Spatial Patterns of Greenhouse Gases Across an Urbanization Gradient in a Suburban River Network – H23I-1792

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Motivation

River networks are important components of the global carbon cycle, and are most often sources of greenhouse gases (GHGs) to the atmosphere (Butman and Raymond, 2013, Battin et al., 2016).

While recent investigations have begun to incorporate aquatic systems into continental carbon budgets (e.g. Butman, 2016), our understanding of what drives GHG dynamics across river networks is poorly constrained.

As urban areas continue to expand globally, a better understanding of the effect of human activities on aquatic carbon and GHG dynamics is needed. Here, we begin to address the question:

How does urbanization affect GHG dynamics in river networks?

Site Description and Methods

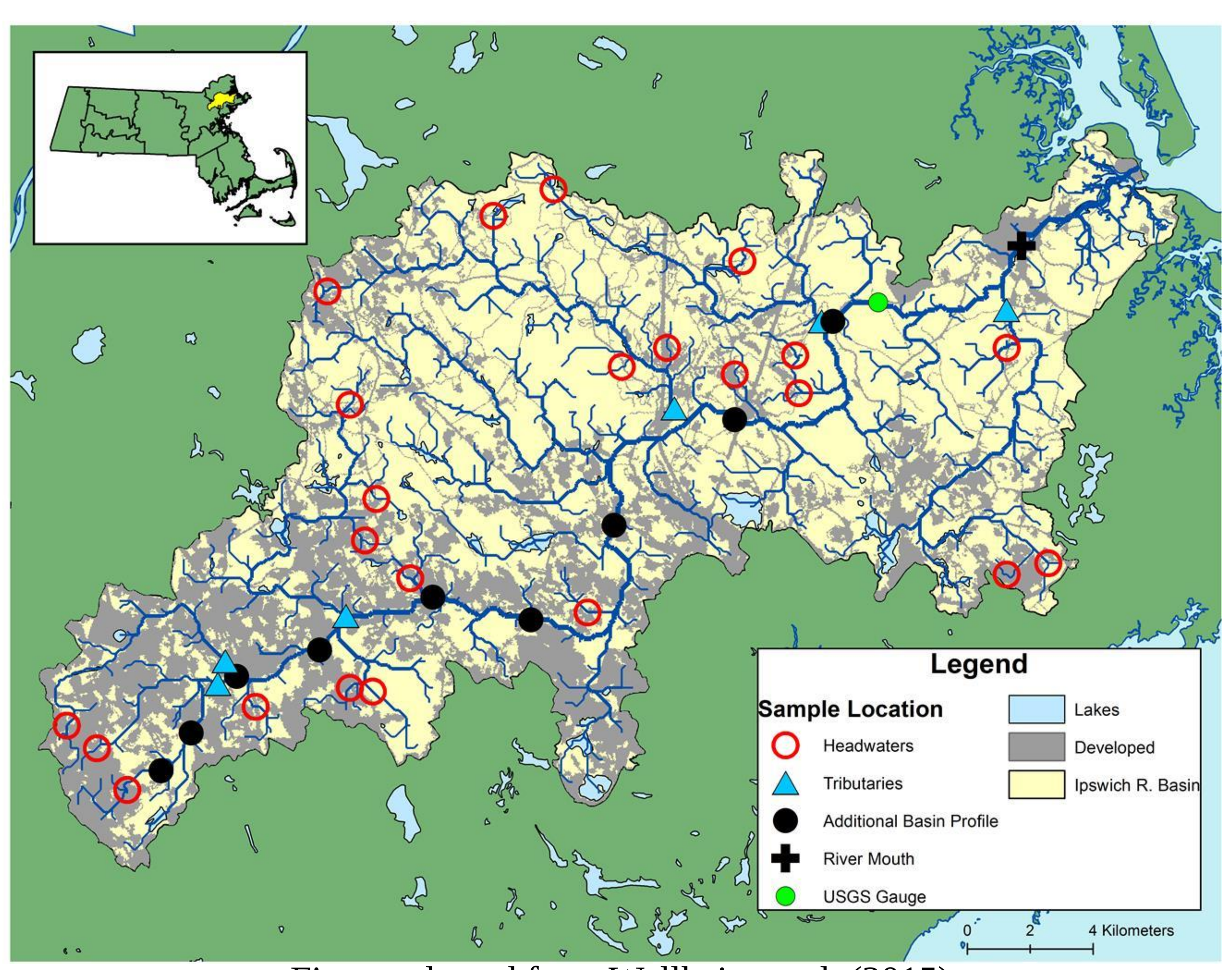


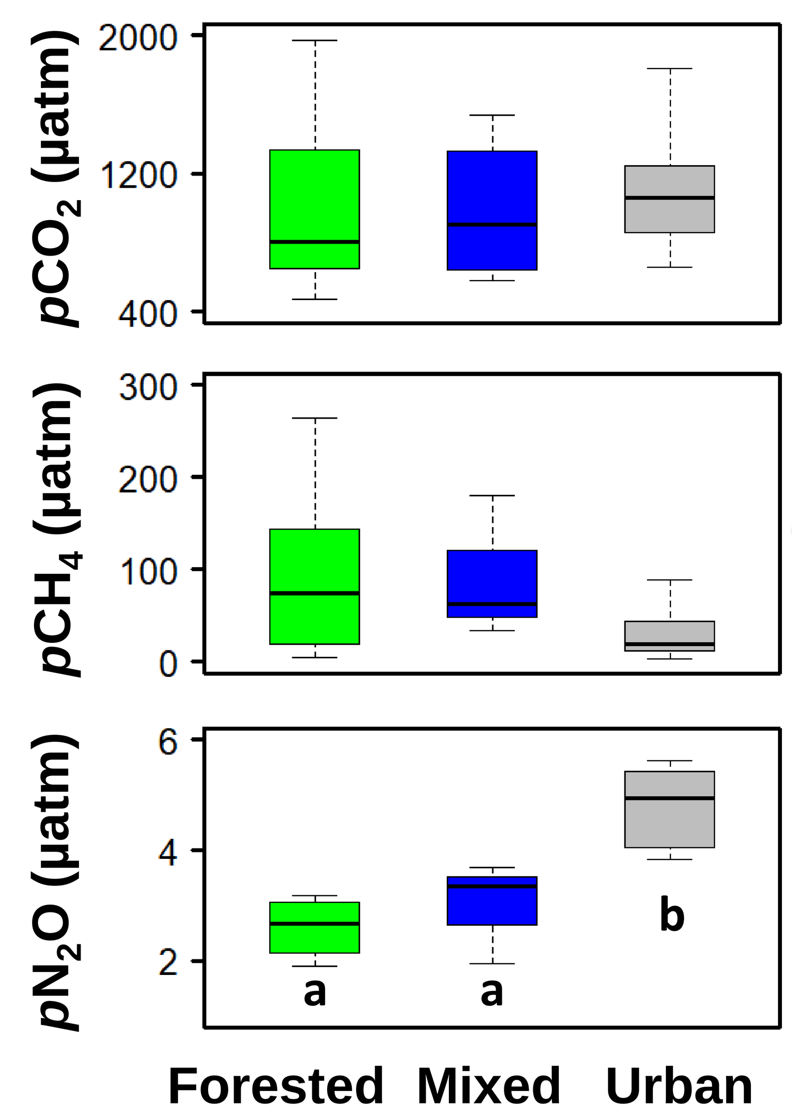
Figure adapted from Wollheim et al. (2015)

We conducted a survey of 45 stream and river sites in a sub-urban river network in New England (Ipswich River, MA), as part of the Plum Island Ecosystems LTER project.

