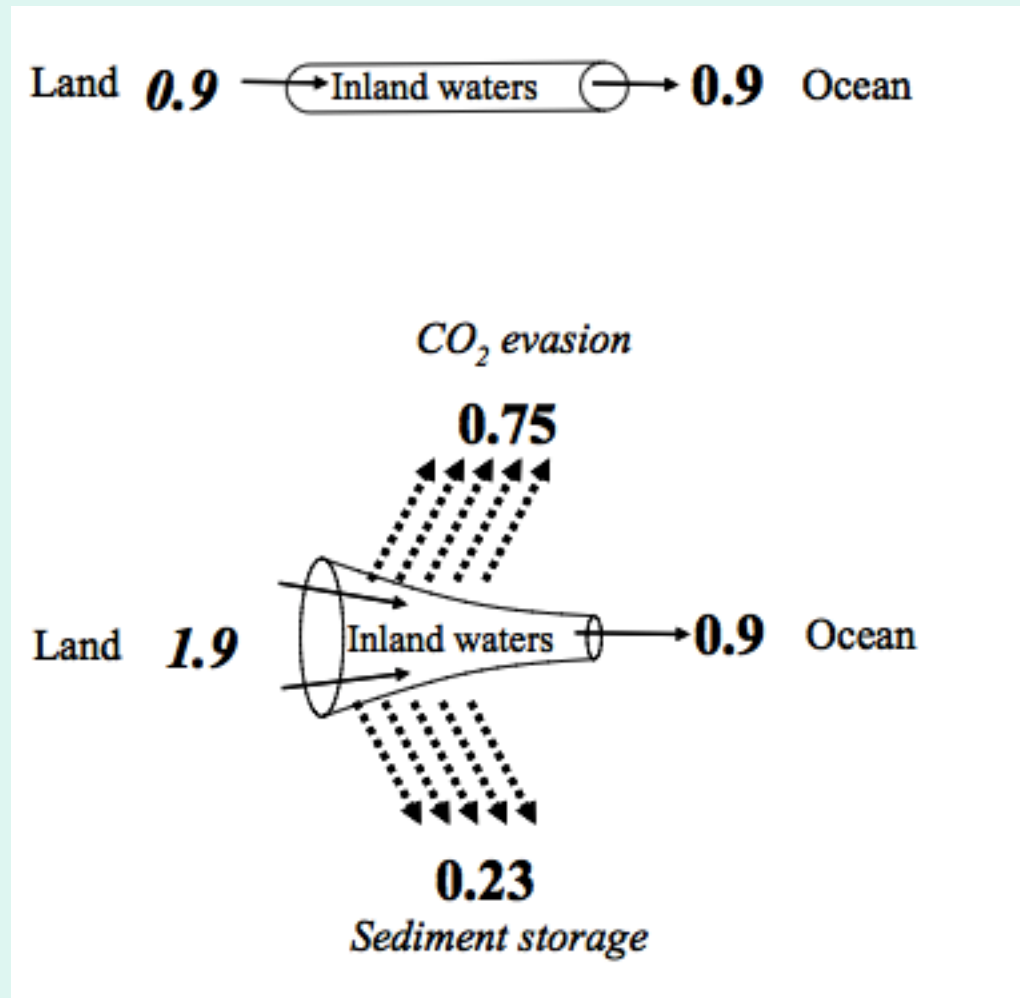




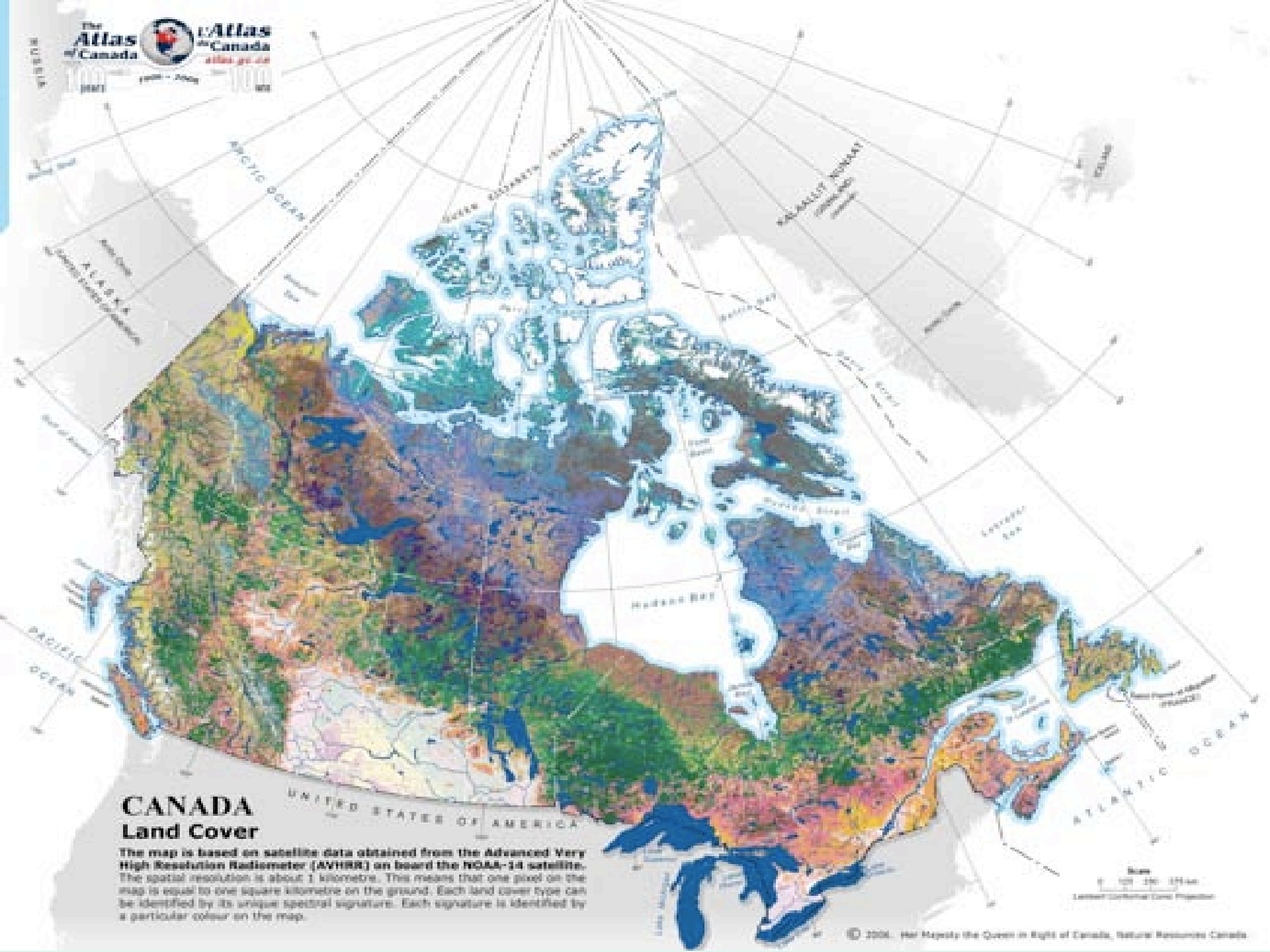
AQUATIC CO₂ EMISSIONS AS A KEY EMERGENT PROPERTY OF THE BOREAL BIOME

Paul del Giorgio, Cristian Teodoru and Yves Prairie
Université du Québec à Montréal

Aquatic systems as pipes or reactors



Plumbing the Global Carbon Cycle: Integrating Inland Waters into the Terrestrial Carbon Budget
Cole et al. Ecosystems (2007)

