# Fluvial Erosion and Transport: A Study of an Ephemeral Stream Located within the Fairfield Osborne Preserve, Sonoma County, California.

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## Overview

The study of streamflow, in regards to fluvial erosion and transport, is critical in understanding the processes that erode, carry, and deposit sediment (Huggett 2011: 193). In the case of the Fairfield Osborne Preserve (FOP), located within Sonoma County, California (Figure 1), the study of sediment transportation is imperative due to the erosive geology forming near the headwaters of Copeland Creek that produce "an astonishing amount of sediment despite its size, through mass wasting events" (Geography 317 2012: 5). This river channel assessment gathered data on a segment of an ephemeral stream during October 25th and November 1st, 2013. The data gathered used specific techniques and methods currently practiced in stream channel research that can yield "quality data without a high degree of specialization and at relatively low cost" (Harrelson et al. 1994:1). The techniques included creating a permanent benchmark reference, cross section, longitudinal profile, pebble count, and placement of erosion pins. The methods supplied data that will allow future researchers to compare and track the physical changes and character of the stream in relation to its ability to erode, carry, and deposit sediment into Copeland Creek.

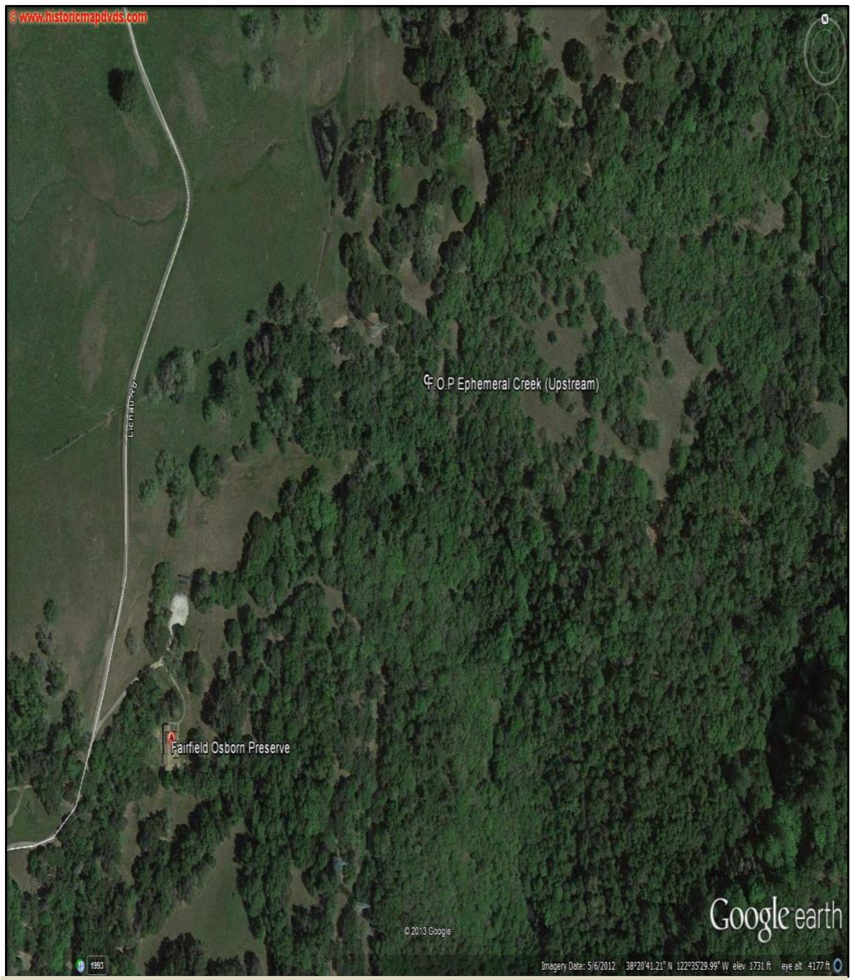



**Figure 1: Aerial Image of FOP and Study Area**

## Environmental Setting

The FOP, located within the foothills of Sonoma Mountains, has an elevation between 411 and 701 meters above sea level. The property is a 411-acre nature preserve that contains a diverse collection of vegetation, soils, and geology. The FOP is situated in a Mediterranean region with cool wet winters and hot dry summers, with much of the temperature affected by the Oceans, with precipitation varying from 100-125 centimeters in dry years and 250 centimeters in wet years, with the most extreme wet perception events associated with atmospheric rivers (Geography 317 2012: 7; Miller 1971). The underlying geology is comprised of bedrock associated with the Franciscan Complex, a mixture of sandstone, basalt, rhyolite and tuff, with rhyolite and Healdsburg Tuff being the two most prevalent rocks. These rock types are also the cause of many mass wasting events that includes the study area location, also known as “The Moving Trail” (Geography 397 2013:7). Dominant soils within the preserve are noted as the Goulding, Raynor and Diablo series (Miller 1972). These soils, forming from sedimentary and volcanic rocks, are situated on an ancient landslide complex, where “over-steepened flanks coupled with weak interbedded sedimentary units have resulted in numerous deep seated landslide complexes” (Geography 317 2012: 8).

