Building a Stream Condition Inventory Geodatabase for Sequoia National Forest

Emily Wilkinson, WRI intern
California State University, Monterey Bay
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Keith Stone, district hydrologist & advisor
Kern River Ranger District, USFS

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Executive Summary

Sequoia National Forest is a land of many uses. These cumulative uses impact watersheds within the forest either directly or indirectly. To maintain or improve watershed health, Stream Condition Inventories were designed for long term monitoring of any response to road construction, wildfire, recreation, or livestock grazing. Forest Resource Specialists use these surveys for environmental analysis under the National Environmental Policy Act (NEPA), which also include projects like, restoration, and trail construction. Until 2018, these surveys were hardcopies filed away in Porterville, which made access inconvenient. WRI sponsored a 300 hour internship with the USFS to streamline access to the surveys via the construction of a geodatabase using ArcMap. The internship provided many valuable skills and reinforcements of knowledge that will no doubt lead the way for a career working with water resources.

Project Objectives

Sequoia National Forest is located in the southern Sierra Nevada and covers 1,144,296 acres of land (USDA FS 2012). Stream Condition Inventory (SCI) surveys are used as a tool in forests to monitor watershed health over time by measuring attributes such as stream cross sections, stream bank stability, and stream shading. Over 15 years of SCI data were stored as physical copies, which made rapid retrieval and spatial assessment of the data time consuming and inefficient for resource scientists and USFS partners. To efficiently store spatial data, PDFs, and images, a geodatabase was desired. Geodatabases store spatial and non-spatial data in one folder that can be shared across the forest and accessed by multiple specialists at one time. Specialists on the Sequoia National Forest requested a WRI intern for the summer with the primary goal of making SCI data more readily accessible via the construction of a geodatabase using ArcMap, then uploading the geodatabase to the forest's shared folder.

SCI sites are located on streams throughout the forest and serve as important baseline data to monitor the effects of forest uses such as timber harvesting, road construction, wildfire, livestock grazing, mining, and recreation on stream condition and watershed health. These uses contribute to the cumulative impact on watersheds. To monitor watershed's responses to forest usage, SCI was established. SCI is used to quantitatively evaluate the morphological and biological condition of a stream and compare those data to a known stream type in order to determine if the stream is functioning within the range of natural variability. The SCI sites are then re-surveyed every 5 years to see if there has been a change in the stream's condition. Long-term monitoring of streams on the Sequoia National Forest is essential to understanding cumulative impact on watersheds. One impact on watershed health can be tied to fire behavior and frequency in mixed conifer forests which are increasing as an indirect effect of climate

change (Liang et al. 2016). Fire is part of the natural landscape and can renew as much as it destroys, but catastrophic forest wildfire (due to drought, insects, and disease) can have lasting impacts to watershed function for decades. Creating accessible data to scientists that work to improve watershed health and understand impacts on watersheds in Sequoia National Forest will be essential for long-term management of our nation's forests.

As an intern, working for USDA's Forest Service would serve as a key career tool where knowledge obtained from school can be to work in real life scenarios. Going into this internship, it was expected that sitting at a computer all summer processing data in GIS would encompass most internship hours, but the district hydrologist went out of his way for field visits to fully express a hydrologist's career, and why it was important.

Project Approach

To begin the creation of the geodatabase, a base map was needed for reference. First, quadrangle maps were combined with the mosaic tool. These were useful for finding a rough location mixed with XY coordinates, but they were not visually appealing. To create a more appealing layer, a hillshade layer was developed from a Digital Elevation Model (DEM) along with a contour line layer. With this hillshade, contour lines, a stream layer, and the quadrangle maps the SCI surveys could be located, input, and then hyperlinked to their PDFs. Geodatabase construction began slowly, but with trial and error it was decided that using a line shapefile to store summary SCI data would be more efficient for data input and long-term storage. From the SCI survey summary sheet, data was stored in the attributes table. PDFs of the SCI surveys were scanned and uploaded to the geodatabase and connected with a hyperlink for easy access. With the combination of scanned PDFs, ArcMap attributes highlighting summary data, and locations

pinpointed on a spatial scale, there are now many ways to view the data and find locations of SCI surveys within Sequoia National Forest.

Scanning multiple files at a time, using Adobe Acrobat Pro to scan and recognize text, and inputting data into the attribute table simultaneously was a challenge. Beginning with the Kern River Ranger District SCI data, rhythm was found, and momentum carried to the remaining 300 surveys in the forest. Once all the surveys were scanned, an older hard drive was found and SCI photos were recovered then added to the correct SCI survey to enhance the data.

