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Combatting highly complex matrices and exploring the human influence on microplastic distributions in Minnesota's lakes and rivers

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Plastic pollution is a concern for both the environment and for human health. Toxicity studies reveal harmful effects when various aquatic and land-based biota are exposed to micro and nano-sized plastic particles, which are often the product of fragmentation of larger plastic particles. Toxicology studies also indicate that exposure to smaller plastic particles may lead to a larger variety and more severe toxicological effects, in part because these particles can cross biological barriers in organisms. Thus, there is also interest in the size distributions of plastic particles in various environments. Toxicology studies also show that the type of plastic polymer involved can also shift what effects an organism exhibit. Unfortunately, current methods for quantifying and characterizing microplastic particles by size and polymer type are not optimized for highly complex matrices, such as many natural water systems, which can have high organic matter loadings (including lipid-rich and woody material) as well as both dissolved and particulate inorganic components (salts, clays, etc.). Highly complex matrices can result in side reactions and particle aggregation that limit the effectiveness of traditional oxidation approaches, resulting in clogging of filtration apparatus, the creation of films which complicate plastic particle characterization via Micro – Fourier Transform Infrared Spectroscopy (μFTIR), and the trapping and obscuring of smaller plastics during characterization via microscopy and spectroscopy. This study focuses on quantifying microplastics in 18 lakes and 7 rivers in Minnesota. Many of these aquatic systems exhibit highly complex matrices that are either unaffected or adversely affected by organic matter removal using Fenton oxidation. This study has tested various additional steps for addressing these matrices and will present the optimized sample preparation approach. Upon removal of the matrix, samples are analyzed using a Bruker LUMOS II μFTIR which enables both precise sizing and compositional analysis of individual microplastics. The resulting microplastics data is being used for in-depth spatial analysis of human influence on microplastic amounts, sizes, and compositions using watershed variables such as population density, developed land use, and impervious surfaces, as well as wastewater treatment plant and landfill locations within a given watershed.