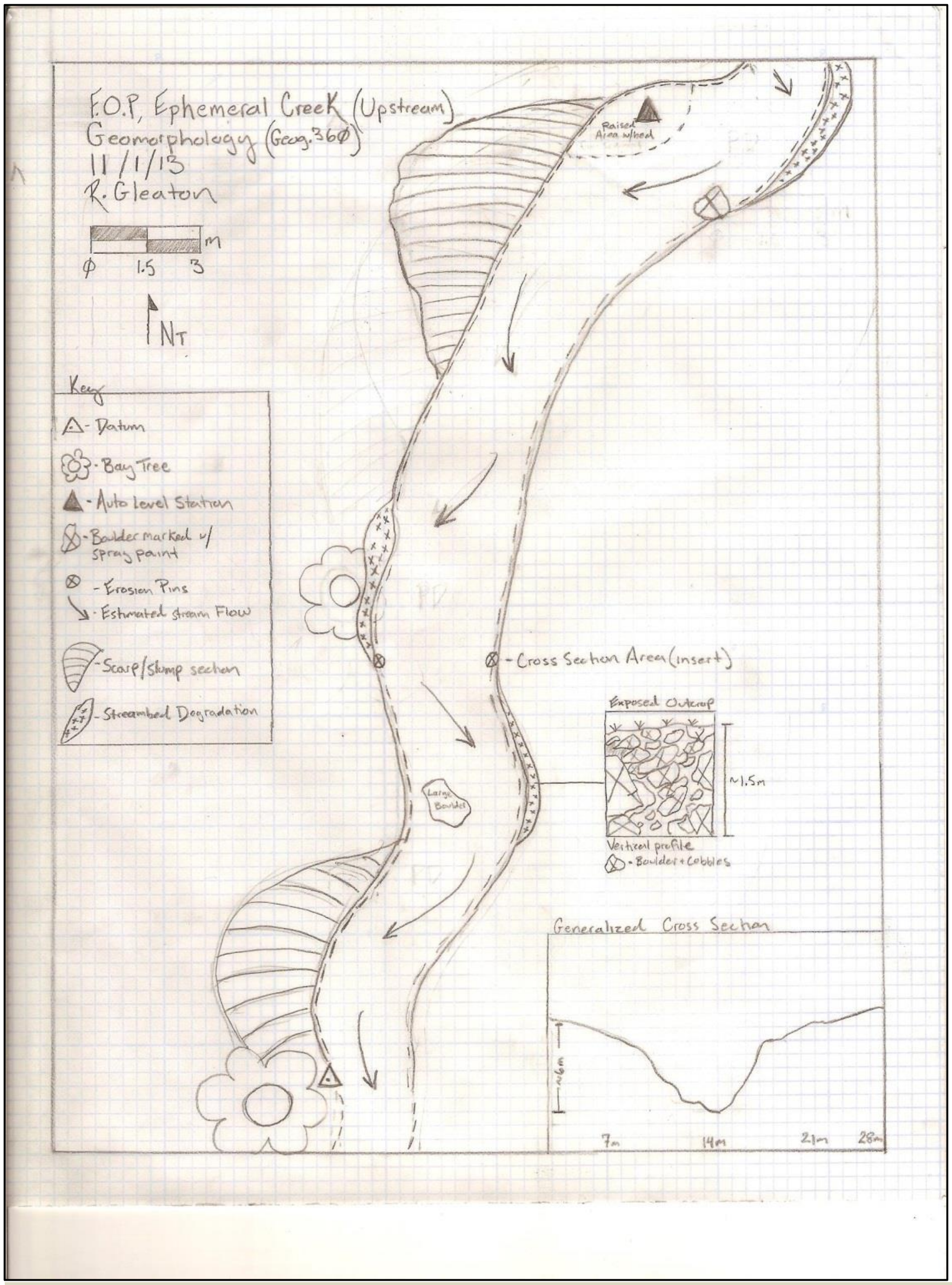



**Figure 2: Sketch Map of Upper Section of Study Area**

The FOP contains the headwaters of the perennial Copeland Creek and contains tributary ephemeral streams, such as the streambed analyzed in this study, which at the time of the research contained no standing or moving water. Various angular to surrounded gravels, ranging from granules to boulders, are located throughout the project area. Vegetation consist mainly of oak woodlands that are comprised of coast live oak (*Quercus agrifolia*), California black oak (*Quercus kellogii*), scrub oak (*Quercus berberidifolia*), and Oregon Oak (*Quercus garryanna*) (FOP 2010). California Bay (*Umbellularia califorincia*) appeared to provide the majority of the canopy in the research area. Various species of annual and perennial grasses and forbs where observed along the understory of the canopy, with heavy detritus covering most of the ground surface. A segment of a historic rock fence is located approximately 6 meters south of the ephemeral creek within the southern section of the study area.

**Methods**

The methods utilized in the data collection and recording of the stream segment included previously established techniques utilized by other stream channel researchers such as: mapping of the site with use of compass and meter tape; measuring the channel cross-section along the upper and lower segments of the stream; measuring the longitudinal profile; installing erosion pins; and the quantification and characterization of bed load material (Harrelson et al. 1994). The field survey of the longitudinal profile and vertical cross-section was conducted by analyzing two sections of the stream (designated the upper and lower sections). These were individually recorded by using an auto-level station, stadia rod, and meter tape in order to record and plot specific topographic features along