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SAN LUIS OBISPO CREEK
STEELHEAD TROUT
HABITAT INVENTORY & INVESTIGATION
1995

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EXECUTIVE SUMMARY

The purpose of this study is to assist the Land Conservancy of San Luis Obispo County to identify restoration opportunities along the main stem of San Luis Obispo Creek. The Land Conservancy has completed two studies related to San Luis Obispo Creek and is continuing to undertake studies on issues of importance to water quality and habitat improvement. This study on Steelhead Trout habitat is considered critical to establishing baseline information and providing a specific characterization of habitat needs.

In this study, Steelhead Trout habitat and habitat components are inventoried by walking the main stem of San Luis Obispo Creek and using measurement methods developed by the California Department of Fish and Game. Research and interviews are conducted to investigate historical Steelhead Trout population sizes, fish stocking activities, and archived pre-1963 documents.

Habitat inventory indicates a severe lack of pool habitat. Sixteen miles of main stem San Luis Obispo Creek have 719 habitat units consisting of 14% riffles, 52% flatwater, 28% pools, and 6% dammed pools. The stream measures a mean width of 14.3 feet and mean depth of 0.9 feet. Stream width and habitat greatly varies above and below the City of San Luis Obispo's wastewater treatment facility.

Habitat components rate low. Most habitat types are only 13% covered with litle instream shelter. Vegetation covers only 40% of the stream banks and overhead canopy is present in only 30% of the stream. Substrate is filled with sediments that embed spawning gravel 50-100%. Invasive non-native vegetation is common throughout the study area.

Flood control, while necessary in urban areas, appears to be the major causative factor driving the removal of hard, pool creating objects, the associated proliferation of sediment from eroding stream banks, and the lack of instream shelter and related cover. A more selective procedure for clearing vegetation at the water's edge could meet the needs of both flood control and fish habitat. Efforts to incorporate pool creation (strategically placed boulders and logs) into flood control management and stream bank stabilization projects could prove very beneficial.

In addition, instream shelter and cover can be created by restoring a continuously vegetated riparian corridor along the creek. Riparian restoration should include planting a wide variety of understory and tree species, especially Sycamore trees which have been found to contribute substantially to trout habitat. Temporary log matts could also provide seasonal shelter and cover.

Eight potential fish passage barriers include a weir, check dams, culverts, and natural cascades. Temporary passage barriers made from hand-stacked rocks are also present. These barriers can be improved by cutting a notch in the weir, adding additional check dams, baffling culverts, creating step pools below the cascades and removing illegally hand-stacked rock barriers.

Fish stocking records estimate 25,000 trout stocked per year from 1967 to 1991 into Laguna Lake on the Prefumo Creek tributary. These fish had access to San Luis Obispo creek during winter months when the lake overflowed. Catfish and carp have also been stocked. The carp have proliferated in the lower stretches and their eradication could provide an opportunity for native trout to re-establish.

Steelhead Trout population surveys were conducted for various portions of the creek from 1966 to 1994. The annual adult run of steelhead was estimated at 200 fish in 1972, 117 fish in 1973 and 179 fish in 1975. The juvenile trout population was estimated for areas above the wastewater treatment facility and in stretches above the City of San Luis Obispo. Above the wastewater treatment facility population estimates ranged from thirteen to twenty-six trout per 100 meters in 1966 and again in 1975. Upstream from the City of San Luis Obispo, a 1975 survey found 174 trout per 100 meters; a second 1975 survey found 269 trout per 100 meters; and a 1985 survey estimated 186 to 311 trout per 100 meters. Due to residual chlorine and un-ionized ammonia toxicity, no trout were found downstream of the wastewater treatment facility effluent prior to 1994 [In 1994, water quality improvements were operational].

INTRODUCTION

Natural production of Steelhead Trout (Oncorhynchus mykiss) in California has greatly declined as the result of many projects which have provided valuable economic growth. Such projects have reduced fish populations by affecting their habitat, adjacent riparian vegetation, spawning areas, migration routes, and most significantly, water flows (California Department of Fish and Game (CDFG), 1995).

Fish are an important public resource with significant economic, environmental, recreational, aesthetic, and educational values. The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act declares that it is the policy of the State of California to increase the state's salmon and Steelhead Trout resources. This is to be accomplished by improving and protecting stream habitat (CDFG, 1995).

In order to make recommendations about the most effective and cost-efficient restoration needs, it is imperative to know the location of fishery resources, relative population sizes, the quantity and quality of available habitat, and the most significant factors limiting fish production.

San Luis Obispo Creek is one of several streams in San Luis Obispo County which historically and cyclically has had a large, self-sustaining population of Steelhead Trout. As recently as the early 1930s, during the Depression years, "if one had nothing else for dinner, there were always the fish in San Luis Obispo Creek. During those disastrous years, the creek literally fed many people, just as it had once fed the Mission Padres and the Chumash Indians" (McKeen, 1988).

