Nitrogen Cycling in Riparian Soils and Sediments Bordering Cold Desert Streams and Lakes (#729)

Barrett, JE[1], MN Gooseff[2,Presenting], DB Bate[1], ML Northcott[2], M Bobb[3], L Zeglin[3], C Takacs-Vesbach[3]

[1]Dartmouth College, Hanover, NH 03755 USA.
[2]Colorado School of Mines, Golden, CO 80401 USA.
[3]University of New Mexico, Albuquerque, NM 87131 USA.

Introduction

Riparian zone processes are critical to whole watershed biogeochemical cycling, because hydrology links the material and energy budgets of aquatic and terrestrial ecosystems. In temperate watersheds, these riparian zones have been identified as ecological "hot-spots" because of the increased biodiversity, microbial activity and biogeochemical exchanges between terrestrial and aquatic ecosystems. In the Antarctic Dry Valleys, riparian zones are crucial landscape features because of the scarcity of liquid water in this polar desert. Dry valley hydrological margins may therefore provide model systems for understanding physical and hydrological influences on microbial ecology and biogeochemistry. We report on our 1st field season investigating aquatic-terrestrial transition zones on the margins of stream and lake systems in the dry valleys.

Our objectives are to examine physical and biotic controls over nitrogen (N) cycling and exchange between aquatic and terrestrial ecosystems in arid environments.

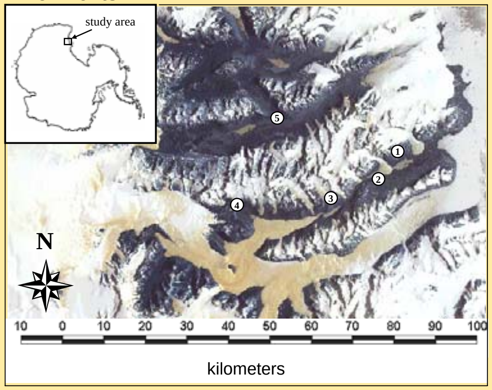


Figure 1. Study Sites

The McMurdo Dry Valleys of Antarctica are a polar desert characterized by extremes in aridity, temperature and physio-chemical limitations (e.g. salt stress) over biotic distribution and activity. We examined the role of physical and hydrological influences over the mobility of N in aquatic-terrestrial transition zones of 4 lakes and 5 streams in the dry valleys.

1. Lake Fryxell, Lost Seal Creek, Upper and Lower Delta Stream, Green Creek (Taylor Valley).
2. Lake Hoare (Taylor Valley).
3. Lake Bonney, Priscu Stream (Taylor Valley).
4. Lake Joyce (Pearse Valley).
5. Upper and Lower Onyx River (Wright Valley).

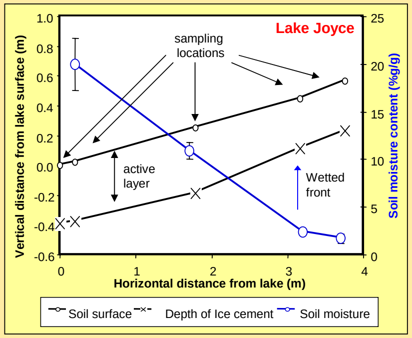


Figure 2. Study Design

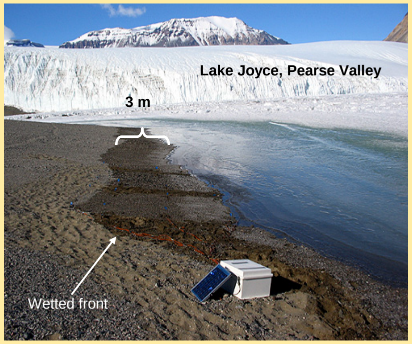
Soils were collected from 4 positions in transects across the riparian zones starting at the water edge and continuing past the "wetted front". Wetted zones extended 2-9 m from the edges of stream and 3-11 m from the edge of lake systems. Active layer thickness was 0.2-1.0 m (estimated by depth of "T-bar" penetration). Samples were analyzed for moisture content, total and inorganic N, major ions and soil organic carbon. Companion studies are examining microbial community structure and hydrology. Here we present data on soil N dynamics in dry valley riparian zones.

