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Temporal and spatial trends in Gulf of Mexico nitrogen biogeochemistry over the last two millennia revealed by the $\delta^{15}N$ of bivalve shells

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Defining the background state of the Earth's nitrogen cycle prior to anthropogenic disturbance is an important benchmark. From here we can quantify nitrogen loading and hypoxia in coastal ecosystems and the efficacy of remediation efforts. Monitoring is now fairly common, but data repositories typically provide a narrow window of only a few decades. Sedimentary archives can provide useful data, but are complicated by sedimentary dynamics and time averaging that make sub-decadal resolution difficult to achieve. Direct dating of sub-fossil skeletal carbonates by bomb-spike ^{14}C geochronology and subsequent isotopic analysis of the shell-bound organic matter has proven to be a suitable proxy for the nitrogen cycle in the past and allows us to gauge how coastal biogeochemistry has been affected by human activities.

Analyses of shell-bound organic matter in the primary consumer *Lirophora obliterata* (class Bivalvia) reveal temporal and spatial patterns in their ^{15}N values that indicate considerable changes in Gulf of Mexico nitrogen biogeochemistry over the last 3000 years. Nitrogen isotope values from nearshore sites on the Louisiana, Alabama and Florida continental shelf show significant increases of up to 10‰ since 1800 CE, consistent with the expansion of human populations, agricultural and urban development and associated nitrogen loading, and growth of hypoxic waters offshore the Mississippi River delta. Relatively higher ^{15}N proximal to the Mississippi River have led to a steepening of the ^{15}N gradient in the northern Gulf over the past 200 years. Ongoing analyses of compound-specific amino acid ^{15}N and ^{13}C will help resolve questions about the background nitrogen cycle and the potential effects of hypoxia on the ^{13}C of dissolved inorganic carbon and the ^{15}N of dissolved inorganic nitrogen.