New Hampshire Space Grant Consortium - Summer Graduate Fellowship Report 2024

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Evaluating the Effects of Wildfires on Microbial Communities and Gene Expression Involved in Nitrogen Cycling in Arctic Tundra Soils

This summer term, I am successfully concluding my master's degree at the University of New Hampshire. My work focuses on understanding how wildfires impact soil microbial communities involved in nitrogen cycling in the Arctic tundra. Wildfire frequency in tundra ecosystems is increasing in response to multiple climate change conditions, such as higher temperatures and increased lightning strike occurrences. Under this changing fire regime, soils are disturbed by the burning of vegetation and organic matter. Microbes are the main drivers of transformation of soil nutrients, such as nitrogen, which is ultimately taken up by both microbes and plants as a nutrient source. However, due to the historical low occurrence of wildfires in tundra ecosystems, the effects of fire on microbial communities involved in nitrogen cycling in tundra soils are underexplored.

During my master's degree, I collected peat soils samples from a tundra ecosystem at the Yukon Kuskokwim Delta, Alaska, with documented fire history from 1972 and 2015. My research explores post-fire changes in soil microbial communities and gene expression involved in nitrogen cycling through 16S rRNA amplicon sequencing and metatranscriptomic analyses, coupled with measurements of nitrogen pools.

Metatranscriptomics is a powerful bioinformatics tool that provides the identification of the actively expressed genes from RNA at the moment of soil sampling, which allows us to better understand changes in metabolic mechanisms in response to environmental disturbances, such as wildfires. This summer, I was able to process my raw RNA sequences dataset through a metatranscriptomics pipeline to assess the differential expression of genes that are relevant to the nitrogen cycle, and I was able to link these results to my amplicon sequencing and nitrogen pools data, and incorporate these results into my thesis manuscript.

My findings indicate a decrease in microbial species richness and changes in community composition in the humic horizon 7- and 50-years post-fire. In mineral soils, total N stocks and dissolved N increased post-fire. However, no changes in N stocks or N-related gene expression were observed between burned and unburned soils in the humic horizon, indicating that despite changes in microbial community composition, ecological function is restored to promote nutrient recovery in tundra soils.

With the support of the NHSGC Summer Graduate Fellowship, I was able to successfully defend my thesis, complete my bioinformatics analysis, and finalize my thesis manuscript. In addition, I had the opportunity to present my work at the Northeastern Microbiologists: Physiology, Ecology and Taxonomy conference, where I was able to network with other brilliant local scientists that carry out diverse microbiology research projects. I am beyond thankful to have received this fellowship that has helped me achieve my academic goals. My next steps are to present my research at the American Geophysical Union conference this fall, and prepare my manuscript to share my findings with the scientific community by submitting my research to a peer-reviewed journal for publication.