

CASPAR CREEK

What have we learned, what can we learn from this project?

Forest B. Tilley^{1/}

INTRODUCTION

For 18 years Jackson Demonstration State Forest, managed by the California Department of Forestry, has been the site of a comprehensive watershed experiment. This experiment, on Caspar Creek five miles south of Fort Bragg on the Mendocino coast (fig.1), is a cooperative project between the California Department of Forestry and the U. S. Forest Service, Pacific Southwest Forest and Range Experiment Station. The Department of Forestry provides the project area, conducts the treatment and collects much of the field data. The Station provides technical assistance, some funding and much of the data processing.

The California Department of Fish and Game, the California Department of Water Resources, the California Division of Mines and Geology and Humboldt State University were all cooperators during initial stages of the project but have since dropped out.

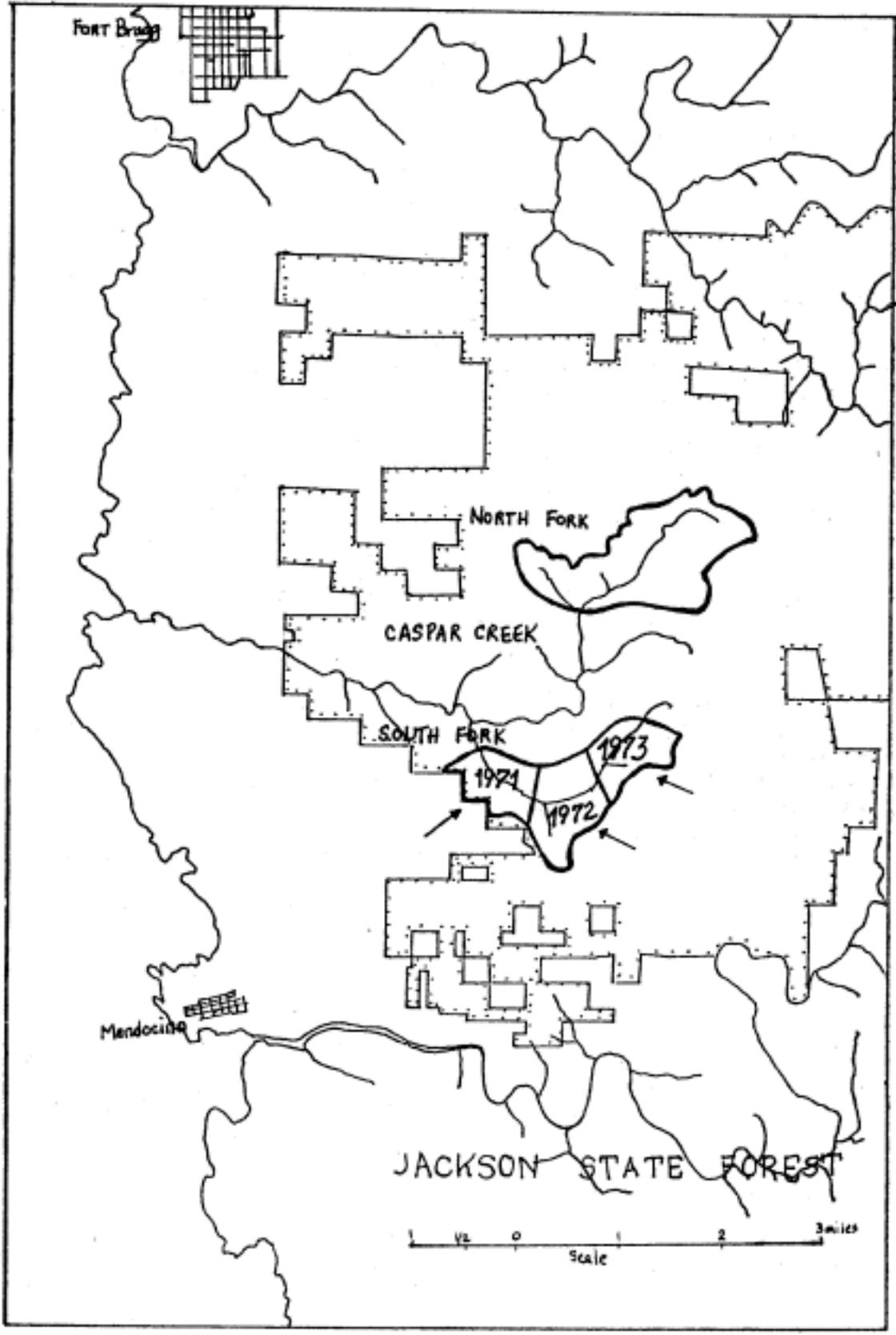
The study area is composed of two similar watersheds, the North Fork (1,228 acres) and the South Fork (1,047 acres) of Caspar Creek. The topography runs from broad rounded ridge tops to steep slopes near the stream. The underlying geology of the Caspar Creek drainage is described by Krammes and Burns (1973) as sedimentary rocks of Cretaceous age. Soils mapped in the area were formerly classed as the Hugo and Mendocino soil series. These soils are now being mapped by the Soil Conservation Service as Irmulco-Tramway, and Van Damme series.

