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CALIFORNIA STATE UNIVERSITY AGRICULTURAL RESEARCH INITIATIVE

RESEARCH REPORT

Study evaluates water quality of a coastal mountain stream

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Executive Summary

The Little Creek Monitoring Project is a long-term study designed to evaluate the water quality and geomorphic conditions of a coastal mountain stream located in the southern-most extent of the redwood/Douglas-fir forest region. The goal of this study is to provide valuable information documenting watershed conditions before, during, and after single-tree and small group selection harvests. Its purpose is to provide substantiated scientific documentation to aid in the debate over impacts from timber harvest on forested watersheds. This information may assist in determining the effectiveness of the current forest practice rules in their ability to permit timber harvests in a manner that maintains healthy and productive watersheds.

The water quality analysis utilizes the combination of paired watershed and upstream/downstream study designs. In 1997, three monitoring stations equipped with rated section flumes were installed on Little Creek. In 2001, a fourth monitoring site was established in a natural channel cross-section, and a fifth site, also natural channel, may be added. At these locations, stage, turbidity, temperature, and event-based samples for lab analysis of turbidity, suspended sediment concentration, and electrical conductivity data is collected. Additionally, rainfall data from several gages is collected and will be used to support analysis of storm events and stream flow.

This natural channel monitoring site was established to enable monitoring of Little Creek's water quality.

Introduction

The monitoring of suspended sediment, turbidity, temperature, and electrical conductivity before, during, and after single-tree and small group selection harvests, is the primary goal to evaluate the effectiveness of timber harvesting practices in protecting the water quality of Little Creek. The collection of this data constitutes a long-term study that will occur throughout a period of approximately 10 years. Additional data that is being collected to support the water quality analysis includes stage, flow, and rainfall. Following are brief descriptions of the current water quality project infrastructure, broken into seven components.

Three flumes were implemented at Little Creek: one at the Main Stem (top), North Fork (middle), and South Fork (bottom).

Project Infrastructure

1. Stage Measurements: Three rated-section flumes were installed on Little Creek in 1997 on the Main Stem, North Fork, and South Fork monitoring sites. These structures channel the stream between two walls, creating an area with permanent cross-section dimensions. The bottom is left as the natural channel and a concrete footer at the downstream end controls the grade. By controlling the channel's shape, the flumes enable accurate stream flow measurements to be taken. Flume sizing was determined by estimating the 100-year flood discharges and sizing flumes accordingly. The flumes were designed conservatively large in order to accommodate the 100-year flood discharges and not to constrict flows or cause a rise in flood elevations.

A natural channel monitoring site was established in the upper North Fork in 2001 to enable monitoring of Little Creek's water quality as it enters Cal Poly's property.

All four of the monitoring sites are equipped with stilling wells. Stilling wells are designed to freely intake water to a depth that is equal to that in the stream channel. Upon entering the well, water loses all velocity and is thereby "stilled." This eliminates the small waves that form as the water flows over the uneven channel bottom, thereby allowing more accurate depth measurements to be made.

During the low flow season, approximately May to November, a weir is installed at each of the flume sites (opposite page). By backing up water, the weir increases channel depth and concentrates flow through a v-notch. This enables more accurate depth and discharge measurements to be made when flows are at their minimum.

Stage is monitored using four different measuring devices. Manual stage measurements are taken by reading a staff gauge each time a site is visited. Inside the stilling wells, an Isco Flow Meter determines water depth using a differential pressure transducer and a flow of bubbles; a Wescor water level sensor monitors depth using a pressure transducer that is suspended in the stilling well; and a Belfort FW-1 stage recorder is located inside each stilling well and is used as back-up stage data to the bubblers and pressure transducers.

2. Discharge Measurements: Stream flow, or discharge, is measured at each of the monitoring sites on Little Creek. By taking velocity readings at many different stages, a rating curve that relates stage to discharge is being developed.

3. Rainfall Measurements: Rainfall totals are measured using two different devices. The first is a tipping bucket recording raingage, and the second is an All Weather Clear View raingage. The recording gages are Onset Data Logging Raingages, which

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log data into a data logger. The Clear View gages provide only rainfall totals. Both types of raingages are positioned at five different locations in the watershed.

