Effect of Tundra Fires on Stream Chemistry in Alaska's Yukon Kuskokwim Delta

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Introduction

Surface air temperatures in the Arctic have been increasing at approximately twice the global average, contributing to myriad changes including shifting vegetation, thawing permafrost, and altered surface and groundwater hydrology. Wildfire frequency and intensity has also been increasing, and in summer 2015, more area burned in the Yukon-Kuskowkwim ("YK") Delta than in the previous 64 years combined. The work presented here investigates the impacts of tundra fire on stream water chemistry, and by extension, on the movement of nutrients and organic matter between terrestrial and aquatic ecosystems.

Study Site

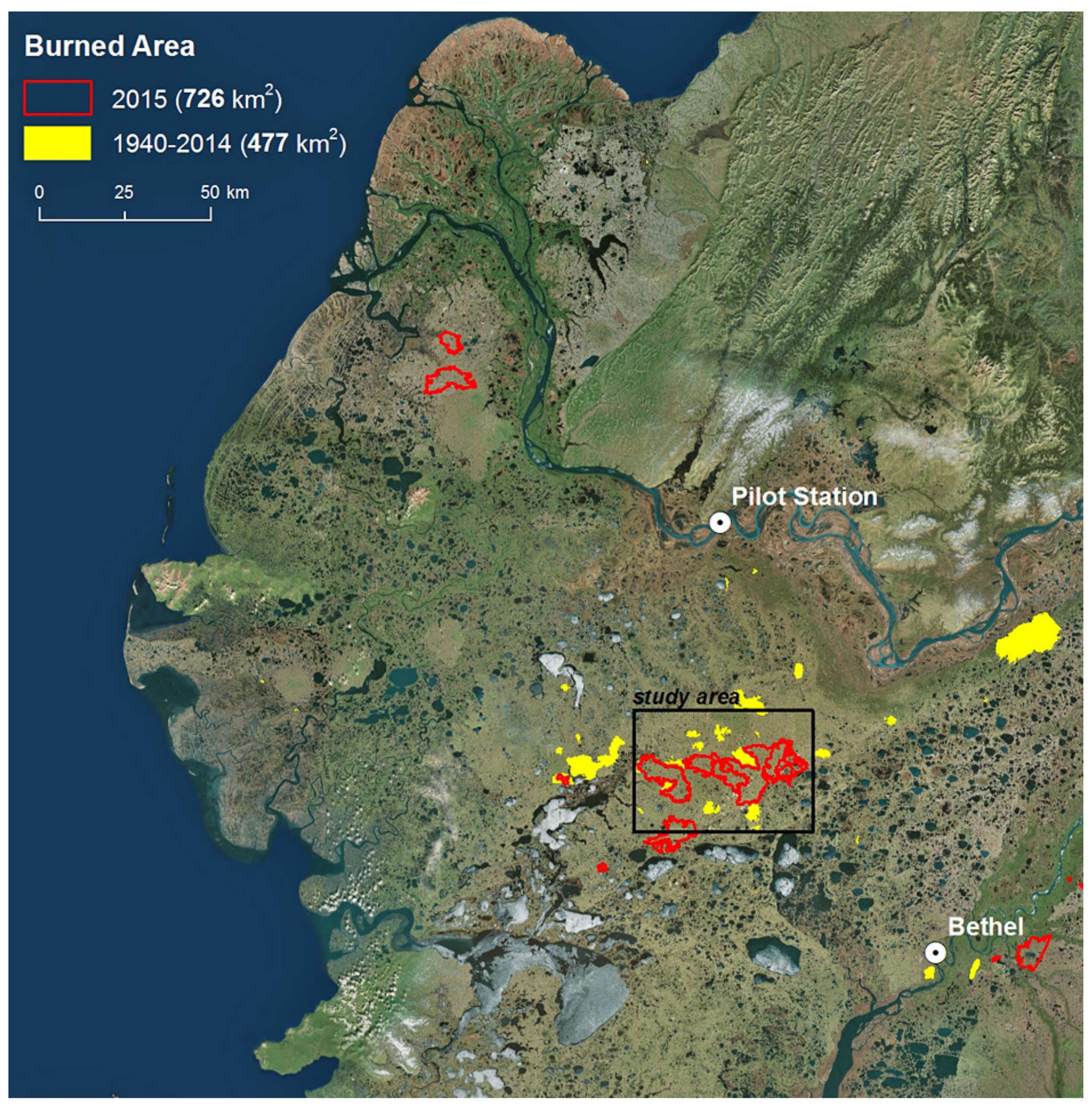

Figure 1. Satellite image of the Yukon-Kuskowkwim Delta showing our study region as well as the locations of 2015 and historical fires.

Approach

We collected water samples from 16 streams and analyzed the samples for a broad range of biogeochemical constituents. Here we focus on nutrients (nitrate, ammonium, and phosphate). Half of the streams were sampled at locations that had burned in 2015 and the remainder were sampled at unburned reaches.

We delineated the sub-watersheds of five of the streams using high-resolution digital elevation models (thanks to Polar Geospatial Center) and GIS analysis, and determined the percent of each of these five watersheds that burned in 2015.