Because of land use and instream activities which have adversely affected instream habitat as well as increasing demands on water resources, the Steelhead Trout population has been severely reduced. To better understand the existing condition of steelhead resources, an extensive evaluation of habitat, historical records (Appendix A), passage barriers, and fish stocking records has been completed. This report describes the results of this inventory and investigation.

People and Fish Use the Watershed

The creeks in the San Luis Obispo Creek watershed provide many functions and are viewed in different ways depending on who is asked. Flood control interests view the creeks as an obstacle-free conduit of water. Sewage facility operators see the creeks as a laboratory for maintaining water quality. Agriculturists find a source for irrigation water. Landowners are mixed between protecting a public resource and clearing a view for themselves. Biologists value the ecology and importance of fish and wildlife habitat. Residents and tourists are charmed by the rippling flow.

Since the founding of the City of San Luis Obispo in the mid 1800's there has been disagreement over which of these functions is most important. A newspaper clipping from 1874 calls the creek nothing more than a sewer that is taking up too much space in the city (The Tribune, 1874). In the 1930's the creek was a liability if flooding and only useful for irrigation, watering stock and fishing. By the mid-1950's there was a gallant effort to center the town plaza around a flowing stream (McKeen, 1988). It was not until 1989 that the Water Quality Control Plan for the Central Coast Region first established a list of beneficial uses in the watershed that were to be protected and respected by all interests.

The 84 square mile San Luis Obispo Creek watershed is surrounded by rough mountainous terrain that drains in a southwesterly direction. It is characterized by slightly compacted granular clay loam in the upper watershed and fine sandy loam in the lower reaches. San Luis Obispo Creek originates at an elevation of approximately 2,200 feet in the Santa Lucia mountain range near Cuesta Pass (Hallock et.al., 1994). In its eighteen mile descent to the Pacific Ocean it is joined by the three perennial tributaries of Reservoir, Stenner, and See Canyon Creeks; the four seasonal tributaries of Prefumo, Froom, East Fork, and Davenport Creeks; and several seasonal minor drainages. Effluent from the City of San Luis Obispo sewage treatment facility also contributes to the flow.

In these streams very few species of fish are present simply due to the fact that they can not reach San Luis Obispo except by ascent from the sea (Jordan, 1895). In fact, only five native species reside in this watershed (Steelhead Trout, Prickly Sculpin, Threespine Stickleback, Speckled Dace, and Pacific Lamprey). Although there is not a great variety of fish, we do know that the local creeks have a history of good trout fishing.

A 1954 creel census (fishermen survey) indicated that San Luis Obispo Creek had more angling effort than any other stream in the region (except the Russian River) when a Steelhead Trout catch of 2,685 fish was sampled (CDFG, 1955). In that same year, popular account describes a deep pool in Mission Plaza "where anyone could catch a fish. You could almost drop a line from the sidewalk." (McKeen, 1988). If fishing was that successful in 1954, one can only imagine how good it was prior to 1861 when "trees of large size lined the banks of all streams in the region." (Daily Republic, 1890).

Adult Steelhead Trout were not counted in the watershed until 1972 when CDFG estimated a good year run of 200 fish. Juvenile trout were first counted in 1966 with findings of 13 to 26 trout per 100 meters in the main stem (Titus, 1996).

Numerous other fish surveys have been completed over the past thirty-five years, each of them finding Steelhead Trout in local streams (Tamagni, 1995). Few of these recent surveys have extensive coverage or detail and because of the lack of historical data, we may never know the amount of fish production that once occurred in the watershed.

Habitat Types and Components

The focus of this report is on trout habitat and the components that enhance this habitat. The three basic habitat types are pools, riffles and flatwaters.

In general, pool habitat is the areas of calm water, typically located along the margin of streams, which provide calm cool surroundings for large and small fish. Riffle habitat is swiftly flowing stretches with exposed rocks that provide a niche for small fish, mix oxygen into water, and produce an important food source of insects. Flatwater habitat is moderately flowing stretches with little or no flow obstructions that, if deep and swiftly flowing, can provide territory to larger fish.

For this study, each of these habitat types was further subdivided (Level IV Classification) into nine types of pools, three types of riffles, and three types of flatwater, as listed in the Results section.

Each of these habitat types can be enhanced, thereby making them more desirable to fish, by the presence of attributes, or components of habitat. These components include substrate, instream shelter, cover, stream bank vegetation and overhead canopy.