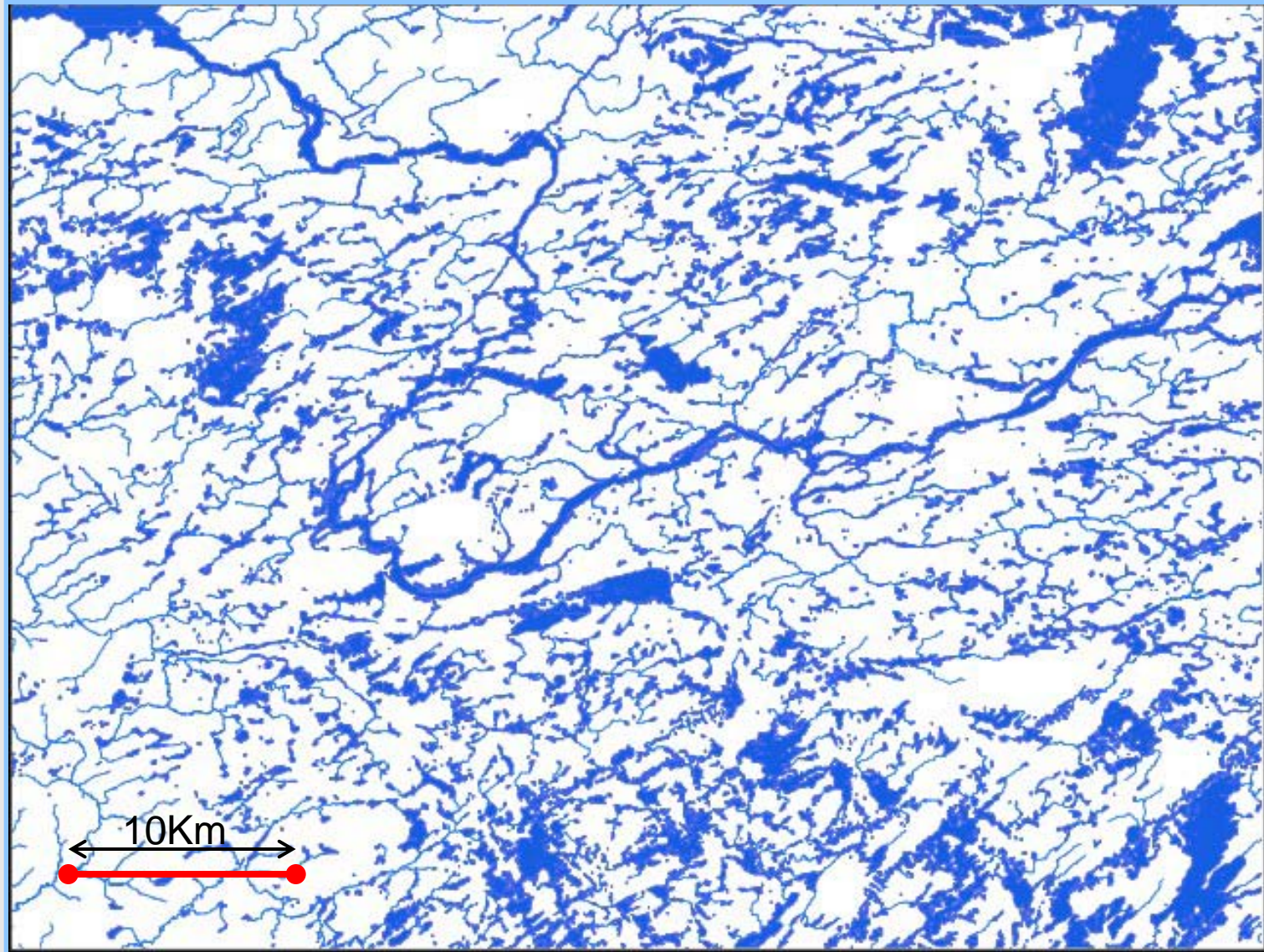


CANADA Land Cover

The map is based on satellite data obtained from the Advanced Very High Resolution Radiometer (AVHRR) on board the NOAA-14 satellite. The spatial resolution is about 1 kilometre. This means that one pixel on the map is equal to one square kilometre on the ground. Each land cover type can be identified by its unique spectral signature. Each signature is identified by a particular colour on the map.

Scale
 0 100 200 300 km
 Legend (Colour Code) Program

A large variety and high density of lakes and rivers





Some basic objectives:

- Establish the baseline patterns of carbon dynamics and green house gas emissions in boreal lakes, streams and rivers
- Integrate and scale up these processes at the regional level
- Place integrated aquatic C processes in the context of landscape processes and C budget