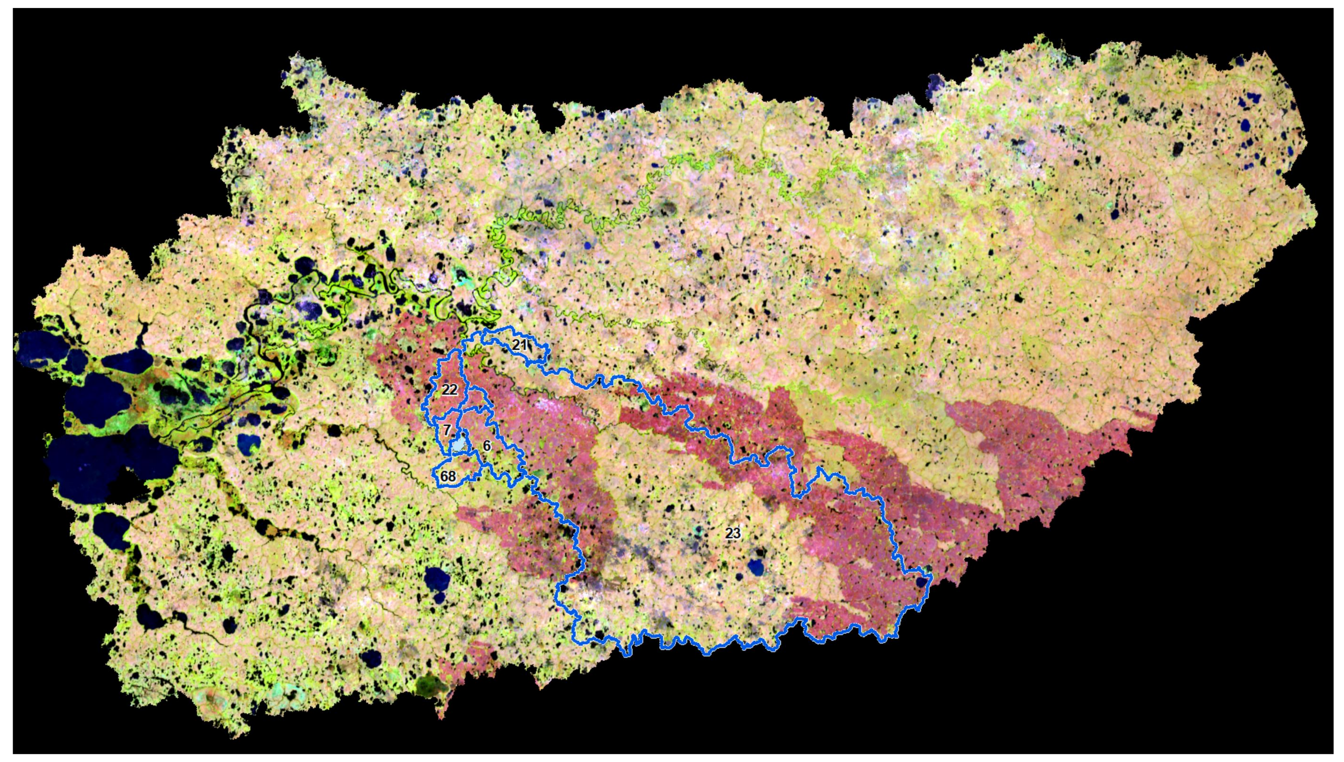

Figure 2: Satellite image showing sub-watershed boundaries for several of the streams we sampled. The five sub-watersheds that we focused on ranged from 3.4 to 7.6 km² and burned areas ranged from 0-100%. Pink = Burned.

