

Effects of timber harvest on the hydrology and climate of four small watersheds

From the Umatilla National Forest Barometer Watershed Program
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Summary:

The High Ridge portion of the Umatilla Barometer Watershed contains 4 first-order streams which together drain about 550 acres. (Fig. 1) Streamflow and other measurements began in 1966 and continued until November 1996. (Fig. 2) After a 10-year calibration period, timber was harvested in 1976 from 43, 50, and 22 percent of watersheds 1, 2, and 4 respectively. In 1984, the remaining timber on watershed 1 was cut, all of the timber on watershed 2, except for 20-25 trees per acre was cut, and an additional 38 percent of watershed 4 was cut. Most of the uncut seed trees on watershed 2 were wind thrown and salvaged. Therefore, by the end of 1984, almost all of the timber on watershed 2 had been removed. Watershed 3 remains undisturbed and serves as a control.

Streamflow records were analyzed to determine possible changes in annual water yield after each harvest. The analysis showed no significant changes ($p=0.05$) in annual yield from treated watersheds after the 1976 harvest or from watersheds 1 or 4 after the 1984 harvest when individual years of runoff were analyzed separately. Yield from watershed 2 was significantly ($p=0.05$) increased during 2 years (1989 and 1992) after the second cutting. Another analysis compared average water yield from each watershed during the two treatment periods with yield during calibration. Yield from watersheds 1 and 2 after the 1984 harvest significantly exceeded the expected values by 0.4 and 2.3 inches per year, respectively. Differences during the first treatment period (1977-1984) were non-significant. Because the water yield responses were smaller than expected, some potential reasons were examined, but no definite conclusions were possible. These included (1) the relatively large error terms associated with regressions developed from calibration data, (2) faster than expected growth of the new stand after clearcutting, (3) below average precipitation during 7 of the 9 years following the 1984 harvest, (4) an increase in wind speeds after forest removal which appeared to transport snow out of the cut areas, and (5) an increase in deep seepage after timber harvest.

Soil moisture records and vegetation surveys in the logged areas provided useful information for interpreting water yield results. In 1985, soil moisture plots were established in undisturbed forest, areas clearcut in 1976, areas clearcut in 1984, and areas where shelterwood cutting was used. Measurements were made each summer between 1985 and 1995. Results showed the expected decline in soil moisture during summer months and the start of soil moisture recharge in late summer and early autumn. Moisture use by vegetation growing in clearcut areas was about the same as in areas where virgin timber remained. A vegetation survey in 1996 showed rapid tree growth in areas cut over in 1976. Tree height averaged 15 feet and many trees

measured between 20 and 30 feet tall. The soil moisture and vegetation surveys both indicate more rapid tree growth and hydrologic recovery after forest harvest than has been previously reported.

When all the daily streamflow peaks were analyzed together, small increases after the 1984 harvest were indicated for watersheds 1 and 2, amounting to a 26 percent increase on watershed 2. No changes were detected in the magnitude of annual snowmelt peaks from any logged watershed, but peaks from watershed 4 occurred earlier after the 1984 harvest, indicating earlier snowmelt from that drainage.

Compared to preharvest conditions, suspended sediment yield from watersheds 1 and 2 during the first 3 years after the 1984 harvest increased by factors of 5 and 17, respectively. Sediment yield gradually declined after 1986 and by 1995, yield from the logged watersheds was lower than from the control. Turbidity trends after the 1984 logging followed closely the trends of suspended sediment, reaching a peak during the first year after logging, then declining to watershed 3 levels by 1995.

Measured bedload was less than 1 pound per acre per year during calibration. It remained low throughout the treatment periods, never exceeding 6.5 cubic feet of wet volume per watershed per year. Volumes of bedload differed little between logged and control watersheds.

Stream cross-sections were established in 1984 and measurements of channel depth were made each year through 1995. Trends over time showed net erosion at 6 locations and deposition or no change at the other 23 sections analyzed. The largest change occurred just upstream from the gaging station and downstream from the bedload box on watershed 4. At this site, erosion deepened the channel almost 5 inches. Observed changes in the stream channel may have been caused more by the placement of the box than by logging activity. From cross-section measurements and on-site observations, it is evident that stream channels are stable and that timber harvest had no lasting effect.

Air and water temperature was measured at each weir between 1986 and 1996. Temperature trends followed the expected annual cycles and air temperature was slightly higher at watersheds 1 and 2 than at watershed 3. Water temperature remained below 70° F in all streams except watershed 4 where a reading of 73.6° F was recorded. Although this temperature is beyond the acceptable range for cold water fisheries, the small flow rates at these temperatures do not threaten downstream resources.

