WRPI Final Report 2018: Stream Condition Inventory for Angeles National Forest

Christopher Notto
California State University, Northridge
Kelsha Anderson, Forest Hydrologist
Angeles National Forest
8/14/2018

Acknowledgements

This project was supported by Hispanic-Serving Institution's Education Program Grant no. 2015-38422-24058 from the USDA National Institute of Food and Agriculture.

Executive Summary

A Stream Condition Inventory was completed a reach of approximately 1,571 feet of San Francisquito Creek, in San Francisquito Canyon, along the Sierra Pelona Mountain range. Data collected includes basic water quality, channel cross sections, longitudinal profile, sediment distribution, and stream bank angle/stability. This data was collected in order to later asses the overall health of the stream habitat.

This specific reach was chosen because of the proximity to the now demolished Saint Francis Dam. Restoration efforts are planned for this area, so the data collected in this survey will influence future actions taken within the watershed.

Introduction

The project that I was placed on for the WRPI Internship during the summer of 2018, was to work with Angeles National Forest Hydrology in order to complete two Stream Condition Inventories (SCI) within watersheds of the Angeles National Forest. One was completed near Cottonwood Campground, and another completed on San Francisquito Creek, in San Francisquito Canyon. The following pages of this document, contain the finished report for the SCI conducted for San Francisquito Creek, in which I took part in all processes of its completion, from data collection, to analyzing collected data, to writing and publishing.

San Francisquito Creek Stream Condition Inventory Report
08/01/2018
by WRI Interns: Luis De Vera, Christopher Notto, Jamie Seguerra, and Jonathan Tejeda

Stream Survey Site

A Stream Condition Inventory (SCI) (Frazier et. al, 2005) survey was conducted downstream of the St. Francis historic site in San Francisquito Creek located in San Francisquito Canyon in the Sierra Pelona Mountains (see *Figure 1*). The survey was performed from July 24, 2018 to July 31, 2018. The reach for this survey is approximately 1,571 feet (*ft.)* and the drainage area is 37.4 square miles. All measurements were taken in tenths of *ft*. The study site is east of San Francisquito Canyon Road with the abandoned old road running through the creek. The surveyed reach includes an area with an aquatic organism passage (AOP) barrier inhibiting passage for aquatic species; located underneath the bridge and is the bridge's concrete footing. Los Angeles County Department of Public Works is anticipated to deconstruct the old road and bridge in the future. Additionally, there are signs of deterioration and road collapse near the bridge.

The vegetation in the area consists of willows (*Salix spp.*), Fremont cottonwood (*Populus fremontii*), cattails (*Typha* spp.), celery (*Apium graveolens*), mule fat (*Baccharis salicifolia*), California sycamore (*Platanus racemosa*), tamarisk (*Tamarix* spp.), coast live oak (*Quercus agrifolia*), smilo grass, algae and unidentified aquatic vegetation. Signs of aquatic fauna exist along the creek that include, red swamp crayfish (*Procambarus clarkii)*, pacific tree frog (*Pseudacris regilla*), California tree frog (*Pseudacris cadaverina*), and arroyo chub (*Gila orcuttii*). A variety of physical data were collected, including a longitudinal profile, monumented cross sections, particle size distribution, stream cover shading, bank stability, large woody debris, and pool tail fine sediment. Basic water chemistry data was collected, including benthic macroinvertebrate (BMI) sampling, dissolved oxygen, pH, conductivity and water temperature, and turbidity.

The reach downstream of the St. Francis dam has not been surveyed or assessed in the past and there is no pre-existing data up until this point. The SCI data will provide a baseline for monitoring temporal change in channel morphology, provide a comparison between streams and access the health and stability of the reach.

Figure 1: Study Site--Downstream of St. Francis Dam, CA

Project Background

The Copper fire of 2002 burned approximately 20,000 acres primarily in the San Francisquito watershed (see *Figure 2*). This resulted in a loss of vegetation and significant sediment loading into San Francisquito Creek causing significant impact to the California red-legged frog (*Rana draytonii*) and unarmored threespine stickleback (*Gasterosteus aculeatus*) habitat. Furthermore, the fire intensified invasive vegetation encroachment. The effects of the Copper fire include natural resources, Los Angeles Department of Water and Power and California Edison infrastructure, an area of Los Angeles aqueduct as well as the drainage area to Bouquet Reservoir. Areas of cultural and historical heritage sites were impacted which includes the St. Francis Dam failure site. The St. Francis dam was completed in 1926, it was the largest dam of its size of the time. It was built as a water storage reservoir for the Los Angeles Aqueduct system. The dam failed in 1928 and left behind large concrete debris remnants that remain in the stream and surrounding landscape today. During the site visit to the stream, several areas were observed blocking and or altering instream flow as well as providing areas with pool formation. St. Francis Dam is slated as a potential national memorial site. In 2005 and 2006 heavy rains and subsequent flooding caused significant erosion and additional sediment loading into San Francisquito Creek. These impacts were exacerbated by decreased hillside stability due to the severe vegetation loss from the Copper fire.

