JDSF Newsletter
Jackson Demonstration State Forest
State of California Dept. of Forestry P.O. Box 1185 Fort Bragg, CA. 95437

No. 27 October 1987

UPDATE ON THE CASPAR CREEK WATERSHED STUDY

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Readers of this Newsletter are aware that CDF and the USFS, through its Pacific Southwest Forest and Range Experiment Station at Arcata (PSW), are carrying out a long term cooperative watershed experiment in JDSF's Caspar Creek drainage. Past issues have briefly discussed: the study's first phase, when the South Fork was selectively tractor logged in the early 1970's, and the effects which were produced in terms of streamflow response (No. 8), and instrumention of the North Fork in preparation for the second phase of the project (Nos. 15 and 20). In the last three years, several new studies have been initiated in the North Fork to further define the influences which logging will have on the watershed. This article will give a brief synopsis of each of these projects. Readers interested in additional results of the South Fork phase, or background information on the North Fork phase, can contact our office in Fort Bragg for more detailed publications.

The Primary North Fork Study-Cumulative Effects

In contrast to the South Fork, the North Fork of Caspar Creek will be harvested by clearcutting selected sub-basins so that approximately 60 percent of the drainage area will have been logged between 1989 and 1994. Furthermore, approximately 70 percent of the timber harvested will be cable yarded. As in the South Fork phase, we will monitor storm sediment discharge and stream flow before, during, and after road building and logging at both the North and South Fork weirs. In addition, we have added 13 gaging stations above the North Fork weir on the main channel and its tributaries. At each of these stations, a rated section or Parshall flume has been built, and an automated pumping sampler is controlled by a microprocessor.

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION
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Three sub-basins in the North Fork have been designated as unlogged controls. The South Fork station's sediment levels have reached a steady state, and it too will be used as a control basin. The remaining sub-basins with gaging stations will receive varying amounts of disturbance resulting from harvesting activities. During the current calibration period, predictive equations based on the control watersheds and meteorological variables are being developed for each of the sub-basins to be logged. Storms having a return period of 4 times per year or less will be the events upon which the calibrations will be based. Separate calibration equations will be developed for suspended sediment discharge, storm runoff volume, peak runoff, and hydrograph lagtime.

Under legislative mandate, cumulative effects must be considered when assessing the environmental impacts of timber harvesting. Few, if any, studies in the past have documented that such an occurrence takes place from logging, and it is this test for cumulative effects which is the primary motivation for doing the North Fork phase of the study. Cumulative effects can be considered to be sediment impacts on the channel system which occur downstream from the locations of the actual logging, and are transmitted through the stream system. We will be testing the hypothesis that if there are cumulative effects, then disturbance of a given proportion of an upstream watershed will have less impact than will the same proportion of disturbance to a larger downstream watershed. The departures of the observed storm parameters from those predicted will be regressed against indices of watershed disturbance. This will allow us to determine whether the effects of disturbance increase with watershed size, and hence indicate the presence of cumulative effects. Dr. Ray Rice of the PSW is in charge of this study.

Channel Studies in the North Fork

Several sub-studies are taking place in the main channel of the North Fork to document sediment movement and large organic debris accumulation. The entire channel system was mapped in 1984; bank characteristics, gravel bars, rock outcroppings, and organic debris were drawn to scale. Surveys of the channel are made after major winter storms to find mass wasting events along the stream. By locating these sediment source areas, we will have a better understanding of how this material is routed through the watershed.

These channel maps have been utilized subsequently in several additional stream evaluations. Dr. Bob Ziemer of the PSW is doing a study to inventory organic debris steps within various reaches of the North Fork. The purpose of this project is to evaluate the mobility and dynamics of these steps, since they have been shown to have important influences on channel morphology and anadromous fish habitat. In low order streams such as the North Fork, these features define most of the vertical fall of the channel. They also reduce stream velocity and increase sediment storage, which provides a buffer in routing sediment through the stream system. Each summer, the various reaches are reinventoried to identify changes in organic step location and storage. The effects of logging will be studied on these reaches to see if channels with abundant steps can buffer new sediment inputs.

A "sediment budget" for the North Fork has been started this year by Dr. Andre Lehre of Humboldt State University. This is a quantitative description of sediment movement through the mainstem channel, and considers input rate, storage volume, and discharge rate of sediment. The first step in this process was to modify the 1984 channel map into a geomorphic map detailing the channel bed, banks, terraces, and adjacent inner gorge slopes. Volumes of sediment in "storage elements" such as alluvial bars, terraces, debris fans, and behind organic debris steps have been recorded. Further work will be done to measure the particle size distributions for the defined storage elements and determine volume-area relationships for debris slides entering the channel.

