

THIRTY-YEAR RESULTS FROM A PAIRED-CATCHMENT STUDY OF UPLAND FLOWPATH RESPONSES TO FOREST COVER CONVERSION IN NORTHERN MINNESOTA

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Long-term studies on paired-research catchments have often showed periods of changes to water yields and peak stormflow after forest harvesting. Most studies have focused on whole-catchment or downstream responses. In contrast, few studies have ever been established to measure and investigate specific pathways of water routing through catchment soils or how sub-catchment hydrological flowpaths respond to experimental vegetation manipulations, as well as common metrics of annual water yields and stormflow magnitudes. At the Marcell Experimental Forest (MEF) in northern Minnesota, subsurface and surface runoff collectors were operated in a paired-catchment study of forest conversion to conifer (spruce/pine) cover after clearcutting of deciduous (aspen/birch) trees on upland mineral soils. The runoff collectors measured amounts of flow from mineral soils on hillslope plots. Upland runoff data were collected from both north- and south-facing slopes in a reference and an experimental catchment. In the MEF landscape, which includes northern peatlands, the hillslope flowpaths drain to central peatlands. As such, we distinguish between sources of water in upland and peatland soils, as well as apportion flow along the two different upland flowpaths. Herein, we report on the timing and magnitude of forest-conversion effects on the routing of water along surface and subsurface runoff pathways. Annual water yields increased during the first post-harvest decade and returned to pre-harvest levels from 10-20 years after harvest/conversion. During the third post-harvest decade, annual water yields continued to decrease and water yields were about 50 percent lower relative to the pre-harvest period. Since the upland clearcut in 1980, total annual surface and subsurface runoff amounts from the converted forest have decreased to a trivial annual amount, while streamflow and upland runoff amounts in the reference catchment showed no trends. To elucidate reasons why these changes occurred, we initiated a study of transpiration. Together, these studies suggested that forest conversion in post-glaciated catchments with northern peatlands may lead to fundamental changes in catchment hydrology. The uplands now yield practically no water and the coniferous forest transpires most of the available water, which means that runoff from a peatland is the primary source of streamflow. These findings have important implications for the management of forested landscapes and the practice of restoring conifer cover to forests of northern Minnesota, which is the headwater of several major rivers.

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