velocity flows. Swimming and jumping abilities are size dependant (Evans and Johnston 1972), so that fewer but larger individuals may be able to reach the upper reach spawning beds. The spawners that do make the effort would be compensated with less competition for available habitats, larger and more numerous fry, and healthier progeny.

Complete high flow barriers are found within almost every major tributary to the Santa Ynez. Many of these barriers are formed by water plunges through boulders jammed against bedrock streambanks and canyon walls. Some of the barriers are waterfalls over bedrock ledges. Boulder barriers may shift to form or open so as to allow fish passage during extreme flood flows or earthquake activity. There is also opportunity for human intervention to blast open a channel for fish passage. The rather immutable waterfalls, however, are often situated at the lower end of reaches with boulder barriers, and thus the potential for opening up additional access for steelhead is limited at best.

During low flows, boulder cascades, bedrock slides, and low gradient riffles may become barriers to upstream fish movement. Steelhead may become stranded on their upstream migration if flows rapidly decline. The presence of good deep resting pools is essential during this period as fish may wait out the period between storms. An average of one out five years is well below normal precipitation (less than 15 inches over the year) potentially severely limiting steelhead spawning migrations and trapping downstream moving smolts.

Low flow barriers are likely found throughout many of the reaches of the upper Santa Ynez River basin. Low to moderate flow fish passage is thought to occur when depth is greater than 0.6 feet over more than 25% of the wetted channel and with velocities of more than 8 feet per second (Thompson 1972). Surveys were not of sufficient detail to describe all low flow barrier locations.

Artificial barriers to steelhead migrations include Bradbury, Gibraltar, and Juncal Dams as well as water diversion structures on Devil's Canyon, Fox, and Alder Creeks. Road crossings may be low flow barriers within the mainstem Santa Ynez below Gibraltar and above Jameson Reservoir. Sediment catchment basins also block upstream fish movements on Indian, Mono, and East Fork Juncal Creeks.

Habitat Quality -- Spawning

Spawning trout seek out riffles or pool tails where gravels are plentiful and within a usable size range (1/4-3/4") and silts are minimal (<15-30% of volume) (Phillips et al. 1975). Stream flow must be adequate to maintain oxygen levels of at least 5 ppm (Bjornn and Reiser 1991) and temperatures between 3 and 20 ^{o}C (Bell 1986). North facing tributaries seem to have the best stream flows and cooler water temperatures extending later into the egg incubation and fry rearing periods.

As previously discussed, steelhead, and likely wild rainbow trout, will move into seasonally flowing reaches to spawn. They are not limited to only perennial waters and may infact utilize intermittent reaches to avoid crowding and potential predators (Carroll, 1985; Everest, 1973). Riffles provide the predominant spawning habitat although small gravel pockets associated with pool tails may also be utilized by steelhead rainbow trout. Juncal, Alder, Fox, Blue Canyon, and Devil's Canyon Creeks have the highest proportions of riffle habitat.

Not all riffle habitat is good spawning habitat, however. Good spawning habitat should have a high percentage of gravels (>20%), no more than 15% fine sediments, and channel morphology (width/depth ± 15) offering the good oxygen and silt carrying velocities. Given these parameters, the most suitable spawning areas would be predicted to be in Blue Canyon and Alder Creeks. And indeed, these areas support some of the highest densities of trout fry.

The majority of mainstem spawning habitat downstream of Bradbury Dam occurs upstream of Refugio Road (ie. approximately 8 miles). Projections from redd densities would indicate that the area could produce about 1.2 million fry but that rearing habitat would further limit numbers produced to about 180,000 (Entrix 1994). In dry years losses might have been greater with most of the available rearing habitat areas going dry in summer.

Rearing Habitat

Two or three weeks after fertilization the eggs hatch and emerge as fry. Fry emergence is a time period when trout are highly sensitive to silt, water temperature, and fluctuations in flow (Phillips et al. 1975; Sigler et al. 1984). The prime spawning habitat is located in low gradient alluvial channels which naturally may go dry in summer or earlier in drought years. Local trout have adapted to local hydrology so as to ensure the timing of emergence almost always proceeds extreme reductions. Once-hatched fry remain in shallow margins of riffles and runs close to the spawning beds until they have grown enough in a month or so to actively migrate to more suitable stable summer habitat (Bisson et al., 1981).

Low gradient riffles, runs, and glides provide the primary rearing habitat into the early summer. The quality of rearing habitat is largely determined by the continuation of water flow of moderate temperatures and the availability of cobble and small woody debris for use as cover from predators and protection from high water velocities.

The best rearing areas do not completely overlap with the localities of the best spawning reaches. Juncal, Alder, and Fox Creeks appear to have sufficient rearing habitat to support the fry that are produced in spawning beds. Blue Canyon and Devil's Canyon may not have sufficient rearing areas to meet the demands of fry produced from spawning beds. Other areas that may provide good rearing habitat but do not necessarily have prime spawning areas include sections of the Santa Cruz, Mono, and Indian drainages.

Food Producing Habitats

Adult steelhead/rainbow trout feed on aquatic and terrestrial insects such as caddisflies, mayflies, and stoneflies in addition to snails and other fish (Shapovalov and Taft, 1954). Temperature extremes, siltation, and loss of riparian vegetation can lead to a reduction in the aquatic food base and overall health and survival. Obviously, a premature loss of flow during the peak period of spring productivity can also affect insects, thus affecting fish.