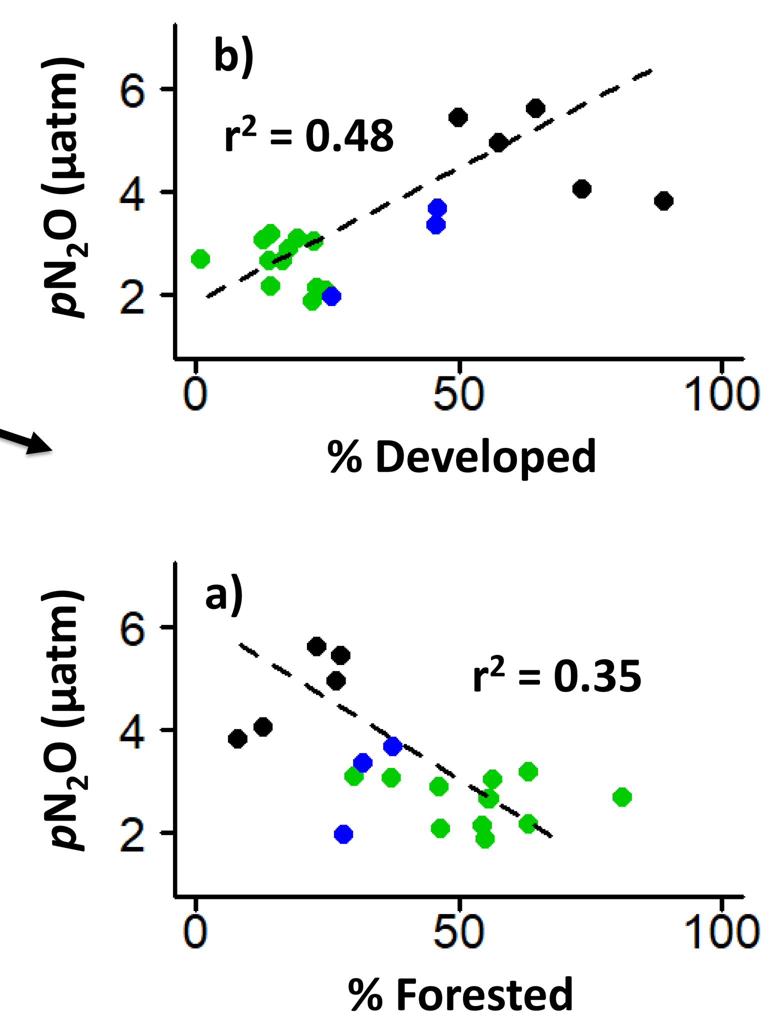
Water samples were analyzed for physical and chemical characteristics, including dissolved carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the nitrogen to argon ratio (N_2:Ar).

Sampling sites spanned an urbanization gradient (1% - 90% developed) and included headwater streams, major tributaries, and sites along the main stem.

