# What We Know About the Water Quality of the Florida Keys National Marine Sanctuary

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This report serves as a summary of our efforts to date in the execution of the Water Quality Monitoring Project for the FKNMS as part of the Water Quality Protection Program. The period of record for this report is Mar. 1995 – Sept. 2004 and includes data from 37 quarterly sampling events at 154 stations within the FKNMS including the Dry Tortugas National Park (Fig. 1). The specific objectives of this project are to:

1. Assess the current status of water quality in the FKNMS by developing a long-term database
2. Assess the current trends in water quality in the FKNMS
3. Integrate the FKNMS project with other existing water quality monitoring projects to provide a more regional view
4. Evaluate the relative effects of terrestrial vs. Gulf/Ocean influences on water quality

Field parameters measured at each station include salinity (practical salinity scale), temperature (ºC), dissolved oxygen (DO, mg $l^{-1}$), turbidity (NTU), relative fluorescence, and light attenuation ($K_d$, $m^{-1}$). Water chemistry variables include the dissolved nutrients nitrate ($NO_3^-$), nitrite ($NO_2^-$), ammonium ($NH_4^+$), dissolved inorganic nitrogen (DIN), and soluble reactive phosphate (SRP). Total unfiltered concentrations of nitrogen (TN), organic nitrogen (TON), organic carbon (TOC), phosphorus (TP), and silicate ($Si(OH)_4$) were also measured. The biological parameters included in the study were chlorophyll *a* (CHLA, µg $l^{-1}$) and alkaline phosphatase activity (APA, µM $h^{-1}$).

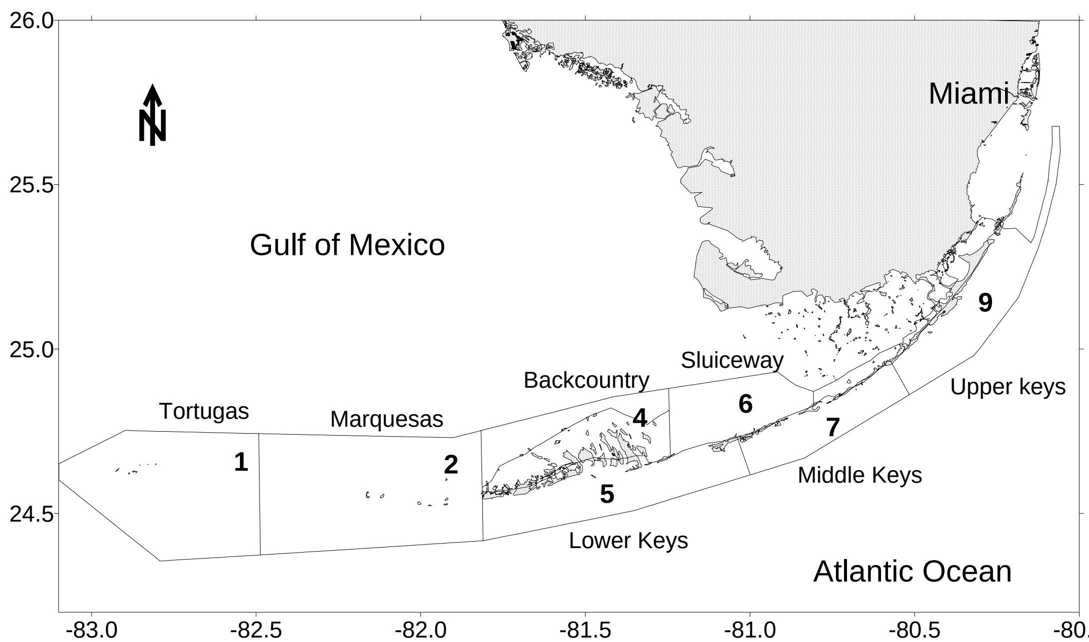


**Figure 1.** Map of the study area, showing sub-regions; Dry Tortugas National Park is in sub-region 1.

Several important results have been realized from this monitoring project. First, there are spatial differences in water quality across the study region (Fig. 2). DIN is elevated in the Backcountry because of its shallowness and potential to be most affected by benthic flux. There are lower concentrations of DIN, TP, CHLA, and turbidity in Upper Keys compared to the Middle and Lower Keys; water quality in the Upper Keys is most comparable to the Tortugas area. The Marquesas have highest CHLA and turbidity as a result of influences from the Southwest Florida Shelf.