Good spawning riffles and pool tails are usually also good food production zones. Highest productivities would be expected where substrate size is dominated by cobble, however. Woody debris contributes nutrients and substrate for primary and secondary production. Less than 15% fines and moderate sunlight but ample streamside vegetation (canopy 40-60%) would be ideal for aquatic insect production. Based upon limited aquatic invertebrate sampling, food availability is good throughout most of the upper Santa Ynez River basin mad may not be the key factor limiting trout recruitment.

Late Summer Habitat

As fish grow in late summer and fall they move into swifter and deeper water, inhabiting runs and pools (Chapman and Bjornn, 1969). Runs are quite common and not limiting. Pools and coolwater refugia from the summer heat are likely the most restrictive bottleneck that reduces population size and limits growth and recruitment. During dry years, summer conditions of high temperatures and low dissolved oxygen are particularly severe reducing fish growth, survival, and health. By August particularly in drought years, only isolated deep pools retain fish, and complete or partial fish die-offs can occur. If there are barriers to upstream movements it is possible that a tributary may become fishless after extreme drought.

Loss of riparian canopy or widening of a stream channel can greatly increase water temperatures and reduce trout survival. Steelhead/rainbow trout are thought to prefer temperatures between 10-13 ^{o}C (Bell 1986) and may die if exposed to temperatures above 25^{o}C (Charlon et al. 1970). Long term exposure to sub-lethal temperatures (14-25^{o}C) weaken trout and leave them more susceptible to disease and predation. High but sublethal water temperatures can also affect growth (Barnhardt, 1986), smoltification, immunity to other stresses, and behavior (Reeves et al. 1987).

Southern California steelhead/rainbow trout appear to survive under higher water temperatures and lower dissolved oxygen levels than other trout. It is unclear however whether they can better withstand heat or if they have developed ways to simply avoid it through microhabitat selection (Matthews and Berg 1994). If subsurface flows are reduced and riparian vegetation declines overall water temperature will increase and seep fed pool refuges will also be reduced. This effect may be particularly damaging during late spring when entire year classes may be lost.

Reaches with denser canopy cover are likely to maintain the coolest water temperatures into late summer. Likewise, cool water springs and seeps may be important. Much of the mainstem Santa Ynez experiences high temperatures (>75^{o}F) that likely limit trout survival and production. Hot springs in Caliente and Little Caliente further increase temperatures. The best end of summer and drought refugia are to be found in reaches of Juncal, upper Alder, Escondido (tributary to Blue Canyon), Fox, Indian, Devil's Canyon, and Santa Cruz. Only limited areas of the mainfork Santa Ynez above Jameson and below Gibraltar Reservoirs have any appreciable shading.

Pool densities may also be related to trout abundance. Deep pools have been shown to retain cooler water near the bottom, offering thermal refugia to fish in late summer (Matthews and Berg 1996). Salmonids, and particularly steelhead require deep pools as resting areas and refuges from high flows and water temperatures (Dunn, 1981). As juvenile steelhead grow they gradually shift from shallow to deeper water habitat, including pools (Bisson et al., 1981). Adult fish with a higher metabolism and larger body mass, require deep holding pools in order to survive winter floods and summer droughts.

Generally, the best and most abundant pool habitat is situated within the mid to upper reaches of side drainages. The mainstem is pool poor which when coupled with higher solar influx with a less dense shade canopy and lack of coolwater springs and lesser late summer flows means inhospitable summer habitat. The side tributaries are presently the most significant resident trout habitat and linkages must be maintained or restored to mainstem reaches in order to restore viable anadromous steelhead runs.

Water Quality

Detailed water quality sampling has not been conducted within the upper Santa Ynez River basin. Low dissolved oxygen can be a problem in mainstem reaches where flows are stagnant, algae growth vigorous, and temperatures are warm. Water quality is likely to be adequate for trout and steelhead throughout most reaches of the side tributaries. PH, mineralization, and alkalinity may be high, especially within reaches with a large influx of groundwater springs and seeps. White crusty sodium chloride and sulfide deposits are common where evaporation is high near spring influxes. In some reaches (as noted in Cachuma Creek) calcium carbonates will precipitate out forming a layer of cement across the stream bottom. Such cementing could lessen the quality of spawning beds although winter high flows appear to dissolve the minerals and break up much of the cement prior to the spawning period. Scattered small iron rich seeps may contribute to local precipitation of iron floculants which can be damaging to fish eggs and gills (McKee and Wolf, 1970).

The water chemistry suggests a moderately productive aquatic community, although nutrient levels have not been measured. Aquatic productivity may be limited at total dissolved solids over 400 ppm (Bell 1973) as may be encountered immediately downstream from high mineral hot springs.

Economics

Based upon the recreational and tourism money ($106/fish) that can be associated with steelhead trout (RPA, 1990), the Ventura watershed is potentially worth at least a million dollars, probably more. Additional economic value can be derived from non-consumptive use of steelhead resources. Other values associated with the presence of a healthy steelhead run can not be assigned a monetary figure.

SUMMARY AND CONCLUSIONS

Steelhead are currently blocked from accessing approximately 60% of their present and historical spawning and rearing habitat. Modification of the dams with fish ladders or trap and truck operations would open up an additional 23, 40, and 5 miles above Cachuma, Gibraltar, and Jameson Reservoirs, respectively. Providing access to Cachuma and Santa Cruz Creeks could produce 540 potential steelhead. Access to the lower Santa Ynez mainstem upstream from Cachuma Reservoir could produce 240 steelhead adults. Just getting fish into the upper most part of this mainstem section and Devil's Canyon would produce 280 steelhead.

