N and P as ultimate and proximate limiting nutrients in the northern Gulf of Mexico and elsewhere

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Abstract

The occurrence of hypoxia in coastal oceans is a long-standing and growing problem worldwide, and clearly linked to anthropogenic nutrient inputs. While the need for reducing anthropogenic nutrient loads is generally accepted, it is costly and thus requires scientifically sound nutrient-reduction strategies. Issues under debate include the relative importance of nitrogen (N) and phosphorus (P), and the magnitude of reduction requirements. The largest anthropogenically induced hypoxic area in North American coastal waters (of 15,000+/-5,000 km^2) forms every summer in the northern Gulf of Mexico where the Mississippi and Atchafalaya Rivers deliver large amounts of freshwater and nutrients to the shelf. A 2001 Action Plan for reducing this hypoxic area by nutrient management in the watershed called for a reduction of N loads. Since then evidence of P limitation during the time of hypoxia formation has arisen, and a dual nutrient reduction strategy for this system has been endorsed. We will report on the first systematic analysis of the effects of single and dual nutrient load reductions with a spatially explicit physical-biogeochemical model for the northern Gulf of Mexico [1] and put the results in context of other coastal low-oxygen zones with large anthropogenic nutrient loads [2].

[1] Fennel & Laurent (2018) *Biogeosciences* **15**, 3121–3131.
[2] Fennel & Testa (2019) *Annual Review of Marine Science* **11**, 105-130.