the transects, including knickpoints, or steeper sections within the channel. Boulders and trees were used as benchmarks to establish reference points (Figure 2). Erosion pins where placed along surveyed cross-section areas and included the installation of spray-pained rebar. A measurement of the exposed metal was taken by use of calipers (Figure 8). A bed and bank material characterization was performed by calculating grain particle size and distribution by using the Wolman Pebble Count.

**Findings**

As anticipated, the longitude and cross-section profiles revealed that the ephemeral creek channel contains a slope gradient that is steeper in the upper section and decreases as the stream moves downslope, with an approximate forty-feet elevation difference overall (Figures 5 and 6). This was apparent in the V-shape incision formed from vertical erosion through abrasion and hydraulicking processes (Figures 4). The lower section contains characteristics of lateral aggradation and levee development, as it is a more suitable platform for deposition (Figure 3). This is to be expected as typically “scour and erosion dominate upstream channels, and fill and deposition dominate downstream channels” (Huggett 2011: 198). This was also apparent as lateral degradation was observed within the upper-section of the stream channel, as channel banks are worn away from being undercut, causing slumping in at least two areas along the banks (Figure 2). These findings are also supplemented by the results of particle sizes taken from the Wolman pebble count (Figure 7). The count revealed that the streams competence, in relation to its bed load, is able to carry particle sizes that range from boulders to small gravels, with the majority of boulders being located within the upper-segment of the streambed, and smaller particles deposited within the lower section, where the gradient is decreased.

