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Baseline Geomorphic Assessment of Tennessee Valley Creek

Introduction.

For this project, we chose Tennessee Valley Creek as a study site (Figure 1). We conducted a longitudinal profile of the mainstem of the creek, and we conducted a longitudinal profile of the tributary from the bottom lip of the culvert that contains the stream as it flows under a road to the confluence of the tributary and the mainstem. We also conducted a monumented cross section survey of the tributary and the mainstem upstream of the confluence of the two, and measured discharge. Our intent was to conduct a cross section downstream of the confluence, but we discovered the area to be inaccessible due to the seasonal abundance of poison oak on the banks. We recommend that this cross section be established at a time earlier in the year to minimize the problems of poison oak. We constructed a plan view map of the mainstem and tributary (Figure 5). Our goal in conducting this project was to establish baseline morphological data and characteristics for future study of the area. The tributary in question has several interesting characteristics worth study. The tributary was dammed well upstream of the mainstem to create a stock pond that is no longer in use. The pond was dam was notched and the pond drained by NPS in July 2003, and most of the dam material was removed in September and October 2003 (Fong, pers comm). In addition to the dam removal, the other main alteration of the tributary is its containment by a culvert as it passes beneath the road just upstream of our study reach.

Physical Setting and Background.

Location

Tennessee Valley Creek is located in the Golden Gate National Recreation Area, at the end of Tennessee Valley Road in Marin County, California. A map of the area can be found on USGS Point Bonita TopoQuad. The entire watershed consists of approximately 620 Ha. See Figure 1.

Soils

Immediately surrounding the streambeds of the Tennessee Valley Watershed are Rodeo clay loams. These are deep soils that are formed in alluvium from chert, sandstone and granite. These Mollisols are poorly drained and contain smectite clays, occurring on slopes of 2 to 15 percent. Runoff is typically slow, as is permeability.

Higher on the slopes surrounding Tennessee Valley streams are other Mollisols including the Tamalpais-Barnabe complex and the Cronkhite Series. These soils are very gravelly or heavy loams formed from sandstone and shale. Tamalpais-Barnabe soils occur on slopes of 9 to 75 percent while Cronkhite soils are typically found on west-facing convex slopes. Though of varying depths, all of the soils are well drained, have moderate to very rapid runoff rates and have slow permeability rates. (Kashiwagi, 1985)

Annual Weather Patterns

Tennessee Valley is located in a Mediterranean climate zone. It is generally dry in summer and wet in the winter. During the summer months, the Pacific High deflects storms to the north and prevents most rainfall events. Additionally, the valley's proximity to the Pacific Ocean provides a moderating influence. Snow is a rarity, as are blistering temperatures. However, heavy fog banks form in the summertime bringing the temperature down in June and July. As a result, the hottest days of the year occur in the early fall. Temperatures average between the low 40s and mid 70s (F) throughout the year, with a mean January temperature of about 52 degrees F and 55 degrees F in July. Normal annual rainfall is about 30 inches (Kashiwagi, 1985).

Vegetation and Wildlife

Near streambeds are grasses, hemlock, willow, poison oak, eucalyptus, and blackberry. In the uplands, coyote brush, poison oak, grasses, lupine, forbs and thistles can be observed (Kashiwagi, 1985). During the survey salamanders, ticks, mule deer, garter snakes, red-winged blackbirds, and warblers were observed. A sign posted at the entrance to the hiking trail states that a mountain lion has been seen in the area.

Human Impacts/History

The Miwok Indians were present in Marin County in 1579, according to European observers. They were all but wiped out by disease and mission lifestyle by around 1834, when ownership of lands in Marin County transferred from the church to private entities. The first livestock grazing in the area began with private ownership. After California became a state in 1850, Portuguese settlers began dairying operations in the Tennessee Valley watershed. (Kashiwagi, 1985) Small dams forming stock ponds persist to today from this legacy, including a dam near the mouth of Tennessee Valley Creek that would provide a barrier to anadromous fish migration (Fong). In 1973 the National Park Service acquired Tennessee Valley Watershed and surrounding lands for the Golden Gate National Recreation Area (Rothman, 2002). In 1982, the Miwok Livery Stables occupied one of the old dairying barns within the watershed and began to offer lessons that both established arenas and trails in the area (Rubio, no date).

Methods.

We conducted the longitudinal profile of the two "treatment" reaches, the tributary and the mainstem below the tributary, first. We used the Fox Trailhead sign as our benchmark, and established elevation there as 60m above mean sea level (according to our GPS readings, this is plus or minus ~10m). After conducting two turning points, we positioned the level on the point between the two reaches of the stream, and from there began the survey, starting at the lip of the culvert and progressing down the tape along the thalweg of the tributary. In addition to the elevation of the streambed, we measured the depth of the water, in order to calculate the elevation of the water surface. Our survey progressed downstream through the confluence (at 80.70m) to 64.2m below the confluence. This profile is shown in Figure 2.

