SAN PEDRO CREEK GEOMORPHIC ANALYSIS

by

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ABSTRACT

San Pedro Creek flows westerly to the Pacific Ocean, draining an 8.2 sq mi watershed in Pacifica, San Mateo County, California. Our Study Site, which includes the lower 2.6 miles of the creek, was analyzed to determine current physical conditions and impacts of land use activities. The San Pedro Creek Watershed Coalition provided funding from the San Francisco Bay Regional Water Quality Control Board. This report provides science-based and process-related findings so that future restoration and management efforts focused on San Pedro Creek will have increased potential for success and cost effectiveness.

Land use impacts from cattle ranching, croplands and suburbanization have increased rates of sediment supply and amount of runoff from San Pedro Creek. Bank erosion and flooding has caused property damages and economic losses to the community. The numbers of migratory steelhead fish and abundance of their habitat has declined dramatically. Citizens and land managers have increasing concerns about the ecological health of the watershed. We present a timeline of significant landscape impacts, document present physical conditions, and discuss how channel processes have responded to the variety of land use activities.

Some of the most significant changes that San Pedro Creek has undergone since its settlement 217 years ago by non-native people include the following:

• San Pedro Creek is longer by 0.8 mi because it flows into a constructed drainage ditch.

• The Creek flows directly to the Pacific Ocean. It has lost access to its previous wetland and a fresh water lake.

• Most of the former Lake Mathilda and its associated wetland has been destroyed.

• The creek has become deeply entrenched, incising as much as 16 ft in some areas, loosing access to its historic floodplain. We roughly estimate that 217 years ago it may have been no more than 5 ft deep along the middle reaches of our Study Site.

• Greater than 4 mi of tributary channel length has been put into underground culverts.

• 13% of the watershed surface area is impervious (EOA, 1998).

• Over 1 mi of the bank length along the Study Site has artificial revetment. Most of the revetment is concrete, riprap, and sackcrete.

• Over 1.9 mi of the Study Site bank length is in an eroding condition.

• Runoff, flood magnitude and frequency has increased as a response to land use activities.

• Water table elevation of the valley floor has lowered from draw down along the entrenched channel banks and from construction of the drainage ditch.

• Large woody debris in the channel is often removed or modified for flood passage.

• Structures have created impassable barriers for migrating steelhead under certain flow conditions.

• Most of the pools in the Study Site that are deeper than 1 ft during low flows are not caused by natural mechanisms; instead, they are inadvertently caused by man-related structures.

• There are at least 10 remnant dam or weir structures that once crossed the channel within the Study Site.

• The amount of sand and finer-sized sediment on the bed surface within the Study site is about 22%. We expect that the amount of fines is greater now than historically.

• For the Study Site, the long-term rate of sediment supply from bank erosion is 46 cu yd/yr. For bed incision the sediment supply rate is 342 cu yd/yr. The combined long-term supply rate from both bed and banks is 388 cu yd/yr. This rate is considered to be greatly accelerated from conditions that existed prior to non-native settlement.

• The proportion of sediment supply that is conservatively estimated to be related to anthropogenic activities is at a minimum 60%.

What can be done? Now that we know that much of the sediment supply is from instream and adjacent land use activities we can focus future restoration efforts on activities that will not reinvent past mistakes and not throw money at poorly conceived projects that have minimal effect upon decreasing bank erosion or sediment supply. By recognizing the responsiveness of channels to instream and adjacent land use perturbations and by designing restoration programs that permit natural processes, it is possible to promote channel stability, ecological diversity, and viable habitat in a naturally functioning system. The following recommendations are given with this goal in mind.

1. Where possible, reduce accelerated rates of bank erosion and bed incision to reduce property loss and input of fine sediment to the channel, but minimize the use of unnatural instream structures for stabilization. Instead, consider reshaping the channel cross section to a stable form, use biotechnical stabilization methods, or use boulder veins to direct flow away from eroding banks. Channel reshaping could be accomplished by surveying cross sections in the stable B type Rosgen Stream Class to potentially construct similar geometry (where appropriate) in the F and G classes.