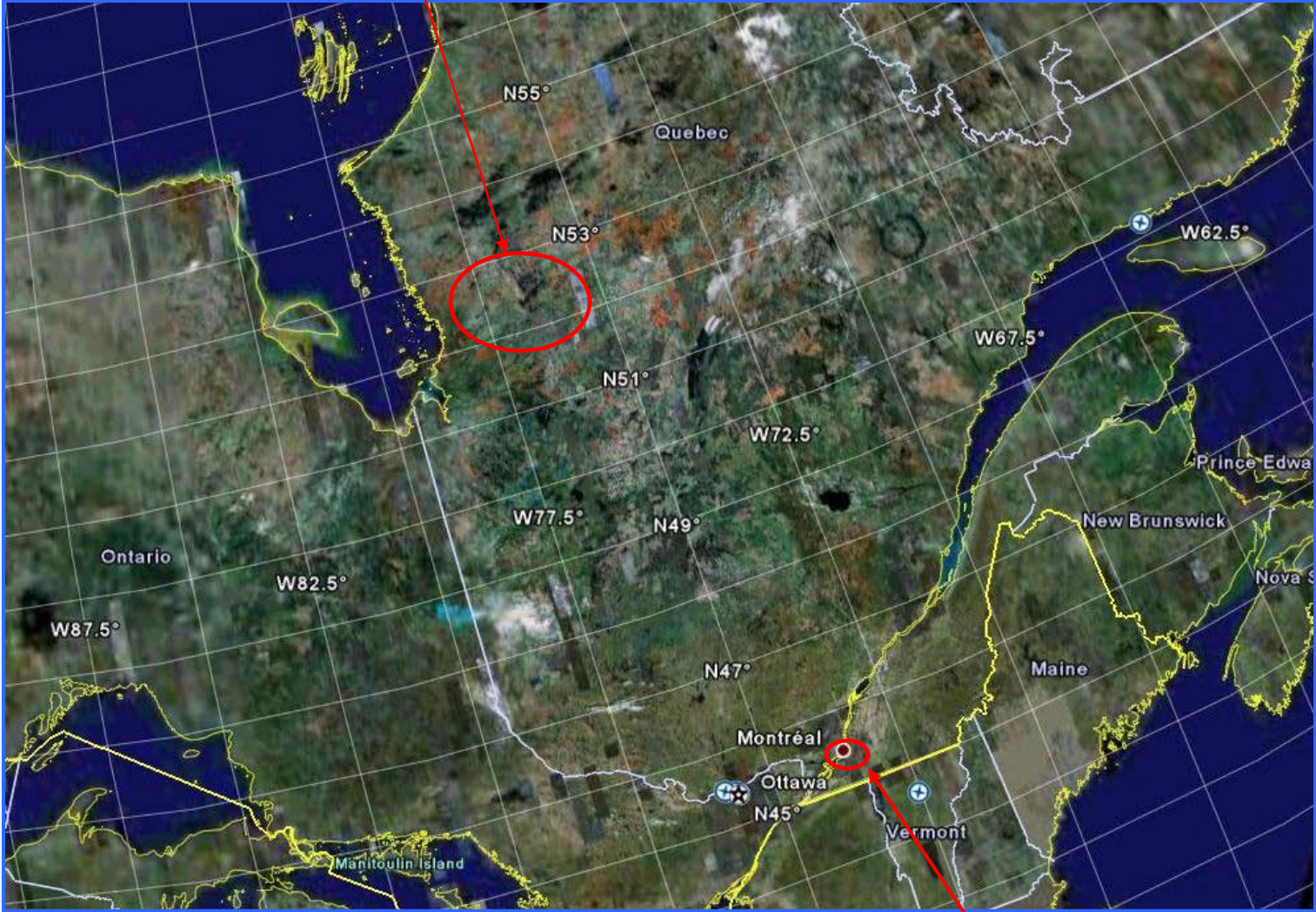
 **Hydro Québec**
Production

 **McGill**

UQÀM

*Environnement
Illimité Inc.*

Eastmain - Boreal

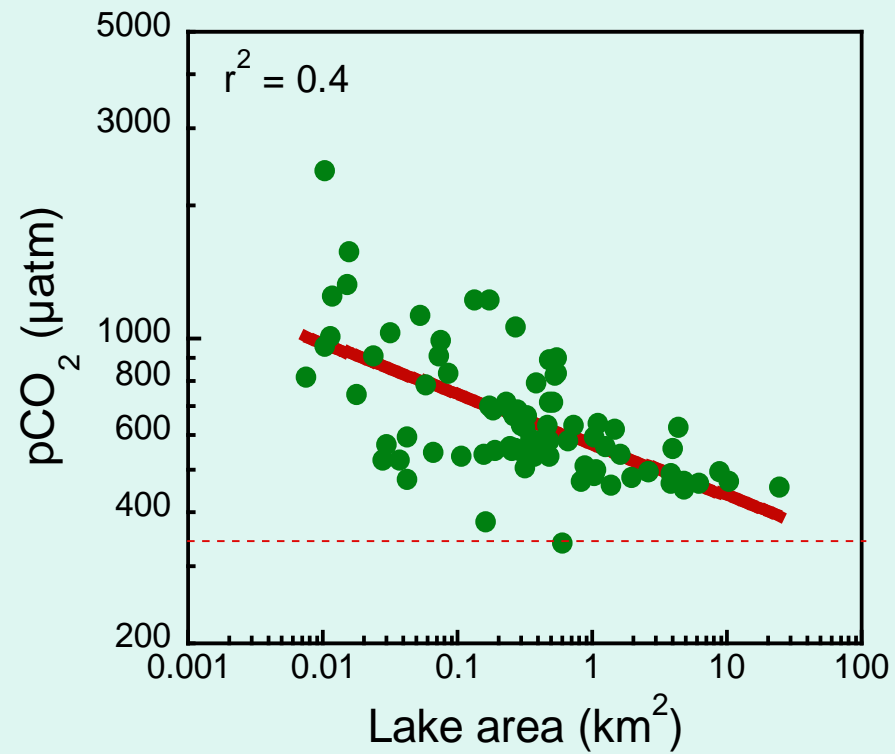
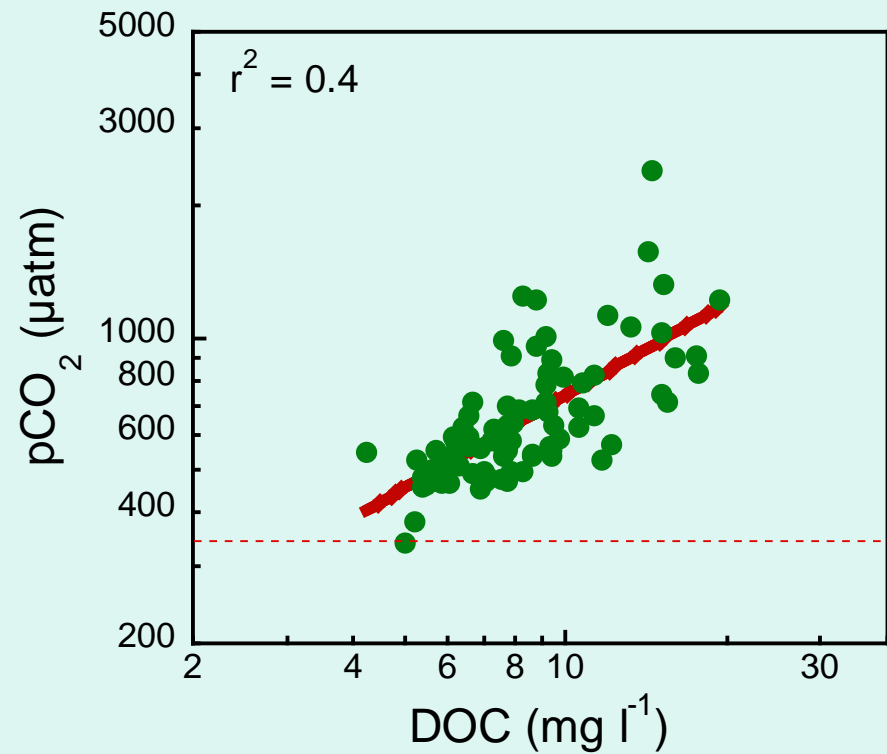


Montréal

Continuous measurement of lake $p\text{CO}_2$, O_2 ,
CDOM, chlorophyll



Patterns in boreal lake $p\text{CO}_2$



Patterns in boreal stream and river $p\text{CO}_2$

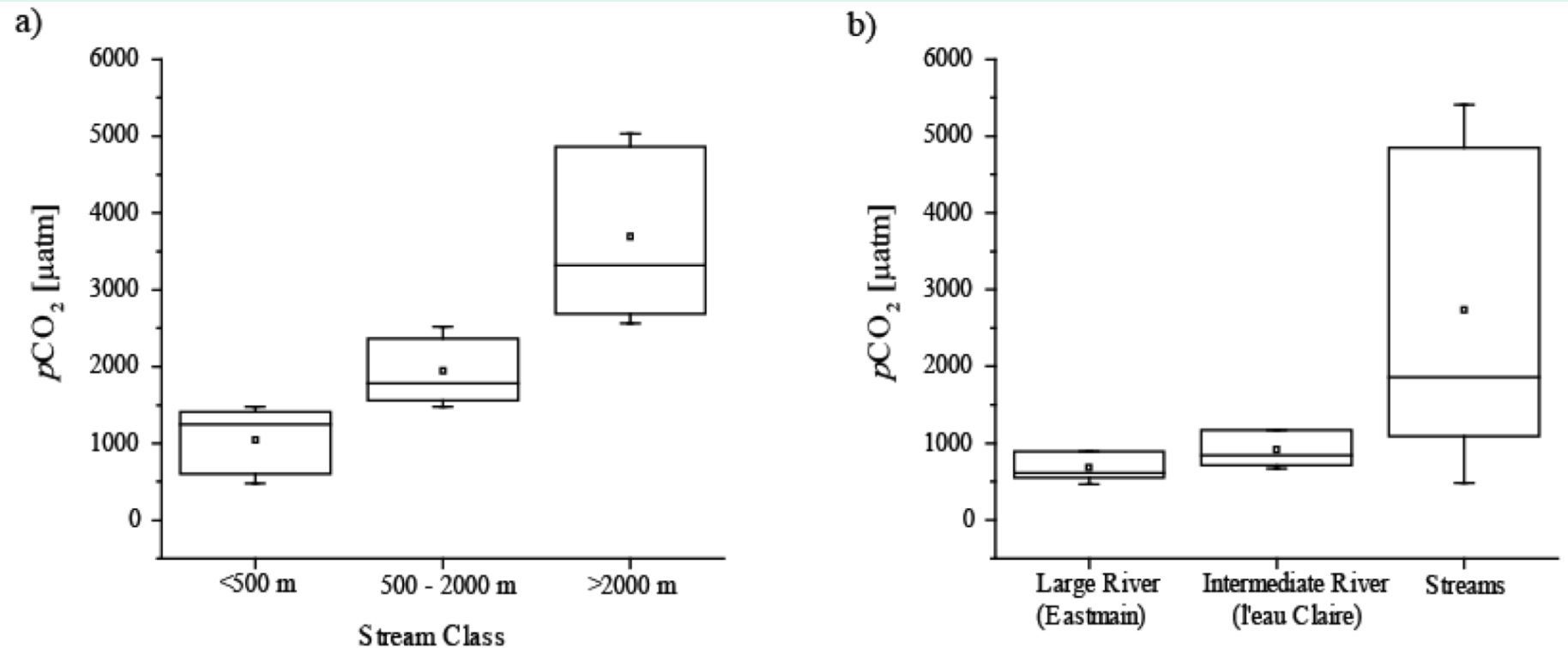
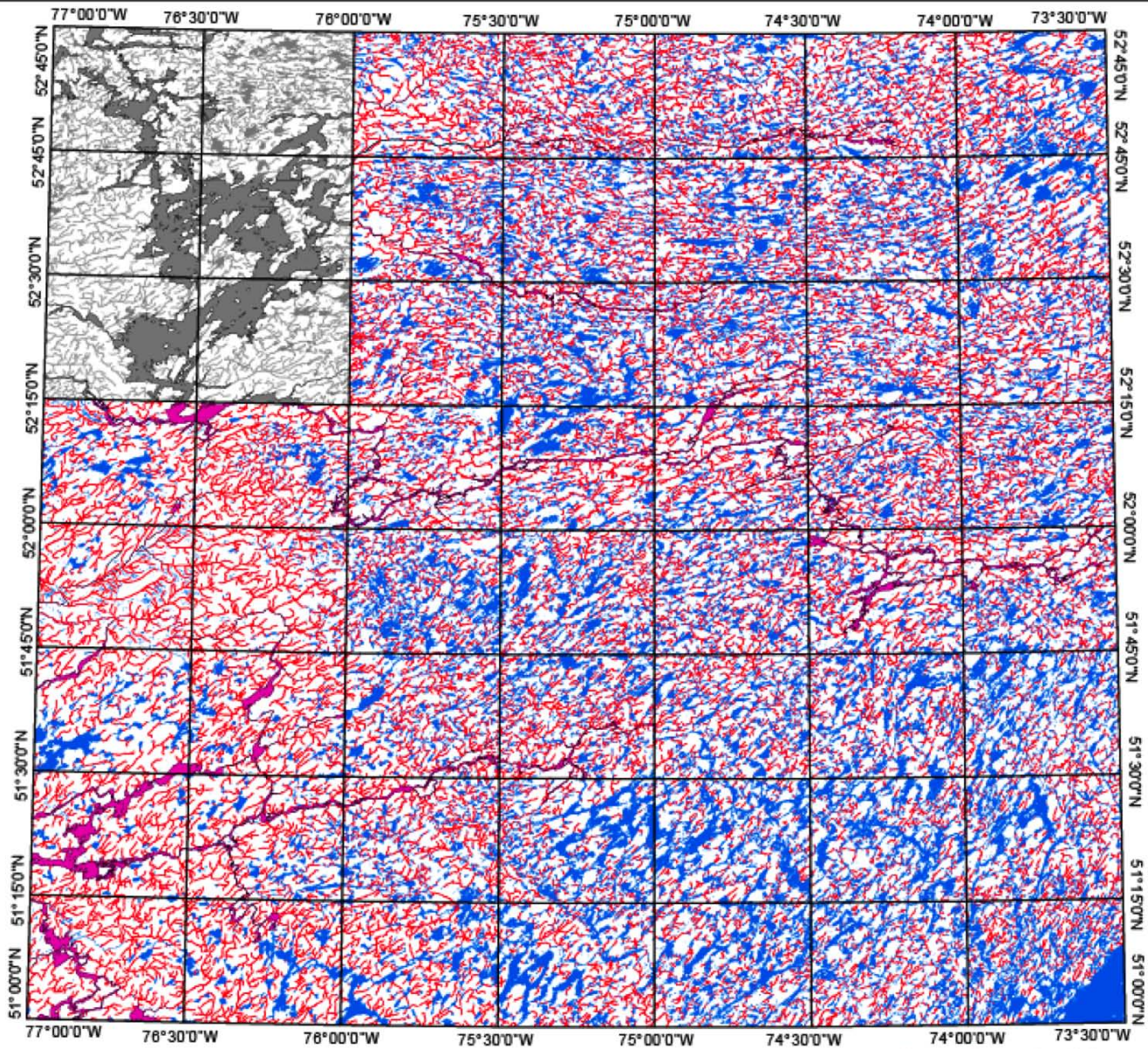


Figure 3. Comparison of surface $p\text{CO}_2$ in different length-categories of streams (a), between streams, intermediate and large rivers (b) in the Eastmain region. Box-plots show range, quartiles, median and outliers.