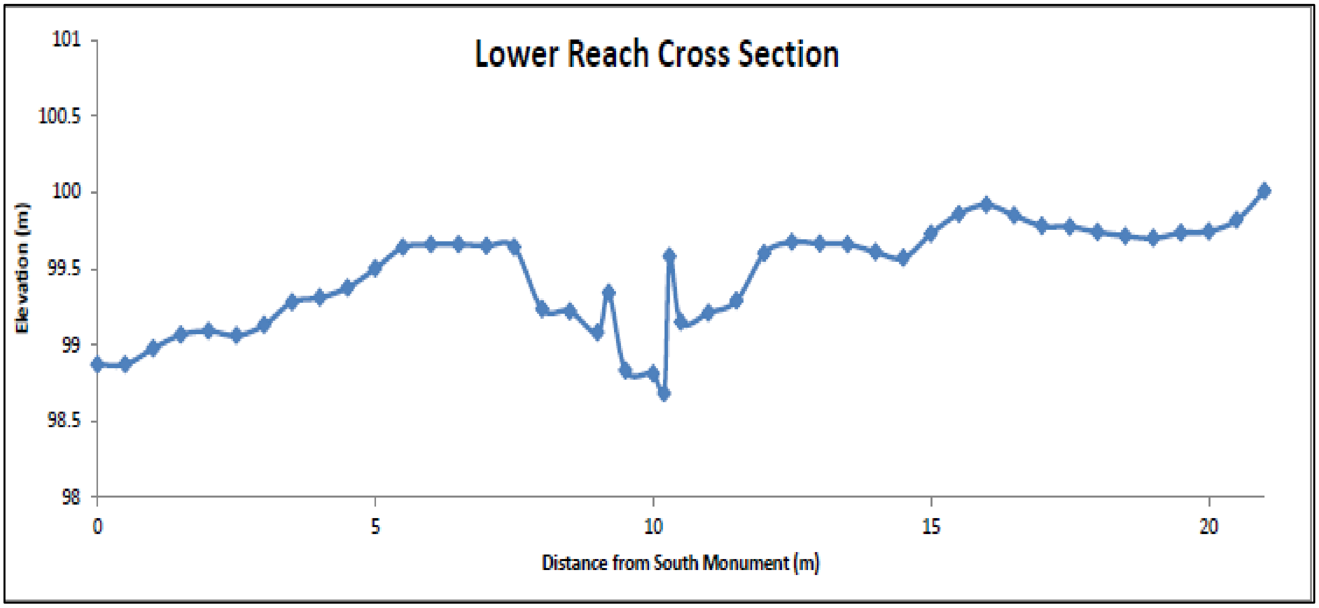



**Figure 3: Lower Reach Cross Section**