Only N_2O Displays Relationship with Land Use

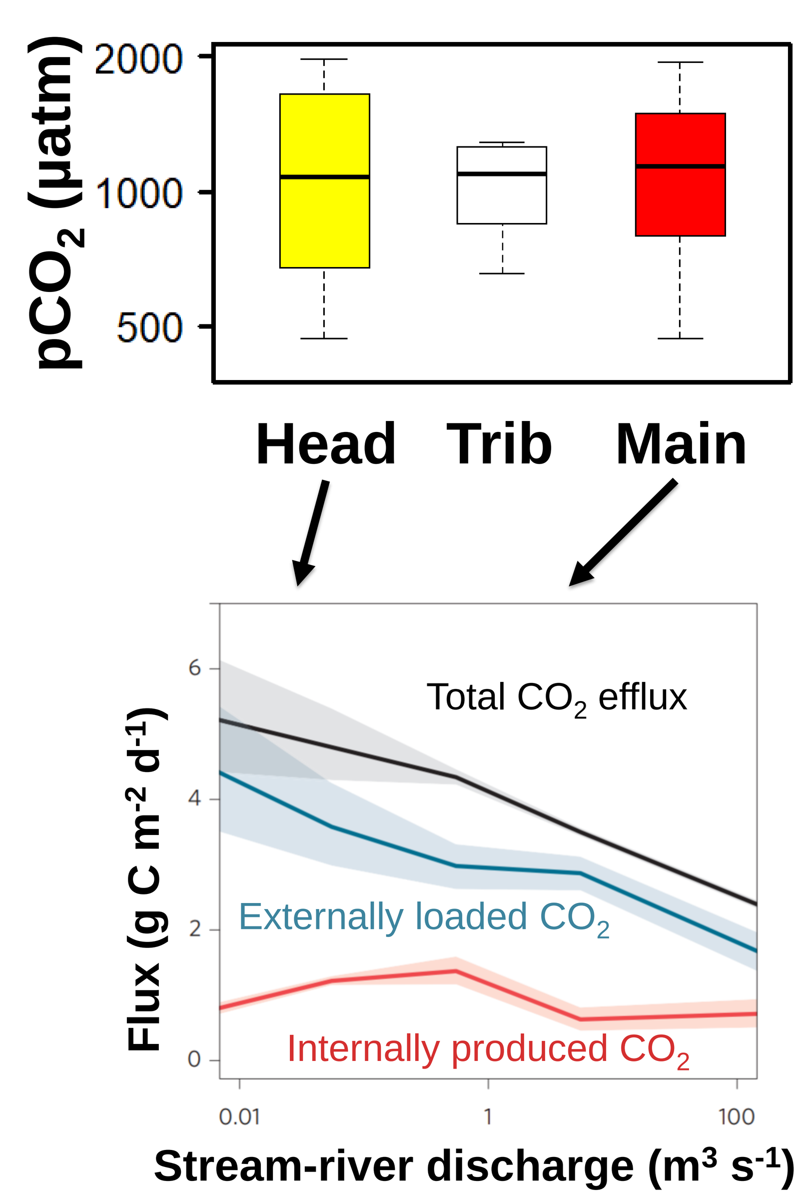


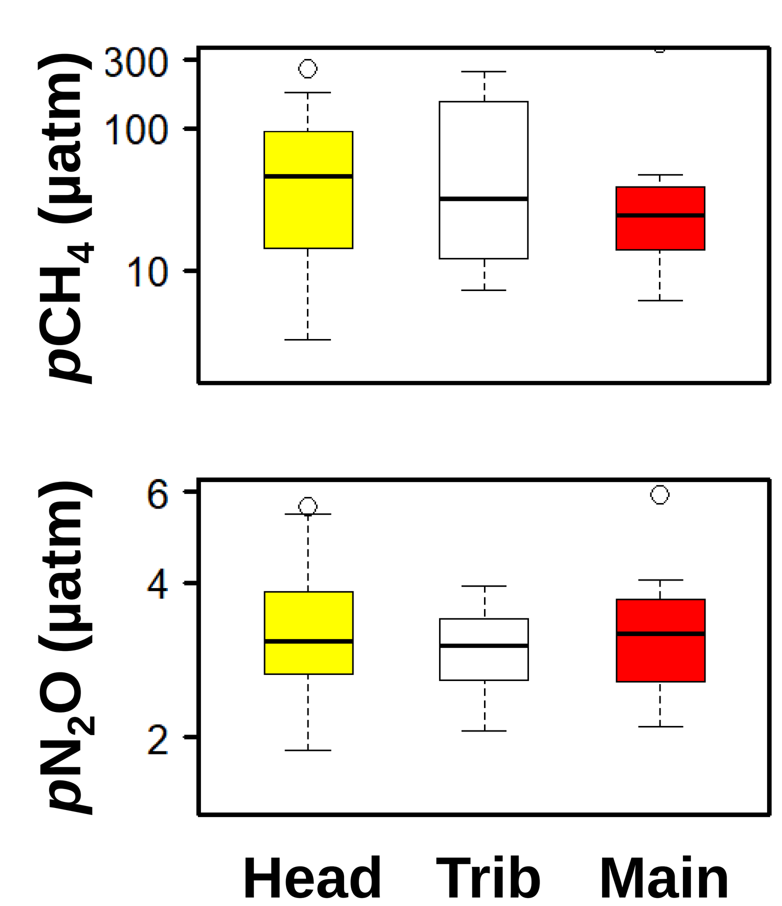
The range of CH_4 concentrations is greater in forested systems, possibly a result of more heterogeneous in-stream conditions (Stanley et al., 2016).



Loadings from a developed landscape, likely nitrate, are important in explaining the variability of N_2O concentration.