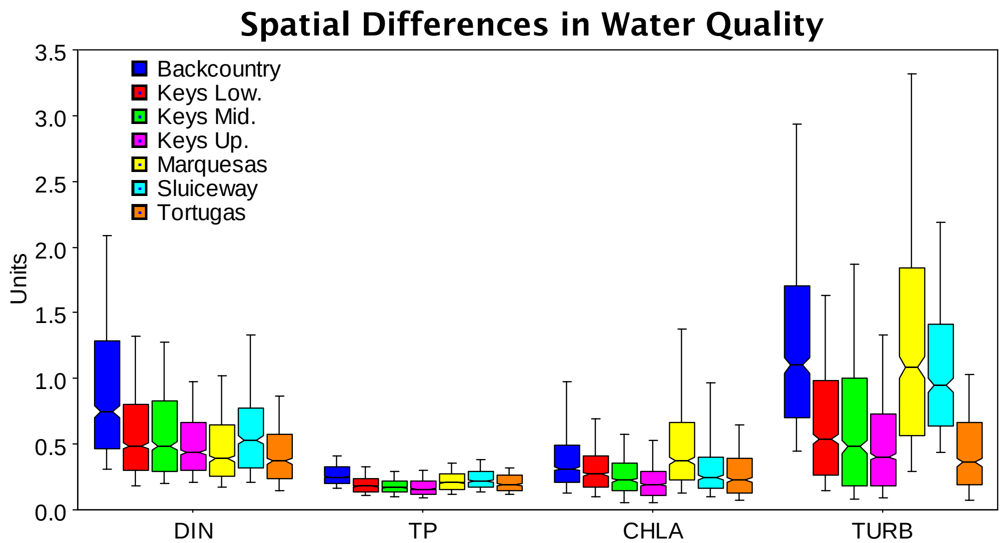


**Figure 2.** Variation of DIN, TP, CHLA, and turbidity among sub-regions.

Second, is documentation of elevated DIN in the inshore waters of the Keys (Fig. 3). This result was evident from the first sampling event in 1995 and continues to be a characteristic of the ecosystem. Interestingly, this gradient was not observed in a comparison transect in the Tortugas. This type of distribution implies an inshore source, which is diluted by low nutrient Atlantic Ocean waters. Presence of a similar gradient in TOC and decreased variability in salinity from land to reef also support this concept. There were no trends in either TP or CHLA with distance from land.

Another observation is that the Backcountry exhibits elevated levels of DIN, TOC, turbidity, TP, and CHLA. I believe most of these distributions are driven by the Southwest Florida Shelf waters moving through this area (median DIN = 0.7 µM, TOC = 298 µM, turbidity = 6.4 NTU, TP = 0.48 µM, and CHLA = 1.6 µg $l^{-1}$). In addition to this Shelf influence, elevated $NO_3^-$ is a regular feature of Backcountry waters, where some of the highest concentrations are observed in non-populated areas (Fig. 4). This is probably the result of the benthic flux of nutrients in this very shallow water column.