Substrate is the material that forms the bed of the stream such as boulders, gravel, cobble, sand, silt, and bedrock. Instream shelter is the material within the water column that provides a place for fish to rest, protection from predation, and a separation of fish territories. It may include undercut banks, woody debris, root mass, aquatic and terrestrial vegetation, bubble curtains, and boulders. Cover is the area of a habitat that is occupied by instream shelter when looking down at the unit (or looking up if you are a fish). Stream bank vegetation is the unique riparian plant life that provides leaf litter and woody debris for primary productivity. It can filter sediments and contaminants from water entering the stream and reduce water flow to trap spawning gravels. It can also contribute to instream shelter, cover and overhead canopy. Overhead canopy is the vegetative mass produced by trees and large shrubs that inhibits solar radiation and maintains a cooler water temperature.

A variety of measurements are made to describe each of these habitat types and habitat components. Habitat types are measured by length, width and depth. Pools have two additional measurements of tail pool crest and substrate embeddedness. Tail pool crest is the depth where water exits the pool, measured from the top of the pool to the surface of the water. This measurement allows one to predict how deep a pool would be if there were a cessation of stream flow. Substrate embeddedness refers to the amount of sediment surrounding the substrate at the pool tail. Because trout typically spawn at the tail of a pool, less embedded pool tail substrate is higher quality spawning gravel.

Habitat components are measured by percentage of occurrence and dominant occurrence. In addition, an instream shelter complexity rating is made based on the quantity and composition of the instream shelter. In other words, the rating takes into account the cover provided by instream shelter and the diversity of this shelter (ie. undercut banks, woody debris, root mass, aquatic and terrestrial vegetation, bubble curtains, and boulders).

METHODS

Habitat Inventory

Methodology followed guidelines presented in the second edition of the California Salmonid Stream Habitat Restoration Manual (Flossi and Reynolds, 1991). Habitat inventory was modified using Sampling Levels For Fish Habitat Inventory (Hopelain, 1994).

The main channel of San Luis Obispo Creek was divided into fifteen reaches in the San Luis Obispo Creek Hydrologic Survey (Land Conservancy, 1996). A graphic delineation of these reaches is provided in Figure 1 and the linear distance of each reach is given in Figure 2.

Each habitat, as defined in the Restoration Manual, was identified and measured by length. Level four classification separates riffles on the basis of water surface gradient; flatwater on the basis of depth and velocity; and pools by either location within the channel or the cause of scour (ie. boulder, bedrock, rootwad, or log) (Nelson, 1994).

Inventory components were collected by walking the stream from the bridge at San Luis Bay Drive and Avila Beach Road to Stagecoach Road at Highway 101 on the Cuesta Grade. The inventory took place during the months of November and December, 1995.

For every ten individual habitat units identified, one was randomly selected with the following parameters measured: length, mean width, mean depth, maximum depth, primary and secondary substrate components, percent instream shelter, instream shelter complexity, percent total canopy, dominant right and left bank composition and percent vegetated, depth and substrate embeddedness of the pool tail crest, and comments. Stream slope was also measured in descriptive areas. Equipment for making measurements included a measuring tape, stadia rod, spherical densiometer (for measuring total overhead canopy), and sight mark level.

Historical Records

Historical data in relation to San Luis Obispo Creek was found at the San Luis Obispo County Museum, the Department of Fish and Game, and by interview.

Passage Barriers

Barriers to fish passage were identified while making inventory measurements. For the purpose of this survey, a barrier was defined as any structure, natural or manmade, that had the potential to inhibit the up or downstream movement of small or large fish.

Fish Stocking

Jim Adams, California Department of Fish and Game's Fillmore Hatchery Manager was contacted by telephone for fish stocking records.

RESULTS

Habitat Inventory

Sixteen miles of main stem San Luis Obispo Creek had 719 habitat units which consisted of 13.9% riffles, 51.7% flatwater, 28.5% pools, and 6.2% dammed pools (Figure 3).

The stream measured a mean width of 14.3 feet, mean depth of 0.9 feet, and maximum depth of 5.0 feet. Inventory components are summarized for each reach and the entire study length in Appendix B.

As shown in Figure 4, the stream width varied greatly above and below the treated sewage effluent of the Wastewater Reclamation Facility (WRF). This facility provided records to indicate an approximate stream flow (for November, 1995) above the facility of 2.0 cfs and a flow of 12.1 cfs downstream of the facility (Fairchild, pers. comm.). Accordingly, the description of predominant habitat types, flatwaters and pools, also differ (Figure 5).

Above the wastewater facility, 44 pools had a mean length of 26.2 ft, width of 9.7 ft, and depth of 0.9 ft. Maximum pool depth was 3.8 ft. Tail pool crest averaged 0.4 ft with embeddedness of 50 - 75%. The mean pool unit cover was 11.9%. The 212 flatwater habitats had an average length of 167 ft, width of 8.8 ft, and depth of 0.5 ft. The mean flatwater unit cover was 6.2%.