Integrating aquatic C fluxes in the landscape

- What is the magnitude and variability of the C emission from the ensemble of boreal aquatic ecosystems?
- How does this total aquatic emission compare with other components of the boreal C budget



Legend

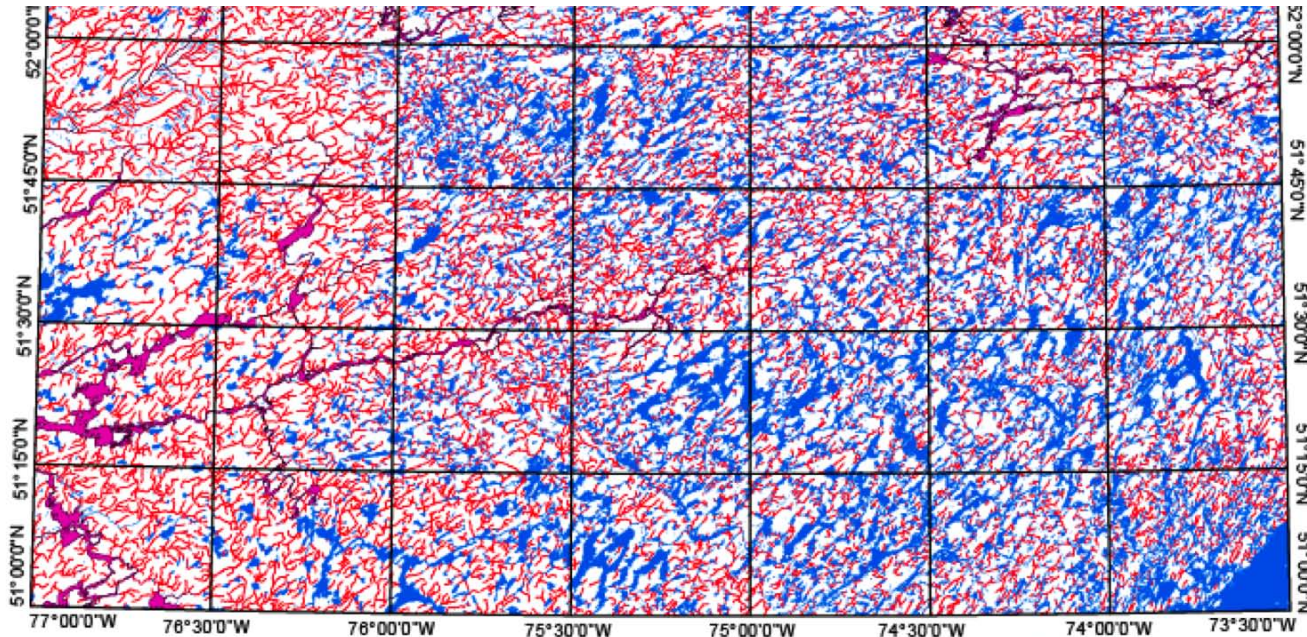
-  Stream
-  Lake
-  River



Base: BNDT, 33A, 33B, 33C, 32N, 32O, 32P
 UTM 18, NAD83



	Area		Aquatic CO ₂ emission		Flux	
	[km ²]	[%]	[tons C]	[%]	[mg C m ⁻² d ⁻¹]	
Total Landscape	48715	100			18.2	(13.4 to 23.4)
Total Aquatic	8064	16.6	159479	100	109.9	(57.0 to 829.6)
Rivers	726	1.5	33560	21.0	256.8	(198.8 to 391.8)
Lakes	7268	14.9	82324	51.6	62.9	(44.0 to 121.6)
Streams	70	0.1	43595	27.3	3467.0	(2395.7 to 4084.6)



