Methane ebullition from headwater streams

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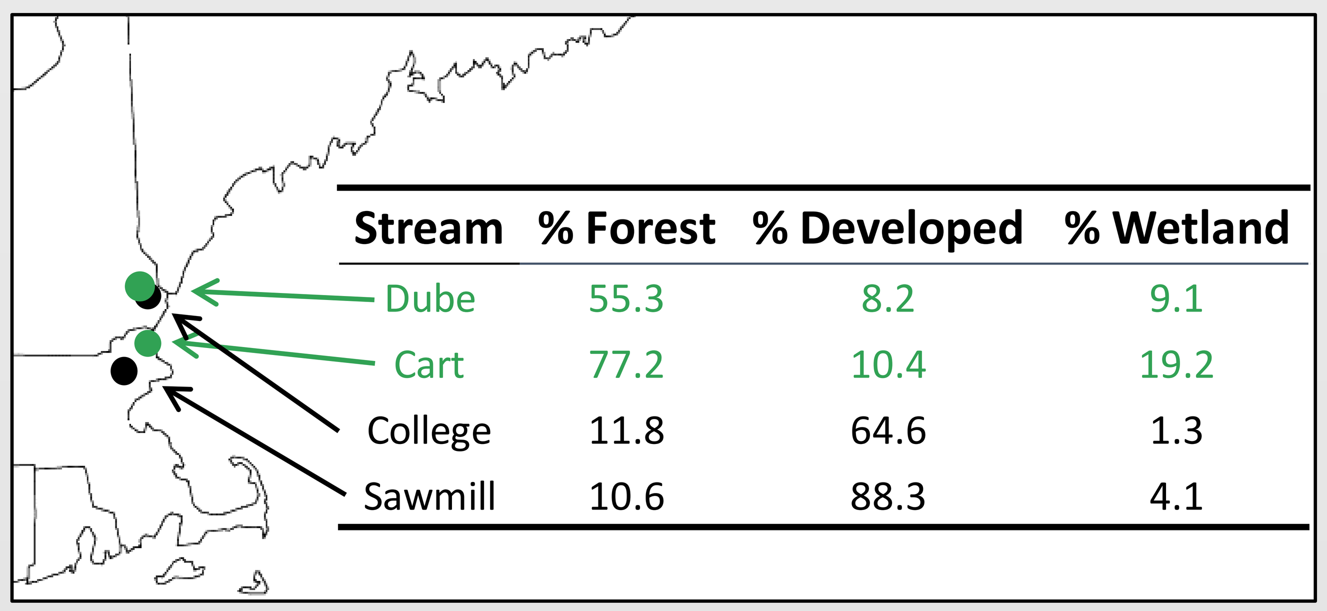
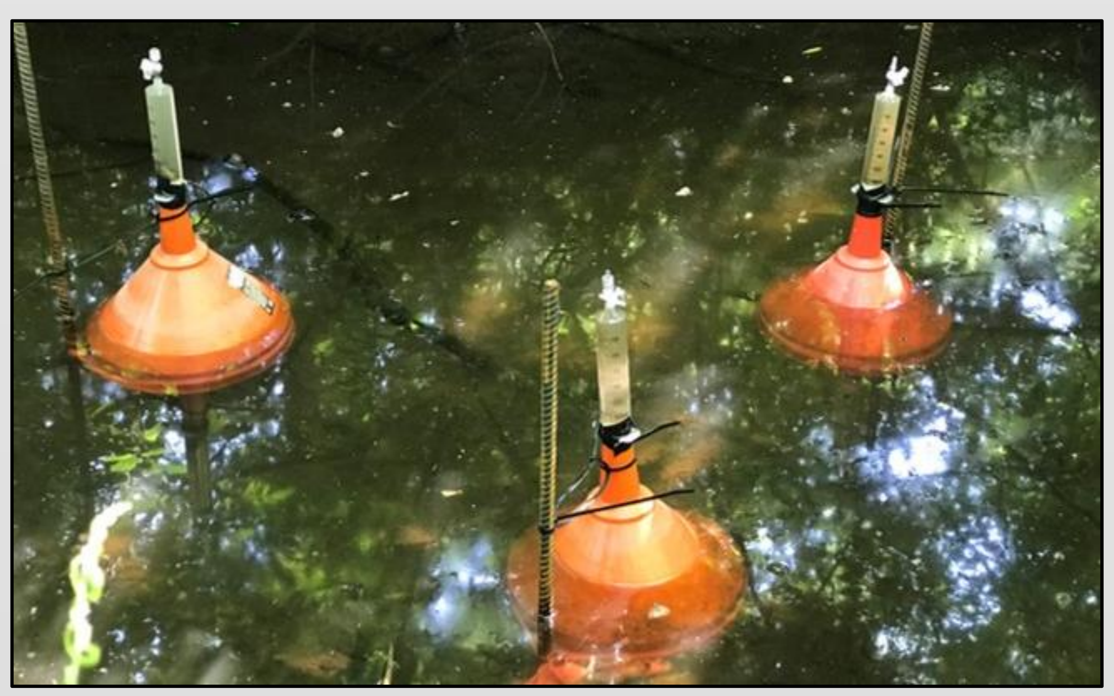
Motivation