Restoration of fish passage above Gibraltar Dam and into Indian and Mono Creeks would support an estimated 1,200 steelhead. Without access up Mono and Indian Creeks around the Mono Debris Dam only about half of the potential steelhead would be produced. Restoration of access to above Juncal Dam would represent potential production of a 100 or so steelhead. If all of the above measures are taken, an additional 68 total miles of spawning and rearing habitat could be utilized to produce an estimated 1,800 to 4,000 steelhead adults. These estimates may be conservative.

Santa Ynez River steelhead can not afford any loss of numbers due to natural or unnatural causes. If the steelhead population was strong and well distributed it could withstand a poor reproductive year due to floods, fires, drought, or temporary barriers to fish passage. At the currently suspected low population size (<200 spawning adults) even minor disturbances could be devastating. The watershed should be managed for a diversity of steelhead habitat areas so as to minimize the risks of simultaneous catastrophic disturbance. Overall steelhead population viability can best be maintained by restoring multiple (ideally at least three) spawning subpopulations within the Santa Ynez watershed and managing these populations without encouraging intermixing.

Based upon the estimates of steelhead smolt production and habitat capabilities, restoring fish passage up through the middle section of the Santa Ynez above Gibraltar Reservoir is the most likely to be biologically effective alternative. The opportunities for long term and unimpeded recovery and restoration of steelhead may be greater in the less heavily used but readily accessed middle section of the upper Santa Ynez. This section also has the advantages of multiple perennial and seasonal side tributaries which could support spawning and rearing steelhead and distribute the population into additional subpopulations which may be able to better withstand disturbances such as floods, drought, and fire. The potential difficulties with exotics in Gibraltar Reservoir should be examined.

Restoration in the lower Santa Ynez entails numerous challenges such as the predominance of exotic species, constant and extensive human disturbance, conflicts with a popular put-and-take fishery, and a lack of adequate flows and appropriate spawning substrates. It may be worth considering getting fish into the upper section below Gibraltar Dam with access into Devil's Canyon.

Re-establishment of a link between Jameson Lake and an anadromous run would be worthwhile as the upper watershed tributaries are productive and isolated from human disturbance. However, the quantity of available habitat and potential for production is less than the other areas and there may be value in maintaining the land-locked native genetic pool separate from the ocean run fish.

Second priority alternatives would be to restore fish passage into Mono and Indian Creeks so as to provide continuity between several tributaries and the mainstem and to encourage linked but separate and diverse spawning subpopulations. If feasible, restoration of steelhead passage into Santa Cruz would also be worth evaluation. Ideally three separate subpopulations should be restored to viable levels to provide insurance against catastrophic loss from fire, flood, drought, or disease.

RECOMMENDATIONS

From a strictly fisheries perspective, the most important actions that need to be taken are those that will allow steelhead to access their prime spawning grounds in the upper Santa Ynez River basin. The Forest Service can contribute to this effort by providing the best available information on the consequences of various alternatives and by addressing opportunities to restore steelhead to Forest lands. As discussed above, restoration of steelhead access to the mainstem Santa Ynez above Gibraltar Reservoir may be biologically the most effective alternative. Of course, the ideal situation would be restoration of steelhead to their entire historic range, from ocean to upper Juncal Creek.

If any of the alternatives prove worth further study, the Forest Service will need to also analyze the consequences of reintroducting steelhead on other Forest activities, particularly recreation. Fish passage issues at Forest Service road crossings and permitted water diversions are already under analysis since fish passage is also a concern for resident trout. Prospects of reintroducing steelhead would step up the analysis and possibly aid in securing funds and earlier implementation.

Protective measures to decrease migratory mortality would also require multi-agency involvement. Any alternatives that would reintroduce steelhead to the lower Santa Ynez below Gibraltar Reservoir would require a great deal of planning, public education, possibly modifications in facilities, and stepped-up law enforcement. Methods of controlling potentially harmful exotic species would need further development and major coordination among the regulatory and management agencies.

The water management and regulatory agencies may need to consider modifications of water release, diversion, and storage schedules. If steelhead restoration to the above Gibraltar Reservoir is possible, it may be worth considering augmentation of flow releases from Juncal Dam during the critical periods when fry need to disperse between the high production spawning reaches downstream to other more perennial areas for late summer rearing.

Measures to reduce streambank instability and control run-off of silts may be indicated. A more detailed analysis of overall watershed conditions would be necessary to identify, prioritize, and plan projects. Although there are some localized areas which could be treated to reduce erosion, efforts to return the watershed to a more natural or desirable fire cycle may be the most significant Forest Service contribution to restoration of steelhead habitat. Not only would siltation be lessened, but watershed hydrology could be improved to lessen the effects of drought and scouring floods and thus enhance habitat. The District has been implementing prescribed burns for a number of years with good success. An update to the fire management plan may be warranted to address steelhead issues and opportunities.