Below the wastewater facility, 166 pools had a mean length of 57.1 ft, width of 17.8 ft, and depth of 1.4 ft. Maximum pool depth was 5.0 ft with only fifteen pools 3.0 ft or greater. Tail pool crest averaged 0.7 ft with embeddedness of 75 - 100%. The mean pool unit cover was 23.6%. The 246 flatwater habitats had an average length of 111 ft, width of 17.7 ft, and depth of 0.7 ft. The mean flatwater unit cover was 12.9%.

Instream Shelter Complexity Rating

Habitat units were 13.4% covered, predominantly by aquatic watercress vegetation. Because this cover was created by only one or no instream shelter components, the instream shelter value averaged 0.7. By multiplying the percentage of cover by the instream shelter value, a mean instream shelter complexity rating of 9.4 was calculated out of a possible range of 0 to 300 (Figure 6).

Overhead Canopy

Overhead canopy (Figure 7) averaged 30.2% with prominent species of willows, walnuts, sycamores, and oaks. In addition, the lower reaches (2 & 3) had many box elders and cottonwoods, while middle reaches (8 & 9) and the upper reach (15) had numerous mature eucalyptus.

Stream Bank Vegetation

The creek banks had a dominant composition of silt, clay or sand and a dominant vegetation of brush or deciduous trees. Overall, right and left creek banks were 40% vegetated, leaving 60% as bare eroding soil, bedrock, or revetment.

Throughout the study area an invasion of non-native pests included giant reed and german ivy. Castor bean was common in the areas of reaches seven through nine.

Historical Records

An annotated bibliography in Appendix A provides a summary of pre-1963 newspaper clippings, interviews, Fish and Game files, and a book.

Passage Barriers

Eight potential barriers to fish passage included the Marre Dam in Reach 1; fish ladder under Highway 101 in Reach 3; small check dam near Bianchi Lane in Reach 10; 4' bedrock cascade under the city in Reach 11; check dam and culvert at Highway 101 below Cuesta Park in Reach 13; 5' bedrock cascade in Reach 15; and culvert at Highway 101 and Stagecoach Road in Reach 15. Temporary passage barriers made out of hand-stacked rocks were found in Reach 13.

Fish Stocking

Department of Fish and Game fish stocking at Laguna Lake, in the San Luis Obispo Creek watershed occurred from 1967 to 1991. Approximately 25,000, one-third pound, trout were planted every year between the months of November and April. These trout were of a strain originating at Coleman and Mt. Whitney hatcheries.

Fish stocking from miscellaneous receipts obtained in CDFG files have also been found which indicate that there are additional stockings left undiscovered. Known fish stockings are as follows:

Steelhead Trout Population Estimates

Titus (1996) researched and compiled CDFG population surveys of San Luis Obispo Creek which are presented in this section. He reports that visual surveys in 1958 and 1960 found rearing habitat in the lowermost creek and spawning gravel in the upper reaches. While trout populations were not estimated, heavy angler pressure was noted. In a 1966 survey (commonly called the "Nokes Study"), Titus describes a cresol sample that estimated trout populations in the lower creek to range from thirteen to twenty-six trout per 100 meters. During this same survey, a bioassay showed that trout could survive only one-half hour below the wastewater treatment facility discharge due to residual chlorine toxicity.

Adult Steelhead Trout were not counted in the watershed until 1972-73 when CDFG estimated an good year run of 200 fish. This study was repeated in 1973-74 with an estimate of 117 adult fish. During these surveys, adult fish were found to range from three to five years age with sizes ranging from fourteen to thirty inches.

The first watershed-wide juvenile trout count took place in 1975 under the direction of Cal Poly professor, Dr. Barclay. This survey found an average of thirteen trout per 100 meters in main stem San Luis Obispo Creek downstream of the Stenner Creek tributary. The upper stream and perennial tributaries averaged 174 trout per 100 meters. This disparity in trout counts was attributed to the poor water quality of the lower stream due to effluent from the wastewater treatment facility.

A second 1975 survey, conducted by CDFG, estimated the trout population in upper San Luis Obispo Creek to average 269 trout per 100 meters. Calculations of the adult population required to produce these offspring was estimated at 179 adult steelhead.

A 1985 CDFG survey had findings similar to those in 1975 with findings in the upper creek that ranged from 186 to 311 trout per 100 meters. No trout were found below the wastewater effluent discharge point.

The latest qualitative survey, conducted by CDFG in 1994, observed juvenile trout in lower San Luis Obispo Creek below the wastewater discharge. No population estimates were made.

