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Blue Nitrogen: Global Rates and Economic Importance

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Nitrogen (N) pollution is driving widespread coastal ecosystem collapse, fueling harmful algal blooms, expanding hypoxic dead zones, and causing billions of dollars in annual economic losses to fisheries and aquaculture. Here, we demonstrate that mangrove forests represent a critically undervalued natural solution to this escalating crisis. Through a comprehensive global meta-analysis, we reveal that mangroves remove 870 Gg N annually—an ecosystem service worth $8.7 billion based on N credit valuation, more than 12 times the carbon credit value derived from mangrove carbon sequestration. Yet despite this substantial economic contribution, mangrove N removal remains entirely absent from current conservation frameworks and policy discussions. Under optimal conditions, we estimate that mangroves could remove over 5 million tonnes of N annually, highlighting immense untapped potential. However, this critical service is vulnerable: extreme eutrophication, mean annual temperatures above 22°C, and hypersalinity all suppress N removal capacity, meaning climate change and worsening pollution threaten to degrade this ecosystem service precisely where it is most needed. Our findings establish the scientific foundation for integrating "Blue Nitrogen" credits into broader N-credit frameworks, offering a transformative financing mechanism that could simultaneously advance mangrove conservation and reshape coastal water quality management strategies worldwide.