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Table 1. Habitat capability and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) Total #YOY from Densities
ABOVE CACHUMA RESERVOIR:													
S.Ynez	1	C3	S	2.0	6.0	10	20	20	flow	40	30	400	1,940
	2	C2	SI	3.0	10.0	30	5	20	flow	724	30	7,240	2,896
	3	C2	PI	3.0	10.0	20	5	20		483	70	4,830	6,760
Cachuma	1	B3?	PI	4.0	1.5	10?	10?	10?		193	25	1,930	320
	2	B3?	PI	4.0	1.5	10?	10?	10?	bldr	193	25		
S.CruzEF	1	B3?	P	3.0	1.5	10	5	0		36	30	720	2,880
	2	B1	P	3.5	2.0	20	10	0	falls	225	45	4,500	5,320
	3	B2	P	3.0	1.0	20	15	5	bldrs	90	130	3,600	12,540
Grapevin	1	C2?	P	0.7	2.0	40	10	10		90	130	1,800	2,900
	2	B3?	P	1.3	1.5	40	10	5		318	50	12,720	2,100
S.CruzWF	1	B2?	P	2.5	1.5	20	10	10		121	30	2,420	2,400
Coche	1	B3?	P	1.3	1.5	20	20	5		126	25	5,040	1,040
	2	B3?	P	1.0	1.5	20	20	5		242	65	4,840	2,100
Black	1	B2?	S	2.0	1.5	20?	10	10	flow	97	0	-	-
Peachtre	1	B3	SI	1.0	1.5	20?	5	30	falls	24	60	240	1,920
Oso	1	B3	S	1.0	1.5			-	flow		0		
	2	B2	S	1.0	1.0				flow		0		
Devil's	1	D3	S	0.1	4.0	60	10	10	flow		0		
	2	B3a	SI	0.1	3.5	60	20	0	flow-x	68	20	2,720	60
	3	B2a	P	1.5	2.0	30	20	5		290	20	11,600	60
	4	B2a	P	1.0	2.0	30?	20	5?	falls	193	0	-	-
Total above Cachuma:				32								66,532	117,016
Total Steelhead potential:				23								56,261	25,456

Table 1. Continued: Habitat capabiity and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) Total #YOY from Densities
ABOVE GIBRALTAR:													
S.Ynez	4	C2	S	8.0	5.0	20	15	10	flow	1545	30	30,900	7,720
Gidney	1	B2?	S	0.6	1.0	20	10	5		193	80	7,720	1,540
	2	B3	P	1.4	1.5				bldrs				
	3	A2	P	1.0	1.0				falls				
Camuesa	1	B3	I	6.0							0	-	-
Indian	1	B2	S -	1.0	3.5	20	15	20		169	30	1,690	960
	2	B3a	SI	1.5	3.0	20	10	30		145	10	1,450	480
	3	B3?	P	2.0	2.0	20	10	5		129	10	5,160	640
	4	B2?	P	3.0	2.0	20?	10	5		193	60	7,720	5,800
	5	B3?	PI	5.0	2.0	20?	15	5	falls	483	30	19,320	4,820
Buckhorn	1	B3?	PI	2.0	2.0	20	15	5		193	65	7,720	4,180
	2	A2	PI	2.5	1.5	40	10	15		241	130	4,820	10,460
Mono	1	C1	S	1.0	3.0	30	5	20	warm	72	0	-	-
	2	C2?	SI	2.5	2.0	20	20	20	warm	322	15	3,220	1,200
	3	B2?	SI	6.0	1.5	20	10	10		290	45	5,800	8,680
	4	B3?	PI	6.5	1.0	10	15	10		157	15	3,140	3,120
A.Calien	1	D1	S	1.0	3.0						0	-	-
	2	B1	PI	3.5	1.5	50	20	10	hot	845	0	-	-
Blue C.	1	B4c	SI	1.2	3.0	50	50	15	flow	1448	450	28,960	1,720
	2	B4	SI	1.6	2.0	40	35	20		901	?	7,200	?
	3	B3	SI	0.8	1.5	30	45	20		435	?	2,300	?
Escondido	1	B3a	P	0.2	4.0	35	30	15		135	100	2,700	640
	2	A2	P	0.6	2.0	?	5	20	steep	29	?	290	
	3	A2a+	P	0.7	1.2	?	30	10	+bldr	20	0		
Fox	1	B3a	P	0.5	2.5	40	10	20		80	110	1,600	1,760
	2	A2	P	1.0	1.5	30	10	5	div	72	0	2,880	
Alder	1	B3	SI	1.6	3.0	40	30	15		927	250	9,270	12,880
	2	A2a	PI	0.8	2.0	40	20	15		206	100	2,060	2,560
	3	A2	P	0.2	1.5	10	5	30	div	2	?		
	4	A2a	P	0.2	1.0	20	5	15	falls	3	0		
Total above Gibraltar:				64								133,720	69,160
Total Steelhead potential:				40								130,210	63,140

Table 1. Continued: Habitat capabiity and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) from Densities
ABOVE JAMESON RESERVOIR:													
S.Ynez	5	B2a	SI	0.9	2.0	25	25	0		188	40	7,520	1,160
	6	A2a+	P	0.9	1.5	30	20	5	xings	143	20	5,720	580
JuncalNF	1	C3b	SI	1.0	2.5	40	5	30		80	?	1,600	
	2	B2a	P	0.5	1.5	40	10	10		48	110	960	1,760
	3	A2	P	0.8	2.0	10	5	20	steep	13	20	130	500
	4	B2a	P	1.0	2.0	10	15	15	flow	48	0	960	
Total above Jameson:				2 5								16,890	4,000
Total Steelhead potential:				3								15,800	3,500
TOTAL:				101								217,142	118,716
TOTAL STEELHEAD POTENTIAL:				69								202,271	92,096
													96

(1) P=perennial, S=seasonal, I= intermittent
(2) Spawning Habitat available = reach lengthxwidth x %riffles x %gravels
(3) Estimated potential YOY or smolt production derived from available gravel spawning habitat, multiplied by 0.20 redds/m^2 (Reiser and White 1981), 2000 eggs/redd (Bulkley 1967), and 0.50 survival of eggs to fry (Bley and Moring 1988). Estimage further reduced by 0.50 if fine sediments 10-20% and 0.25 if fines >20%.