We conducted the longitudinal profile of what was termed the "control" reach, upstream of where the tributary joined the mainstem, separately. This survey began on a riffle just upstream of the beginning of the grove of eucalyptus trees that surrounds the study reaches. The beginning point was somewhat arbitrarily decided, though we tried to use the beginning of the eucalyptus grove as a reference point, and we wanted to get at least 100m of streambed. The level was set up on the point again, using the Fox Trailhead (elevation 60m) for the benchmark as in the previous survey. We surveyed the streambed downstream, ending at the confluence (marked by a stake we placed there during the previous survey), for a distance downstream of 128.1m. This profile is shown in Figure 3.

From the two profiles, it can be seen that the character of the stream changes after the tributary joins. The control reach has a lower gradient, and deeper pools than the two treatment reaches. The tributary is steeper in gradient than the control reach, and the mainstem below the confluence has a steeper gradient as well.

We began our monumented cross section 57m from the benchmark trailhead sign at an azimuth of 136• magnetic from the sign to the rebar monument. The tape was run across the streams at an azimuth of 68• magnetic from right bank to left bank. We chose this site because it provided a clear view of the stadia rod from the level in the center point for the most part, and we were able to get cross sections of both the tributary and the mainstem above the confluence in one survey. We determined bankfull and width at twice bankfull depth for both reaches. However, determining bankfull proved to be a difficult task. We used our best judgment, but it seems that our lack of experience and lack of familiarity with this particular stream decreased our confidence in our estimations. The cross section survey is shown in Figure 4. The tributary is very entrenched at this point with an entrenchment ratio of 1.33, and a width/depth ratio of 6.32 and a streambed slope gradient of 0.43. This would put the tributary reach into Rosgen's A category (Rosgen 1994). The mainstem (control reach) had an entrenchment ratio of 2.11, a width/depth ratio of 2.48, and a streambed slope gradient of 0.016, which makes this reach a difficult fit into Rosgen's (1994) classification system.

We also made discharge measurements at the cross section points, though the flow was so low on the tributary that the discharge was immeasurable. The discharge at the cross section point on the control reach was 0.054cfs. We measured discharge by taking velocity measurements every 0.2m across the 0.6m wide stream and multiplying the velocity by the cross sectional area from which it was measured. We measured discharge on the mainstem below the confluence, at our intended second cross section site, in the same way, where the stream was 1.8m wide. The discharge there was 0.002cfs. As can be seen in the discharge measurements, there was very little flow in either stream during the study. According to NPS sources, the last bankfull event there was 29 December 2003 (Fong pers. comm.).

We made an attempt to characterize the storage of sediment in representative pools in each reach using a method called V-star developed by the US Forest Service (Lisle and Hilton 1992). Our familiarity with this method was limited at best, thus the data we collected is not adequately representative of reality. Our attempted measurements and observations during the course of the study, however, lead us to state comfortably that there is significant fine sediment storage in all reaches studied. We hypothesize that a main contributor of fine sediment to the mainstem is the stable complex upstream, with its exposed dirt roads and grounds.

Fish Habitat Needs.

The Golden Gate National Recreation Area may consider further removal of legacy dams in the Tennessee Valley Watershed if Tennessee Valley Creek shows potential for adequate spawning and development habitat for anadromous fishes. To this end, we hoped to establish a base for future monitoring of possible fish habitat. Needs include unconsolidated gravelly beds and adequate flow for spawning, cover for the protection of fry during their growth cycle, pools in which migrating fish may rest, and a brackish lagoon for adjustment to salinity levels. Excessive fines will inhibit development of anadromous fish habitat.

Considerations for Future Study on Tennessee Valley Creek.

Conducting a survey earlier in the year would have yielded more data, as poison oak thickly covered large areas of the reach. We were unable to get a cross section of the main channel below the confluence due to the poison oak coverage. Additionally, we were unable to get flow readings due to very low flow in the stream as a result of the late date. The ticks had already emerged, and though it was not Lyme season, we encountered many ticks during our fieldwork. More hands would have made the fieldwork go more smoothly. Two have difficulty juggling it all, though we worked together well as a team and were able to achieve most of our goals. Our foresight in bringing both binoculars and radios aided us greatly in the completion of our tasks. More accurate compasses and a second clinometer and measuring tape would have increased our accuracy and decreased the time that we took to perform readings. On reflection, our methodology would have been better had we used a continuous distance measurement on the main stem above and below the confluence, rather than adding the main stem above the confluence to the tributary/main stem below the confluence continuous measure. Also, the V* method was not well enough understood to implement for Tennessee Valley Creek in the limited time that we had available. A field guide and training were needed to understand the method and interpret the results. Through visual assessment, we observed that there were many fines in both the tributary and the main stem of the creek. Future studies of the tributary reach above the culvert and above the former stock pond will provide more insight into the characteristics of Tennessee Valley Creek.

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