THE CASPAR CREEK WATERSHEDS: A CASE STUDY OF CUMULATIVE EFFECTS IN A SMALL COASTAL BASIN IN NORTHERN CALIFORNIA[1]

R.R. Ziemer and P.H. Cafferata[2]

ABSTRACT: Since 1962, the 483-ha North Fork and 424-ha South Fork of Caspar Creek in northwestern California have been used to evaluate the hydrologic impacts of road building and harvesting second-growth redwood/Douglas-fir forests. Three tributaries are serving as untreated controls. In 1985, the study was modified to evaluate the cumulative watershed effects of logging the North Fork. Intensively measureed were precipitation, soil moisture, groundwater, subsurface pipeflow, streamflow and suspended sediment discharge at 15 gauging stations, bedload movement, stream channel stability, large woody debris, and anadromous fish habitat. Clearcut logging emphasizing cable yarding was begun in 1989 and will be completed by 1992. The amount of roads and the proportion of the area clearcut will vary among the 10 treated watersheds.

The Caspar Creek Experimental Watersheds are located on the Jackson Demonstration State Forest in northwestern California. The 483-ha North Fork Caspar Creek and the 424-ha South Fork Caspar Creek have been gauged continuously since 1962 by the Pacific Southwest Research Station, USDA Forest Service, and by the California Department of Forestry and Fire Protection.

The watersheds are located about 7 km from the Pacific Ocean and about 10 km south of Fort Bragg at 39^{o}21'N 123^{o}43'W. The catchments generally have a southwest orientation. Topographic development of the area is youthful, with uplifted marine terraces deeply incised by antecedent drainages. About 35% of the basins' slopes are less than 17^{o}, and 7% are steeper than 35^{o}. The hillslopes are steepest near the stream channel and become more gentle near the broad, rounded ridgetops. Elevation ranges from 37 to 320 m.

The soils of the basins are well-drained clay-loams, 1 to 2 m deep, and are derived from Franciscan graywacke sandstone and weathered, coarse-grained shale of Cretaceous Age. They have high hydraulic conductivities and subsurface stormflow is rapid, producing saturated areas of only limited extent and duration.

The climate is typical of low-elevation watersheds on the central North American Pacific coast. Winters are mild and wet, while summers are moderately warm and dry. About 90% of the average annual precipitation of 1200 mm falls from October until May. Snow is rare and rainfall intensities low.

---

[1] A poster presented at the Poster session at the SAF National Convention held at San Francisco, CA, on August 4-7, 1991.

[2] Robert R. Ziemer, Pacific Southwest Research Station, USDA Forest Service, 1700 Bayview Drive, Arcata, CA 95521; and Peter H. Cafferata, California Department of Forestry and Fire Protection, P. 0. Box 944246, Sacramento, CA 94244.

Prior to treatment, the watersheds supported an 80-year-old second-growth forest composed of coast redwood (*Sequoia sempervirens* [D.Don] Endl.), Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), western hemlock (*Tsuga heterophylla* [Raf.] Sarg.), and grand fir (*Abies grandis* [Dougl. ex D.Don] Lindl.). The forest contained about 700 m^3 ha^{-1} of stem wood.

From 1963 to 1967, streamflow was measured in both watersheds. In 1967, a main-haul logging road and main spurs were built near the channel in the South Fork. The road right-of-way occupied 19 ha, from which 993 m^3 ha^{-1} of timber was removed. The first of three stages of tractor logging began in the South Fork in 1971, during which 59% of the stand volume was selectively cut from 101 ha. In 1972, 69% of the stand volume was selectively cut from an additional 128 ha. The remaining 176 ha had 65% of the stand volume selective cut in 1973. Sediment levels were elevated nearly three-fold for the first 3 years after logging, and then slowly returned to pre-treatment levels. Streamflow, suspended sediment, and bedload continue to be measured in the two watersheds.

Many forest management conflicts continue to center around water quality degradation due to erosion and sedimentation from logging and forest roads and the subsequent effect on anadromous and resident fish habitat. Federal and State laws require that soil stability and water quality must be considered in timber harvest plan review.

The concern over "cumulative effects" has become a major political and land management issue. It is based on the hypothesis that significant adverse impacts may be experienced at some point downstream even though all of the activities within the watershed are conducted in a manner which limits their individual effects to an acceptably low level. A key element in the cumulative watershed effects hypothesis is that increases in sediment, water or heat or both, resulting from land management activities enter the stream system in small headwater drainages and produce off-site damage in downstream channels, This damage may include increased sedimentation or degraded fish habitat downstream.

In 1985, the study was expanded to evaluate cumulative watershed effects. The current studies include measurements of solar radiation, precipitation, air and water temperature, soil moisture, groundwater, subsurface pipeflow, streamflow and suspended sediment discharge (at 15 gauging stations), bedload movement, stream channel stability, large woody debris, and anadromous fish habitat. Clearcut logging emphasizing cable yarding and ridge-top roads was begun in the North Fork watershed in 1989 and will be completed by 1992. Timber operations and road construction intensity will vary among the 10 treated tributaries. The extent of clearcutting in individual tributaries will range from 35% to 100%. Overall, nearly 60% of the North Fork basin will be clearcut. New roads, landings, and skid trails will occupy from 2.8% to 13.5% of individual logged watersheds. Three tributaries will continue to be maintained in an untreated condition.

Data collected during and after logging and road construction will reflect watershed responses to a wide combination of storm intensities and watershed impacts. These variable responses will be analyzed to determine if synergistic cumulative effects are occurring. Specifically, we will test if, for a given intensity of storm and management impact, the watershed response increases with watershed area. If it does, we will conclude that cumulative effects are occurring and will estimate the magnitude of those effects. Regardless of the outcome of the cumulative effects analysis, the intensity of data collection required by the experiment will undoubtedly provide valuable new insights into the environmental effects of forest management activities. We will also learn much about the mechanisms by which water and sediment are routed through a watershed and how these mechanisms are altered by currently applied practices. We will also learn what effect changes in sedimentation, runoff, stream temperature, and organic debris have on anadromous fish spawning and rearing habitat.