4. Instream Water Quality Measurements: The in-stream water quality monitoring is accomplished using several different probes that are housed inside a YSI 6820 sonde. The sonde can accommodate a number of probes that measure several different parameters. This study utilizes a turbidity probe and a temperature probe. Each of these probes takes readings at 15-minute intervals, and the data is logged into an ISCO 6700 sampler's data logger. During the low flow months, the sondes are removed from the stream. When there are no storm events and turbidity is negligible, there is no need to monitor turbidity. Temperature data for these months is collected by HOBO Temp temperature loggers. There are five loggers placed throughout the stream, located within waterproof cases.

Weir at Main Stem flume.

5. Storm Sampling: Stream samples to be used in water quality testing are collected at the four monitoring sites on Little Creek using ISCO 6700 automated water quality samplers. These samples are then taken to the Swanton Pacific Ranch Water Duality Lab and tested for turbidity, suspended sediment concentration, and electrical conductivity. When a storm event is forecast, the automated samplers are manually turned on and samples drawn automatically at one-hour intervals. The bottles are then collected within 24 hours and replaced with an empty set.

7. Lab Water Quality Measurements: Sample bottles are transported from the field to an on-site lab for analysis. There are 24 bottles in each set, so while sampling on a one-hour interval, bottles are swapped once a day. Each time the sample bottles are collected a new set of bottles replaces the old set for the next event.

Turbidity is a measurement of the amount of suspended particles in the water that affect clarity. It is measured in Nephelometric Turbidity Units (NTUs), which is the measure of light scattering through a water sample. Lab analysis of turbidity is conducted using a HACH Model 2100AN Lab Turbidimeter.

Electrical conductivity is the ability of a solution to pass an electrical current. The measurement of conductivity is easy to perform and can be related to applications such as measuring the chemical purity of water or the amount of dissolved solids in a solution. Lab analysis of electrical conductivity is conducted using a HACH 44600 Conductivity Meter.

Suspended sediment concentration (SSC) measures the total amount of suspended material in a water sample collected from the flow in open channels.

Major Accomplishments

- Acquired and installed six raingage stations, four automated water samplers, four in-stream turbidity meters, four instream temperature gages, four pressure transducers, three stage recorders, and two flow meters
- Constructed four instrument shelters to house and protect equipment at each monitoring site
- Upgraded flumes by building new wingwalls to protect streambanks, installing bridges to facilitate data collection, reinforcing weir for low-flow data collection, and reinforcing concrete footers to increase flume's support
- Built new water quality lab and installed instrumentation as needed to meet U.S. EPA protocols for water quality analysis.

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- Developed operations manual that details monitoring project infrastructure and protocols
- Converted all data to compatible format for analysis with the software Flowlink
- Collected water samples from storm events over two years and analyzed in lab for suspended sediment concentration, turbidity, and conductivity

Impact Statements

Thus far, the study has installed and operated hydrologic instrumentation necessary to establish baseline data that can be used during the post-harvest period to evaluate whether a statistically-significant change has occurred in suspended sediment export. The success of the data collection is governed to a large extent by the weather conditions experienced in each year. During the rain year 2000-2001, the greatest rise in stream stage during a storm event was only three inches. This resulted in no events being monitored for suspended sediment. Rain year 2001-2002 was somewhat better; however, the goal is to collect complete data for each event at all four stations. This has proven to be problematic due to malfunctions in the automated equipment. Since then improvements have been made to lessen the chance of data loss through the installation of new backup stream level monitoring equipment and improvements to the design of the intakes for the water quality samplers. It is expected that a minimum of three more years of baseline data will be required to evaluate the statistical significance between the stations. Project work has been greatly facilitated by the development of the Swanton Pacific Ranch Water Analysis Lab. This project is ongoing and funded partially by smaller projects that are monitoring geomorphic parameters of the channels.

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For More Information

This research report contains summarized results of Brian Dietterick's study entitled "Long-term Evaluation of Suspended Sediment Exiting a Coastal Mountain Stream Following Selection Timber Harvesting Activities," ARI Project No. 00-3-011 (Research Focus Area: *Biodiversity*). To view and/or obtain a copy of the complete final report, or to obtain additional information about this or other research projects, visit the ARI website at *ari.calstate.edu.* For information on projects specific to Cal Poly San Luis Obispo, visit the Cal Poly ARI website at *ari.calpoly.edu*.

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