Streams and rivers receiving nitrogen inputs from human activities are a source of N_2O to atmosphere

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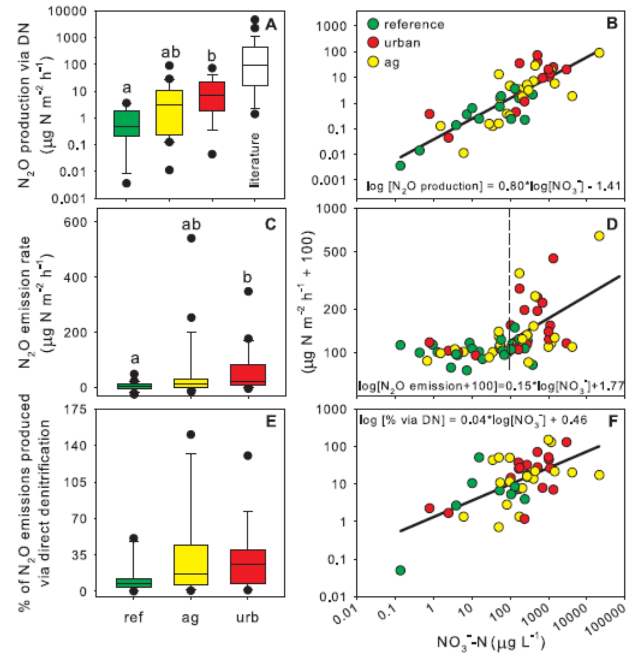
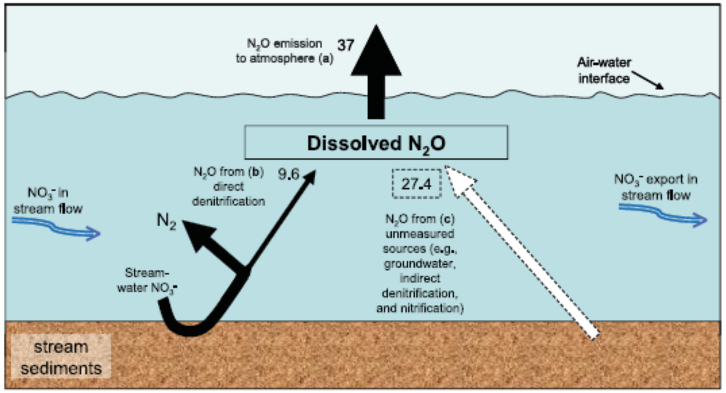
- Atmospheric concentrations of the greenhouse gas nitrous oxide (N_2O) have increased ~20% over the past century and continue to rise at ~0.2-0.3% y^{-1}.
- Using a field tracer $^{15}NO_3$ addition approach, we measured N_2O production rates from denitrification as well as total N_2O emission rates in 72 streams draining multiple land-use types across the United Sates.
- The majority of streams were a source of N_2O to the atmosphere and rates of N_2O production via denitrification increased with stream-water nitrate concentration.
- More than 99% of denitrified N in streams is converted to the inert gas N_2 rather than N_2O. Nevertheless, river networks are a source of at least 10% of global anthropogenic N_2O emissions from in-stream nitrification and groundwater N_2O inputs to streams.
- Results suggest that reductions in N_2O emissions from stream and river networks can be achieved by decreasing nitrogen inputs to watersheds (e.g., reduced agricultural fertilizer use).





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Nitrous oxide (N2O) is a potent greenhouse gas that contributes to climate change and stratospheric ozone destruction. Anthropogenic nitrogen (N) loading to river networks is a potentially important source of N2O via microbial denitrification which converts N to N2O and dinitrogen (N2). The fraction of denitrified N that escapes as N2O rather than N2 (e.g., the N2O yield) is an important determinant of how much N2O is produced in river networks, yet little is known about the N2O yield in flowing waters. Here, we present the results of reach-scale 15N-tracer additions conducted in 72 headwater streams draining multiple land-use types across the United States. We found that stream denitrification produces N2O at rates that increase with stream-water nitrate (NO3-) concentrations, but that less than 1% of denitrified N is converted to N2O. Unlike previous studies, we found no relationship between the N2O yield and stream-water NO3, suggesting that increased stream NO3 loading stimulates denitrification and concomitant N2O production, but does not increase the N2O yield. In our study, the majority of the streams were sources of N2O to the atmosphere and the highest emission rates were observed in streams draining urban basins. We used a global river network model to demonstrate that microbial N transformations in river networks (e.g., denitrification and nitrification) convert at least 0.68 Tg y-1 of anthropogenic N inputs to N2O, equivalent to 10% of the global anthropogenic N2O emission rate, three times greater than estimated by the Intergovernmental Panel on Climate Change.

Beaulieu, J.J., J.L. Tank, S.K. Hamilton, W.M. Wollheim, R.O. Hall, P.J. Mulholland, B.J. Peterson, L.R. Ashkenas, L.W. Cooper, C.N. Dahm, W.K. Dodds, N.B. Grimm, S.L. Johnson, W.H. McDowell, G.C. Poole, H.M. Valett, C.P. Arango, M.J. Bernot, A.J. Burgin, C. Crenshaw, A.M. Helton, L. Johnson, J.M. O'Brien, J.D. Potter, R.W. Sheibley, D.J. Sobota, and S.M. Thomas. 2010. Nitrous oxide emission from denitrification in stream and river networks. Proceedings of the National Academy of Sciences of the United States of America (published online 20 December 2010).