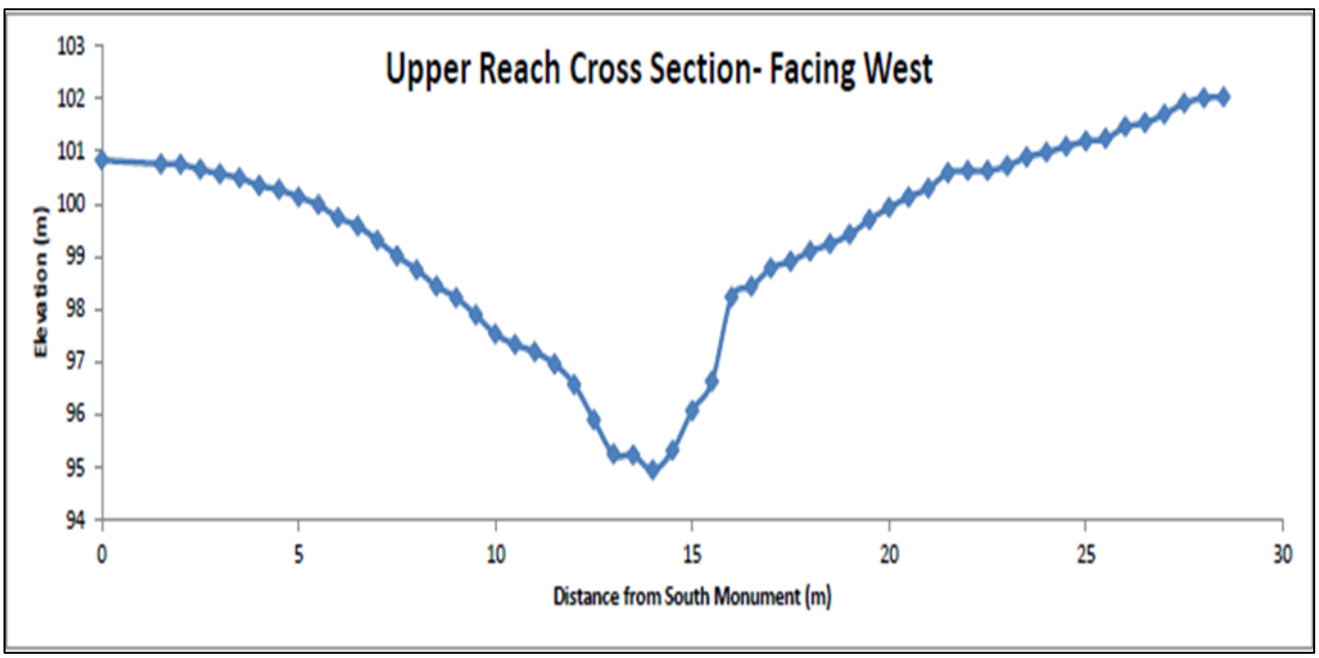



**Figure 4: Upper Reach Cross Section**

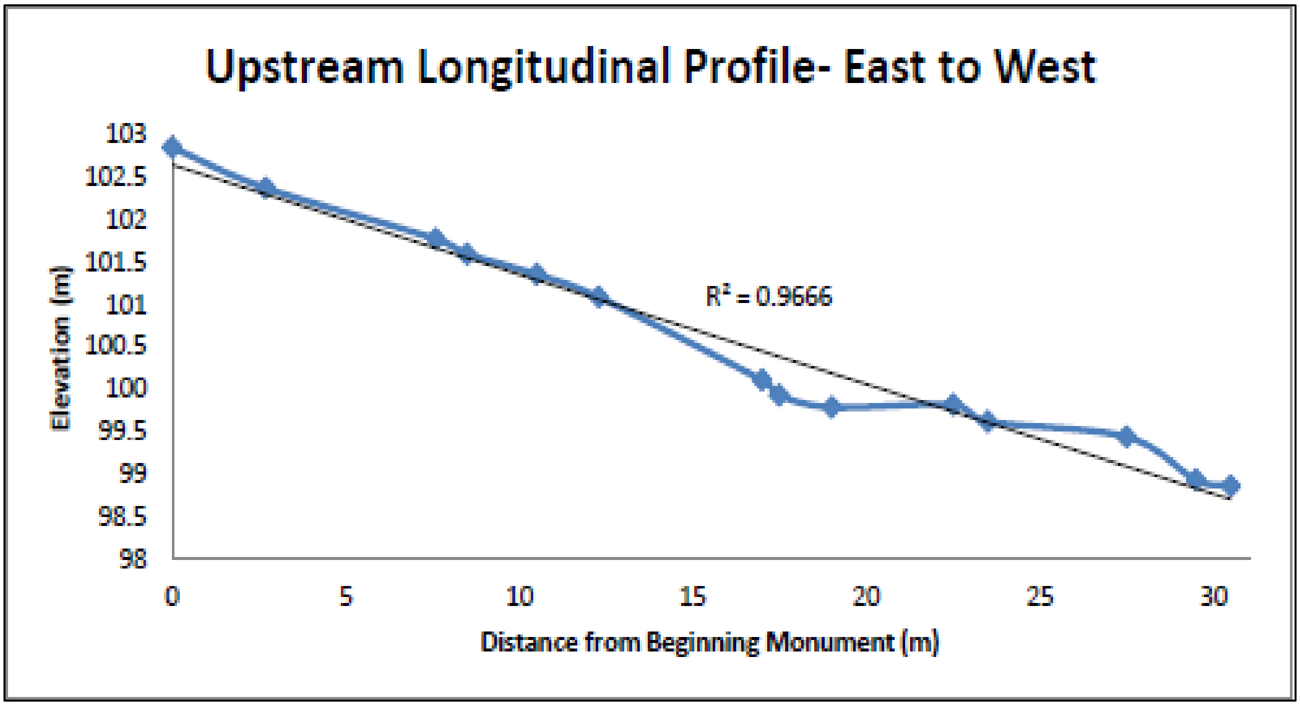