Subsequently, the United States Forest Service (USFS) has partnered with the National Fish and Wildlife Foundation (NFWF) to restore areas affected by the Copper (2002), Ranch

(2007) and Sayre (2008) fires within the Angeles National Forest lands through the Angeles National Forest Wildfires Restoration Grant Program. The "projects aim to restore the watersheds and ecosystems affected by these fires, promote ecological resilience to future wildfire events, inform efficient post-fire restoration through innovation, and increase awareness and understanding of fire's impact on Southern California landscapes" (NFWF, 2017)

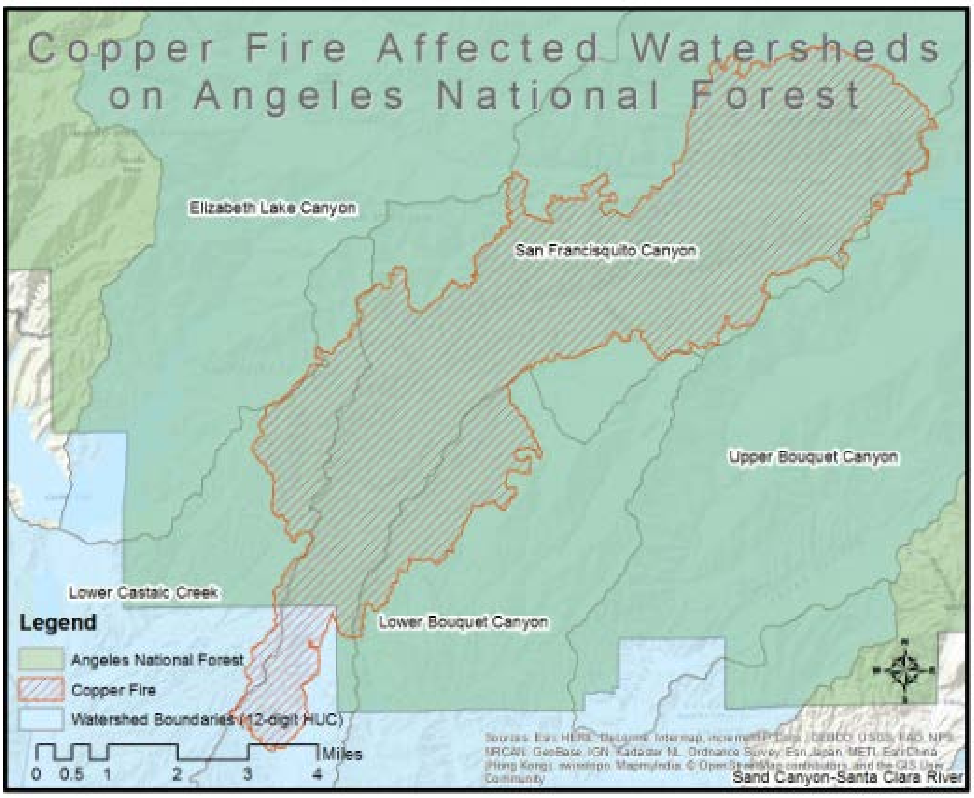

Figure 2: Source: National Fish and Wildlife Foundation.

Methods

Water Quality

There were five samples of turbidity, pH, conductivity, dissolved oxygen and water temperature taken downstream of cross section 2. This area was the furthest downstream of the reach with water present.

Benthic Macroinvertebrate (BMI) Sampling

Three random samples were collected at each cross section. A total of 6 samples were collected from cross section 2 and 3. The channel was dry at cross section 1, therefore no BMI samples were collected in this area. A tape measure was placed in the stream at a length of 20 feet, 10 feet upstream and 10 feet downstream across each cross section. Random numbers were generated in order to determine stations of sample collection.

Channel Cross Sections

Three monument riffle cross sections were selected in the surveyed reach. Cross section 1 was established to accommodate multiple side channels within the area. Cross section 2 was established in the middle of the reach at a riffle. Cross section 3 was established upstream of a bridge on the old road that is planned for removal.