Research shows streams and rivers are sources of methane (CH_4), a potent greenhouse gas. However, not enough is known about the variability of methane emissions across flowing waters to confidently scale to continental or global scales. In particular, there is a severe lack of studies on ebullition; that is, bubble-mediated fluxes. We examined ebullitive emissions of CH_4 from four headwater streams to better understand this process.

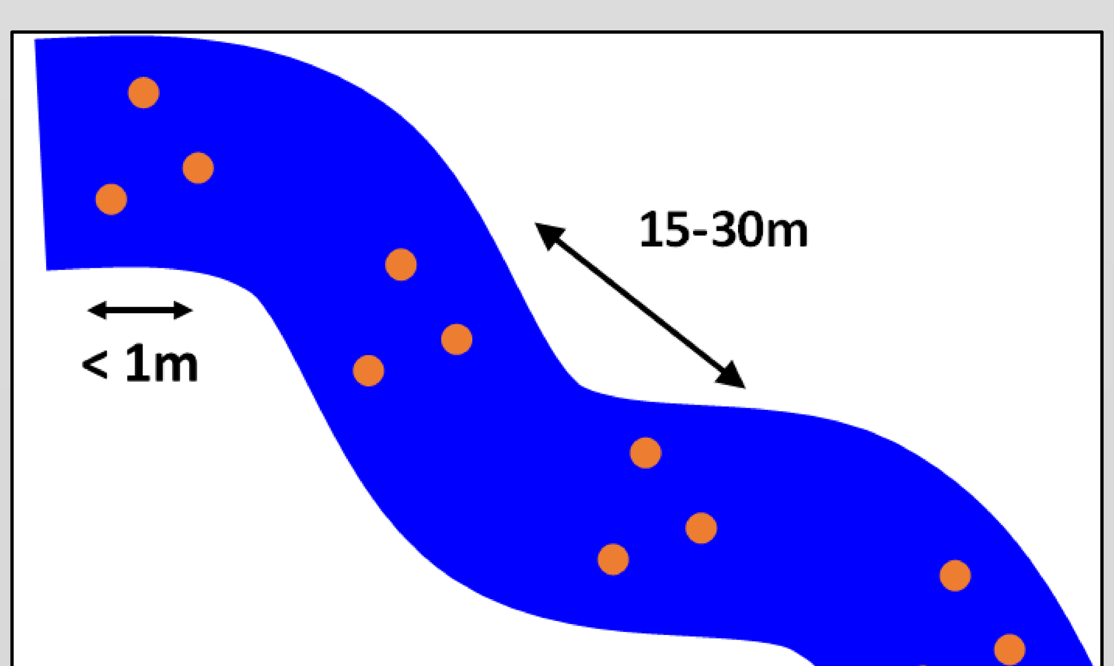


Stream	% Forest	% Developed	% Wetland
Dube	55.3	8.2	9.1
Cart	77.2	10.4	19.2
College	11.8	64.6	1.3
Sawmill	10.6	88.3	4.1

