

An Empirical Analysis of Freshwater Mussel Abundance and Pollutant Abatement in Minnesota Rivers

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Freshwater mussels are a sentinel species for ecosystem function and contribute towards many ecosystem services, such as water filtration, nutrient cycling, and aquatic habitat, while having an important role in food webs. Ecosystem services being essential for human well-being, there is a need to protect freshwater mussels both for conserving the species and for sustaining the flow of ecosystem services. As mussels require clean water to survive, and since conserving ecosystem services is implicit in the federal Clean Water Act, incorporating mussel conservation into clean water goals could serve multiple conservation goals, including ecosystem restoration for major river systems such as the Mississippi, Minnesota, St Croix, Red, and Rainy River basins in Minnesota. However, freshwater mussels are also one of the most sensitive and imperiled aquatic taxa, and are threatened by water pollution, habitat loss, and altered hydrology. Regulating pollution through National Pollutant Discharge Elimination System (NPDES) permits has a variety of benefits but also entail costs in terms of wastewater treatment technology as well as resources and time needed to implement water quality standards. To understand better the association between regulation, improvements in water quality, and mussel conservation, we link data on mussel abundance and extirpation rates to the temporal change in key pollutants such as sediment, nutrients, and chloride, as well as other factors including flow alteration, habitat features, and fish diversity. These data will be analyzed using a generalized mixed effects regression model to generate findings on the relationship of mussel health with improvements in water quality. We will look at these relationships for different freshwater mussel life history strategies, such as equilibrium, periodic, and opportunistic to gain more insight into their effective conservation. Our results will inform more effective strategies for ecosystem protection through mussel conservation, thereby improving cost-effectiveness in meeting multiple Clean Water Act goals.

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