Longitudinal Profile

Two permanent monuments were established, a lower monument and an upper monument. The elevation used was taken from a GPS unit. The longitudinal profile was started downstream and tied into the lower monument with a series of turning points. Once the height of the instrument was established, points of elevation were measured in the thalweg, throughout the entire surveyed reach in order to measure stream gradient and change in the morphology of the streambed.

Pebble Counts

There were four pebble counts conducted on the surveyed reach; one at each of the cross sections and one pebble count for the representative reach for a total of four pebble counts conducted with 400 samples measured. The cross section pebble counts were done in a series of 20 transects perpendicular to flow with five samples measured per transect. The representative reach pebble count was taken in “fast” and “slow” water habitat areas with a total of 55 samples measured in “slow” water and 45 samples measured in “fast” water. The B-axis was used to measure the diameter of all samples.

Stream Shading

Using a Solar Path Finder, measurements were collected every 31 feet along the surveyed reach in order to quantify the amount of canopy cover on the stream banks. The month that was utilized in the Solar Path Finder was July.

Bank Angle/Bank Stability

A clinometer was used to determine stream bank angles every 31 feet along the surveyed reach. A section of PVC pipe was situated at the slope and a clinometer was placed along the top of the pipe to determine angle of the stream bank at each station. Bank stability measurements are based on a ranking scale from 1 to 3 where:

1. Stable: 75% or more cover of living plants and/or other stability components that are not easily eroded.

2. Vulnerable: 75% or more cover of living plants or more cover but have one or more instability indicators
3. Unstable: less than 75% cover and may have instability indicators, often bare or nearly bare banks composed of particle sizes too small or in cohesive to resists erosion at high flows.

Discussion

Longitudinal Profile

The longitudinal profile characterizes channel bed gradient, water surface gradient, and depths of riffles, pools, runs, glides, rapids and step pools. The average stream gradient is required for delineating stream types. At the broadest resolution level, fluvial geomorphologists recognize fast water (riffles, runs, and glides) and slow water (pools) as the two primary stream habitat unit types. These units are important attributes that explain the characteristics of its base stratification and topography of the habitat that support the life of aquatic organisms.

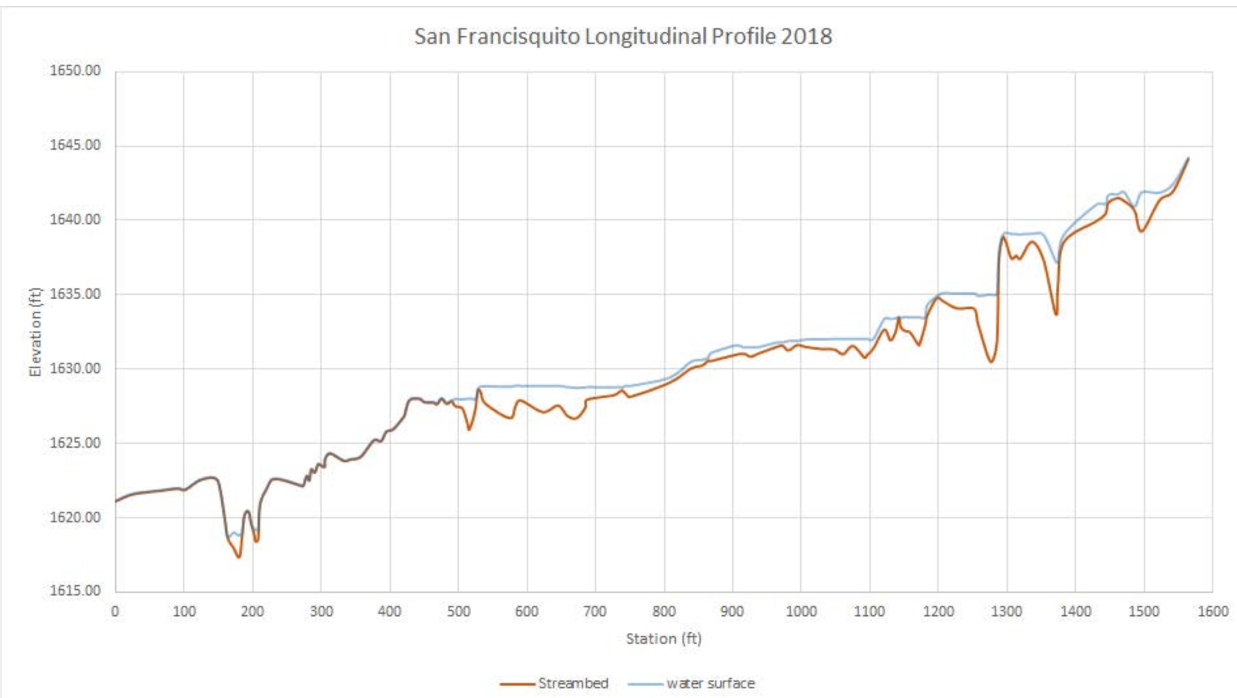

Figure 3: Longitudinal Profile of San Francisquito Creek, CA.