To better understand data being processed, field visits were necessary to learn how to conduct an SCI survey. Beginning first at Cedar Creek in the Greenhorn Mountains with three cross sections, the hydrologist taught how to setup and use a laser level to measure and record the stream's elevation points. Later, by inputting this data into Excel, calculating flood prone width, bankfull width, and water surface elevation as a 2D visual graph, a better understanding of cross sections and their pieces developed. These calculations are an important key to SCI surveys to monitor for changes like aggradation, which could be a stream's response to fire-caused erosion.

Another key experience was on the Western Divide Ranger District's Bull Run Creek located within Dry Meadow. The meadow along the creek underwent dramatic changes since the last SCI was conducted and specialists only had one SCI file on hand with black and white photos from 2003 as a reference. Under the supervision and instruction of two hydrologists, a full SCI survey was conducted. During this event it took several hours to locate the original cross section points, making the completed geodatabase more appealing to more easily locate points. Points were especially difficult to find due to cow grazing and a past fire in the meadow. The

geodatabase will be a future tool with every SCI note ever taken in a SCI location with GPS points to help pinpoint sites and reduce wasted hours in the field.

Project Outcomes

300 SCI surveys for the entirety of Sequoia National Forest were successfully scanned, uploaded, enhanced, GPS pinpointed, and populated attribute tables. While the last few SCI surveys were being input, the district hydrologist already needed the geodatabase for a project involving new trail construction in several sensitive watersheds. The geodatabase was a quick and easy tool to pull up and see that indeed there were previous surveys in the region (Fig. 1). He was able to export the SCI locations onto GPS and use them for site visits to ground truth. During the site visits, the SCI locations were accurate for some sites and rough in others. SCI surveys with older GPS points will need further editing for future precision. With future SCI surveys these points can be edited and perfected with time.

While the 2018 SCI survey at Dry Meadow hasn't been uploaded or analyzed yet, data from cross sections at Cedar Creek was able to be uploaded and analyzed (Fig. 2). This will be used to compare various models to watershed responses to fire by the district hydrologist. With this information, the hydrologist can more accurately predict watershed response to fire with respect to erosion.

Conclusion

The creation of a geodatabase for SCI surveys will help Sequoia National Forest by preserving data and creating an accessible platform for any hydrologist, biologist, planner, Forest Service employee, or stakeholder. A future recommendation for the geodatabase would be for hydrologic technicians to use a tablet for data entry in the field. This would streamline data

analysis and geodatabase addition. A type of data dictionary with GPS pinpointing would be ideal, but could be expensive.

This summer WRI internship experience went beyond expectations. I was able to complete the goal of building a geodatabase, reinforce GIS skills, preview a hydrologist's career, and see how other USFS jobs operate. A future career goal is restoration, and this summer I was able to jump into a couple field days of harvesting willows, sedges, and rushes, then planting them in a meadow that has recently been restored and needed more vegetation to stabilize the banks. The hydrologist went above and beyond to incorporate interests into this internship as well as keep the workload full, but manageable, with different hydrology projects.

