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Effects of mountain resort development on stream geomorphic function in the White River National Forest, Colorado, USA

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The effects of ski slope development on morphology and stability of stream channels is poorly understood. Development of ski slopes includes tree-clearing, road construction, machine-grading and snow-making. Although, each of these types of development has been studied individually, particularly the effects of tree-clearing and road construction, the combined effect of all four on channel morphology has not been investigated thoroughly. Changes in land-use affect the hydrology of a basin by either causing an increase in the water yield or peak flow, or a change in the size and amount of sediment that the stream transports. The United States Forest Service (USFS) funded this project because of their concern with the potential impacts of development on stream channels in national forest land, where the majority of ski resorts are located. Changes in the channel morphology can result in a decrease in habitat diversity and water quality as the stream moves towards a new equilibrium. We used field data from the White River National Forest in Colorado, which includes several major ski resorts, to test the hypothesis that there is a significant difference in bank stability, undercut banks, fine sediment, wood loading, pool residual depth and D84 between the ski area "project" and reference streams, because of ski slope development. We further hypothesize that the changes in a stream are mitigated by the density and type of vegetation growing along the banks. A significant impact is defined as a project stream that is outside the range of variability of the reference streams.

To test these hypotheses, we surveyed channel condition, channel dimensions, and vegetation along 47 stream reaches (200 - 800 m in length). Twenty-three "reference" streams with very little to no development in their basins are used to define reference conditions of bank stability, bank undercutting, bank height, wood loading, pool residual depth, sediment size, and vegetation structure. Twenty-four project streams are located in drainage basins with ski slope development ranging from 1.5 to 60% of the basin area. A combination of statistical techniques, including Principal Components Analysis (PCA) and best subsets regressions, was used to assess the controls on stream channel morphology and to analyze the differences between project and reference streams.

Significant differences between project and reference streams were evident, although the differences are subtle. Project streams that are significantly impacted have a combination of a higher percentage of fine sediment, smaller pool residual depth, and higher percentage of unstable banks. Roads and machine-grading have the most significant impact on the streams, causing bed fining and pool filling. These data and results will help in revising a forest management plan to provide guidelines for planning and development of ski areas on public lands.