Channel Cross Sections

Channel cross section measurements express the physical dimensions of the stream perpendicular to flow. They provide fundamental understanding of the relationships of width and depth, streambed and streambank shape, bankfull stage and floodprone area, etc. Three monumented cross sections were surveyed within the reach at fast water (riffles, runs, and glides) features. *Table 1* describes the dimensions of the cross sections while *figures 4-6* depict their shape. The stream is currently at low base flow with a low velocity. It is important to note the abundant presence of aquatic vegetation within the channel, which further affects flow by creating greater friction within the stream.

Table 1: Cross Section statistics of San Francisquito

	XS - 1	**XS - 2**	**XS - 3**
Bankfull Width (*ft.*)	19.5	23.6	40
Floodprone Width (*ft.*)	70.2	60.60	133.5
Entrenchment ratio	3.6	2.6	3.3
Mean BF Depth (*ft.*)	1.36	1.13	3.24
Max BF Depth (*ft.*)	2.04	1.49	4.09
Cross Section Area (ft^3)	26.5	27.8	129.6
Width/Depth ratio	14.4	20.07	12.35

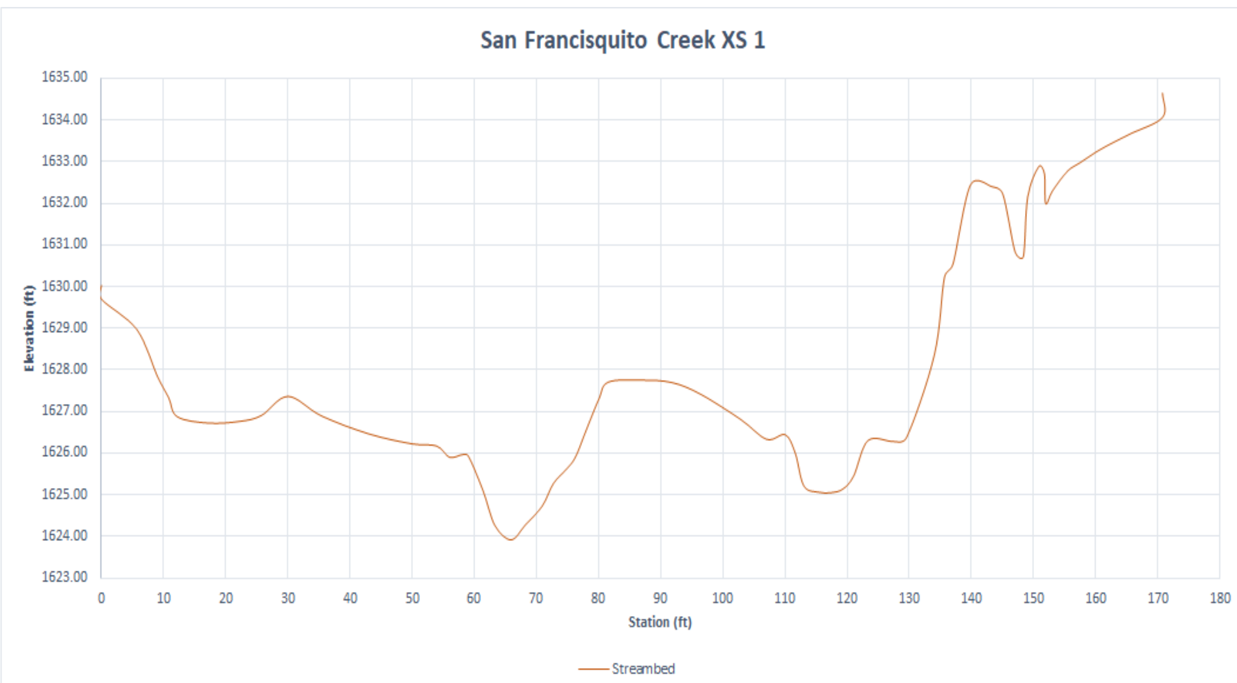

Figure 4: Cross section 1 of San Francisquito Creek.