Legend

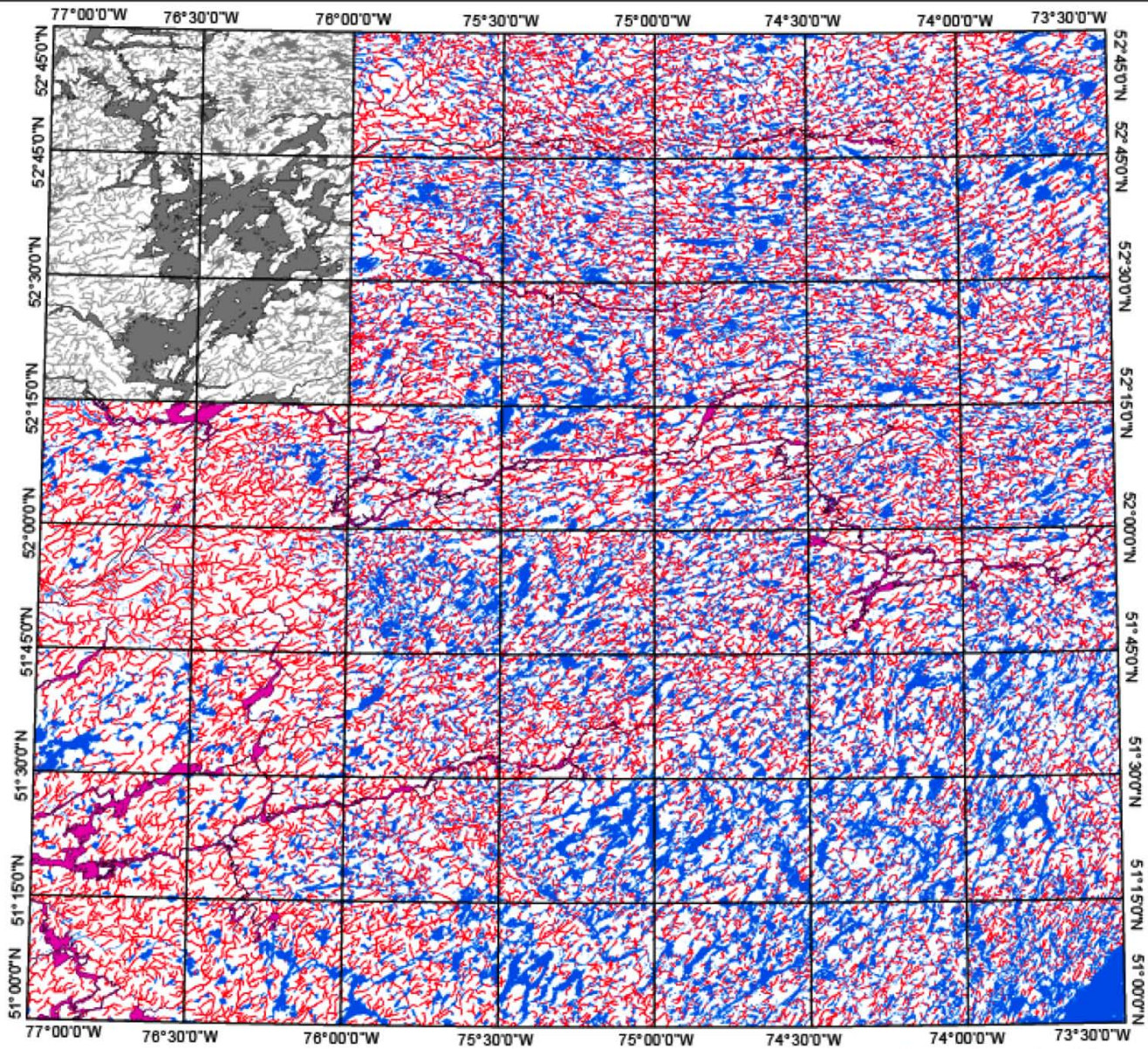
-  Stream
-  Lake
-  River



Base: BNDT, 33A, 33B, 33C, 32N, 32O, 32P
UTM 18, NAD83

0 20 40 80 Km





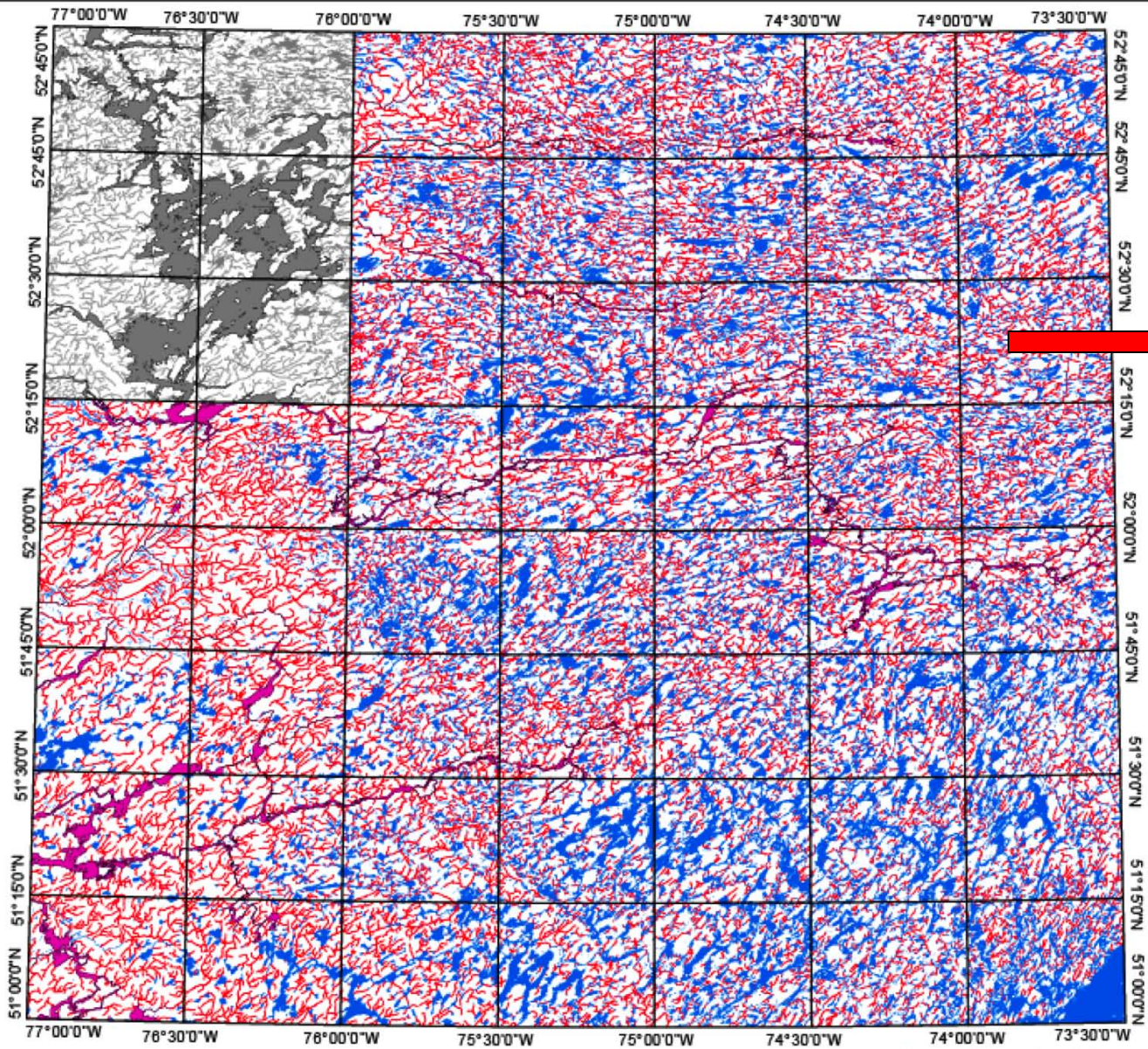
Legend

-  Stream
-  Lake
-  River



Base: BNDT, 33A, 33B, 33C, 32N, 32O, 32P
 UTM 18, NAD83





→ 970 km²

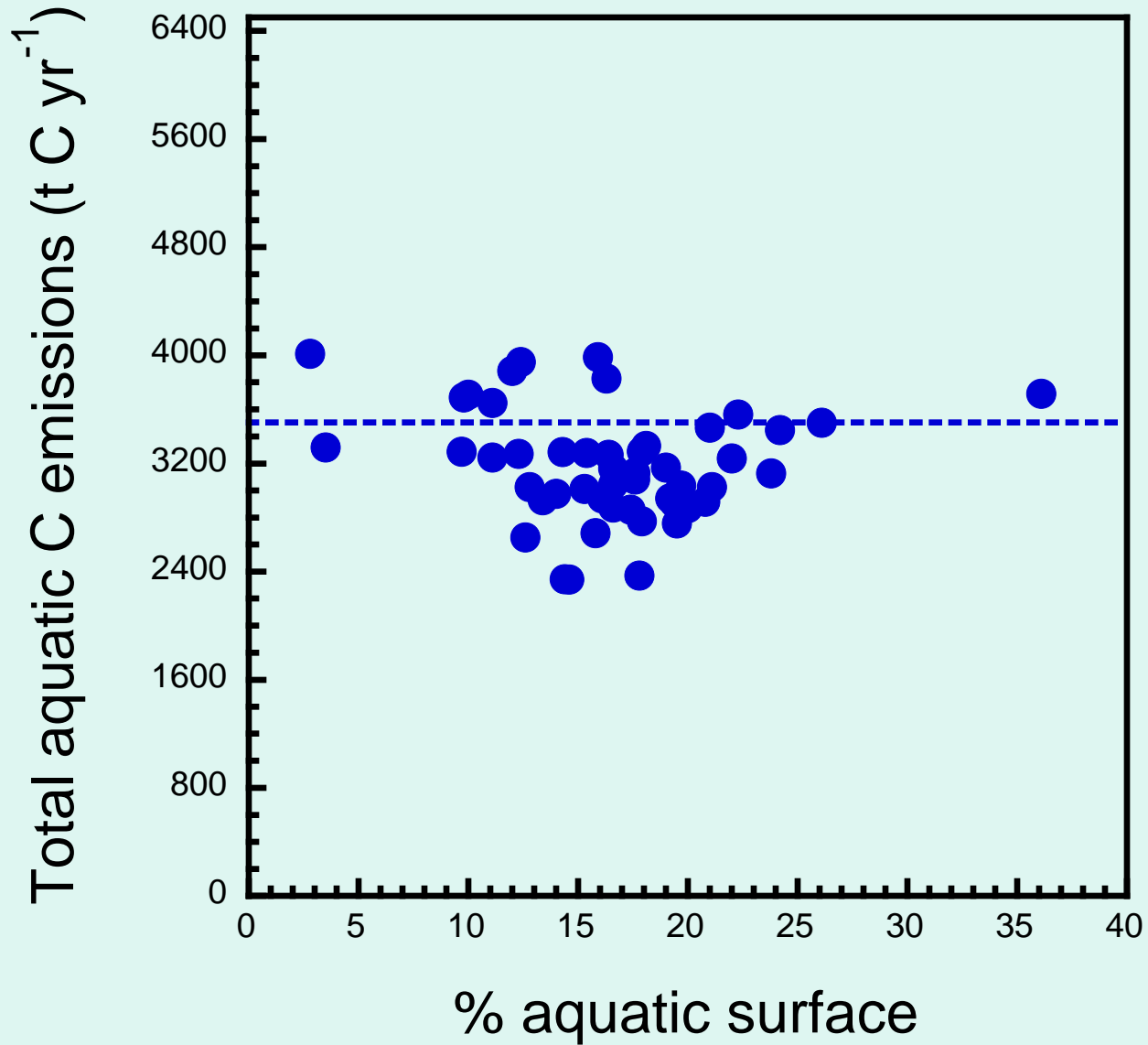
