

Nutrient Cycling in the Sierra Nevada: The Roles of Fire and Water at Little Valley, Nevada¹

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Spatial and temporal patterns of water flux, ion flux, and ion concentration were examined in a semiarid, snowmelt-dominated forest on the eastern slope of the Carson Range in Little Valley, Nevada (Johnson and others 2001). Variations in data collected from 1995 to 1999 were used to examine the potential effects of snowpack amount and duration on ion concentrations and fluxes.

The analysis of interannual trends in this data set was complicated by the fact that all 5 years had above-normal snowfall; nonetheless, the data show that interannual differences in ion input via snow can vary considerably and quite independently from total snowfall amount. On a spatial basis, increased snowmelt resulted in increased inputs of only some ions (primarily base cations and Cl^- during some seasons). It is therefore not safe to assume that changes in snowfall amount will cause concomitant changes in ion inputs via snowfall in this system. Soil solution NO_3^- and NH_4^+ concentrations and fluxes were uniformly low, and the variations in concentrations bore no relationship to snowmelt water flux or the input of these ions from the snowpack. Apparently, biological uptake controlled NO_3^- and NH_4^+ quite closely at all times. It was clear that weathering caused a net loss of base cations from these soils and that the water flux alone did not greatly influence base cation concentrations; it was equally clear that soil solution cation concentrations were affected by cation concentrations in snowmelt. Soil solution $o\text{-PO}_4$ concentrations were uniformly low and unaffected by either water flux or variations in inputs of $o\text{-PO}_4$ from snowmelt. Soil solution SO_4^{2-} concentrations, although not directly related to water flux, closely followed the patterns in snowmelt water, suggesting minimal buffering by solid-phase soil SO_4^{2-} adsorption. It appeared that Cl^- was a conservative ion in this system: snowmelt Cl^- concentrations did not decrease with increasing water flux, either on a temporal or spatial basis.

Perhaps the most interesting result of this investigation was the timing of ion release during snowmelt. Most studies have found that the majority of ions exit the snowpack in advance of the bulk of the water. This pattern clearly did not hold for the Little Valley site. Possible reasons for this include sublimation and dry deposition of dust and organic detritus to the snowpack during the later periods of snowmelt. Sublimation may well accelerate during the later phases of snowmelt as daytime temperatures rise, causing an increase in the concentration of ions remaining in the snowpack. The presence of both mineral and organic matter in the snow in Little Valley was quite evident during the later stages of snowmelt. These materials may be leached of nutrients as temperatures increase, resulting in higher ion concentrations.

In another study in Little Valley, carbon (C) and nitrogen (N) losses (due to a wildfire and post-fire salvage logging) and gains (due to regrowth and N fixation during a 16-year period) were estimated (Johnson and others [In press]). The wildfire caused minimum losses of approximately 42 percent (100 kg ha^{-1}) of aboveground N in trees, but only 6 percent (3,800

¹ This paper was presented at the Sierra Nevada Science Symposium, October 7–10, 2002, Kings Beach, California.

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kg ha⁻¹) of aboveground C (assuming all foliage was consumed). On an ecosystem level, the fire consumed approximately equal percentages of total C and N (12 and 9 percent, respectively), but a considerably greater proportion of aboveground N (71 percent) than C (21 percent). Salvage logging was the major factor responsible for losses, and C lost from the site will not be replenished until forest vegetation is established and succeeds (that is, largely replaces) the current shrub vegetation. N₂ fixation by *Ceanothus velutinus* (snowbrush) in the post-fire shrub vegetation over the first 16 years appears to have more than made up for N lost by gasification in the fire and may result in long-term increases in C stocks once forest vegetation takes over the site. N loss from the fire was equivalent to more than 1,000 years of atmospheric N deposition and more than 10,000 years of N leaching at current rates. Soil N pools were larger in snowbrush-dominated sites than in an adjacent intact forest, but no definitive value for N accretion in soils could be calculated. The benefits of allowing post-fire N fixation by shrub vegetation to replenish and even exceed the N losses due to fire and logging must be weighed against the severe competition such vegetation creates for regenerating forests.

References

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