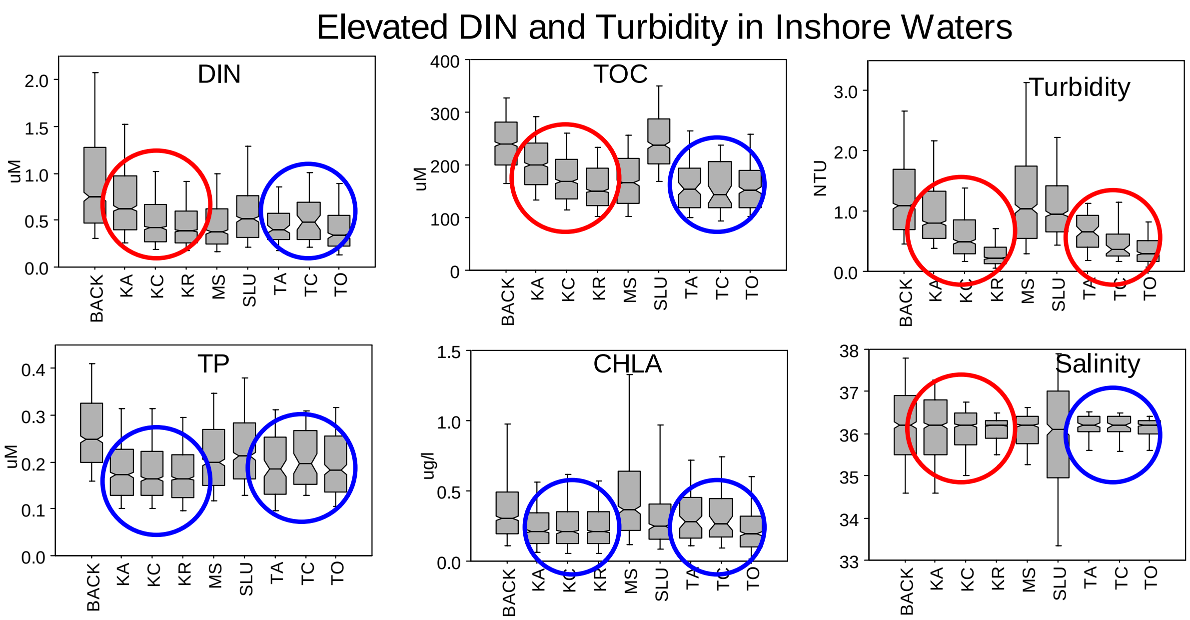


**Figure 3.** Variation in DIN, TOC, turbidity, TP, CHLA, and salinity, including onshore-offshore variation in the Keys (KA-KC-KR) and Tortugas (TA-TC-TO).

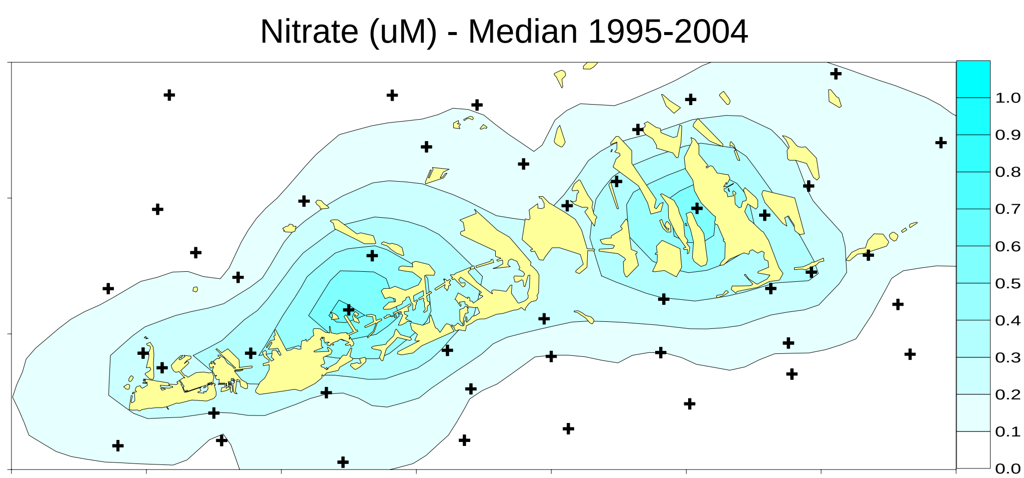


**Figure 4.** Spatial variation in nitrate concentrations.

The third important result is that highest CHLA concentrations occur on the Shelf and show a strong N-S gradient toward the Marquesas and Tortugas (Fig. 5). This is because of higher TP concentrations on the Shelf as a result of southward advection of Gulf of Mexico waters along the coast with entrainment of coastal rivers and runoff.