Legend

-  Stream
-  Lake
-  River

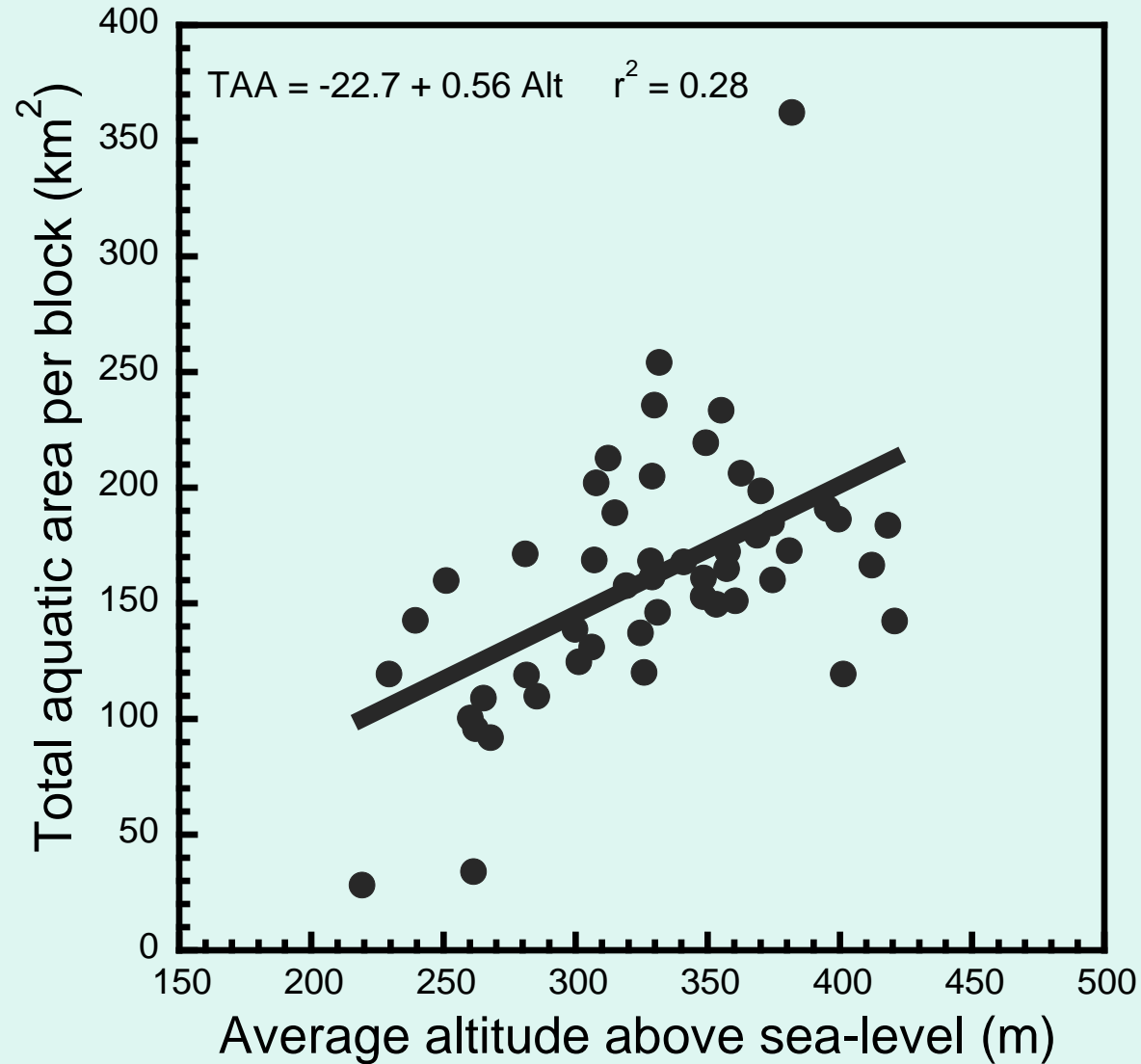


Base: BNDT, 33A, 33B, 33C, 32N, 32O, 32P
UTM 18, NAD83



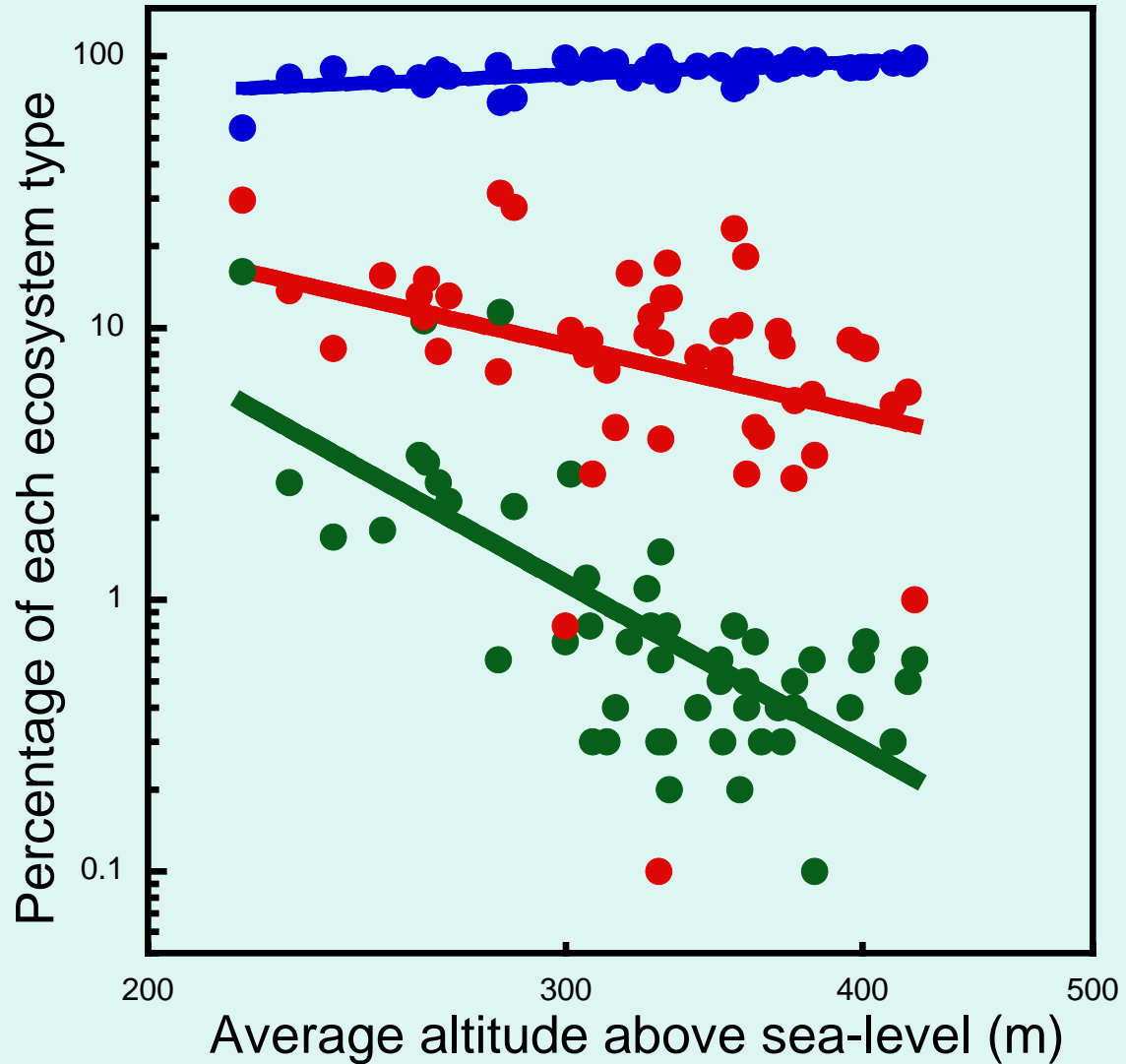
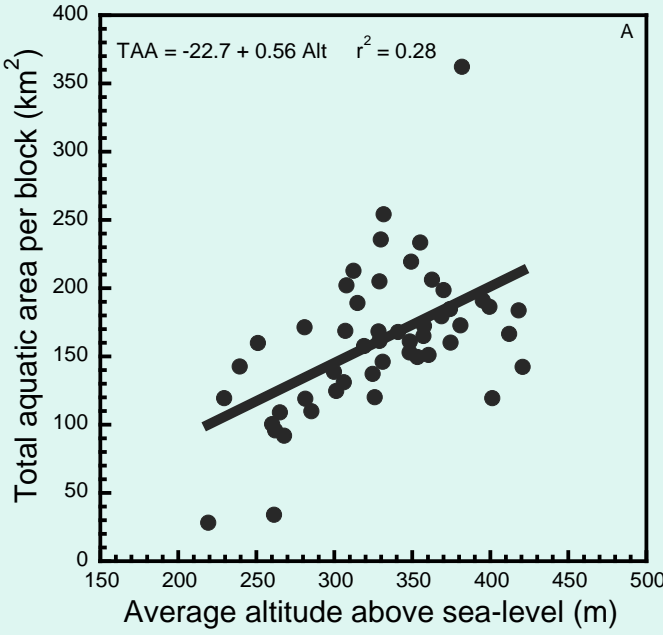


Altitude influences the relative contribution of the aquatic network to the total area