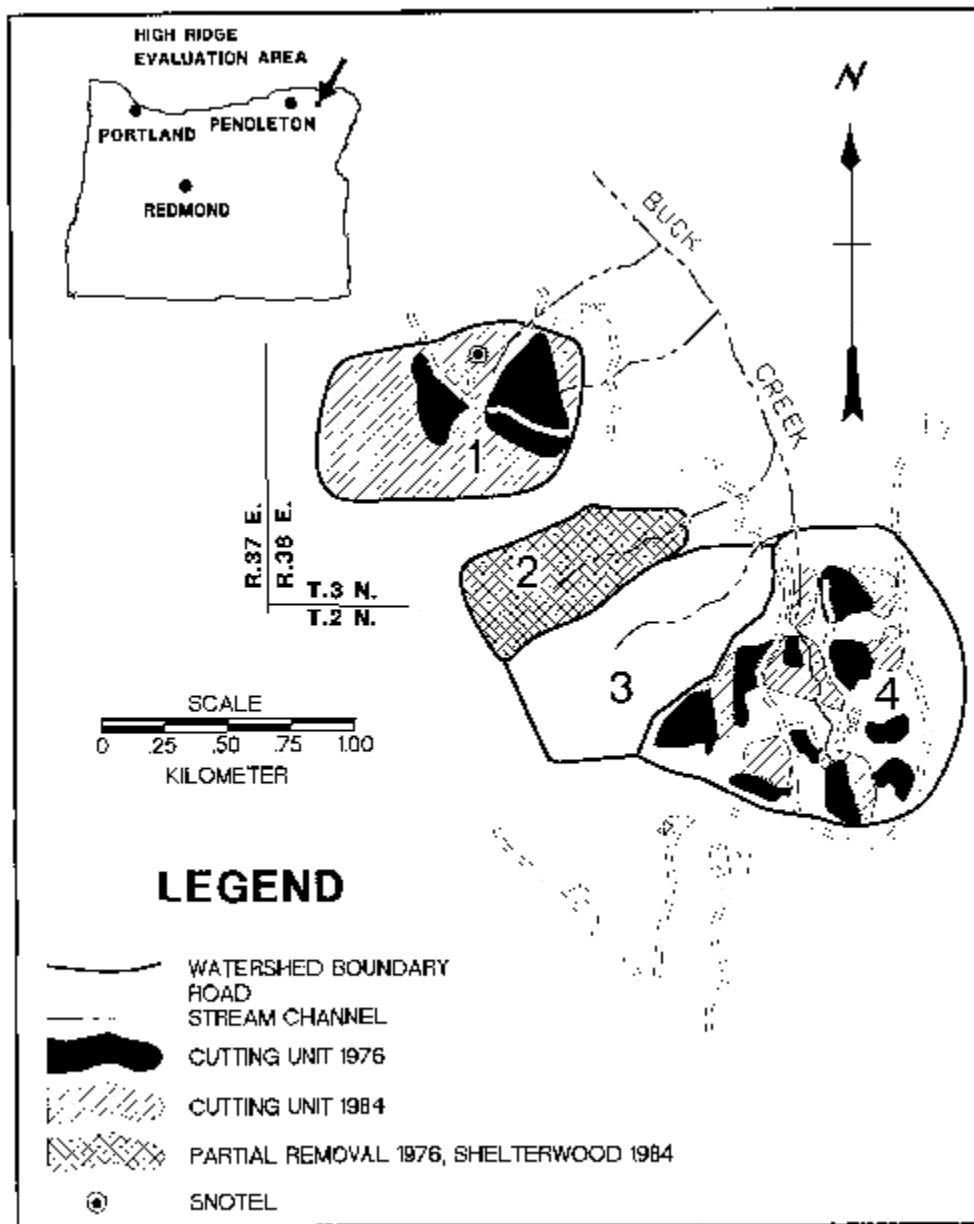


FIGURE 1. The High Ridge Evaluation Area. Umatilla National Forest, Oregon

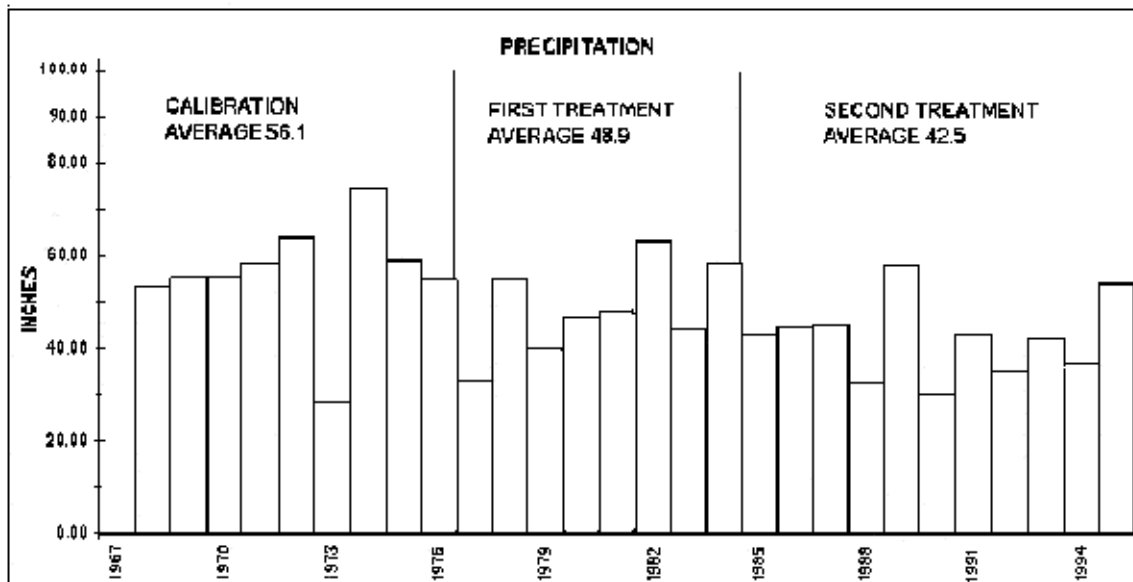


Figure 2. High Ridge annual precipitation during the study period with computed averages for calibration, first treatment, and second treatment periods. Overall average was 48.7 inches annually.