GHG Concentrations Independent of Stream Size

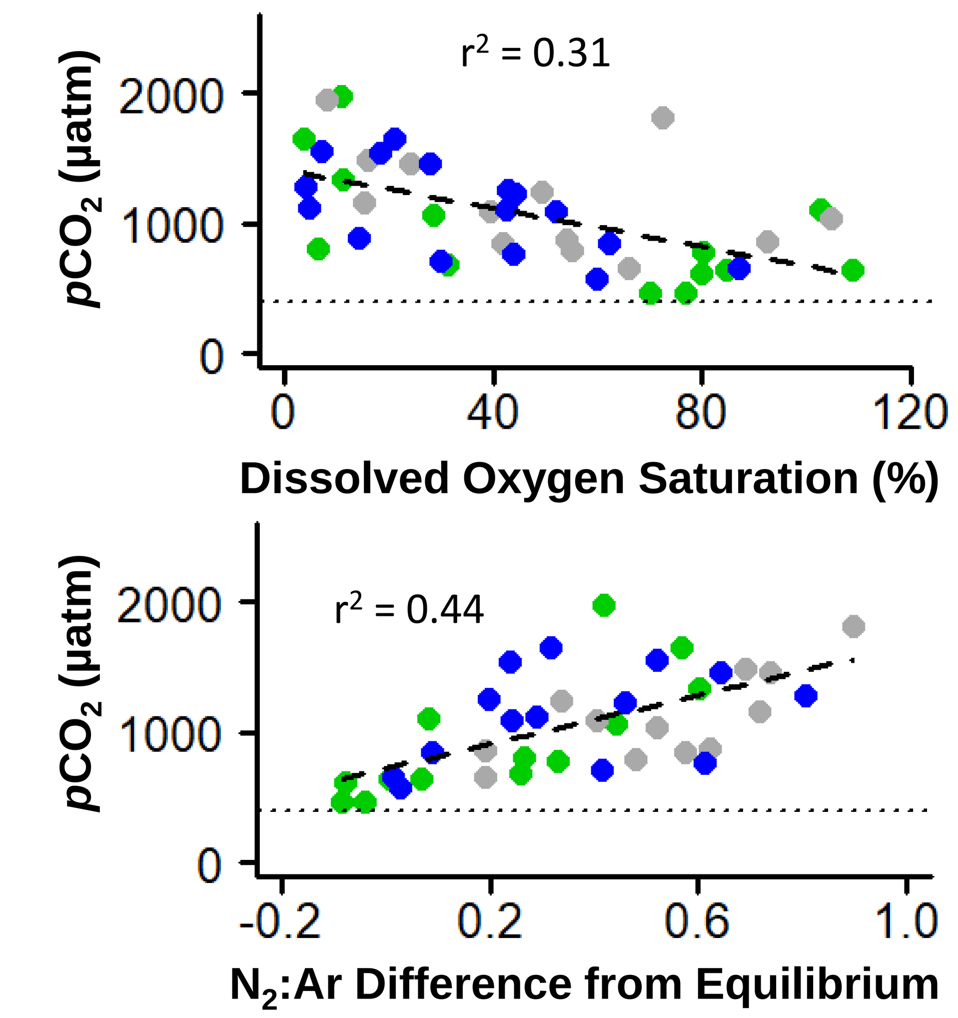




Similar concentrations do not equate to similar fluxes between size classes. Moreover, sources can vary significantly (Figure from Hotchkiss et al., 2015).

pCO_2 Related to D.O. and Aeration

CO_2 correlates strongly with N_2:Ar. Higher N_2:Ar (and CO_2) is achieved under low O_2 conditions and aeration rates, which allow for accumulation in the water column.



Conclusions

N_2O displays strong correlation with land use, suggesting inputs from a developed landscape can increase N_2O production.

CO_2 correlates with measured N_2:Ar, which can serve as a proxy for both lower dissolved oxygen and aeration rates.

The lack of correlation between CH_4 and land use is likely a result of measuring dissolved concentrations rather than ebullitive fluxes, and a dependence on unmeasured, in-stream variables (e.g. sediment depth, organic content, etc.; Stanley et al., 2016).

Works Cited

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