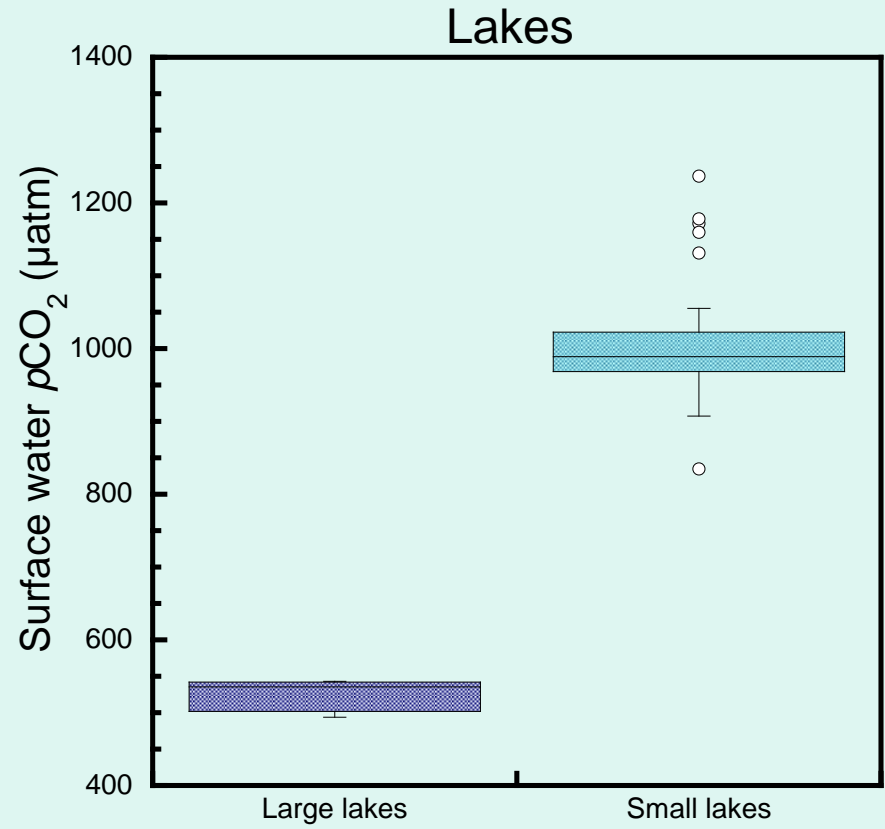
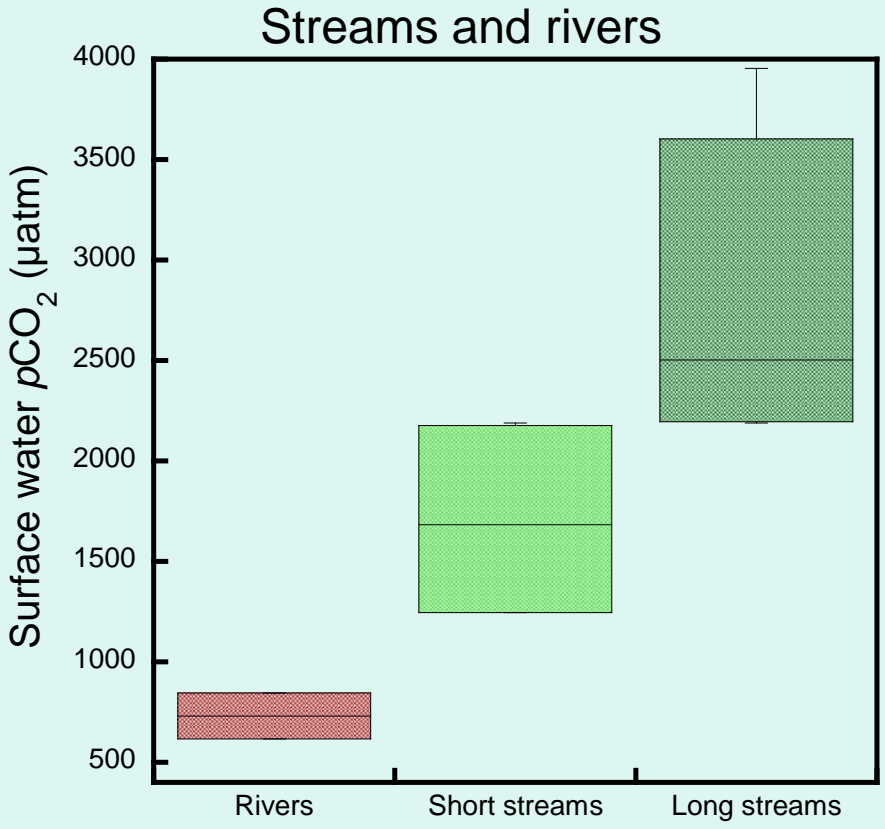


Altitude also influences the relative contributions of different aquatic systems to the total aquatic surface