**Figure 5: Upstream Longitudinal Profile**

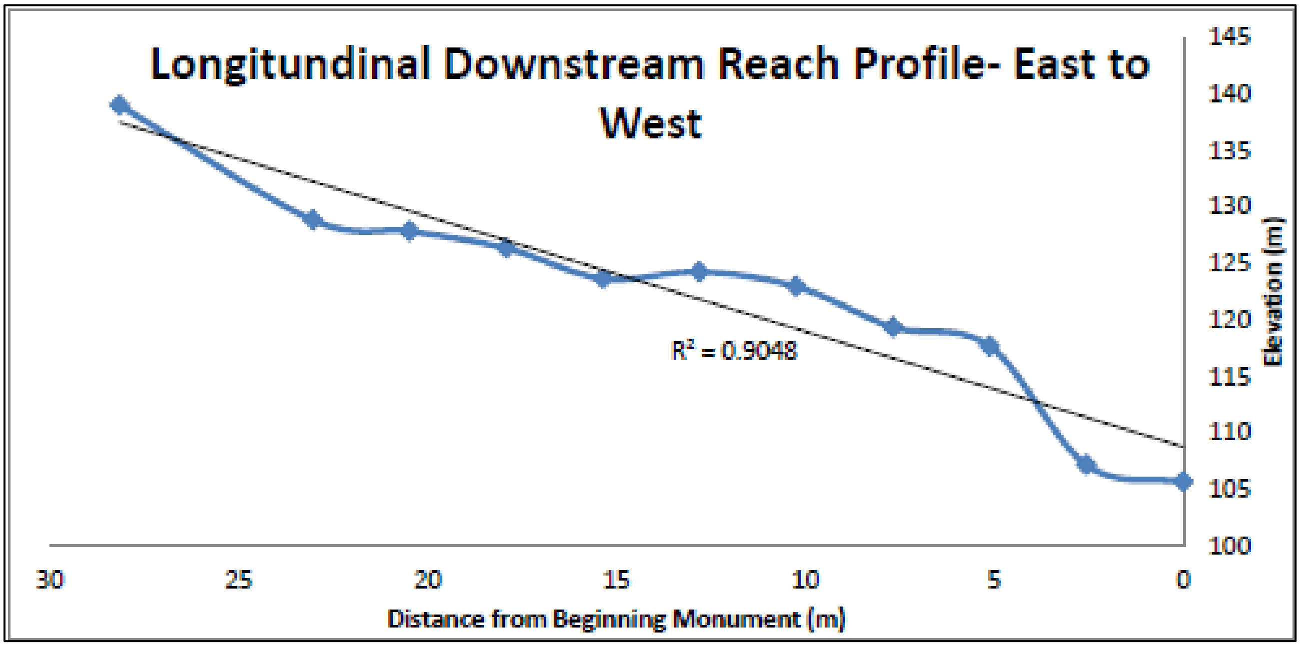