2. Increase the width of the riparian buffer along the channel, especially where vegetation is presently missing. Promote the replacement of non-native invasive vegetation with native species to improve riparian habitat.

3. Increase the potential for LWD recruitment by not removing or modifying LWD unless it threatens a structure or causes backwater flooding at bridges, and by performing recommendation # 2.

4. The longitudinal profile of the mainstem channel should be surveyed to establish future monitoring stations that will show changes in bed elevation and correctly define terrace heights and stream gradient. The profile should be detailed enough to define pool riffle morphology.

5. Consider long-term funding solutions for 1) restoration projects; 2) future bridge designs that will not interfere with large floods, the passage of LWD, and the transport of sediment; 3) subsidies and incentives for landowners to stabilize banks using methods discussed in recommendation #1; and 4) long-term monitoring San Pedro Creek as an Observation Watershed for future change.

6. The rest of San Pedro Creek Watershed should be assessed for sources of sediment resulting from land use and instream activities upstream of the Study Site. The quality of water and habitat in mainstem and tributary reaches should be assessed. It is important that the remaining fragments of high quality channel habitat be maintained into the future.

7. Consider opportunities to ameliorate increased, flashy flows from the urban areas by constructing floodplains, off-channel habitat, wetlands, and lakes (consider the previous functions of Lake Mathilda).

8. Redesign the Capistrano fish ladder and downstream pool. Also modify or redesign the upstream 640' long, concrete-walled channel to improve fish migration by incorporating resting areas into the channel geometry.

9. Investigate whether there is potential to daylight portions of North Fork to increase salmonid habitat and reduce velocities above the confluence with the mainstem channel..

10. Historical questions about the extent of wetlands or frequency of native burning practices cannot be answered by this study, but a program of coring select parts of Lake Mathilda and the valley floor could provide some resolution.

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San Pedro Creek Watershed (SPW) was first viewed by non-natives in 1769, in the month of October, typically the peak of seasonal drought for the Bay Area. At that time, the autumn base flow sank into the ground in a large marsh of cane grass that extended to sand dunes at the western extent of the valley. A high groundwater table maintained the wetland. A few trees in the beds of the arroyos and as well as some moderate-sized willows could be seen along the creek. The 1835 Barceno Diseño shows the San Pedro Creek flowing through a willow grove to Lake Mathilda, but the later 1838 DiHaro Diseño shows the creek ending upstream at the head of the willow grove. The first topographic depiction of SPW in 1853 also shows San Pedro Creek ending upstream of a willow grove with no channel connection to Lake Mathilda. By the time this map was made the land had already sustained impacts from 77 consecutive years of grazing and 71 years of agricultural farming. San Pedro Creek was already responding to changes in runoff and sediment supply that were influenced by reduced thatch cover in the grasslands, trampling of riparian and wetland areas by cattle, conversion of native bunch grasses to European annuals, plowing practices that created large areas of bare soil, water diversion, and the cessation of native people's land use practices such as frequent burning and plant harvesting. As a result of these many prior impacts, we caution that the 1853 map does not illustrate the natural pristine condition of San Pedro Creek or the distribution of riparian vegetation that existed prior to non-native settlement.

Today, it is not entirely clear what San Pedro Valley used to look like prior to non-native settlement. Investigations of this study suggest that Lake Mathilda may have been much larger or it may have been an ephemeral lake that would come and go as dunes were built and eroded by storm waves or flood flows. Wetlands of this kind may have been important nursery and feeding habitat as temporary holding areas for smolts awaiting their seaward migration. Non-native land use practices could have caused the channel to respond to increased runoff. Increased runoff and accelerated sediment supply into the lake may have caused a delta to rapidly build and become colonized by willows and/or alders. This may be an explanation for the sausal that seems to expand in size through the sequence of early maps. The creek may have braided and separated into several distributaries beneath the sausal, as its capacity to carry high sediment loads was overwhelmed. Erosion in the reach above the delta may be a reason for documented accounts, by Padres of bridge repair and replacement only six years after farming began. We suggest that the channel was responding to increased runoff and instream structures and that it was probably less than 5 ft deep at the time of early non-native settlement. The valley floor may have been a functional floodplain in the middle of San Pedro Valley, later separated by channel incision.