Appendices

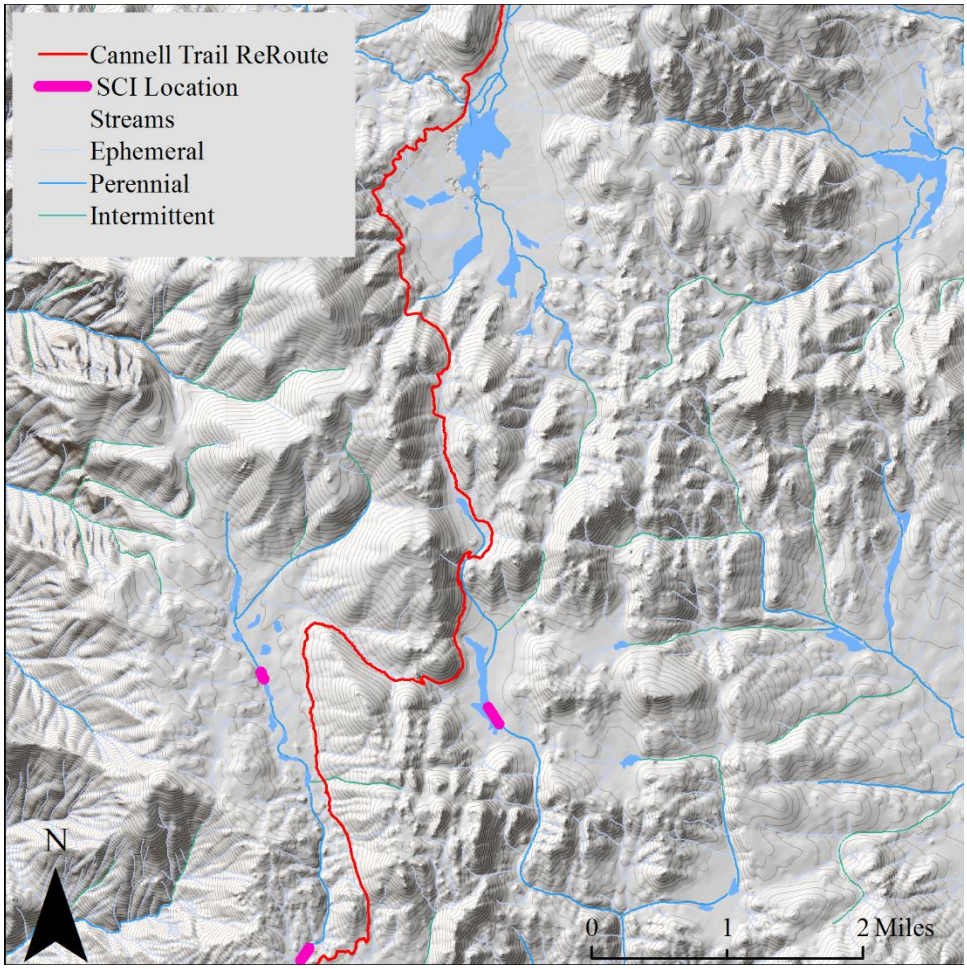

Figure 1. Sample map from the geodatabase of SCI locations used for a trail re-route in the Kern River Ranger District.

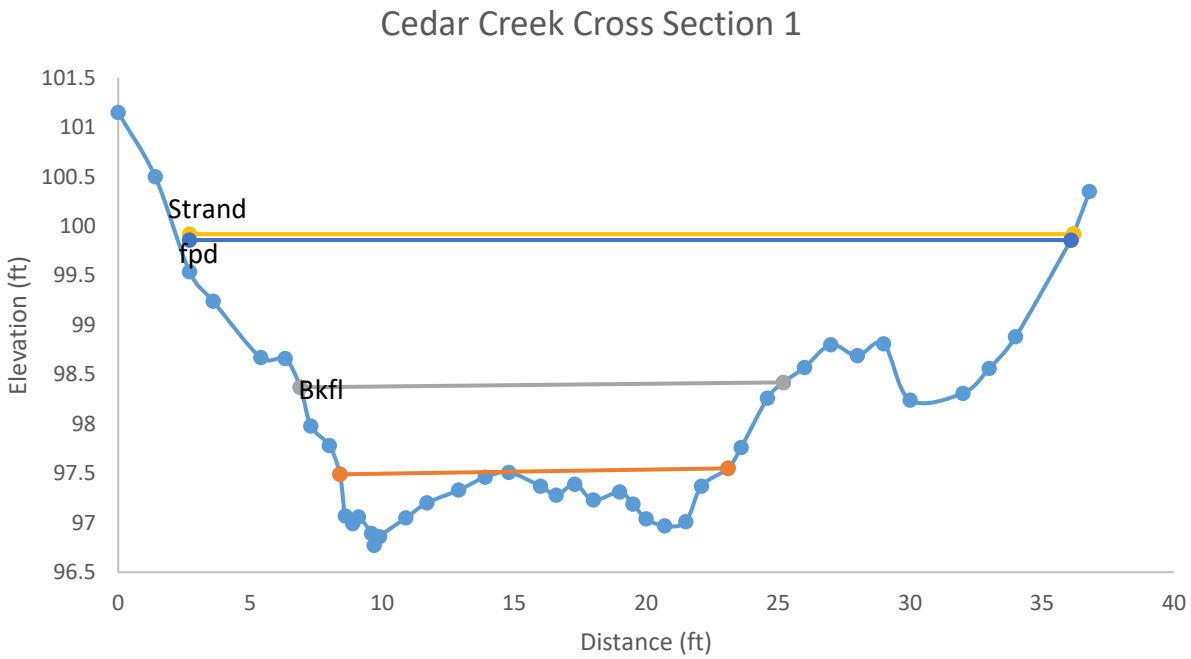

Figure 2. Cross section 1 taken at Cedar Creek showing the strandline, flood prone depth, bankful depth, and water surface elevation.

References

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