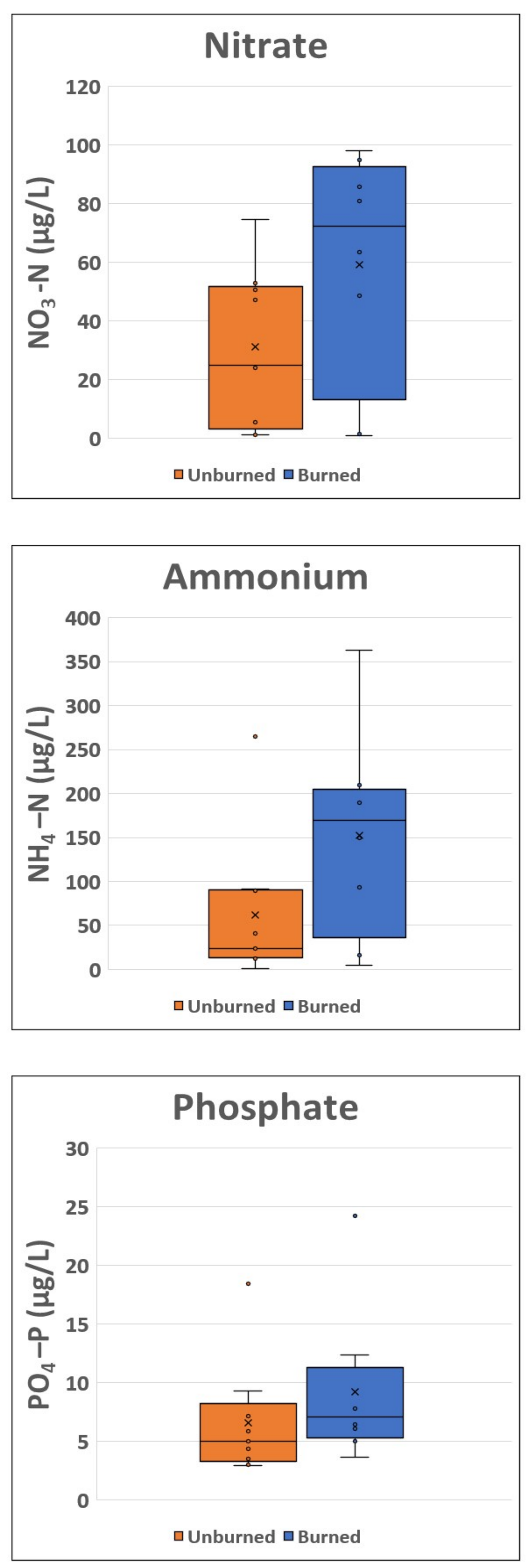

Figure 3: Nutrient concentrations for the 16 sampled streams. Half were sampled in unburned reaches and the rest were sampled in reaches that burned in 2015.