Estimates of bedload (sediment particles greater than 0.8 mm) have been made for the past 25 years in both drainages by measuring the sediment in each weir pond deposited by the previous winter's storms. These estimates of bedload also included fine material which settled out in the large ponds, and never allowed the measurement of transport rates. Therefore, a new study by Jeff Albright and Dr. Tom Lisle of the PSW was begun this summer to quantify bedload transport in the North Fork. A pit has been dug in the streambed at the first rated section above the weir and 4 steel boxes will sit on pressure sensitive pillows. A slotted cover is installed over each box horizontally level with the streambed. Pressure exerted on the fluid filled pillows by bedload moving during storms is monitored and recorded on a continuous basis by pressure transducers and data loggers. This study should greatly aid in the calculation of the sediment budget for the North Fork, and also assist in determining the significance of cumulative watershed effects, especially those pertaining to fish habitat.

Finally, large organic debris along the main North Fork channel has been inventoried by Matt O'Connor of the PSW in the last year. Volume of debris was estimated in three zones: suspended above the channel, within the horizontal boundaries of the active channel, and in the riparian area adjacent to the channel. The relation between large organic debris and the formation of pool habitat critical for anadromous fish survival in summer months was also evaluated. For the primary study reach of 1.8 km, three-fourths of the pools were found to be associated with organic debris.

Biological Studies in the North Fork

In addition to studying the physical parameters associated with logging sub-basins in the North Fork, biological evaluations are being done. Lynn Decker of the PSW is evaluating the effects of logging on fish habitat and survival. Two techniques are being used to assess treatment effects. Observational sections have been established in both the North and South Forks. These 100 meter long stretches are electro-shocked twice a year during low flow periods to get population estimates of coho salmon, steelhead trout, other fishes, and amphibians.

Three experimental sections have also been established in both Forks; each consists of a pool bounded by a short riffle upstream and downstream. Two-way fish traps are installed on both ends of these reaches. During the low flow months of July and August, all resident vertebrates occupying these reaches are first removed to another section of stream. Marked young-of-the-year steelhead trout captured from lower Caspar Creek are then introduced into these bounded reaches at 5 times their natural density. "Flooding" these reaches with fish will insure that natural variations in fish density due to off-site effects are eliminated. Fish movement into and out of each reach is monitored daily. In September, remaining steelhead in the reaches are weighed, measured, and the number of marked versus unmarked fish determined. Fish numbers and survival will be correlated with sedimentation and habitat data before, during, and after logging.

Dr. Allen Knight of UC-Davis is investigating the effects that timber harvesting may have on macro invertebrate (aquatic insect) densities and diversities in the North Fork. Sampling locations are in the main channel upstream and downstream of major tributary junctions. Several different sampling methods are being utilized. After the last major storm flows of the winter, multi-rock substrate baskets are placed in the channel to assess spring insect population densities. In late May, drift rate samples for macro invertebrates are collected with nets over 5 consecutive days. Knight will look for changes in drift density of specific taxa following logging. Algae production and organic matter processing experiments are also being conducted.

Hillslope Hydrology Studies in the North Fork

In the headwaters of the North Fork, two studies are being done to document how infiltrating precipitation is routed down to an open channel. Dr. Bob Ziemer and Jeff Albright of the PSW have studied subsurface pipeflow dynamics in three small swales for the past two winters. Soil pipes, 1 to 2 meters below the soil surface, have diameters which range from 1 to 100 cm and commonly discharge into headwalls of gullies. These pipes are believed to develop through several processes; they include root decay, animal activity, stress fractures in the soil, and seepage forces. Soil pipes were exposed by trenching and enlarging existing gully features. Water from the pipes is routed to calibrated standpipes. Digital data loggers connected to pressure transducers in the standpipes monitor discharge. During storms, pipeflow up to 500 liters/minute has been observed, while within the same swale, no surface channel flow occurred.

Near the ridge of one of these instrumented swales, the author has started a study this summer to describe how subsurface drainage is routed down to the soil pipes in the swale axis. A series of five transects have been located up the hillslope. Piezometers are being installed at five meter (m) intervals to a depth of 1.5 m and to hard bedrock (roughly 3 m). In addition, tensiometers are being placed at 1.2 m and 1.5 m on selected transects. These instruments will indicate if water movement during storm events is saturated above the rock, or unsaturated. Flow nets will be drawn for the saturated zones to determine whether a saturated "wedge" moves up the hillslope during a storm. Since this swale is to be roaded and harvested, we will determine if subsurface drainage patterns change after completing these activities.

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US FOREST SERVICE WORK EXCHANGE PROGRAM

This fall we have two German forestry students assisting in the Caspar Watershed Study as part of a work exchange program coordinated through the USFS's Redwood Sciences Laboratory at Arcata. Susanne Geisler and Malte Munte have come from Hamburg, Germany to learn about U.S. forestry practices and watershed management research. They will stay through most of the winter and then tour portions of the U.S. before returning to Germany. Earlier this year, two other German students, Johannes Rudzinski and Alex Scheerman, completed a similar program.