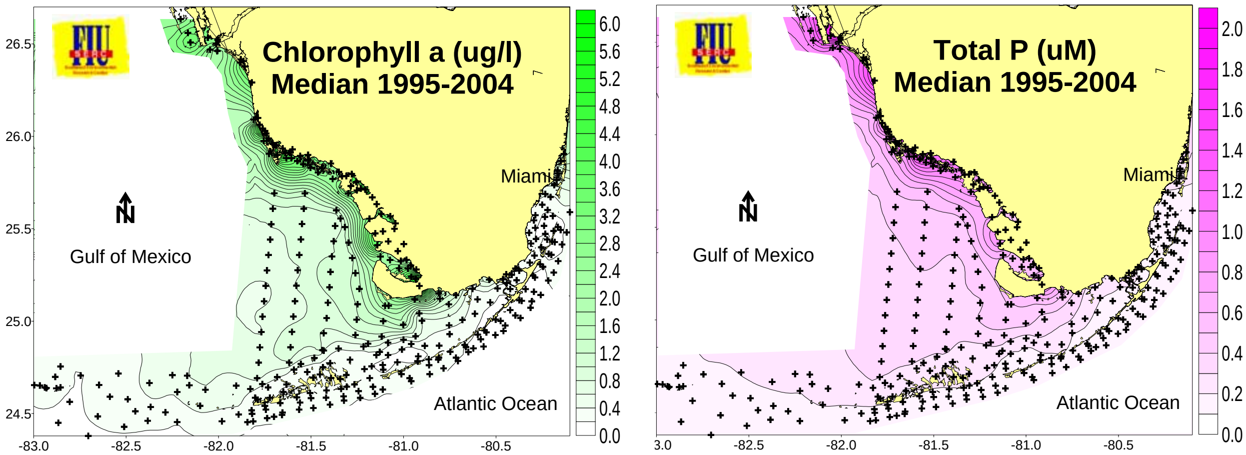


**Figure 5.** Spatial variation in CHLA and TP.

The fourth result is that trends in water quality showed most variables to be relatively consistent from year to year (Fig. 6), with some parameters showing seasonal excursions. Overall, there were statistically significant **decreases** in DIN, TON (except for increases in Tortugas), TP, TOC, and DO throughout the region. This is contrary to some of the trend analysis reported last year. Clearly, there have been large changes in FKNMS water quality over time, and some sustained monotonic trends have been observed; however, we must always keep in mind that trend analysis is limited to the window of observation. Trends may change, or even reverse, with additional data collection.

This brings up another important point: when looking at what are perceived to be local trends, we find that they seem to occur across the whole region but at more damped amplitudes. This spatial autocorrelation in water quality is an inherent property of highly interconnected systems such as coastal and estuarine ecosystems driven by similar hydrological and climatological forcings. It is clear that trends observed inside the FKNMS are influenced by regional conditions outside Sanctuary boundaries.

The large scale of this monitoring program has allowed us to assemble a much more holistic view of broad physical/chemical/biological interactions occurring over the South Florida hydroscape. Much information has been gained by inference from this type of data collection program: major nutrient sources have be confirmed, relative differences in geographical determinants of water quality have been demonstrated, and large-scale transport via circulation pathways has been elucidated. In addition we have shown the importance of looking “outside the box” for questions asked within. Rather than thinking of water quality monitoring as being a static, non-scientific pursuit it should be viewed as a tool for answering management questions and developing new scientific hypotheses.