Table 1. Stream margin soils had significantly lower inorganic N concentrations relative to lake margin sediments. Inorganic N (& solute chemistry) were more variable in lake riparian zones compared with stream margins.

	Lake Margins	Stream Margins
Mean (NO_3^-)	15.01	0.60
Variance (NO_3^-)	646.04	2.35
df	64	
P(T<=t) two-tail	2.66E-05	
Mean (NH_4^+)	0.37	0.18
Variance (NH_4^+)	0.18	0.06
df	64	
P(T<=t) two-tail	1.69E-03	

Table 2. ANOVA of soil NO_3^- among sampling positions in lake and stream margins.

Variable	SS	df	MS	F	P-value
Lake margin NO_3^-	7725	3	2574.9	4.69	0.0053
Stream margin NO_3^-	37	3	12.2	5.89	0.0009



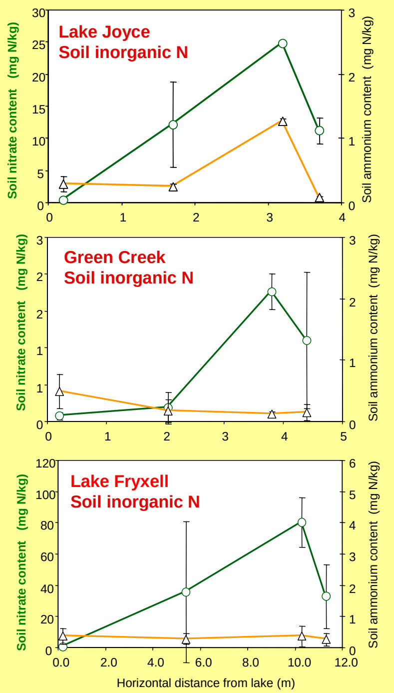


Figure 3

Inorganic N and salinity (not shown) varied significantly across these riparian zones in both stream and lake systems (Table 2), with the highest soil nitrate concentrations and highest salinities occurring at the edges of the wetted fronts.

Preliminary Conclusions and Ongoing Work

Inorganic N concentrations were greatest near the distal boundary of wetted zones in lake and stream margins (Fig. 3), presumably due to evapo-concentration of pore water solutes.

Stream riparian zones had low nutrient concentrations relative to lakes (Table 1), and appear to be flushed more regularly through hydrologic exchange with stream waters.

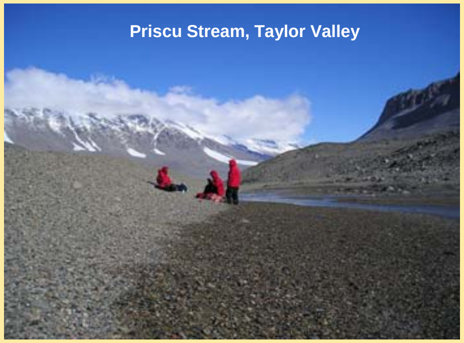
These trends in nutrient availability across riparian zones generate distinct chemical environments. Preliminary results indicate that variation in nutrient availability coincides with the spatial distribution of microbial communities across these aquatic-terrestrial transition zones*.

Two hypotheses may explain the covariance in spatial variability of nutrient dynamics and distribution of microbial communities:

H1: Spatial distribution of biotic communities is structured by the underlying variability in soil physical and biogeochemical properties.

H2: Spatial variability in the distribution and activity of specific functional groups of organisms contribute to the observed patterns of soil nitrogen (e.g. variation in redox conditions may facilitate more rapid denitrification within the wetted zones closest to the water edge).

Continuing work is addressing the functioning of the microbial communities and their role in controlling transformation and mobility of nitrogen in these wetted zones.



Acknowledgements

This work was supported by the National Science Foundation Office of Polar Programs (#0338267). Raytheon Polar Services and Petroleum Helicopters Inc. provided logistical support for field operations. We especially thank Paul Zietz of Dartmouth College and Nick Andrews of Montana State University for analytical support.

*Bobb, M, L Zeglin, J. E. Barrett, MN Gooseff, C Takacs-Vesbach. Scales of microbial diversity across aquatic/terrestrial interfaces in a polar desert. American Society of Limnology and Oceanography 2005 Meetings, Salt Lake City, UT, 2005.