DISCUSSION

Steelhead Trout Lifecycle

Adult Steelhead Trout enter San Luis Obispo Creek between January and March during the subsidence of highwater storm flows. In all accessible areas they find suitable gravel and lay eggs that hatch in about 20 days (at 58°F). Within two to three weeks after hatching, fry emerge from the gravel and, if necessary, emigrate to perennial streams (Barnhart, 1986).

Small schools of young trout fry live along the stream banks in shallow water. As they grow, the schools break up and individual fish defend their territory. Most steelhead tend to inhabit riffles during their first year with the larger fish inhabiting deep fast runs or pools (Barnhart, 1986).

After approximately two years of feeding on a variety of aquatic and terrestrial insects, some steelhead migrate to the ocean. All steelhead do not migrate and those that remain in the stream are called "resident" Rainbow Trout. Little to no genetic variation has been found between these two forms of the same fish (McEwan, 1996).

In the ocean, steelhead grow rapidly for one or two years before returning to spawn. Their distribution in the ocean is not completely known but some evidence suggests they roam north and south along the Continental Shelf. Most Steelhead Trout will repeat their migration to spawn two to three times (Barnhart, 1986).

Habitat Types and Components

Physical and chemical features of instream habitat are closely related to land uses in the surrounding landscape. The habitat needs of trout are rather precise and alteration of this landscape can have profound impacts on the creation or destruction of different habitat types and their attributes (Meehan, 1991).

The following discussion will present the habitat types and habitat components inventoried in this study, their use by Steelhead Trout, and the impact of land use activities.

Pools

Pools appear to be created and maintained by water continuously hitting hard objects, thereby causing a turbulence (eddy current) which scours depressions in the stream bottom. Such hard objects include boulders in the stream and branches that extend over the waters edge. Inventory results show that only one-quarter of the habitat is pools (50% is preferred), most of which are shallow (less than three feet deep), without instream shelter, and therefore, of poor quality. The majority of these pools, 166 out of 210, are located below the Wastewater Reclamation Facility in a seven mile stretch to the ocean.

Probable cause for the low percentage of pools is the removal of vegetation and other hard, pool creating objects, by municipalities and landowners, under Fish & Game agreement, for flood control.

The most complex and desirable pools were formed by rootwads of large trees, especially sycamores. These pools, continually maintained through natures design, provide deep, covered, complex instream shelter.

Dammed Pools

Dammed Pools are created by manmade barriers such as the Marre Dam in Avila Beach, and several handmade cobble dams in the City of San Luis Obispo, that create pools for pumping water. They do not appear to provide good habitat. They have poor shelter, silt substrate, and limit upstream passage if a small fish should happen to move below the barrier. If the dams creating these pools were removed, the resulting habitat would most often be flatwater. Therefore, these Dammed Pools have not been included in the Pool category. Inventory results show that Dammed Pools comprise 6.2% of the habitat.

Riffles

Riffles are created when cobbles and boulders are deposited in the stream channel. Their deposition appears to occur during the initial subsidence of storm water flows and in the eddy currents created by pool forming turbulence. Inventory results show that 13.9% of the stream consists of riffles. These are food producing areas and provide habitat to very small fish (Chamberlin, 1991). They are characterized as shallow, swiftly flowing turbulent reaches with exposed substrate (Flossi and Reynolds 1991). The turbulence in a riffle appears to mix oxygen into the water and supply it to downstream pools.

Riffles were found in downstream reaches four through seven and upstream reaches ten through thirteen. They were also found in reach fifteen. While this author is not familiar with a preferred percentage for riffle habitats, it does appear that the addition of riffles in lacking reaches would be beneficial. The cause for an apparent shortage of riffles may be associated with an abundance of silt substrate, a lack of pools and vegetation, and the absence of large cobble or boulders.

Flatwater

Flatwater predominates San Luis Obispo Creek with 51.7% of the habitat units in this category. Comprised of glides, runs, and step runs, flatwater is moderate to swiftly flowing reaches with little surface agitation and lacking major flow obstructions. The majority of flatwater is evenly divided between runs and glides. These sub-habitat types differ only slightly in morphology with runs having shallow, agitated flows and glides having calm surface waters, a wide uniform channel bottom, and a variety of water depths.

Flatwater can provide habitat to larger fish if it is deep and swiftly flowing (Barnhart, 1986). The mean flatwater depth of 0.7 ft below the wastewater facility and 0.5 ft above this facility would probably not qualify as "deep". No trout were seen in these habitats, although an abundance of dace and stickleback were observed. Also contributing to the lack of trout was the poor instream shelter in flatwater habitats, ranging from 6.2% upstream to 12.9% downstream of the WRF, which may increase chances for predation.

As with riffles, this author is not familiar with a preferred percentage for flatwater habitat. It does appear that overall habitat could be improved by breaking the long stretches of flatwater with pool and riffle habitats. An example of this can be found in reach fifteen where one flatwater habitat is nearly two miles long - this is a lengthy distance for a fish to swim without a pool to rest or a riffle to add oxygen.

