Environmental Genetic Reconnaissance for Monitoring and Managing HABs

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USACE Harmful Algal Bloom Research & Development Initiative

Delivering scalable freshwater HAB prevention, detection, and management technologies through collaboration, partnership, and cutting-edge science.

Problem

Recurrence and severity of harmful algal blooms (HABs) are increasing due to several factors (e.g., human practices and climate change). Sensitive, robust methods that allow for early and rapid HAB detection are needed. Among the suite of HAB detection tools available, a powerful option exists in genetics-based approaches utilizing environmental sampling, or environmental DNA (eDNA). The eDNA field has rapidly matured in recent years, with several new and improved methods available for use in HABs. A synthesis of these recent methods—and comparisons of benefits and/or tradeoffs of each—are missing from the literature.

Approach

We conducted a literature review of recent eDNA methods and their application for freshwater HAB detection and monitoring. In total, we reviewed 14 papers with a specific focus on two HAB species of significant concern (*Microcystis aeruginosa* and *Prymensium parvum*). The review provides a synthesis of available HAB eDNA methods and associated in-field instrumentation: quantitative PCR (qPCR), PCR-free isothermal amplification, and high-throughput sequencing (i.e., metabarcoding). Each technology was assessed for deployment suitability across different scenarios and ability to meet varying HAB monitoring and management objectives. A companion white paper gleans from the review; it details strategic future directions for eDNA-based HAB surveillance and eDNA-informed HAB management.

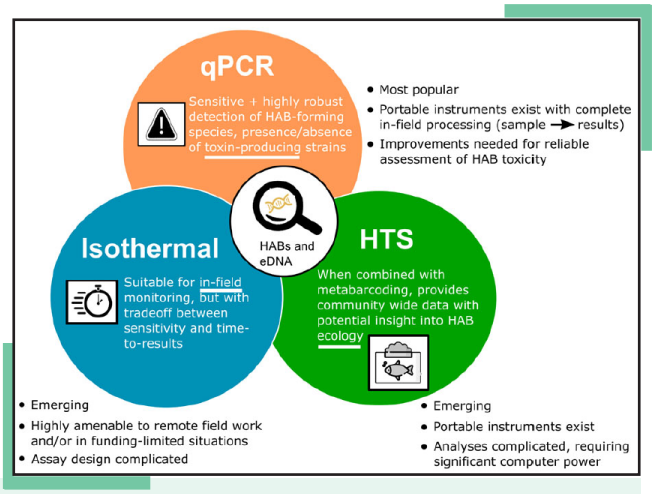

Figure 1. *eDNA methods available for HABs, reproduced from separate author's publication.*

Major Milestones

Deliverable	Description
Publications	**Journal Article:** Feist and Lance. 2021. "Genetic Detection of Freshwater Harmful Algal Blooms: A Review Focused on . . . *M. aeruginosa* and *P. parvum*." *Harmful Algae* 110:102124. https://doi.org/10.1016/j.hal.2021.102124.
Documents	**White Paper.** Feist and Lance. 2021. "HAB Environmental Genetic Reconnaissance: State of the Science and Future Strategies."

Value to USACE Mission

eDNA methods are extremely sensitive, reliably specific, expedient, and cost-effective. As such, eDNA-based detection of HAB-forming species results in several potential advantages as compared to other HAB monitoring technologies. These advantages translate to early detection, large scalability of efforts, and capacity to provide data potentially useful for predicting bloom formation and/or informing bloom treatments. Data can also improve our understanding of the ecological impacts of HABs, including impacts to high-risk aquatic systems housing economically important species.