

## Restoring Balance: Tracing Nutrient Patterns from Ridge to the Reef

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Water column nutrient concentrations are the result of interactions between biota and the environment in response to long-term and episodic changes to the system transposed over decadal or multi-decadal climatic forcing factors. Long-term, or press events, include eutrophication, sea-level rise, and warming. Meanwhile, episodic events can include hurricanes/tropical activity, drought, fire, and cold snaps. Over the last three decades, the southern Everglades, Florida Bay, and Reef track have undergone significant changes in water quality conditions in response to long-term and episodic changes while experiencing climatic shifts, whilst also undergoing restoration and water management operational changes. Using a multi-decadal dataset from 1996 to 2025 with monitoring locations across the freshwater Everglades to the outer marine reefs along the Florida Keys, trends and potential drivers were evaluated for Chlorophyll-a (Chl-a), total phosphorus (TP), total nitrogen (TN), and nutrient stoichiometry. Relative changes in Chl-a, TP, and TN concentrations were highly dynamic across space and time, with several periods of significant changes occurring in cyclic patterns. Periods of significant sharp increases and subsequent decreases correspond to tropical storms and hurricanes while periods of change with smaller amplitude occurred relative to other events such as droughts, fires, and high water levels. Persistent and significant changes in Chl-a and TN:TP stoichiometry have also occurred in regions of the study area that have experienced dynamic changes due to sea-level rise, reduced hydrologic connectivity, and warming. Changes in water quality parameters are important indicators of environmental change. Nutrient concentrations along the ridge-to-reef continuum are inherently dynamic; however, this effort will demonstrate that the system exhibits measurable responses to both long-term environmental shifts, such as ecosystem restoration or climate forcings, and shorter-term event-based fluctuations. Combined, this highlights the connectivity of these ecosystems and the resulting cascade of effects and processes.