These soils are formed from hard to highly weathered sandstone. They are moderately deep to deep and usually well drained. They have a clay to clay loam subsoil ranging from 20 to 60 inches deep and they are classed as slowly permeable.

Forest cover on both watersheds consists of fairly dense stands (60,000 board feet per acre) of second growth redwood (Sequoia sempervirens (D. Don) Endl.). Douglas-fir (Pseudotsuga menziesii (Mirb.), hemlock (Tsuga heterophylla (Raf.) Sarg.), grand fir (Abies grandis (Dougl.) Lindl.) and some minor hardwoods. These stands are now 90 to 100 years old. Both drainages were clearcut and burned in the late 1800's, the North Fork about fifteen years after the South Fork. There were some selected pole and piling operations conducted along a few of the ridge tops during World War II.

^{1/} Forest Manager, Jackson Demonstration State Forest, Fort Bragg, CA 95437

FIGURE 1.



Undergrowth consists of huckleberry (*Vaccinium ovatum* (Pursh.)), tanoak (*Lithocarpus densiflorus* (Hook. & Arn.) Rehd.), sword fern (*Polystichum munitum* Kaulf.) Presl.) and other species typically found in association with redwood/Douglas-fir type. The climate is common to north coastal California with foggy days during the summer and mild winters. Rainfall averages 40+ inches per year falling mostly during the period of October through May.

The State of California acquired the area from the Caspar Lumber Company through a purchase agreement reached in 1947. Acquisition was for the purpose of including a redwood forest in the State Forest system. Chapter 9 of the Public Resources Code relates to Purposes, Policies and Management of State Forests. Management is specifically defined in Section 4639 (PRC) as the handling of forest crops and forest soil so as to achieve maximum sustained production of high quality forest products while giving consideration to values relating to recreation, watershed, wildlife, range and forage, fisheries and aesthetic enjoyment. It was under this premise that the Caspar Watershed Study was initiated in 1960.

The primary objectives of the study are to measure the sediment yield of a north coastal watershed and to quantify the degree to which logging a relatively undisturbed second growth forest affects water quality, flood peaks, suspended sediment and bedload.

Measurements were carried out on both the South Fork or "treated" watershed and the North Fork or "control." The measuring process started in 1961 with the installation of rain gages in and around the selected watersheds. In November 1962 installation of "V"-notched weirs and attendant Stevens A-35 recording stream gages in both watersheds was completed. This was followed by a period of calibration. In the summer of 1967 a road system was built providing access to the South Fork watershed. From 1967 to 1971 measurements were taken to record the impact of this road construction. In addition, the aquatic habitat was studied to determine the changes caused by road construction. The results of this study were published by Krammes and Burns (1973).

Selective logging of the South Fork watershed began in 1971 and was completed in 1973. In total 38.3 million board feet were harvested from 1,000 acres. The amount of ground disturbance and effect on timberstand resulting from this selective harvest is summarized in table 1. The 15 percent total ground disturbance is about average as tractor logging normally takes up 10 percent to 25 percent of the surface area in roads, landings and skid trails.

The debris basins behind the weirs have each been cleaned out three times since 1962. Cross sections of the weir ponds are measured annually and before and after each cleanout to provide information on the amount of debris and bedload each stream produces.

Table 1. Harvest effects on South Fork watershed.

Timber volumes	Per acre	Total	Percent
Stand before harvest	61.3 MBF	184 MBF	100
Harvest volume	38.3 MBF	117 MBF	64
Leave stand	23.0 MBF	67 MBF	36

Ground disturbance in acres and by percent of total watershed.

Type of disturbance	Acres	Percent
Roads	55	5.2
Skid trails	87	8.3
Landings	21	2.0
Total	163	15.5

RESPONSE TO DISTURBANCE

The effects of logging were summarized by Tilley and Rice (1977) and were explored in more detail by Rice, et al. (1979). Ziemer analyzed the effect on storm flow response (in press) and Lisle discussed the project as part of a field trip to observe natural and management related erosion in Franciscan Terrane of northern California in April of 1979.

SEDIMENT LOADS

Rice, et al. concluded that road building and logging changed Caspar Creek from supply dependent to stream power dependent. That is, before disturbance sediment discharge in Caspar Creek was dependent on the availability of material. After road building and logging sediment discharge was more a function of the ability of the stream to transport material. This change resulted in substantial increases in suspended sediment discharge. The most significant effect was on water quality. The effect of timber harvest on site quality expressed through changes in nutrient regimes is not part of the current project. However, degradation of site quality as projected through soil losses, which can be estimated from erosion or sedimentation measured on Caspar Creek, would indicate that timber harvesting as conducted in the South Fork, given existing soil depths and estimated replenishment rates, would not be cause for concern.