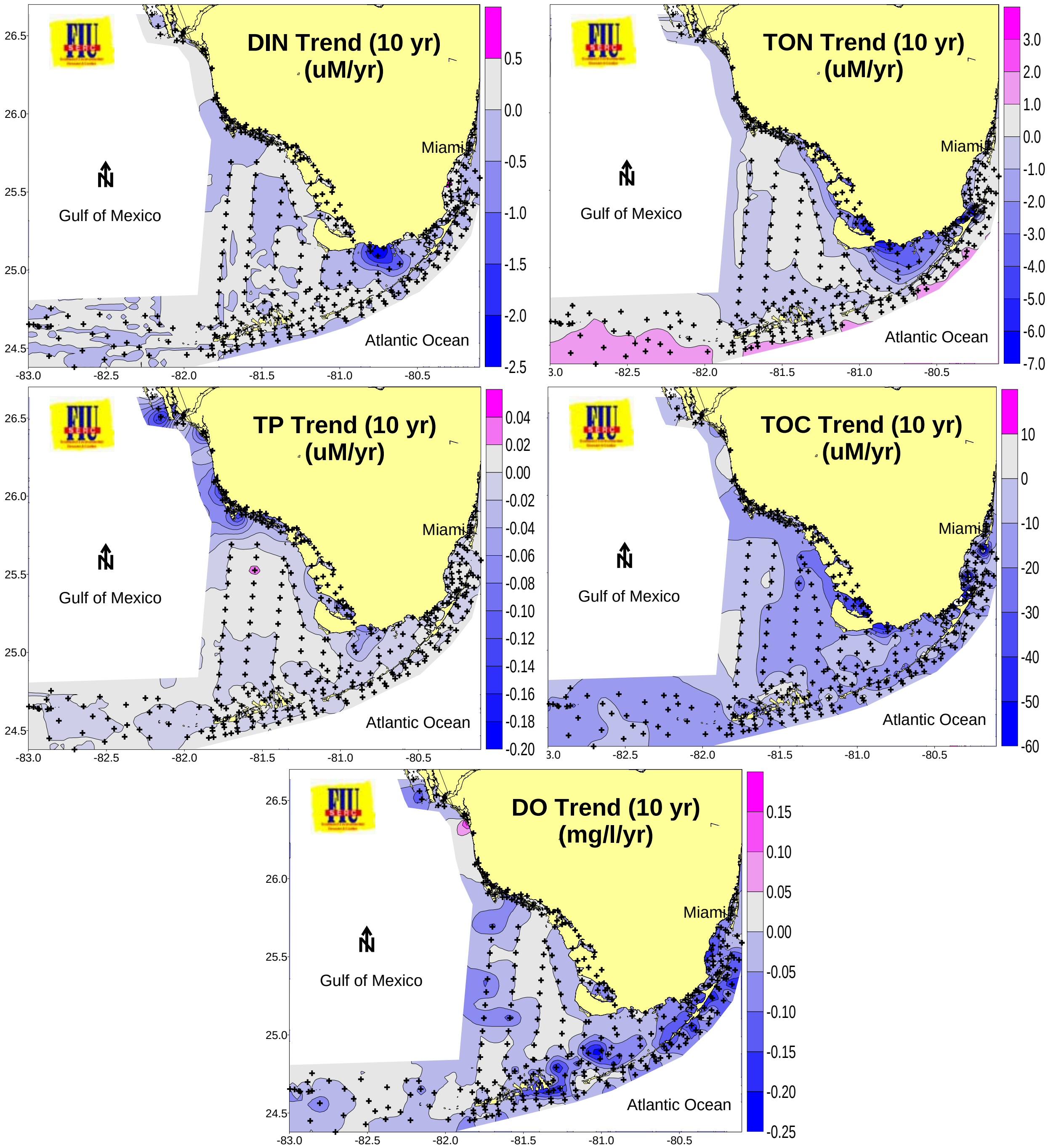


**Figure 6.** Spatial variation in temporal trends of DIN, TON, TP, TOC, and DO.

We continue to maintain a website (http://serc.fiu.edu/wqmnetwork/) where data from the FKNMS is integrated with the other parts of the FIU/Southeast Environmental Research Center water quality network (Florida Bay, Whitewater Bay, Biscayne Bay, Ten Thousand Islands, and Southwest Florida Shelf) and displayed as downloadable contour maps, time series graphs, and interpretive reports.

**Acknowledgments**
I thank all the field and laboratory technicians involved with this project, especially Pete Lorenzo, John Fulop, George Meichel, Ruth Justiniano, Pura Rodriguez de la Vega, Pierre Sterling, and Frank Tam. Special thanks to Danielle Mir-Gonzalez for help with time series analysis. We also thank the captains and crew of the R/V Bellows of the Florida Institute of Oceanography for their professional support of the monitoring program. This project was possible due to continued funding by the U.S. EPA (Agreement #X994621-94-0) and the South Florida Water Management District (Contract #C-15397). This is Contribution #366 of the Southeast Environmental Research Center at Florida International University.