(4) Estimated current YOY production derived from observed salmonid fry densities projected over total reach length and multiplied by 0.20 for mortality to smolting.

Table 1. Habitat capabiity and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) Total #YOY from Densities
ABOVE CACHUMA RESERVOIR:													
S.Ynez	1	C3	S	2.0	6.0	10	20	20	flow	40	30	400	1,940
	2	C2	SI	3.0	10.0	30	5	20	flow	724	30	7,240	2,896
	3	C2	PI	3.0	10.0	20	5	20		483	70	4,830	6,760
Cachuma	1	B3?	PI	4.0	1.5	10?	10?	10?		193	25	1,930	320
	2	B3?	PI	4.0	1.5	10?	10?	10?	bldr	193	25		
S.CruzEF	1	B3?	P	3.0	1.5	10	5	0		36	30	720	2,880
	2	B1	P	3.5	2.0	20	10	0	falls	225	45	4,500	5,320
	3	B2	P	3.0	1.0	20	15	5	bldrs	90	130	3,600	12,540
Grapevin	1	C2?	P	0.7	2.0	40	10	10		90	130	1,800	2,900
	2	B3?	P	1.3	1.5	40	10	5		318	50	12,720	2,100
S.CruzWF	1	B2?	P	2.5	1.5	20	10	10		121	30	2,420	2,400
Coche	1	B3?	P	1.3	1.5	20	20	5		126	25	5,040	1,040
	2	B3?	P	1.0	1.5	20	20	5		242	65	4,840	2,100
Black	1	B2?	S	2.0	1.5	20?	10	10	flow	97	0	-	-
Peachtre	1	B3	SI	1.0	1.5	20?	5	30	falls	24	60	240	1,920
Oso	1	B3	S	1.0	1.5				flow		0		
	2	B2	S	1.0	1.0				flow		0		
Devil's	1	D3	S	0.1	4.0	60	10	10	flow		0		
	2	B3a	SI	0.1	3.5	60	20	0	flow-x	68	20	2,720	60
	3	B2a	P	1.5	2.0	30	20	5		290	20	11,600	60
	4	B2a	P	1.0	2.0	30?	20	5?	falls	193	0	-	-
Total above Cachuma:				32								66,532	117,016
Total Steelhead potential:				23								56,261	25,456

Table 1. Continued: Habitat capability and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) Total #YOY from Densities
ABOVE GIBRALTAR:													
S.Ynez	4	C2	S	8.0	5.0	20	15	10	flow	1545	30	30,900	7,720
Gidney	1	B2?	S	0.6	1.0	20	10	5		193	80	7,720	1,540
	2	B3	P	1.4	1.5				bldrs				
	3	A2	P	1.0	1.0				falls				
Camuesa	1	B3	I	6.0			-				0	-	-
Indian	1	B2	S	1.0	3.5	20	15	20		169	30	1,690	960
	2	B3a	SI	1.5	3.0	20	10	30		145	10	1,450	480
	3	B3?	P	2.0	2.0	20	10	5		129	10	5,160	640
	4	B2?	P	3.0	2.0	20?	10	5		193	60	7,720	5,800
	5	B3?	PI	5.0	2.0	20?	15	5	falls	483	30	19,320	4,820
Buckhorn	1	B3?	PI	2.0	2.0	20	15	5		193	65	7,720	4,180
	2	A2	PI	2.5	1.5	40	10	15		241	130	4,820	10,460
Mono	1	C1	S	1.0	3.0	30	5	20	warm	72	0	-	-
	2	C2?	SI	2.5	2.0	20	20	20	warm	322	15	3,220	1,200
	3	B2?	SI	6.0	1.5	20	10	10		290	45	5,800	8,680
	4	B3?	PI	6.5	1.0	10	15	10		157	15	3,140	3,120
A.Calien	1	D1	S	1.0	3.0						0	-	-
	2	B1	PI	3.5	1.5	50	20	10	hot	845	0	-	-
Blue C.	1	B4c	SI	1.2	3.0	50	50	15	flow	1448	450	28,960	1,720
	2	B4	SI	1.6	2.0	40	35	20		901	?	7,200	?
	3	B3	SI	0.8	1.5	30	45	20		435	?	2,300	?
Escondido	1	B3a	P	0.2	4.0	35	30	15		135	100	2,700	640
	2	A2	P	0.6	2.0	?	5	20	steep	29	?	290	
	3	A2a+	P	0.7	1.2	?	30	10	bldr	20	0		
Fox	1	B3a	P	0.5	2.5	40	10	20		80	110	1,600	1,760
	2	A2	P	1.0	1.5	30	10	5	div	72	0	2,880	
Alder	1	B3	SI	1.6	3.0	40	30	15		927	250	9,270	12,880
	2	A2a	PI	0.8	2.0	40	20	15		206	100	2,060	2,560
	3	A2	P	0.2	1.5	10	5	30	div	2	?		
	4	A2a	P	0.2	1.0	20	5	15	falls	3	0		
Total above Gibraltar:				64								133,720	69,160
Total Steelhead potential:				40								130,210	63,140

Table 1. Continued: Habitat capabiity and estimates of potential steelhead production in the upper Santa Ynez River basin (based upon U.S.Forest Service stream surveys 1982-present).