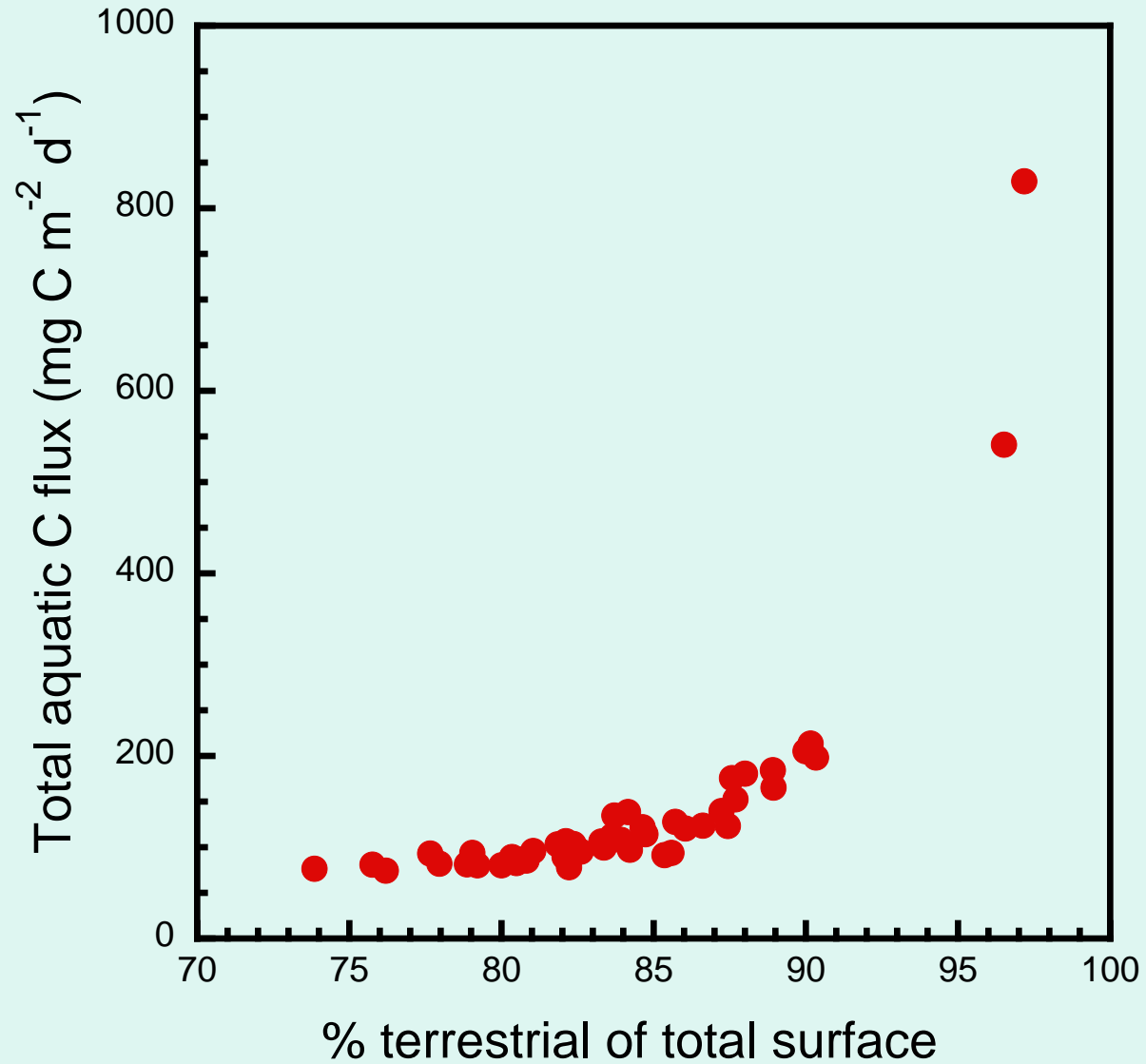
- % Lake
- % Stream
- % River

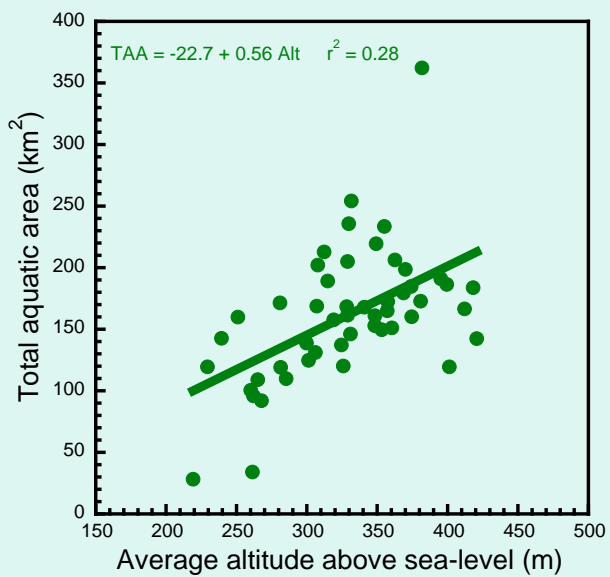
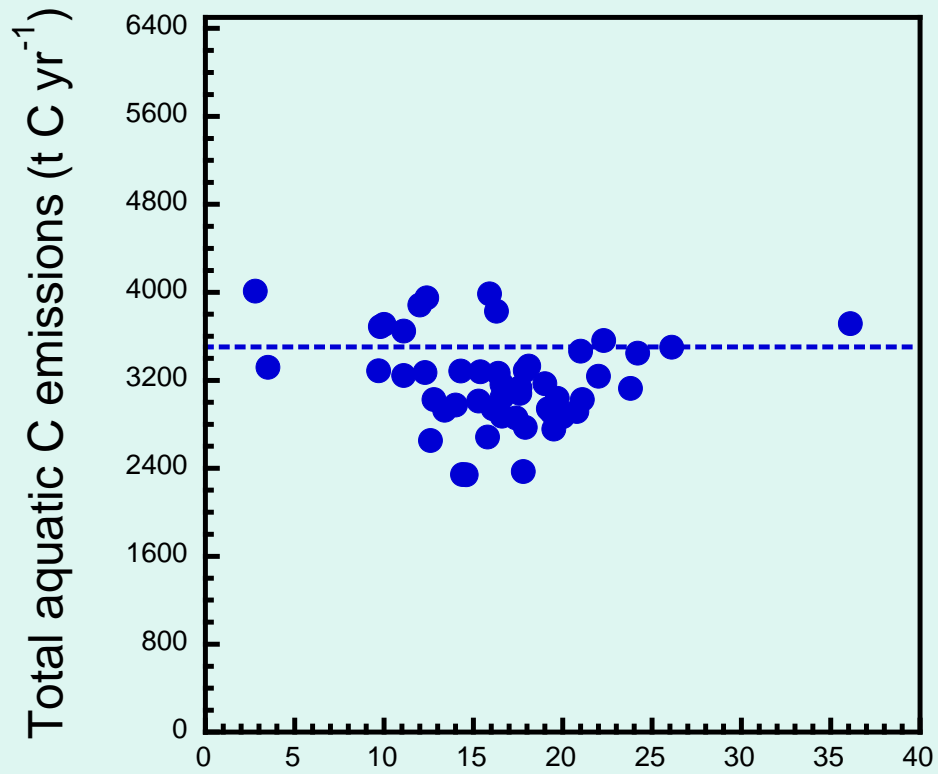


Surface water $p\text{CO}_2$ (and CO_2 flux) vary with network configuration

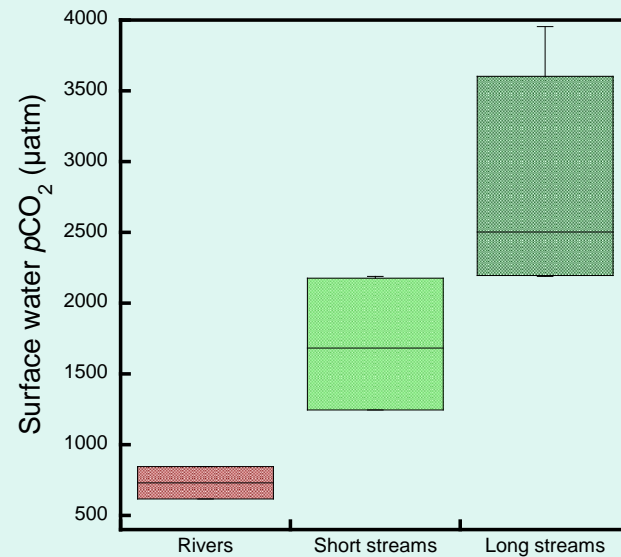
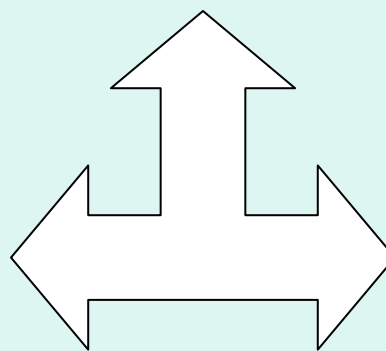


The average areal aquatic flux tends to increase as the aquatic surface declines

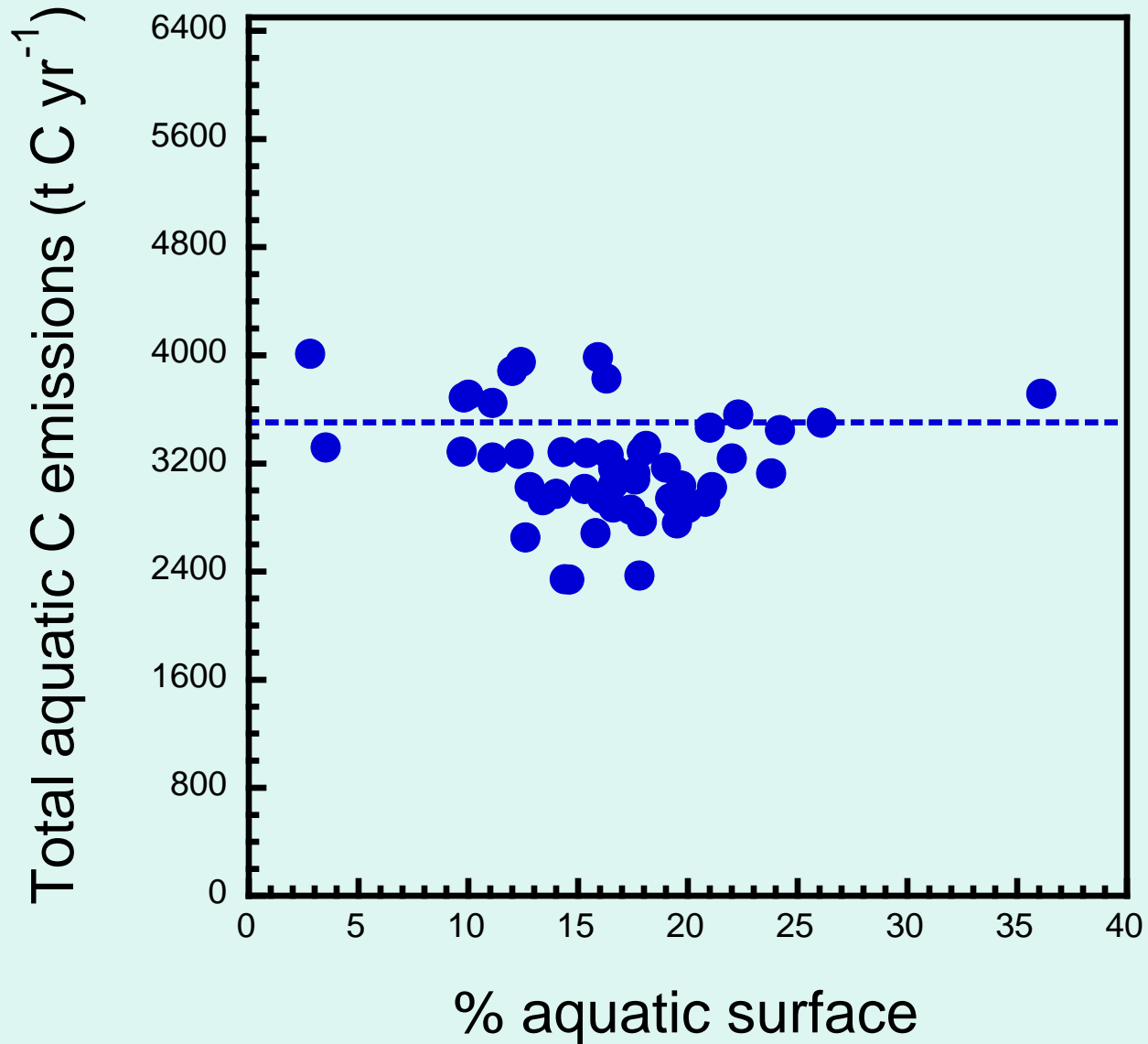




% aquatic surface



Net Biome Aquatic C Evasion (NBACE)



Some approximate numbers

Gross primary production Gower et al. 2007	600 to 800 g C m ⁻² yr ⁻¹
Net ecosystem exchange Dunn et al. 2007	-20 to +30 g C m ⁻² yr ⁻¹
Fire C emissions Bachelet et al. 2005	8 to 12 g C m ⁻² yr ⁻¹
Net soil C accumulation Banville et al. in press	1-2 g C m ⁻² yr ⁻¹
Net Biome Aquatic C Evasion This study	3 to 6 g C m ⁻² yr ⁻¹

Some conclusions

- The total aquatic C emissions result from the interplay between landscape architecture and aquatic C biogeochemistry, and can not be derived from its individual components
- We thus suggest that this may be an emergent ecosystem property of boreal regions
- NBACE is remarkably constant in this landscape, suggesting compensatory mechanisms
- NBACE is significant relative to other components of the regional C budget