By 1790, a deep ditch that was 1375 feet long was constructed to drain the land. This may have been the first effort to disconnect San Pedro Creek from its wetland. Modern and more extensive ditching took place again during the farming era. It is unclear to us when San Pedro Creek was actually moved into its present drainage ditch, but this impact may have been the most significant because it initiated a cycle of downcutting and channel entrenchment. The channel gradient was steepened, as the channel cut down it could hold larger floods that could exert more shear stress on the bed and banks, and as the channel cut down more of the water table drained into the channel.

By the 1860's the Adobe land was subdivided and leased to farmers and dairy ranchers. Additional tributaries were probably ditched and moved to the valley sides. An increasing number of flashboard dams were placed across the creek to supply reservoirs for irrigation. As irrigation systems became modernized the size of the reservoirs probably increased. Nearly all available land along the valley flat was plowed and planted with crops and the width of riparian corridors was reduced as much as possible, sometimes restricted to just the inner banks that had formed within the entrenched channel system. As flashboard dam and bridge structures were increasingly placed across San Pedro Creek, the channel would adjust its local geometry to another wave of impacts. This maintained instability and high sediment loads. Removal of water during summer drought would certainly have diminished available salmonid habitat.

Suburbanization of SPW during the mid 1900's initiated yet another surge of channel adjustments. Increased runoff from impervious areas and the faster delivery of runoff from gutters and miles of culverts caused floods to increase in magnitude and frequency. As banks continued to erode, more instream bank revetments were placed along the channel banks. These structures continue to increase today, while many of the relict structures of abandoned dams and deteriorating revetments continue to cause new channel adjustments as they collapse into the stream. Some, however, have actually increased the number of pools but they have also increased bank erosion and may not provide the desirable diversity and cover that would be gained from natural or wood-formed pools.

We have listed below some of the obvious cause and effect relationships that have influenced SPW. It is always important to remember that increased erosion rates in one part of the watershed have the potential of increasing sedimentation rates elsewhere. San Pedro Creek currently appears to have the capacity to transport most of its sediment load out of the watershed to the Pacific. How this increased sediment supply has influenced marine habitat is beyond the scope of this study but should not be discounted as unimportant. Furthermore, although the inputs of nutrients, pathogens and toxins as they affected water quality in San Pedro Creek are beyond the scope of this project, the sources and processes that supply them must be defined for maximum success of future restoration efforts.

Important land use impacts in San Pedro Valley and some example channel responses

- Cattle grazing = increased runoff, increased fine sediment load from hillsides, headward erosion of tributary channels = increased drainage density and more flow to mainstem channel = internal mainstem channel adjustments and increased sediment supply
- Construction of drainage ditch = increased erosion and sediment supply by initiating an incision/entrenchment cycle in upstream channel network
- Entrenchment = loss of floodplain = channel adjustments and increased sediment supply
- Concrete walls = loss of riparian vegetation, loss of pools, increased water velocity = loss of fish winter refuge during high flows and increased bed incision = increased sediment load
- Trapezoidal channel geometry = over-widened bankful width, sediment deposition, loss of pools and base flow
- Plowing = increased fine sediment load from raindrop splash, surface erosion and overland flow

- Destruction of riparian vegetation = increased bank erosion = increased sediment supply and increased water temperature
- Lack of riparian vegetation replacement = loss of LWD recruitment, unchecked bank erosion, and increased water temperature
- Lack of LWD recruitment = greater sediment transport, loss of pools, less sediment storage = increased bed incision
- irrigation reservoirs = loss of summer flows for fish and wildlife
- bank revetments and instream structures = possible fish migration barriers, increased bank erosion on opposite banks and/or at endpoints of structure = increased sediment supply
- urbanization = impervious surfaces = increased runoff causes channel adjustments = increased sediment load
- disconnection of wetland = loss of summer nursery habitat for smolts, loss of biological diversity and wildlife habitat
- Loss of tributary channels to miles of box culvert = loss of fish/wildlife/riparian habitat, increased flow velocity, reduced sediment load from length of channel in culvert = increased erosion and channel adjustment downstream of box culvert

RECOMMENDATIONS

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