DRAINAGE	Reach	Chan Type	(1) Flow Type	Miles	average Width (m)	%Rifl	%Gravl	%Fine	Barrier Type	(2) Spawning Habitat (m^2)	YOY Trout Densities (#/100m)	(3) Total #YOY from Habitat	(4) from Densities
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	6	A2a+	P	0.9	1.5	30	20	5	xings	143	20	5,720	580
JuncalNF	1	C3b	SI	1.0	2.5	40	5	30		80	?	1,600	
	2	B2a	P	0.5	1.5	40	10	10		48	110	960	1,760
	3	A2	P	0.8	2.0	10	5	20	steep	13	20	130	500
	4	B2a	P	1.0	2.0	10	15	15	flow	48	0	960	
Total above Jameson:				2 5								16,890	4,000
Total Steelhead potential:				3								15,800	3,500
TOTAL:				101								217,142	118,716
TOTAL STEELHEAD POTENTIAL:				69								202,271	92,096
													96

(1) P=perennial, S=seasonal, I= intermittent

(2) Spawning Habitat available = reach lengthxwidth x %riffles x %gravels

(3) Estimated potential YOY or smolt production derived from available gravel spawning habitat, multiplied by 0.20 redds/m^2 (Reiser and White 1981), 2000 eggs/redd (Bulkley 1967), and 0.50 survival of eggs to fry (Bley and Moring 1988). Estimage further reduced by 0.50 if fine sediments 10-20% and 0.25 if fines >20%.

(4) Estimated current YOY production derived from observed salmonid fry densities projected over total reach length and multiplied by 0.20 for mortality to smolting.

Santa Ynez Watershed Stream Data
Last Updated May 31, 1997 by Nicolas Romero

Legend

Vegetation Key:

AD = Al[der] LT = L[ilac] CW = Cottonwood
B = Bay M = Maple SM = Sycamore
SH = Brush O = Oak W = Willow
GR = Grass SH = Shrub

Methods Key:

FHR = Fish Habitat Relationships
RSHT = Region 5 Habitat Typing
Tran = Transects
SCI = Pacific Southwest Region Stream Condition Inventory

Note 1 Width/Depth was calculated by dividing the mean bankful width by mean bankful depth
2 Asterik* denotes surveys where W/D was calculated by dividing mean wetted channel width by mean wetted channel depth

Stream channel attributes associated with the channel mapping layer of the Santa Ynez watershed analysis