Substrate

Clean gravel substrate, required for spawning, is found only in Reach 15, a two mile flatwater habitat up Cuesta Grade. The dominant substrate throughout the remaining fourteen miles of stream consists of silt, clay and sand. While gravel or cobble is often the co-dominant substrate, it is 75 - 100% embedded with sediment, making it poor for spawning (less than 20% sediment is preferred). The winter rains may flush the gravel long enough for fish to spawn, but continuing erosion can quickly fill interstitial spaces and smother deposited eggs. Substrate is also important to the production of an insect food source and it has been found that an increase in fine sediments will lead to a decrease in insect productivity (Bjornn and Reiser, 1991).

The source for much of these sediments in San Luis Obispo Creek appears to come from eroding creek banks due to vegetation removal (flood control), cattle access, and encroaching development. Additional sources include runoff from agriculture fields and erosion resulting from the "Highway 41 Fire" of 1994. This sediment does not enter the stream continually, but during episodic events such as large storms (Swanston, 1991).

Instream Shelter Complexity Rating

Habitats in San Luis Obispo creek have very little cover, averaging 13.4%, and poor complexity, averaging 0.7 (from a range of 0 - 3). While the mean instream shelter complexity rating is 9.4 there is a notable increase to 62.2 in Reach 4. This reach is different from other reaches for one pronounced reason: no flood control measures have been taken to remove instream or stream bank vegetation and woody debris.

Elsewhere, the majority of instream shelter consists of aquatic vegetation, mostly watercress, followed by overhanging terrestrial vegetation, root mass, and undercut banks. Woody debris, in the form of broken branches and logs, is almost completely absent. This is a significant missing feature because woody debris not only provides instream shelter and cover, but it also forms the basis for primary productivity in the food chain and nitrogen fixation (Meehan, 1991).

Overhead Canopy

In its contribution to fish habitat, overhead canopy, produced by trees and large shrubs, is vital to reducing solar radiation and maintaining a cooler water temperature. Overhead canopy was the least dense from a point one-mile upstream of San Luis Bay Drive to the Marsh/Higuera Street intersection (Reaches 5 through 10). Hallock (et.al., 1994) found that this section of stream has significantly higher water temperatures than other sites - the primary reasons for which are the lack of canopy and warm water effluent from the wastewater treatment facility. Their suggestion for reducing temperature is to restore and maintain a continuous riparian corridor along the stream.

Overhead canopy also provides important cover and instream shelter (leaf litter and woody debris) as well as stream bank stabilization. Under Pools, above, tree roots and branches were identified as responsible for forming the most complex and desirable pools. Observations indicate that Sycamore trees are also the most capable of reaching long branches across streams and providing all of the attributes associated with canopy.

Bank Vegetation

The relationship between stream bank, or riparian, vegetation and healthy trout habitat is a strong one. Riparian vegetation is unique to wetlands, such as stream banks, and influences stream ecology in many ways. Its deep root system helps stabilize banks against erosion and maintain undercut areas that trout utilize as instream shelter. Its roots, branches and leaves act as a buffer that filters sediment and contaminants from water before it enters the stream. It provides leaf litter and woody debris. It causes roughness that slows water velocity, traps gravel for use in spawning, and harbors insects that drift into streams to feed trout.

A local newspaper story (White, 1996) provides anecdotal information which sums the contribution of bank vegetation to stream bank integrity and erosion control. In this story, a bridge washed out after vegetation was removed:

During the heavy storms a year ago in January, the bridge held firm. In February, the county cleaned out the creek bed, removing vegetation and debris from the Highway 41 fire to prevent potential flooding. Then in March, more torrential rain came. The creek was bare and clean and the water moved much faster. On March 10, the mud in the creekbed turned to goo and the foundations for the bridge sank. Then the rushing water began to eat away at the dirt sides of the banks and the bridge fell in.

In San Luis Obispo Creek the stream bank vegetation is fragmented throughout the study area. Most lacking of vegetation is the downtown city stretch from the Marsh/Higuera Street intersection upstream to Cuesta Park (Reaches 11 & 12). Also lacking stream bank vegetation are Reach 6, downstream, and Reaches 13, 14, and 15, upstream.

Stream Width and Depth

The depth of the stream remains fairly constant throughout the study area at an average of 0.9 feet. The average width, however, changes considerably in two stretches. Below Los Osos Valley Road (Reach 8-1), the average width almost doubles from eleven feet to twenty-one feet. Above Cuesta Park, in Reaches 13 &14, the average width doubles from six feet to twelve feet.