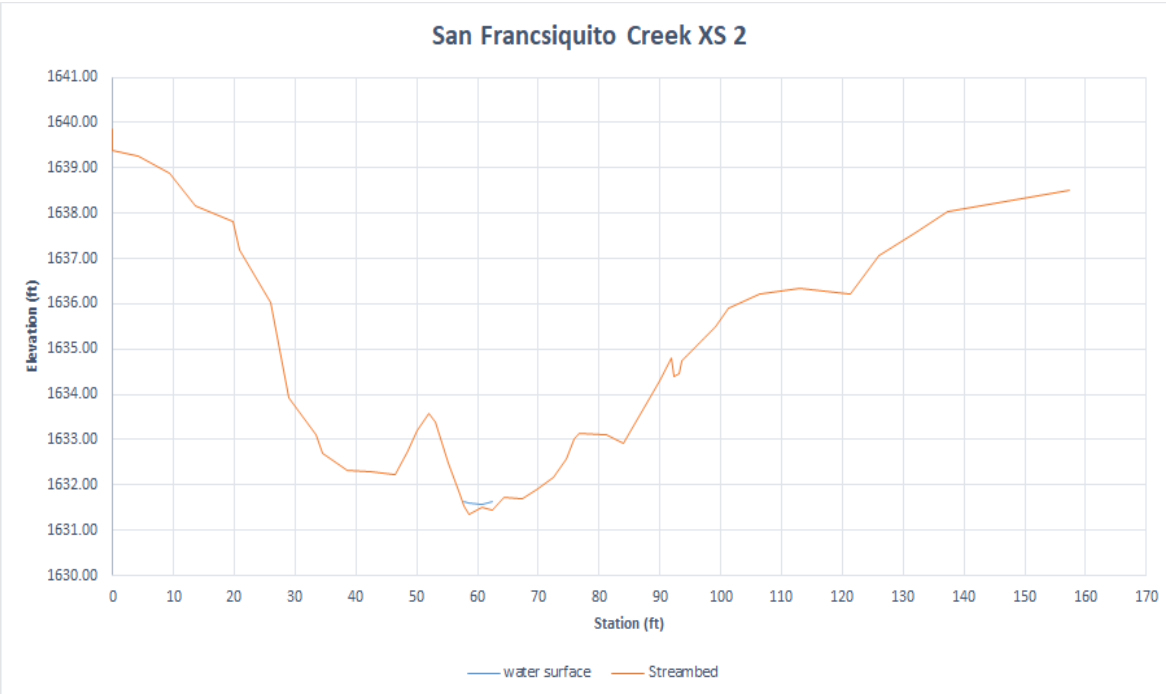

Figure 5: Cross section 2 of San Francisquito Creek.