Date	Subbasin Name	Method	Reach#	Length (mi)	Flow (ESP)	Rosgen Chan/Sub Type	Width/Depth (BF/D)	Mean Width (m)	Mean Depth (m)	Pools/mi >3'	Avg Pool Depth (m)	% pool	% run	% riff	% Erod Bank	% fines	% gravel	% cobble	% canopy	% inst cover	Rip Veg Dom	Rip Veg Subdom	Rip Veg width (m)	Fish Size (mm)	Fingerling #/100 (m)	Sub Adult #/100 (m)	Adult #/100 (m)	Flow (CFS)
07-27-94	Juncal (Proper)	FHR/Trans	01	0.85	I	B2a	12.1	6.6	0.58	-	-	75	0	25	12.5	0	28	21	100	24	AD	SM	24.5	41-250	29.8	34.3	22.9	0.312
07-27-94	Juncal (Proper)	FHR	02	0.87	I	A2a+	11.1	4.2	0.38	-	0.2	67	0	33		24	22	5	100	27	AD	W	11	83-210	0	44	3.3	0.144
06-21-94	NF Juncal	Transect	0001	0.85	I	C3b	21.6	3	0.45				-	-	31.7	31	6	41	74		AD	W	37.4					0.003
06-21-94	NF Juncal	Transect	0002	0.53	P	B2a	16	2.77	0.57	-	-	-	-	-	-	25	15	20	100		AD	W	23.8					0.513
06-21-94	NF Juncal	FHR/RSHT	0002	0.83	P	B2a	8.43	2.53	0.3	0	0.38	37	24	39		14	8.2	19	23	52	AD	W	11.1	27-320	111.3	42.3	14.5	0.513
06-21-94	NF Juncal	Transect	0003	0.76	P	A2	16.3	2.32	0.47	-	-		-	-	0	15	5	16	79		W	AD	15.7		-			0.156
06-21-94	NF Juncal	RSHT	0003	0.76	P	A2	6.14	2.27	0.37	0	0.37	59	28	13	47.5	26	6	16	22	57	AD	W	8	45-200	27.8	30.3	7.0	0.165
06-22-94	NF Juncal	Transect	0004	1.02	P	B2a	7.9	5.2	0.66	-	-		-	-		15	15	13	100		AD	SM	16.7					0.082
07-10-90	Alder	Rosgen*	01	0.12	I	B1	12	0.98	0.1	0	0.17	5	21	22	-	10	24	19	73.6	30.8		-	-	150-205	0	21.2	21.2	
07-10-90	Alder	Rosgen*	02	0.03	I	A2a	5.7	1.03	0.18	0	0.09	35	37	15	-	35	5	22.6	74.6	36.8	-	-	-	90-240	0	71.8	23.9	
07-10-90	Alder	Rosgen*	03	0.13	P	A2	8.1	1.71	0.19	7.7	0.25	30	58	12		30	6.6	19.2	74.8	41		-	-	150-220	0	74.1	125	
07-10-90	Alder	Rosgen*	04	0.11	P	A2a	8.1	1.83	0.3	9.1	0.38	72	7	21	-	12.5	5	7.5	81.1	45.5		-	-	-			-	
09-21-92	Alder	Rosgen*	01	0.47	P	A3	10.7	1.36	0.12	0	0.5	70	13	2	-	0	30	20.8	55.5	31.7	-	-	-		-			
04-19-93	Alder	Rosgen*	01	0.23	-	B1	7.5	4.57	0.61	0	0.36	20	73	7	-	10	15	25	-		-	-	-	36-168	21	2.6	1.3	1.49
04-20-93	Alder	Rosgen*	02	0.25	-	A2	9.5	5.18	0.55	12	0.5	15	3	47	-	10	35	30	-		-	-	-	58-182	9.5	21	5.7	4.83
04-28-94	Alder	FHR/Tran	0001	1.5	-	B3	16.1	6.4	0.4	-	-	67	0	33	0	28	21	28	29	-	W	SM	17.4	30-130	-	-		0.16
04-28-94	Alder	FHR/Tran	0002	0.8	-	A2a+	11.8	8.7	0.57			63	0	37	8.3	18	16	14	95		B	AD	6.6	44-135				0.25
07-29-94	Alder	FHR/Tran	0004	1.5	-	B3	14.7	1.76	0.12	8	0.16	67	0	33	-	28	21	28	29	24.1	AD	O	13.5	30-130	62.3	16.7	0	0.16
07-29-94	Alder	FHR/Tran	0002	0.8	-	A2A+	13.5	1.75	0.13	1.3	0.18	63	0	37	-	18	16	14	95	15	AD	n/a	7.3	44-135	100.1	51.5	3	
02-10-95	Alder	FHR	0001	1.8	S	-	22	9.67	0.44	-	-		-	-	-	15	28.3	48	38.8	24.4	SM	AD	32.5		0	2.3	2.3	6.16
02-07-95	Alder	FHR	0002	-	P	-	17.5	6.65	0.38	-	-		-	-	-	25	20	25	100	-	B	AD	18.3			-	-	3.08
4-18-95	Alder	RSHT	01	1.6	I	B3	11.2	3.36	0.3	0.6	0.4	18	35	48	-	7	31	31	16	22	SM	W	16.9	-	0	2.6	2.4	8.24
09-18-95	Alder	SCI	01	1.7	I	B4	23.5	-	-	0	0.61	-	-	-	-	8	40	-	8.7	-	-	-		-	-			-
06-04-96	Alder	RSHT	02	0.38	P	A2	5.85	2.09	0.37	11.1	0.5	11	56	33	-	0	9	32	57.5	37.5	AD	B	10.6	-	-			
07-19-96	Alder	RSHT*	01	1.8	I	B3	8.5	1.37	0.15	0	0.31	10	24	37	-	10	31.5	39	34.4	10.3	-	-		-	257.1	3.8	1.7	
07-19-96	Alder	RSHT*	02	0.33	P	A2	7.2	1.71	0.24	3	0.46	8	48	43	-	8	21	20	83.5	11.2	-	-	-	-	431.3	0	1.1	
09-21-92	Fox	RSHT*	01	0.11	P	A2	14.8	2.71	0.18	0	0.65	37	16	27	-	5	7.5	5	68.8	28.8	-							
04-21-93	Fox	RSHT	01	0.39	P	A2	18.5	6.1	0.37	-	-	7	33	60	-	35	0	16	90	15	AD	-	-	52-201	18.8	21.5	13.4	2.8
09-21-94	Fox	FHR/Tran	0001	0.45	P	B3a	12.1	3.4	0.28	6.7	0.6	34	11	55	37.5	20	13	38	100	21	AD	W	21.7	32-530	108.2	35.3	6.6	
09-21-94	Fox	FHR/Tran	0002	1	P	A1a+	9.8	5.4	0.55		0.89	50	33	33	23.8	8	8	20	100	23	AD	B	21.5	-	0	0	0	0.01