These width increases appear to have natural and man induced causes. The natural causes are the merging of tributary streams that increase flow rates and carry away erosive soils during flash flood episodes. In the downstream stretch, this natural process seems to be exacerbated by non-porous paving in the City of San Luis Obispo which increases runoff and associated erosion.

The main cause of the upstream width increase, and contributing to the downstream stretch, is possibly due to years of improper livestock grazing practice, the impacts of which are well documented.

Away from the stream, livestock change vegetative composition and compact soil, thereby increasing runoff and erosion. Near the stream, livestock compact soil and trample vegetation which weakens the stream bank integrity. In San Luis Obispo Creek, the stream banks have a high content of clay which, when compacted, tends to break off in large clumps. The combination of increased erosion, reduced vegetation, and stream bank instability, lowers the water table and causes streams to become wider and more shallow (Meehan, 1991).

Barriers to Fish Passage

Barriers in San Luis Obispo Creek cause two negative effects. They inhibit the opportunities for fish to freely travel up and downstream. They also alter habitat by creating dammed pools, as previously discussed.

Most barriers in the main stem of San Luis Obispo Creek are probably not what is frequently referred to as a "migration barrier," as they do not impede the upstream movement of adult fish during episodes of high water. Two possible exceptions are the culverts that cross under Highway 101 above Cuesta Park and at Stagecoach Road on Cuesta Grade. These "velocity barriers" can impede adult fish migration by causing water flows in excess of a fishes ability to swim against the current. They can easily be improved by adding baffles to create areas of backwater.

Another possible "migration barrier" that deserves special recognition is the Marre Dam in Reach 1. In 1969, this steel plate dam was constructed to produce a source of freshwater by preventing seawater intrusion into the ground and surface waters. A ladder for fish passage was not installed until two years after construction of the dam. That fish ladder was ineffective and later replaced by a DeNil fishway which today is rusted through and functional only at higher tides. A possible solution to the passage problems created by this dam would be to cut a low flow notch in the steel plates (Leggett, 1994).

All of the other barriers are more of a problem for small fish during summertime low flows. Trout are very territorial. If food is limited, big fish chase small fish away. When a barrier is present, small fish can move only downstream. Once a fish drops below a barrier there is no going back.

Of the six low-flow barriers inventoried in San Luis Obispo Creek, two have fish ladders, two are natural bedrock cascades, and two are manmade check dams (all locations given in Results section). The check dams maintain a gradient that prevents the creekbed from eroding at the base of culverts. At the time of their installation they work well, but after a period of time, they create their own barrier as water erodes away the creekbed below them. Installation of additional check dams would improve conditions by creating a series of steps that small fish can pass over. This approach would also improve the bedrock cascade barriers.

Fish Stocking

Although most of the estimated 625,000 stocked trout were planted in Laguna Lake on the Prefumo Creek tributary, they did have access to San Luis Obispo Creek whenever the lake overflowed during the rainy season. In 1991, a new area Department of Fish and Game Biologist put a stop to stocking in the watershed since this practice was in direct conflict with Steelhead Trout policies. Such guidelines were established based on salmon studies that found fish stocking tended to introduce competition for space and food, disease that could transfer to wild fish, and a false sense of stream health [assumption: if a stream has fish, it is healthy](McEwan, 1996).

Recreational fishing is very popular and receiving increased attention in waters with thriving fisheries (Hunter, 1991). If a thriving fishery is the goal for San Luis Obispo Creek, three options could be considered. Habitat can be improved to increase natural production; habitat can be improved to support stocking, at a risk of replacing natural production; or fishing can cease - it is already limited to a short season in the lower creek.

Interference with Habitat

Carp, a non-native fish flourishing in the lower reaches are known to interfere with native fish habitat. They dig up aquatic plants, disturb substrate, and increase suspended matter in the water (Moyle, 1976). The stretch of creek below the wastewater treatment facility was directly toxic to Steelhead Trout from either chlorine or un-ionized ammonia for nearly twenty-five years. During this time, hardy carp had an opportunity to proliferate and it appears they were successful. While this inventory did not specifically look for fish, many large carp were seen in downstream reaches 2 through 8. Now that water quality has been greatly improved in this area, it might be effective to try and eradicate carp so that the native trout will have a better chance to re-occupy the area.

CONCLUSION

Steelhead Trout on the Central Coast are an opportunistic species with precise habitat needs. They require clean gravel for spawning, deep cool pools to survive the heat of summer, instream shelter to hide them from predators throughout the year, and lively riffles to produce an insect food source.

Findings that limit Steelhead Trout production in San Luis Obispo Creek are described as follows:

€ The most limiting habitat type is pools.
€ One most likely cause for the lack of pools is the removal of hard objects that create them and the high sediment loads that fill them.
€ All habitat types lack instream shelter and associated cover.