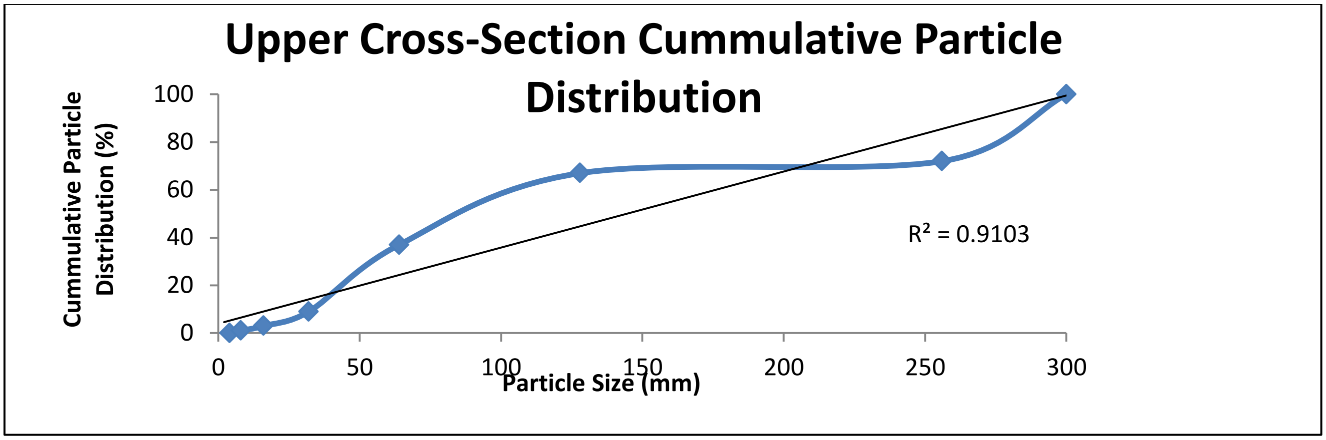
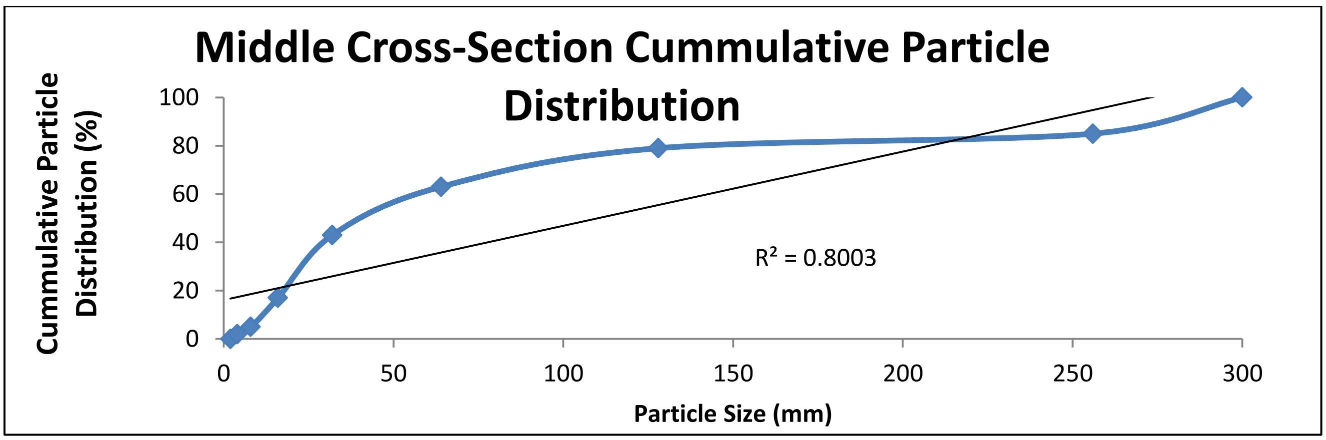