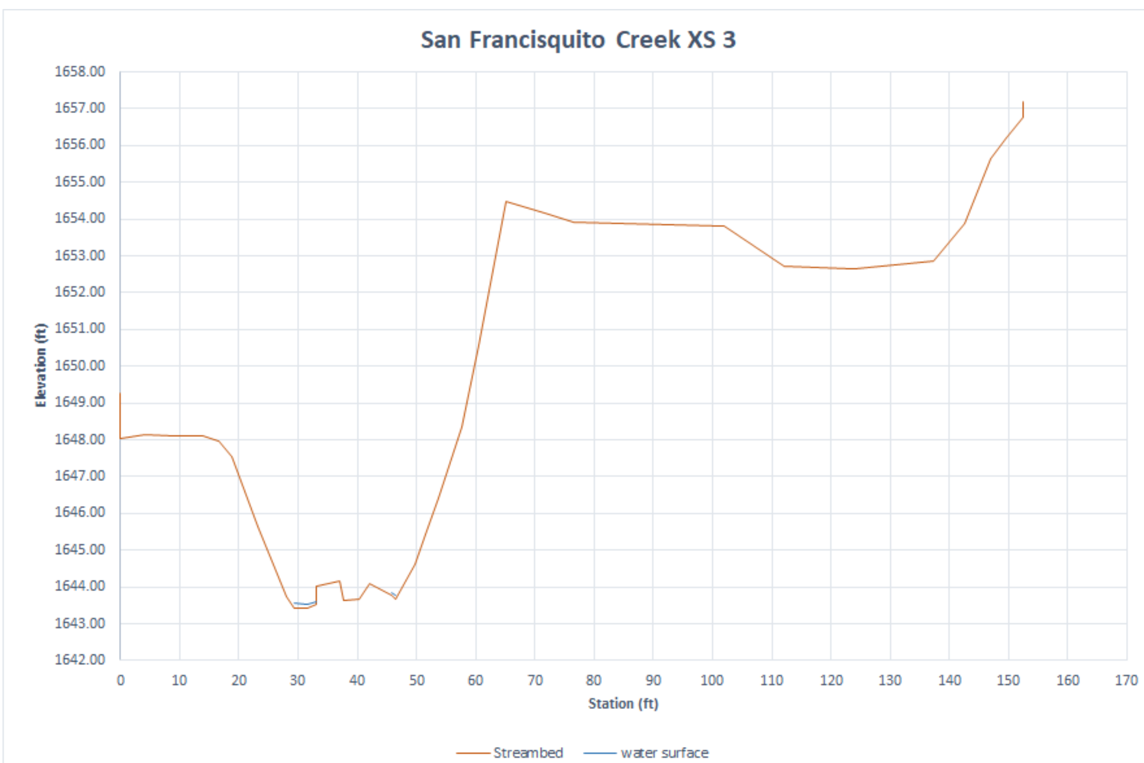

Figure 6: Cross section 3 of San Francisquito Creek.

Particle Size Distribution

Streambed materials are key elements in the formation and maintenance of channel morphology. These materials influence channel stability, resistance to scour during high flow events, and also act as a supply of sediment to be routed and sorted throughout the channel. The amount and frequency of bedload transport can be critically important to fish spawning and other aquatic organisms that use stream substrate for cover, breeding, or foraging. Particle size distribution can change over time as a result of management activities and/or natural disturbances.

Particle size distribution surveys were conducted at each of the three cross sections and along the longitudinal profile to represent the studied reach. *Figure 7* shows that particle size distribution is greatly varied among the three cross sections. "Weighted particle size distribution" was collected according to the amount of fast versus slow water within the reach. In other words, 45 % of particles were collected from "fast" water while 55 % were collected from "slow" water. By doing so, the result show there is a fair amount of fine sediment in the pools (*Table 2* and *Figure 7*). It is important to note the abundant presence of aquatic vegetation in the stream along a majority of the reach which made pebble sampling difficult when trying to breach through heavy vegetation. Furthermore, the channel bed was firmly consolidated adding an additional burden on sample selection.

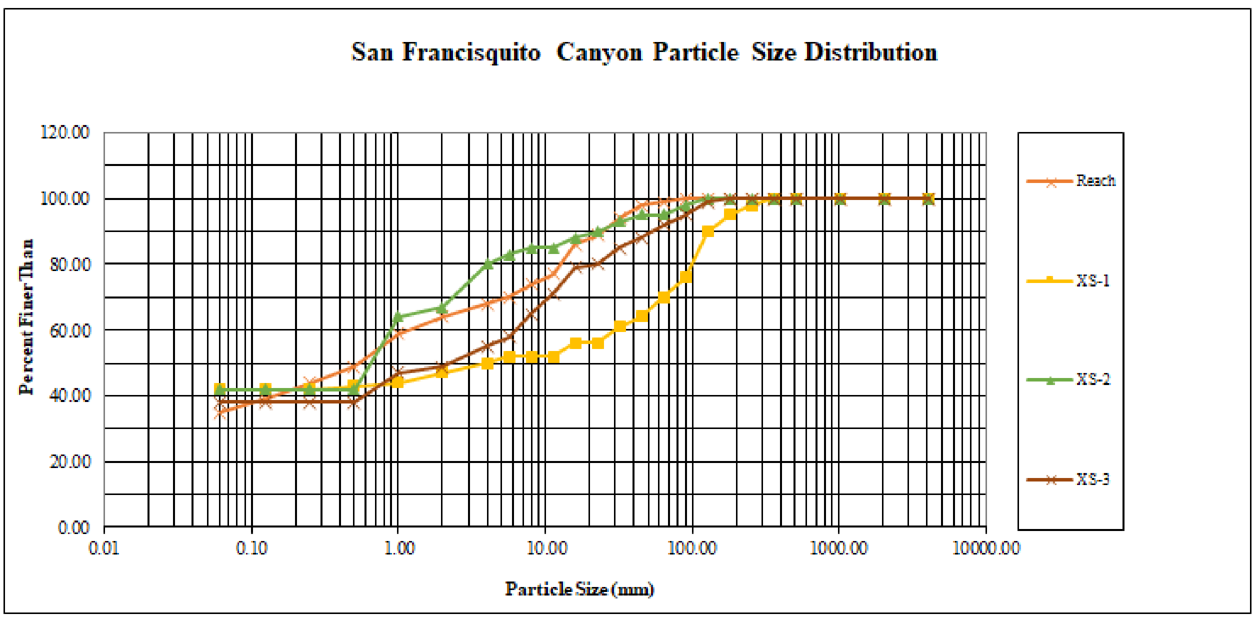

Figure 7: Particle size distribution analysis.