In addition to the suspended sediment and bedload measurements at the weir, the erosional impact of logging was measured from seven plots throughout the South Fork. These plots were part of a larger study conducted by Datzman (1978) to assess soil movement associated with the various logging systems studied. This study included 102 plots stratified so as to sample important site variables such as partial cutting, clear cutting, tractor yarding and cable yarding, in as many combinations as possible. Each plot was based on a 10-chain transect through a landing. Additional transects were run across the slope at 2-chain

intervals bisecting the skid trail system leading into the landing. All major events (defined as one cubic yard or gully cross section in excess of one square foot) within the plot were surveyed. Nine of these 102 plots for a total of 94 acres were located in the South Fork watershed. A net soil loss of 151 cubic yards per acre was recorded in Caspar Creek as opposed to an average of 90 cubic yards from the partial cut analysis and 134 cubic yards from the total tractor yarded analysis for all 102 plots.

Most of the soil movement recorded in this survey came to rest downslope from its original position. Many of the measurements were of road bank failures which slumped on to the road bed.

One of these seven plots accounted for almost one-half of the erosion or displacement measured. This plot encompassed a landing located on the toe of an unstable rotational failure. When compared with other groups from Datzman's data and other studies, domination by a few large events appears to be common in analysis of erosional data. This landing location along with problems with waterbar placement makes Caspar Creek a good test of the logging practices common before the implementation of the present Forest Practice Rules. Therefore Caspar Creek appears to be an acceptable model for logging impacts resulting from selective tractor harvests of second growth stands during that period. This landing location also points out that the most important determinant of disturbance and erosion is not variation in site conditions but how those variations are treated.

An additional potential contributing factor to erosion and sediment production is public access and use of secondary roads and skid trails for "recreation" and salvage. Hunting, fuelwood gathering and harvest of minor forest products are allowed on State Forests. Recently-logged areas are prime targets for these activities, therefore, the effects of logging may have been compounded for a few years by this continued minor disturbance. Steps have been taken in recent years to minimize this impact.

STREAM FLOW

Peak flow analysis as reported by Ziemer showed no significant impact by logging except on those peaks generated by the first three or four storms of the year. Ziemer concluded that the higher peaks from the logged watershed during early storms are the result of higher soil moisture levels due to differences in total evapotranspiration rates between the treated and untreated watersheds. These storms and resultant peaks usually are small (less than 12 cubic feet per second) and have relatively low transport capabilities, therefore, they account for a very minor portion of the sediment production.

THE LAST FOUR YEARS

The seven plots surveyed as part of Datzman's study were resurveyed in July of this year. This survey shows the extent to which recovery has taken place. Most of the ground surface has been covered with vegetation. The exceptions are some roads and landings where compaction was too great for seed to take

hold and germinate. Rills and gullies measured in the earlier survey have for the most part stabilized and become revegetated naturally. No effort was made to artificially revegetate slopes, skid trails, roads or landings.

In 1978 some hand work was done to improve or repair drainage of skid trails and roads most severely affected by vehicle use since logging. Barricades were also erected to control access. The sale of minor forest products from the South Fork area was curtailed. These efforts were successful to varying degrees.

A total of approximately \$10,000 or \$10 per acre was expended on this waterbar/barricade work. To put this effort in relative terms, 150 man days were expended plus supervision, 1,000 vehicle miles and the purchase of hand tools, such as shovels, mattocks, post hole diggers and chain saws comprised the total expenditure.

Table 2. Rehabilitation expenditures (1978).

Salaries and benefits - 150 man days @ \$50/day	7,500
Supervision and support (clerical and staff time)	1,500
Vehicle (rental and maintenance - 1,000 miles @ 50¢/mile)	500
Tools and materials	500
Total	\$10,000
$\$10,000 \div 1,000 \text{ acres} = \10 per acre	

Continued monitoring of Caspar Creek supports the belief that the South Fork is progressing toward a stabilized state. Although the period 1978-80 has not included any major hydrologic events as occurred in 1966 and 1974 there has been a continued decline in suspended sediment loading of the South Fork and an increase in vegetative cover indicating a return toward a supply dependent regime. Stream channel observations help support this theory.

INTERPRETATION

We have discussed how Caspar Creek responded to logging, some minimal rehabilitation measures and their effect. We recognized some significant deficiencies, by today's standards, in the design and conduct of the logging operation, i.e., the location of some landings and the inadequacy of waterbar installation and maintenance.