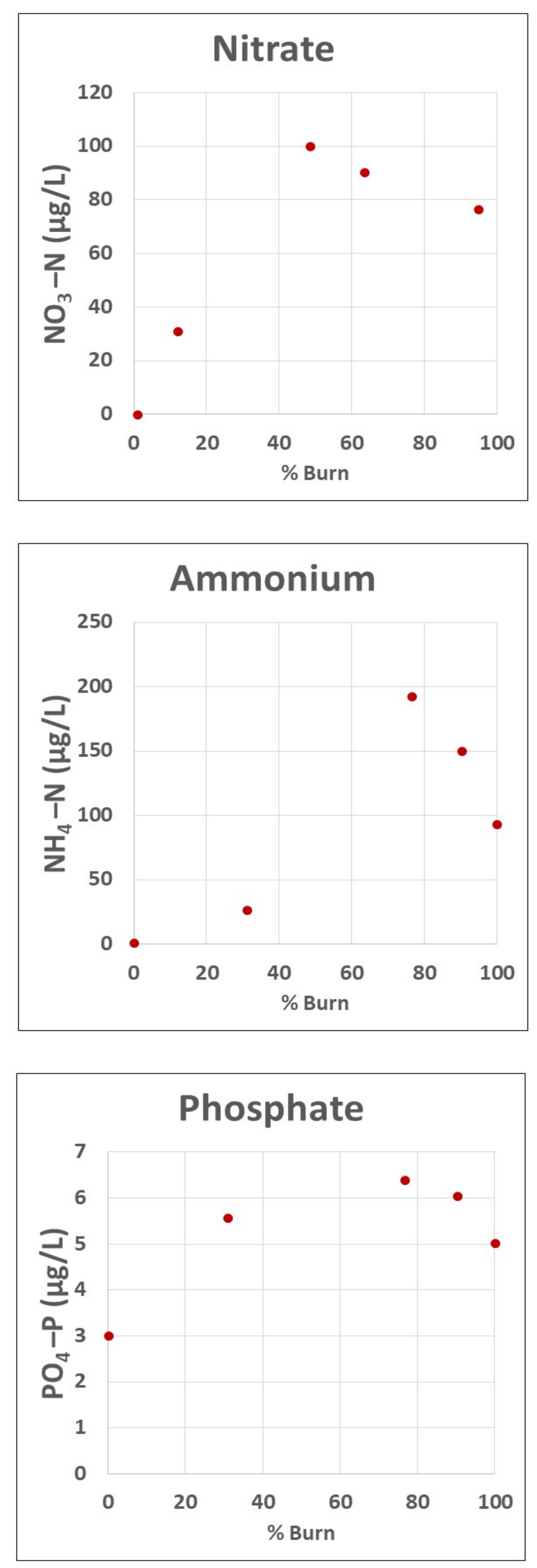

Figure 4: Nutrient concentration vs. percent of sub-watershed land area burned in 2015.

Conclusions

Once considered relatively rare in tundra ecosystems, fire is increasingly recognized as an important force in tundra environments, and its prevalence is on the rise. Fire not only impacts the functioning of terrestrial ecosystems, but it may also impact the exchange of materials between terrestrial and aquatic components of the tundra system. Altered nutrient fluxes from land to stream systems could influence the productivity of inland waters in the tundra as well as the functioning of receiving coastal and ocean waters.

We found a general increase in nitrate, ammonium, and phosphate concentrations in streams sampled adjacent to areas that burned during the widespread fires of 2015 (Fig. 3). We identified the watershed contributing areas for five of the streams we sampled, and found that nitrate, ammonium, and phosphate concentrations initially increased as percent burned area increased, but concentrations levelled off or even decreased at higher burned percentages (Fig. 4). We do not currently understand why nutrient concentrations seem to plateau at higher burn percentages, but in any case these data indicate that terrestrial to aquatic nutrient fluxes increased in the tundra watersheds that were impacted by fire in 2015. The higher nutrient inputs likely impact the productivity of Yukon-Kuskowkwim tundra streams in burned watersheds, and increased nutrient transport from the watershed may impact the long-term fertility of the tundra environment.

Figure 5: Stream sampling in Alaska's Yukon-Kuskowkwim Delta.

Acknowledgements

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