SCWQA

Water Quality Through Sound Science

May 2, 2025

By Electronic Mail

Andrew Edwards
Bureau of Water, Water Quality Standards Coordinator
South Carolina Department of Environmental Services
2600 Bull Street
Columbia, South Carolina 29201

RE: Use of Diatom Indices as Indicators of Water Quality Impairment

Dear Mr. Edwards:

We hope this finds you doing well.

We write today to share the South Carolina Water Quality Association's (SCWQA) technical concerns with the potential use of diatom indices as a basis for the assessment of nutrient impairments in South Carolina's streams. Shifts in diatom indices alone have not been sufficiently correlated to the attainment of designated uses in streams to justify such an approach. Put another way, as we explain below, we don't think diatom indices are an appropriate predictor of water quality standards attainment and, accordingly, should not be used.

The SCWQA comprises local governments, wastewater authorities, and leading wastewater engineering firms from across the state. SCWQA members strive to protect public health and the environment in an affordable and cost-effective manner. We appreciate DES' willingness to provide regular updates on future water quality regulations, including those that pertain to nutrients.

A diatom index is a metric of diatom species assemblage in a water body calculated from the composition and relative abundance of diatom species in samples taken from that water body. Because diatom species assemblages and metrics can correlate with nutrient concentrations, a few states have contemplated categorizing a stream as impaired if instream samples contain diatom indices that are statistically associated with higher nutrient concentrations. That approach is erroneous.

In SCWQA's view, diatom indices are interesting academic indicators of nutrient concentrations but not indicators of whether water quality standards are attained instream. Even if certain diatom indices were shown to be statistically associated with higher nutrient concentrations, this relationship alone fails to demonstrate harmful effects on higher trophic levels, recreation, drinking water, and other designated uses.

Streams can experience variability in diatom assemblages without causing an impairment of the overall ecological function of the stream or its designated uses. Streams experience different diatom assemblages in different seasons and even in different ecological niches of the same stream[1]. Diatoms also provide various ecosystem services such as oxygen production, nutrient cycling, habitat, and grazing substrate.[2] Thus, higher assemblages are often expected and not necessarily detrimental in many streams.

The scientific literature does not support the conclusion that diatom assemblages associated with higher nutrient concentrations fail to provide the beneficial services noted above or that they are intrinsically harmful. Some changes in stream algal communities can indeed cause impairments, such as shifts to toxic or nuisance algal species, and excessive algal blooms can cause low dissolved oxygen and/or high pH.

Diatom assemblages shift in response to many environmental variables in addition to nutrients, including temperature[3], light[4], hydraulics[5], salinity[3], pH[3], silica[6], and various trace elements[7]. The sensitivity of diatom indices to these various environmental factors is what makes them useful for certain scientific purposes, such as detecting changes in past climate conditions. But it would be arbitrary to take just one of these gradients (nutrients) and label one end as "impaired" without evidence of harmful effects to designated uses. For example, agencies would be highly unlikely to use diatom indices to assess for hydraulic, light, or silica-related "impairments", despite strong correlation in diatom metrics with those environmental variables.

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[1] Mykrä, H., Saarinen, T., Tolkkinen, M., McFarland, B., Hämäläinen, H., Martinmäki, K., & Kløve, B. (2012). Spatial and temporal variability of diatom and macroinvertebrate communities: How representative are ecological classifications within a river system? *Ecological Indicators, 18*, 208-217.

[2] B-Béres, V., Stenger-Kovács, C., Buczkó, K. *et al.* Ecosystem services provided by freshwater and marine diatoms. *Hydrobiologia* **850**, 2707–2733 (2023)

[3] Adams GL, Pichler DE, Cox EJ, O'Gorman EJ, Seeney A, Woodward G, Reuman DC. Diatoms can be an important exception to temperature-size rules at species and community levels of organization. Glob. Change Biol. 2013 Nov;19(11):3540-52.

[4] Liess, A., Lange, K., Schulz, F., Piggott, J. J., Matthaei, C. D., & Townsend, C. R. (2009). Light, nutrients and grazing interact to determine diatom species richness via changes to productivity, nutrient state and grazer activity. *Journal of Ecology, 97*(2), 326-336.

[5] Snell, M.A., Barker, P.A., Surridge, B.W.J. *et al.* Strong and recurring seasonality revealed within stream diatom assemblages. *Sci Rep* **9**, 3313 (2019). https://doi.org/10.1038/s41598-018-37831-w

[6] Krause, J. W., Duarte, C. M., Marquez, I. A., Assmy, P., Fernández-Méndez, M., Wiedmann, I., Wassmann, P., Kristiansen, S., and Agustí, S.: Biogenic silica production and diatom dynamics in the Svalbard region during spring, Biogeosciences, 15, 6503–6517, https://doi.org/10.5194/bg-15-6503-2018, 2018.

[7] Patrick, R. (1978). Effects of trace metals in the aquatic ecosystem: The diatom community, base of the aquatic food chain, undergoes significant changes in the presence of trace metals and other alterations in water chemistry. *American Scientist*, 66(2), 185-191.

SCWQA is aware of the scientific challenges of deriving meaningful nutrient-related standards/policies, and our concern regarding the regulatory use of diatom indices is not intended to discourage efforts to understand any linkages between nutrient concentrations and the composition of biota in the streams of South Carolina, or the exploration of other algal-related indicators that are more directly related to designated use impairments.

Nutrient impacts on streams can be diagnosed with other response/indicator variables that have demonstrated direct links to stream use impairment, such as dissolved oxygen, pH, cyanotoxins, or excessive and/or persistent growths of identifiable nuisance or toxic algae. For example, persistent blooms of *Didymosphenia geminata* are a documented nuisance and an example of a true diatom-related impairment, albeit one that is more associated with the spread of an invasive species than nutrient enrichment *per se*[8]. Other states have developed methods for identifying persistent and unambiguous recreational impairments caused by excessive growth of filamentous green algae in streams[9]. SCWQA believes that DES should consider more direct measures of impacts to specific designated uses rather than diatom indices.

Thank you for considering our views regarding diatom indices. We look forward to continuing to work with DES to address water quality issues in South Carolina. If you have any questions or would like to discuss these concepts, please contact Dr. Clifton Bell at CBell@brwncald.com.

Sincerely,

F. Paul Calamita
General Counsel

C: SCWQA Members

[8] Spaulding, S. A., & Elwell, L. (2007). *Increase in nuisance blooms and geographic expansion of the freshwater diatom Didymosphenia geminata* (Open-File Report 2007–1425). U.S. Geological Survey.
[9] e.g., see Virginia's filamentous green algae criteria for the Shenandoah River; https://law.lis.virginia.gov/admincode/title9/agency25/chapter260/section310/