D50 (at a cross section) is the median particle size in the streambed used to classify stream type and can also provide a minimum estimate of the shear stress necessary to initiate general movement of mixed-size sediment (Rosgen, 2006; Elliot, 2002). D84 (84^{th} percentile particle size) among the Weighted particle size distribution is used in part to estimate Manning's roughness coefficient. Manning’s roughness coefficient is then used in part to estimate bankfull velocity and discharge (*Figure 6*).

Table 2: D50 and D85 distribution.

Percentiles	**X-Sec 1**	**X-Sec 2**	**X-Sec 3**	**Reach**
D50	4.00	1.00	4.00	1.00
D84	128.00	8.00	32.00	16.00

Stream Type Discussion

Given results from the particle distribution analysis, longitudinal profile, and cross section, it is determined the reach is a Rosgen stream type **C4 (**see *Table 3***)**. These streams are meandering, predominantly gravel, with lesser amounts of cobble, sand and silt/clay, slightly entrenched (> 2.2), displays a high width/depth ratio (>12), slope < 2% and are moderately sinuous (>1.2).

This stream type has the following generalized management interpretations (Rosgen, 2-31):

- Very high sensitivity to disturbance
- Good recovery potential
- High sediment supply
- Very high streambank erosion potential
- Very high vegetation controlling influence

Table 3: Reach Statistics.

Entrenchment Ratio	3.17
W/D Ratio	15.59
Valley Slope %	1.47 %

Sinuosity	1.237

Shading and Stream Temperature

Stream temperature has impacts on health, behavior, and survival of aquatic organisms and is strongly influenced by streamside shading. Streamside vegetation is a primary source of energy to most streams. *Table 4* summarizes the stream shading along the surveyed reach of San Francisquito Creek. The data was obtained on July 26, 2018. The solar pathfinder was utilized to characterize stream shading coverage along the surveyed reach. The solar pathfinder consists of quantitative data identifiers for areas covered by tree canopy, vegetation, mountains, etc. that provide shade over the shade.

Table 4: Shade calculations along San Francisquito Creek.

Shade Calculations	
High	100 %
Average	66.5 %
Low	2 %

Large Woody Debris

Large wood is important to the morphology of many streams; it influences channel width and meander patterns, provides for storage and bedload, and is often most important in pool formation in streams. Large wood is also an important component of instream cover for fish, as well as providing habitat for aquatic insects and amphibians.

In sections of the stream, large pieces of dam debris are present and impacting the channel morphology and in stream flow. These observations were noted in the survey. Large wood was tallied within the surveyed reach, with criteria being over 0.1 *m* diameter and at least 1.5 *m* in length. Results of the tally show approximately **234.5** ft^3 of large wood within the reach, or **0.22** ft^3/ft**.** over the entire reach.

Pool Tail Surface Fine Sediment

Watershed and streambank disturbance often result in increased sediment input to streams. Increased fine particles in the stream substrate can impair aquatic food production and decrease survival of young fish. Particles of 2 *mm* or less are the principal barriers, although particles up to 8 *mm* have resulted in increased mortality. Average fine count for this reach is **100**

% in pools. This value is high, though not surprising for the amount of disturbance caused by the 2005 and 2006 debris flow.

Pfankuch Scoring

The Pfankuch rating system was developed to systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production (Pfankuch, 1975). Although these ratings can be fairly subjective, they are still used as a way to identify key problem features.

Modified Pfankuch rating for stream type C4 for the surveyed reach in San Francisquito Creek is **Good (Stable)**. The areas of concern would be the frequent obstructions to flow by large woody debris and large dam debris inhibiting flow and causing channel shifts, high amounts of fine sediment in the channel as well as the low density of vegetation on the banks.

Table 5: Pfankuch Stability Rating.

Excellent Total = 5	Good Total = 38	Fair Total = 24	Poor Total = 20

Grand Total = 87	Stream Type = C4	Modified Channel Stability Rating = Good (Stable)

Basic Water Chemistry

Table 6: Basic Water Chemistry.

Dissolved Oxygen	8.286 *mg/L*
pH	8.406
Conductivity	649.8 *µs*
Water Temperature	26.16 º*C*

Aquatic Fauna

There has been evidence of aquatic life present in San Francisquito Canyon. Amphibians that were observed within the reach are the pacific tree frog (*Pseudacris regilla*) (HYRE) and the California tree frog (*Pseudacris cadaverina*) (HYCA) near Cross Section 3 within stations 1270-1571 *ft*. Arroyo chub (*Gila orcuttii*) were also seen in areas near Cross Section 2. In addition, the entire reach of the stream the western fence lizard (*Sceloporus occidentalis*)

(SCOC) and the invasive red swamp crayfish (*Procambarus clarkii*) were observed numerous times throughout the stream.