Had the error in landing location been realized immediately some work could have been done to mitigate the problem. An estimated three days cat time would have been necessary to restore the landing to a reasonably stable slope configuration. The planting of approximately 1,000 alder seedlings on the landing site and skid trail approaches and the installation of check dams on the drainages downstream from the landing would have helped control entry of sediment to the main channel and eventually helped stabilize the area. However, these would have been "band-aid" measures. The best and most cost effective method would be

to have not located the landing there to begin with and to have kept equipment intrusion to a minimum on surrounding unstable areas.

Avoiding the placement of a landing on the toe of this unstable area would have been far more cost effective than rehabilitation procedures. Certainly if we could have prevented the movement caused by that one landing (i.e., almost 75 cubic yards per acre), the potential hazard would have been less.

Under the current Forest Practice Act^{2/} the preparation of a timber harvest plan requires an on-site analysis of the silvicultural method, harvest system and road network as well as provisions for erosion control based on topography and soils. This on-site analysis would probably have identified unstable areas and plans would have been made to avoid crossing them or provide for remedial measures immediately stabilizing the area.

If this area were to be logged today, the steeper slopes next to the streams would probably be cable yarded. Roads and skid trails would be farther from streams and water courses. Landings would not have been constructed in draws as was common practice when the South Fork was logged and drainage facilities would receive much more attention.

Cable yarding would require 4.5 miles of road to be constructed at the break in topography where slopes steepen to 50 percent or more as they drop into the canyon. It would also be twice as expensive as tractor logging. This would amount to sixty percent increase in logging costs for the area, which would have to be offset against the benefits of lessening soil disturbance and keeping it farther from the stream.

FUTURE PLANS

I have discussed what did happen with an "average" logging operation of ten years ago and what might have happened had the South Fork been logged today. The future plans for the Caspar Creek Study area include a proposal to use the North Fork area to study the results of a harvest operation carried out under strict adherence to a timber harvest plan. developed under rules current at the time and employing technology, equipment and methods foreseen as the State of the Art ten to fifteen years down the line when the results will be known.

This plan will not only measure gross amounts but will trace the movement of sediment from its source through the system to the outlet. While this project will still have limitations as to its applicability outside of the redwood or north coast region, it will provide information on many of the questions that are of major concern to the project area.

A major limiting factor but what may also be a significant contribution of the project is determination of a "steady state" for the South Fork so that calibration may be achieved and allow the South Fork to become the control area. It is this determination among other factors that has prohibited setting a definite starting date for the project.

^{2/} Public Resources Code, Div. 4, Chap. 8.

One of the strongest reasons Caspar Creek is proposed for this continued study is the fact that twenty years of data are on hand and the major expenses of weir construction and instrumentation have already been absorbed. There will be additional expense for erosion trough construction and the instrumentation of these troughs necessary for measurement and tracking of sediment passing through the system. As in any endeavor the second time through benefits from the experience of the first activity, therefore, the cooperators have a much more lengthy list of variables to measure and consider.

This list includes, in addition to the precipitation, gross sediment load and stream flow measurements of the South Fork, before and after slope stability surveys, detailed sampling of suspended sediment through the smaller catchments, and tracking of bedload down the stream channel.

A significant part of the study will be the development of a linear model relating measured total storm sediment at stations to various physiographic and meteorological variables.

This model may give land managers better information from which to make intelligent cost effective decisions giving appropriate weight to all the important variables of soil, water and harvestable present and future timber resources.

LITERATURE CITED

Datzman, Patricia A.

1978. The erosion hazard rating system of the coast forest district. How valid is it as a predictor of erosion and can a better prediction equation be developed? M.S. thesis, Humboldt State Univ., Arcata, Calif.

Krammes, J. S. and David M. Burns

1973. Road construction on Caspar Creek watersheds. . . a 10-year progress report. USDA Forest Serv. Res. Paper PSW-93, 10 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Lisle, Thomas

1979. The Caspar Creek Experimental Watershed. In: Guidebook for a field trip to observe natural and management-related erosion of Franciscan Terrane of northern California. The Cordilleran Section of Geological Society of America. April 9-11, 1979. San Jose, Calif.

Rice, R. M., Forest B. Tilley and P. A. Datzman

1979. A watershed's response to logging and roads: South Fork of Caspar Creek, California, 1967-1976. USDA Forest Serv. Res. Paper PSW-146, 12 p. Pacific Southwest Forest and Range Exp. Stn., Berkeley, Calif.

Tilley, F. B. and Raymond M. Rice

1977. Caspar Creek Watershed Study - A current status report. Calif. Department of Forestry State Forest Notes No. 66, 15 p. Calif. Dept. of Forestry, Sacramento, Calif.

Ziemer, R. R. Influence of road building and logging on storm flow response in small coastal streams (in press). Water Resources Research.