**Figure 6: Downstream Longitudinal Profile**



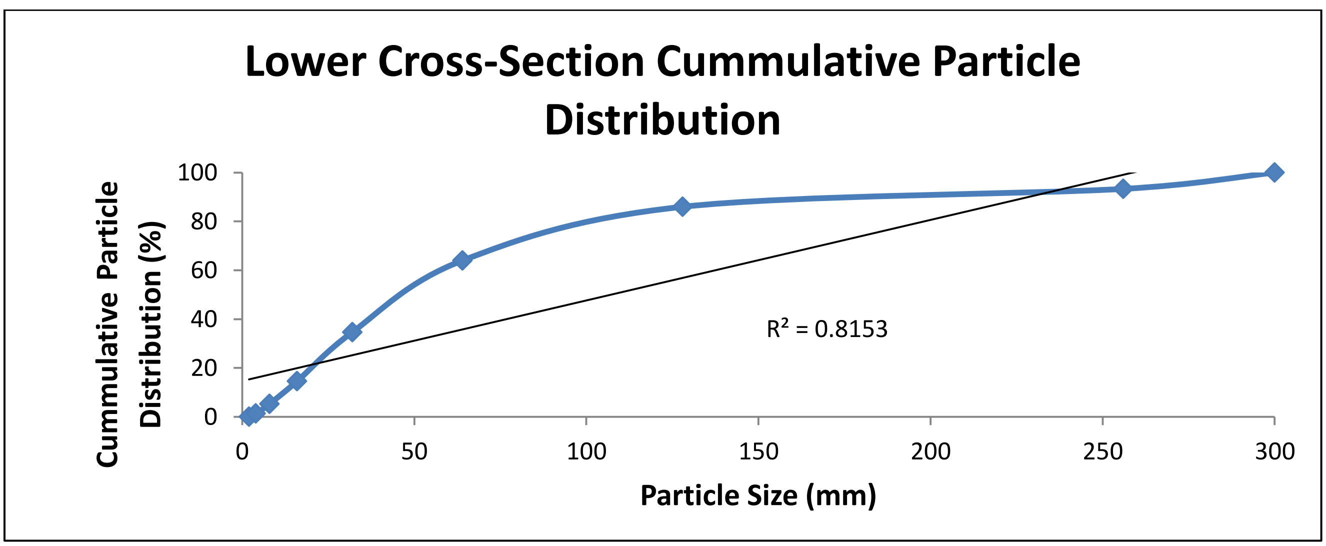




**Figure 7: Wolman Pebble Count**

| Orientation: Looking downstream | Exposed length of pin (cm): Top | Exposed length of pin (cm): Bottom | Notes | X-Section | Compatriots | Elevation (m) below transit | distance from beginning monument (m) |
|---|---|---|---|---|---|---|---|
| Left bank pin | 20.5 | 15.1 | Pin is in a gap in the rocks, the top is exposed farther than the bottom due to rocks. | Lower | Syd | 0.31 | |
| Right bank A (top) | 11.92 | | | Upper | David, Ryan, Jason, Aaron | 5.09 | 14.9 |
| Right bank B (bottom) | 15 | | | Upper | David, Ryan, Jason, Aaron | 5.24 | 14.9 |
| Left bank A (upstream) | 11.33 | | | Upper | David, Ryan, Jason, Aaron | 4.83 | 12.2 |
| Left bank B (downstream) | 21.1 | | | Upper | David, Ryan, Jason, Aaron | 5.67 | 13 |
| | | | | | | | |
| West bank (right bank), in lower x-section (A) | 10.9 | 10.9 | Pin is located 11.5cm from riverbank surface. Almost all of spray-paint is exposed | | | | |
| West bank (right bank), in lower x-section (B) | 18.5 | 18.5 | Pin is located 29.4cm above Pin A, and 40.3cm above riverbank. Rebar is positioned at extreme angle, had trouble positioning pin due to angular cobbles. | | | | |
| | | | | | | | |
| Left bank pin 1 | | | | Lower | Grace, Kayla | 0.31 | |
| Right bank pin 1 | | | | Lower | Grace, Kayla | 1.2 | |
| Right bank pin 2 | | | | Lower | Grace, Kayla | 0.91 | |

**Figure 8: Erosion Pin Data**

**Conclusion**

The study of the upper and lower sections of an ephemeral creek segment located at the FOP revealed that the channels physical characteristics, such as gradient, topography, underlying geologic formation, and soils, have a direct impact on the streams aggradation and degradation processes. Lateral and vertical degradation caused by gradient and stream flow resulted in undercutting and slumping along its upper-banks, and will eventually cause future collapse of those areas that will expand the width of the channel and supply additional sediment that will redeposit downstream. The ephemeral creek appears to have stream erosion and deposition take place during high precipitation, fast-flow events. This is causing alluviation, where erosion dominates the upstream section and fill and deposition dominate the downstream section. The placement of erosion pins, as well as detailed longitude and cross-section profiles, will help future researches calculate the ephemeral creek's stream power in relation to eroding, carrying, and depositing sediment. This study can then be applied to further the knowledge of how these processes of sediment distribution affect Copeland Creek.

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