Bubble traps



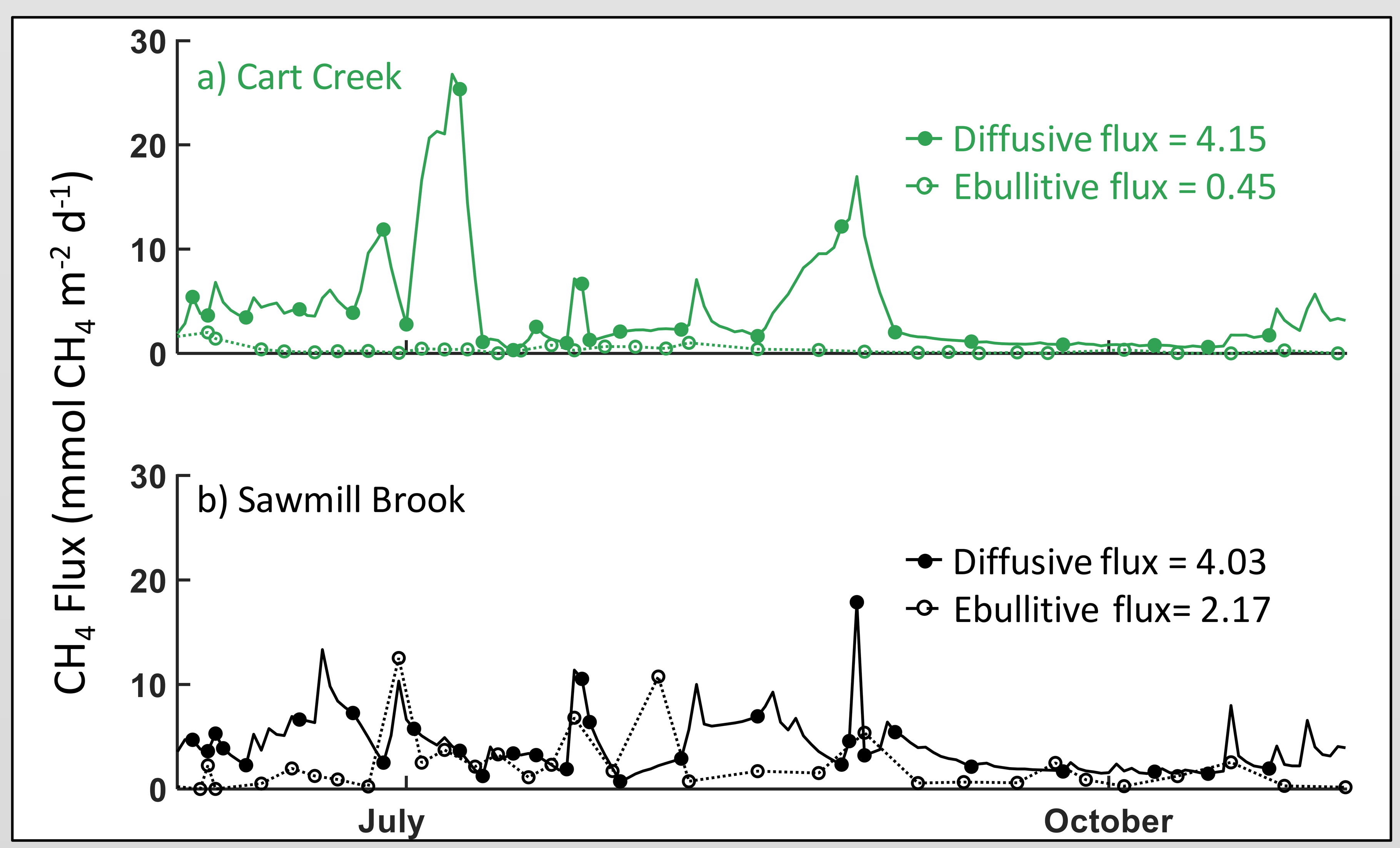
Bubble traps were deployed in triplicate, at four sites within each of four streams of varying land use. Traps were visited weekly from June-October of 2018 and 2018. Captured volume was measured, and some samples were analyzed for gas concentrations. No significant amount of carbon dioxide or nitrous oxide was emitted via ebullition.



Example deployment at a stream.

Bubble fluxes of methane from streams can be significant, and future studies of these fluxes should consider temporal and spatial heterogeneity.

Ebullitive vs. diffusive emissions



During June-October, 2019, ebullitive emissions of CH_4 made up ~35% of total CH_4 emissions at Sawmill Brook and ~10% at Cart Creek. Thus, ignoring ebullition in these streams would significantly underestimate total CH_4 emissions.

