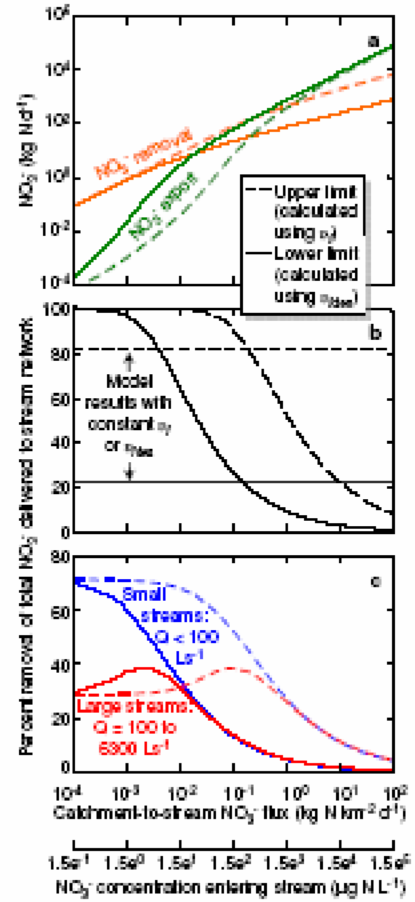
Streams are effective nitrate filters in the landscape: *a synthesis of results from field ^{15}N experiments across biomes and land uses*

Contact: Patrick Mulholland, mulhollandpj@*ornl.gov*, 865-574-7304
DOE/Office of Science/Biological & Environmental Research

- A large study of nitrate removal in streams using field ^{15}N addition experiments in 72 streams across many biomes and land uses in the U.S. indicated effective removal of nitrate by stream algae and microbes, including substantial removal by the process of denitrification.
- Nitrate removal rate was controlled primarily by nitrate concentration and biological processes associated with autotrophic and heterotrophic metabolism in streams.
- A stream network model (figure) based on the field ^{15}N experiment results indicated that streams are effective nitrate sinks but can be overloaded by high nitrate inputs with a loss of nitrate removal efficiency and increased exports to downstream systems.



Streams are effective nitrate filters in the landscape: *a synthesis of results from field ^{15}N experiments across biomes and land uses*

Contact: Patrick Mulholland, mulhollandpj@*ornl.gov*, 865-574-7304
DOE/Office of Science/Biological & Environmental Research

Worldwide, anthropogenic addition of bioavailable nitrogen (N) to the biosphere is increasing and terrestrial ecosystems are becoming increasingly N saturated, causing more bioavailable N to enter groundwater and surface waters. Large-scale N budgets show that an average of about 20-25% of the N added to the biosphere is exported from rivers to the ocean or inland basins, indicating substantial sinks for N must exist in the landscape. Streams and rivers may be important sinks for bioavailable N owing to their hydrologic connections with terrestrial systems, high rates of biological activity, and streambed sediment environments that favor microbial denitrification. Here, using data from 15N tracer experiments replicated across 72 streams and 8 regions representing several biomes, we show that total biotic uptake and denitrification of nitrate increase with stream nitrate concentration, but that the efficiency of biotic uptake and denitrification declines as concentration increases, reducing the proportion of in-stream nitrate that is removed from transport. Total uptake of nitrate was related to ecosystem photosynthesis and denitrification was related to ecosystem respiration. Additionally, we use a stream network model to demonstrate that excess nitrate in streams elicits a disproportionate increase in the fraction of nitrate that is exported to receiving waters and reduces the relative role of small versus large streams as nitrate sinks.

Mulholland, P. J, A. M. Helton, G. C. Poole, R. O. Hall, Jr., S. K. Hamilton, B. J. Peterson, J. L. Tank, L.R. Ashkenas, L. W. Cooper, C. N. Dahm, W. K. Dodds, S. Findlay, S. V. Gregory, N. B. Grimm, S. L. Johnson, W. H. McDowell, J. L. Meyer, H. M. Valett, J. R. Webster, C. Arango, J. J. Beaulieu, M. J. Bernot, A. J. Burgin, C. Crenshaw, L. Johnson, B. R. Niederlehner, J. M. O'Brien, J. D. Potter, R. W. Sheibley, D. J. Sobota, and S. M. Thomas. Stream denitrification across biomes and its response to anthropogenic nitrate loading. **Nature** (in press).