Dr. Mark J. McCarthy, Research Assistant Professor at Wright State University, completed an Ohio Water Resources Center 104(b) funded project. The project, **"Maumee River sediments as a nitrogen source or sink to Lake Erie: the competing roles of ammonium recycling and denitrification,"** aimed to quantify the removal and recycling pathways of both nitrate (NO_3^-) and ammonium (NH_4^+) in Maumee River sediments to determine whether the sediments are a nitrogen (N) source or sink to the water column, promoting or mitigating harmful algal blooms in Lake Erie.

Lake Erie has experienced toxic cyanobacterial blooms due to high nitrogen and phosphorus inputs from its tributaries including the Maumee River, which has the largest drainage area into western Lake Erie. Many studies evaluating the amount and form of P in the Maumee River have been conducted, but N studies are comparatively rare. Of the bioavailable N forms, NH_4^+ may be the key N form for harmful algal blooms, but it is challenging to measure accurately in discrete samples because of rapid microbial cycling processes.

Figure 1. Megan Reed (L) and Emily Holliday (R) conducting sampling at Mary Jane Thurston State Park

Dr. McCarthy's team collected water samples and sediment cores from four sampling sites along the Maumee River and measured net nutrient (N and P) fluxes across the sediment-water interface, using stable isotope techniques to quantify N sources and sinks (denitrification/anammox), and scaling seasonal results to estimate the annual internal load of bioavailable N forms compared to N removal capacity.

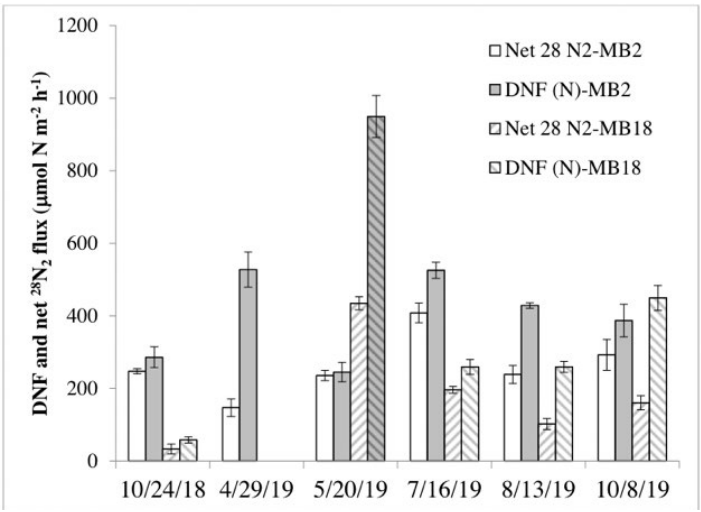

Figure 2. Net N_2 flux in unamended cores and potential denitrification rates (DNF) measured in intact sediment cores incubated in a continuous-flow system. MB2 = Maumee River discharge at Brenner 75 Marina (Toledo, OH). MB18 = Maumee Bay

Preliminary results focused on dissolved gas fluxes across the sediment-water interface indicate that Maumee River sediments act as a net N sink, primarily via denitrification. River sediments thus perform a valuable ecosystem service by removing bioavailable N before it is discharged to Maumee Bay, where it can provide fuel for toxic cyanobacterial blooms. However, isotope patterns for NH4+ also show that Maumee River and Bay sediments release substantial amounts of NH4+ to the overlying water. Since denitrification converts NO3- to N2 gas, and NO3- is energetically less favorable for cyanobacteria assimilation compared to NH4+, the positive effects of N removal via denitrification (and anammox) are mitigated to some extent by sediment NH4+ releases.

Researcher Profile: Dr. Mark J. McCarthy is a Research Assistant Professor at Wright State University. He has spent the last 19 years studying the nitrogen cycle in aquatic systems around the world. He received his Ph. D. from Université du Québec á Montréal and did his Post-Doctoral work at the University of Texas at Austin Marine Science Institute.