Report for 2001KY1982B: Retirement and restoration of forest roads in steep terrain: Influence on nonpoint source pollution and hillslope hydrology

- Conference Proceedings:
  - Smidt, M.F., and R.K. Kolka, 2001, Alternative Skid Trail Retirement Options in Steep Terrain, in Proceedings Council on Forest Engineering Conference, Showshoe, WV.
- Other Publications:
  - Kolka, R.K. and M.F. Smidt, 2001, Revisiting Forest Road Restoration, American Water Resources Association, Water Resources IMPACT, 3, 15-18.

Report Follows:

Problem and Research Objectives

Forest roads constructed as a result of harvesting operations severely disturb soil which leads to enhanced nonpoint source pollution, altered hillslope hydrology and lower productivity. Current best management practices (BMPs) for forest road retirement in Kentucky and many other states are effective at *reducing* nonpoint source pollution but sediment fluxes can still be on the order of 10 to 40 times those in unharvested systems the first few years after harvest. Also, none of the current forest road BMPs specifically address the recovery of soil properties, normal hillslope hydrology, and site productivity. It is critical that we develop new road closure techniques to lessen the transport of sediment and nutrients and minimize the altering of hillslope hydrology while still leading to more productive ecosystems. The overall objective of this project is to examine the effects of restoration (i.e. recontouring the hillslope) and a new subsoiling retirement technique on forest roads on steep side slopes. Specific objectives include the following:

1) Examine how hillslope restoration and deep subsoiling affect the transport of sediment and nutrients from forest roads;
2) Examine how hillslope restoration and deep subsoiling affect hillslope hydrology and soil moisture;
3) Identify amelioration techniques that efficiently and effectively improve soil properties and seedling growth on severely disturbed areas.

Methodology

Three sections of forest roads in NE Kentucky were chosen that have approximately a 10% grade on hillslopes ranging from 30-50%. Each road section has three duplicated, randomly placed experimental treatments including (1) cover crops only (KY BMP), (2) deep tillage and cover crops, and (3) re-contouring and cover crops. An undisturbed hillslope site at a similar landscape position as the road section was also instrumented at each site and is considered as a reference. Road sections are 200 m long with six 25 m treatment plots (duplicate of treatments 1-3) with treatment plots separated by 5 m buffers. Time and cost data was collected during the installation of the treatments. TDR probes at 15 and 25 cm soil depth were installed 3 m above, 3 m below and in the center of road treatments and on the reference hillslope. Soil moisture is measured (with TDR) on a biweekly schedule and after precipitation events greater than ~1.25 cm (1/2 inch). Surface runoff diversion plots (~ 8 m^2) were constructed and graded to collect road surface runoff that was measured for volume and analyzed for sediment and nutrient concentration. Surface runoff collected with the diversion plots was analyzed for pH, conductivity, alkalinity, TSS, TDS, NO_3, NH_4, PO_4, Ca, Mg, K, Na and TOC. Soil physical properties (bulk density, particle size and soil resistance measured with a cone penetrometer) and soil chemistry (pH, plant available nutrients, organic carbon and cation exchange capacity) measurements were made within the road surface prior to plot installation. Subsequent measurements of soil physical and chemical properties were conducted to characterize recovery. Twenty tulip poplar (*Liriodendron tulipifera* L.) and eastern white pine (*Pinus strobus* L.) seedlings were planted in each plot during the spring of 2000. Seedling dimensions were measured at the end of each growing season for the duration of the study.

Principal Findings and Significance

The recontour treatment had significantly lower bulk densities than either the subsoiling or control treatments. The control and subsoil treatments had similar runoff percentages with the recontour treatment having significantly lower runoff than the control treatment. The control and subsoil treatments had similar sediment production with the recontour treatment having significantly lower sediment production. The relatively undisturbed reference sites had very little runoff and hence, very low sediment production. Reference sites had significantly lower soil moisture than treated sites. Across sites and treatments, soil moisture at 15-25 cm was significantly higher than soil moisture at 0-15 cm. Few differences were found among treatment:landscape position combinations. No differences were found at 15-25 cm soil depth when comparing similar positions in relation to the road. At 0-15 cm soil depth soil moisture below recontoured plots was significantly greater than those below reference plots. Soil moisture at 0-15 cm soil depth tended to be greater within the road on control and subsoiled plots whereas on recontoured and reference plots soil moisture tended to increase from the road to the below road locations. Recontour and subsoil treatments had significantly greater white pine diameter growth than control plots. No treatment effects were seen for white pine height growth. Yellow poplar diameter and height growth was greatest for recontoured plots followed by the subsoiled plots and the control plots. The combination of data indicates that recontouring the hillslope leads to lower bulk densities, less surface runoff and sediment production and greater seedling growth than both traditional and subsoiling road retirement methods.