Soil nitrogen turnover and release 25 & 50 years after harvesting subalpine forests in the Rocky Mountains of central Colorado

Chuck Rhoades, Rob Hubbard, Banning Starr & Michael Ryan

Overview
Removal of subalpine forest canopy increases snow accumulation, shallow subsurface flow and nutrient export from high-elevation catchments. In the central Colorado Rockies, augmented streamflow and subsurface nitrogen (N) export continue for at least 50 and 20 years, respectively, following two separate clear cut harvests. Few studies have measured the long-term effects of forest harvesting on the biogeochemical processes responsible for watershed-scale N dynamics. This study quantifies soil N pools, turnover and release from two catchments where harvesting was conducted in the mid 1950s and early 1980s as part of paired watershed research at the Fraser Experimental Forest.

Our findings indicate that in high-elevation forests, the soil processes that control nitrate production and release remain significantly altered 25 years after harvesting and like other ecosystem properties may require a half century to recover from canopy removal.

Study Site
Our study sites are located in the Fool Creek and Deadhorse watersheds at the USDA Forest Service, Fraser Experimental Forest near Granby, Colorado. The Fraser Experimental Forest is on the western edge of the Front Range of the Colorado Rockies and contains 9,300 ha of subalpine and alpine ecosystems.

Nitrogen Dynamics
- **Resin N**
  - In 25-year-old harvest areas, there was a 1.7-fold more total IER-N released during spring snowmelt compared to adjacent uncut stands.
  - In both age harvests, snowmelt nitrate was more than double and the proportion of total IER-N moving as nitrate was greater.
  - Ammonium was lower in both age regenerating harvest areas during summer months.
  - In the 50-year-old harvest areas, decreased ammonium offsets the increase in nitrate-N percolating in snowmelt.

- **Extractable Inorganic N**
  - Mineral soil in the forest regenerating from the 1980s harvests had 21% the extractable N of adjacent unharvested areas.

- **Forest N Transformations**
  - There was 0.7 and 0.3 kg N/ha more N mineralized in forest floor and mineral soil, with >95% in the ammonium form. Similarly, N mineralized in forest floor was 5-fold higher than that in mineral soil.
  - Net N Transformations
    - The forest floor in harvested stands was significantly drier (10 - 20%) than adjacent old growth.
  - N transformations did not differ in 50 year-old stands and adjacent old growth forest in Fool Creek.

- **Nitrogen Export**
  - Combined with greater snowpack and subsurface flow in regenerating Fool Creek and Deadhorse stands, higher N movement (25 & 50 yr stands) and nitrate production (25 yr stands) indicate the potential for elevated watershed N export for half a century after subalpine forest harvest.