02-10-95	Fox	Transect	0001	0.45	P	B3a	10.5	5.2	0.5		-		-	-		3	43	38	100		AD	SH	18.9		-		-	1.9
02-10-95	Fox	Transect	0002	1	P	A2	9.8	4.7	0.48				-	-		0	27	-	97		M	B	17.5				-	2.48
06-03-96	Fox	RSHT*	1	0.45	P	A2	10.4	2.01	0.19	6.7	0.41	15	30	55	-	1.3	11.3	30	76.3	33.8	AD	B	28.1					
04-21-93	Agua Caliente	RSHT	1	0.625	P	B1	11.2	8.54	0.76	0	1.52	1	39	60	-	12	28	39	-		-	-	-					22.9
04-21-93	Agua Caliente	RSHT	2	0.97	P	D1	18.2	14.3	0.86	-	0.6	2	48	50	-	13	18	26			-	-	-					
04-21-93	Agua Caliente	RSHT	3	0.89	P	C1	15.8	8.54	0.54	-		3	38	88	-	0	13	38			-	-			-	-	-	25.2
04-21-93	Agua Caliente	RSHT	4	1.12	P	B1	13.2	10.1	0.76	3.6	0.66	4	55	38	-	5	17	37			-	-			0	0	0	26.32
04-21-93	Agua Caliente	RSHT	5	0.17	P		14.5	9.78	0.67	11.8	1.17	13	48	39	-	10	20	30			-	-			0	0	0	34.7
05-31-94	Agua Caliente	FHR	3	-	-	-	12.6	12.3	0.97	-		-	-	-	36.1	16.3	8.7	40	28.1	-	W	SH	28.5		-	-	-	3.86
06-08-94	Agua Caliente	FHR	4	-	-	-	11.5	9.3	0.81	-		-	-	-	35.6	85	0	43	33	-	W	GR	14.6					-
06-09-94	Agua Caliente	RSHT	0001	-	-	-	6.81	2.11	0.31			37	50	13	-	8	0	70	10		-	-			0	0	0	0.103
05-02-84	Diablo	Transect	001	-	-	-	16.8	6.75	0.43	-			-	-	12.6	32.4	0	57	38.8		BR	W	22.5		-			
06-27-94	Mono	FHR	1	0.95	I	C1	37.4	18.3	0.49	-		1	67	32	-	0	5	75	-		-	-	-	50-127				
08-02-94	Indian	FHR/Trans	0001 (01)	0.87	S	B2	16.8	12.6	0.75	0	0.31	39	23	17	22.5	18	15	16.5	82.8	35.7	AD	W	14.3	50-279	33.4	23.7	11.8	
08-04-94	Indian	FHR/Trans	0002 (02)	1.8	S	B3a	12.5	7.25	0.98	0	0.6	33	32	21	37.5	30	8	34	56.3	38.3	LT	B	27.5	50-284	13.8	38.2	6.1	
05-18-94	Blue Canyon	FHR/Trans	0004	1.2	I	B4c	21.7	11.7	0.54	-	-	80	0	50	25	15	51	21	4	16	W	SM	18.9	44-76	458.4	0	0	0.3
05-19-94	Blue Canyon	FHR/Trans	0002	1.6	I	B4a	17.2	6	0.47	-	-	-	-	-	18.7	26	39	16	35	-	W	AD	13.2		-	-	-	0.3
05-19-94	Blue Canyon	FHR/Trans	0003	0.83	I	B4	12.2	5.8	0.48	-	-	-	-	-	35.8	18	53	18	3	-	W	BR	15	-	-	-	-	
02-28-95	Blue Canyon	Transect	02	1.6	I	B4c	22.1	8.6	0.39	-	-	-	-	-	-	5	27.5	35	85	-	AD	W	14.8			-	-	4.62
02-28-95	Blue Canyon	Transect	03	0.83	I	B4	13.8	6.1	0.37	-	-	-	-	-	-	2.5	42.5	28	50	-	W	SM	30.5			-	-	3.32
05-02-94	Escondido	Transect	0001 (02)	0.6	P	A2	13	6	0.46	-	-	-	-	-	0	23	5	5	100	-	O	B	24	-	-	-	-	0.1
05-05-94	Escondido	Transect	0002 (03)	0.7	P	A2a+	14.13	5.4	0.39	-	-	-	-	-	6.7	7	27	22	86.7	-	B	AD	19.2	-	-	-	-	0.1
05-10-94	Escondido	FHR/Trans	0000 (01)	0.2	P	B3a	8.98	6.1	0.75	0	0.4	18	35	47	23.1	18	29	29	62.5	28.8	AD	O	21.3	27-380	102.2	0	18.3	0.1
02-21-94	Escondido	Transect	0000 (01)	0.2	P	B3a	13.93	5.4	0.4	-	-	-	-	-	-	15	41	39	81.9	n/a	R	AD	29.4	-	-	-	-	2.18
06-06-93	SYR	RSHT	01	1.13	S	C3	80.8	13.2	0.24	-	-	4	84	12	-	21	63	36	-	-	-	-	-	-	-	-	-	-
06-08-93	SYR	RSHT	02	3.28	S	C2	7.37	6.71	0.81	-	-	7	67	38	-	25	0	50	-	-	-	-	-	101-302	0	0.52	2.8	-
06-17-94	SYR	FHR/Trans	0001	-	-	B1	13.3	9.5	0.71	-	-	-	-	-	80	11	34	18	35	15	CW	W	10	45-82	-	-	-	1.2
07-21-94	SYR	FHR/Trans	01	-	-	-	28.3	10.2	0.73	-	-	-	-	-	-	4	29	29	20	12	W	CW	28.5	0	0	0	0	1.3
06-10-95	SYR	Walk Srvey		0.11	I	-	9.92	12.1	1.22	-	-	20	70	10	-	25	45	25	30	-	W	-	-	0				
06-10-95	SYR	Walk Srvey		-	I	-	12.3	14	1.3	-	-	10	50	35	-	20	45	25	-	-	W	-	-	-				
10-23-95	SYR	SCI	07SY1	0.48	-	C3	34.3	20.6	0.6	-	-	-	-	-	-	19	14	59	0	-	-	-	-	-	-	-	-	
10-17-95	SYR	SCI	07SY2	0.44	-	C3	95.3	30.5	0.32	-	-	-	-	-	-	1	86	24	0	-	-	-	-	-	-	-	-	
10-17-95	SYR	SCI	07SY3	0.93	-	C3	14.8	11.2	0.86	-	-	-	-	-	-	3	7	46	2	-	-	-	-	-	-	-	-	
10-11-95	SYR	SCI	07SY4	1	-	C3	35.3	28.5	0.73	-	-	-	-	-	-	3	48	47										
07-18-94	Oso	FHR	-	-	-	-	-	-	-	-	0.52	-	-	-	-	-	-	-	41	38	-	-	-	-	0	0	0	0.00
10-20-93	Peachtree	RSHT	-	-	-	-	5.6	1.5	0.4	-	-	-	-	-	-	50	8	10	50	38	-	-	-	80-180	0	104.9	16.4	