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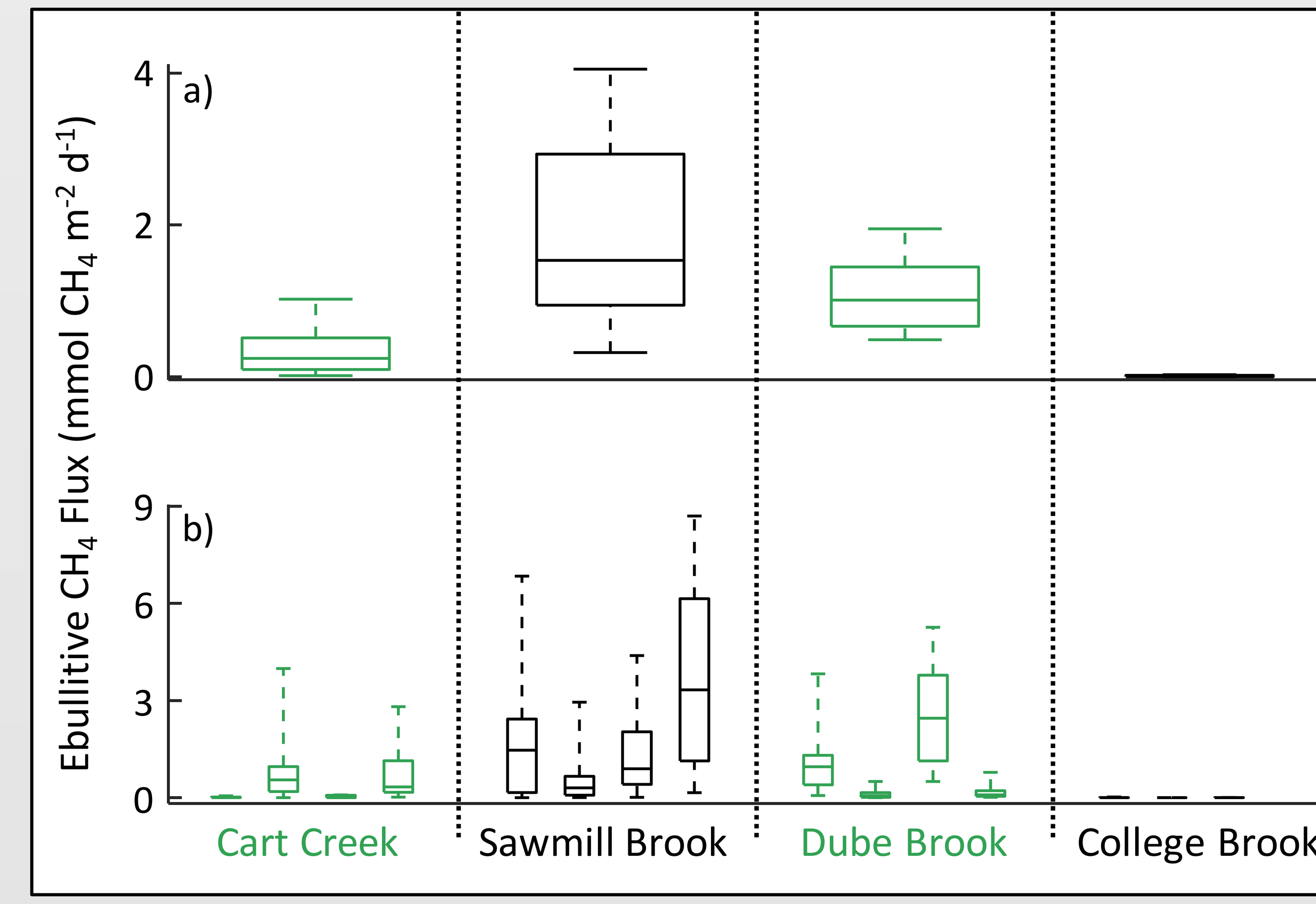
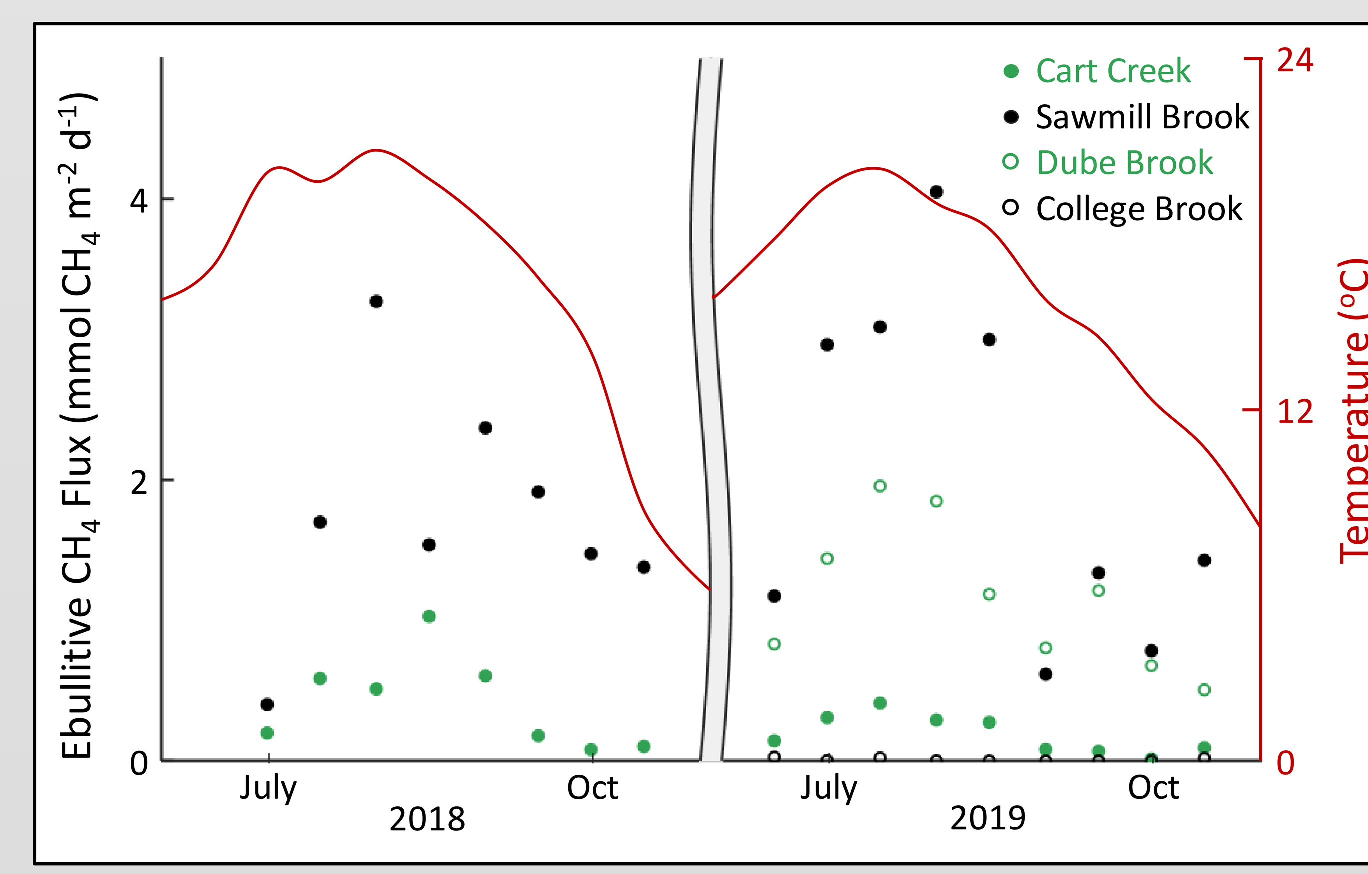
Variability of emissions

Land use of the watershed does not predict overall stream ebullition of CH_4. The high spatial variability of CH_4 ebullition between and within streams is not well explained by sediment properties like texture or organic content..



Temporal variability in CH_4 ebullition due to temperature was also observed, with greatest emissions during the warmest part of the year.



Discussion

Ebullition can be a significant pathway of CH_4 emissions from watersheds of differing land use.

The observed variability in space and time suggests ebullition studies should include multiple locations within a stream sampled at multiple times of the year.

Better refining the controls on spatial variability of ebullition will be critical to scaling emissions to larger areas.