Bank Angle

Bank angles were measured every 31 *ft*. along the reach, at left and right bank using a clinometer. There were inaccessible areas due to deep pools and concrete below the bridge. The deep pools endangered the safety of the researchers therefore bank angles were not measured. Inaccessible areas were noted on *Form 8* accordingly with stations numbers. *Table 7* indicates the averages of left bank, right bank, and total bank.

Overall the bank stability appeared to be vulnerable: 75 % or more cover of living plants or more cover but have one or more instability indicators.

Table 7: Bank Angle Stability

Bank	Total # of Banks	Total Bank Angle Sum	Total Bank Angle Average
Right Bank	46	7,045	153.15
Left Bank	45	6,290	139.78
All Banks	91	12,970	142.53

References

Dunne, T. and L. Leopold. 1978. Water in Environmental Planning. San Francisco, CA; W.H. Freeman and Company. ISBN-13: 978-0716700791

Elliot, J. 2002. Bed-Material Entrainment Potential, Roaring Fork River at Basalt, Colorado. US Geological Survey. Denver, Colorado. Water-Resources Investigations Report 02–4223

Frazier, J.W., K.B. Roby, J.A. Boberg, K. Kenfield, J.B. Reiner, D.L. Azuma, J.L. Furnish, B.P. Staab, and S.L. Grant. 2005. Stream Condition Inventory Technical Guide, Version 5.0. USDA Forest Service, Pacific Southwest Region- Ecosystem Conservation Staff. Vallejo, CA.

Harrison, S. 2016. St. Francis Dam Collapse Left a Trail of Death and Destruction. LA TIMES.MAR 19, 2016. Web.

Leopold, L.B., M.G. Wolman, and J.P. Miller. 1964. Fluvial Processes in Geomorphology. W.H. Freeman and Company, San Francisco, California. ISBN-13: 978- 0486685885

National Fish and Wildlife Foundation, 2017. *Angeles National Forest Copper, Ranch, and Sayre Fires Restoration Strategy* (pp. 1-24, Rep.). doi: http://www.nfwf.org/angelesfire/Documents/ANF_RestorationStrategy_Final_03_14_17.pdf

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. USDAFS No. R1-75-002, GPO No.696-260/200). Washington, D.C.: US Government Printing Office.

Pitlick, J. Cui, Y. Wilcock, P. 2008. Manual for Computing Bed Load Transport using BAGS (Bedload Assessment for Gravel-bed Streams) Software. National Stream Systems Technology Center.

Rosgen, D.L. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology. Fort Collins, Co. ISBN-13: 978-09791308

Wolman, M. and J.P. Miller. 1960. Magnitude and Frequency of forces in geomorphic processes. Journal of Geology 68: 54-74.

SCI Equation Glossary

Entrenchment Ratio = flood prone area width/bankfull width

Width/depth ratio = bankfull width/ bankfull mean depth

FP Elevation = 2x bankfull depth + Thalweg elevation

Valley Gradient = (End of reach-beginning of reach)/valley length

Sinuosity = Stream Length/ Valley Length

Stream Gradient = (End of reach-beginning of reach)/stream length

Percent stream slope = stream gradient x 100

Percent Valley Slope = valley gradient x 100

Cross Section Area = Mean BF Depth x Bankfull Width

Floodprone elevation = Thalweg elevation + 2x Bankfull depth

Meander width ratio = belt width/bankfull width

Project Outcomes

Although data that was required for a complete SCI were collected, the methods used to collect the data were not efficient. There are well known current methods of collection this data using newer, more efficient technology, that would have smoothened out the workflow of each survey that we completed. For example, taking elevation measurements with an RTK GPS instead of a laser level and stadia rod, like we did. Even though these old methods slowed us down, it was a valuable experience in that we had a chance to gain experience using technology that we otherwise wouldn't have used.

Conclusions

All data that was required was collected for each SCI, in accordance to U.S. Forest Service protocol. This data can further be utilized to make decisions on restoration and other projects that might affect critical watershed on the forest. Also, it would be interesting for these areas to be surveyed multiple times over a period of time, perhaps annually, in order to track geomorphic change on the streams.

Overall, this experiential learning internship has furthered my career goals by giving me exact hands-on experience working in the earth sciences. I am now more than confident in my ability to foster a future career within branches of the USDA, utilizing the skills I have learned in geomorphology and hydrology.