€ Habitat could be improved by selective vegetation removal and restoration of a continuous riparian corridor, especially with Sycamore trees.

Flood control, while necessary in urban areas, appears to be the major causative factor driving the removal of hard objects, the proliferation of sediment from eroding stream banks, and the lack of instream shelter and associated cover. A more selective procedure for clearing vegetation at the water's edge could meet the needs of both flood control and fish habitat. Modified clearing and maintenance practices should strive to create a central, deep, narrow thalweg (flowline) within the stream channel and well vegetated stream banks.

Of the fifteen reaches inventoried, none provided exemplary habitat. Downstream reaches 2 through 8 offered pools and riffles, but lacked gravel substrate, complex instream shelter, and continuous riparian vegetation. An exception in this lower creek stretch was Reach 4. At the time of inventory it had not had its vegetation cleared, and as a result, provided a substantial amount of diverse habitat.

Measures to improve habitat deficiencies in downstream reaches should include modifying vegetation removal practices for flood control activities, as described above, and restoring a continuously vegetated riparian corridor. Riparian vegetation restoration should include planting a wide variety of understory and tree species, especially Sycamore trees. Since trees grow relatively slowly, a short-term understory should be planted that will provide characteristics associated with riparian vegetation yet will not out-compete the growing young trees.

Upstream reaches 8 through 13, in the City of San Luis Obispo, lacked pools, riffles, complex instream shelter, gravel substrate, and a continuous riparian corridor. Stream channelization and maintenance has removed hard pool-creating objects. Urban encroachment has replaced riparian vegetation with revetments, gabions, cement sacks, and rip-rap, as well as destructive exotic plant species, decks, and storage sheds.

Since many of the upstream reaches are within the urban boundary of the City of San Luis Obispo, flood control activities must be given suitable management priority. However, measures to improve habitat might include modification of flood control activities, as described above, and strategic placement of rip-rap boulders used for stream bank stabilization. Boulders are preferred over concrete revetments because of their ability to create pools and support vegetation, if properly maintained. Efforts to incorporate pool creation and vegetation into flood control management and stream bank stabilization projects could prove very beneficial.

Upstream from the city, habitat in reaches 14 and 15 was similar to urban reaches with an exception of clean gravel substrate in Reach 15. A severe lack of instream shelter and pool habitats limit the habitat value in these reaches.

There are three short-term restoration practices that will provide immediate benefit to the

Steelhead Trout in San Luis Obispo Creek. These are bank-placed boulders, log shelter structures and carp eradication. Because of the swift currents produced by "flash-flood" events, most fish habitat structures would not remain in the stream. Boulders and log shelters will last only if strategically placed and well anchored with cables. Temporary small log matts that provide shelter can be installed during the summer and removed prior to winter rains. Carp, if eradicated from the lower stretch of creek, may provide trout with an opportunity to inhabit the area.

This report would not be complete without some mention of maintaining a minimum stream flow and limiting water diversions in the creek. If San Luis Obispo Creek is to be managed as a Steelhead Trout stream, as recognized by the Department of Fish and Game, present and future water diversions should be limited to maintain a minimum summer flow. In other words, no water should be taken from the stream, through riparian rights or other means, unless instream uses by fish are first adequately provided. Adjudication is a viable option.

RECOMMENDATIONS FOR FURTHER STUDY

Fish Surveys

Two fish surveys will compliment this study through outmigrant trapping and electrofishing. Outmigrant trapping will determine timing and general morphological characteristics of Steelhead Trout smolt and parr movement. Electrofishing will assess fish population sizes (for all species) and, possibly, associate life stages with habitat types.

Stream Hydrograph

A stream flow hydrograph can be prepared from wastewater facility records and supplemented with additional data collection. A hydrograph can also be prepared by relating an unguaged stream to a gauged one. Data from a hydrograph can be used to determine what is normal flow and what is a reasonable minimum flow.

Tributary ,Upstream and Estuary Inventory

Because inventory of main stem San Luis Obispo Creek did not reveal a tremendous amount of habitat, perennial tributaries, upstream reaches, and the estuary (Reach 1) should be evaluated for habitat value. Perennial tributaries historically important to fish production include See Canyon, Stenner, and Brizziolari. Two miles of main stem San Luis Obispo Creek were not inventoried in this current study and may offer habitat if the velocity barrier under Highway 101 were improved. Additionally, it is not unusual to find abundant numbers of Steelhead Trout in estuary environments. The San Luis Obispo Creek estuary in Avila Beach is not known to harbor trout and an investigation may provide useful information for improvements.

Verify Source of Sediments, Flood Control Impacts, Livestock Impacts, and Pool Creation

This inventory made observations and estimations for the source of sediments, impacts of flood control and livestock, and the natural process for creating pools. Studies should be conducted or references researched that support and verify these observations.

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