Stream Greenhouse Gas Emissions Along a Wetland Gradient in the Ipswich River, Massachusetts

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RESEARCH QUESTION

How does N_2O flux vary in space across the temperate Ipswich River Watershed?

INTRODUCTION & BACKGROUND

Greenhouse gases (GHG) from aquatic ecosystems are a significant source of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) to the atmosphere.

GHG emission: not fully understood in fluvial wetlands, suburban and agricultural areas (Fig. 1; Crawford and Stanley, 2015).

CH_4 and N_2O warm the atmosphere much more than CO_2 therefore understanding the controls on their production and emission from aquatic ecosystems is critical to understanding their impact on climate change.

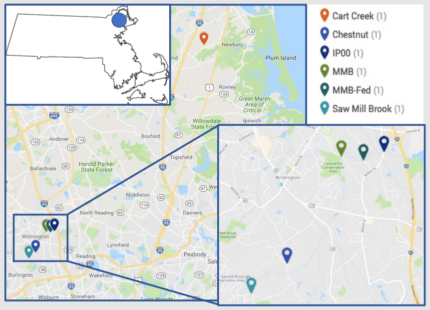

Figure 1. Top inset: Blue circle represents the Plum Island Ecosystem Long Term Ecological Research Network in northeastern Massachusetts which contains the Parker and Ipswich River watersheds. Headwater sites: Cart Creek (CC) and Saw Mill Brook (SMB); and fluvial wetland sites: Chestnut inlet (CHEST), Maple Meadow Brook (MMB), Maple Meadow Brook Federal St. (MMBFed), Ipswich River outlet (IP00).

Figure 2. a) Fluvial wetland site MMB; b) floating chambers collecting gases and stream stage and gauges at SMB; c) Diane measuring water parameters with YSI handheld instrument at SMB.

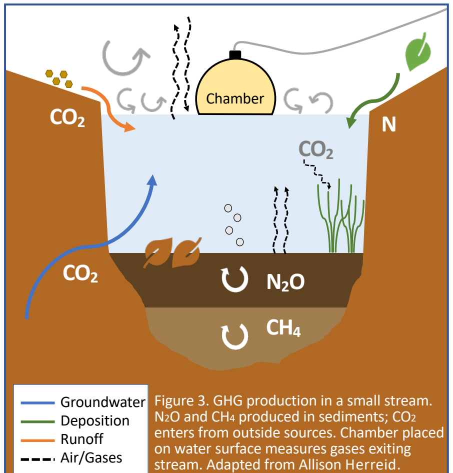

Figure 3. GHG production in a small stream. N_2O and CH_4 produced in sediments; CO_2 enters from outside sources. Chamber placed on water surface measures gases exiting stream. Adapted from Allison Herreid.

OBJECTIVES

- Measure physical and chemical environment and landscape features along stream gradient
- Gain insight into how N_2O, CH_4 and CO_2 flux varies along a gradient

APPROACH

- Sampled weekly from May to July at sampling sites (Fig. 1)
- Measured GHG flux with floating chambers for CO_2, CH_4, and N_2O using static chamber method (Fig. 2b and 3); water samples analyzed for GHGs
- Water samples were collected for NO_3^-, DO, and dissolved nitrogen (N_2) concentrations
- Compared emissions with environmental and water chemistry parameters: pH, temperature, dissolved oxygen, discharge (Fig. 2c)

RESULTS

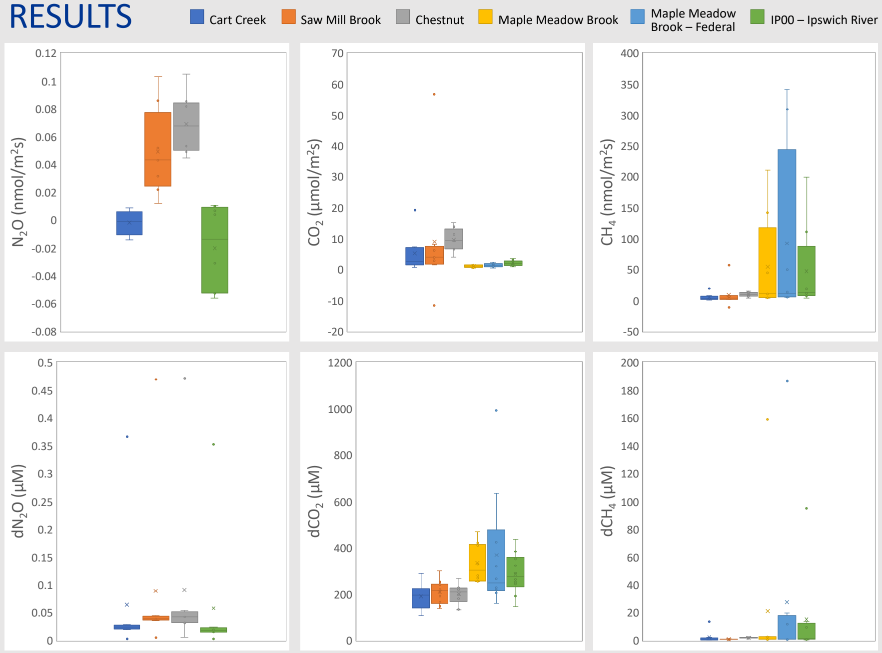

Figure 4. Boxplot panels representing CO_2 and CH_4 concentrations at 6 sites across 3 months and N_2O concentrations at 4 sites across 2 months. Headwater sites: CC and SMB, and fluvial wetland sites: CHEST (inlet), MMB, MMBFed, IP00 (outlet).

TAKEAWAYS

- Urban streams are a source of N_2O, but little is known about relationship of human-caused nitrogen loading in watersheds over time or role methane plays in nitrogen loss from streams (Fig. 3)
- N_2O flux varies seasonally across a watershed; in-stream drivers are likely very different. Both N_2O flux and dissolved N_2O follow a similar pattern, as well as CO_2 flux (Fig. 4)
- N_2O flux varies significantly between sites, with increase across wetland gradient (Fig. 4). At site IP00, there is an increase in CH_4 but a decrease in N_2O and CO_2. This suggests an increase in CH_4 may be driven by headwater wetland inputs and not necessarily by outlet stream sediments (Fig. 2a).

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CITATIONS

Crawford, J. T., and E. H. Stanley. (2015). Controls on methane concentrations and fluxes in streams draining human-dominated landscapes. *Ecological Applications*. doi:10.1890/15-1330.1

Hinshaw, S. E., R. A. Dahlgren. (2016). Nitrous oxide fluxes and dissolved N gases (N_2 and N_2O) within riparian zones along the agriculturally impacted San Joaquin River. *Nutrient Cycling in Agroecosystems*, 105(2), 85-102. doi:10.1007/s10705-016-9777-y