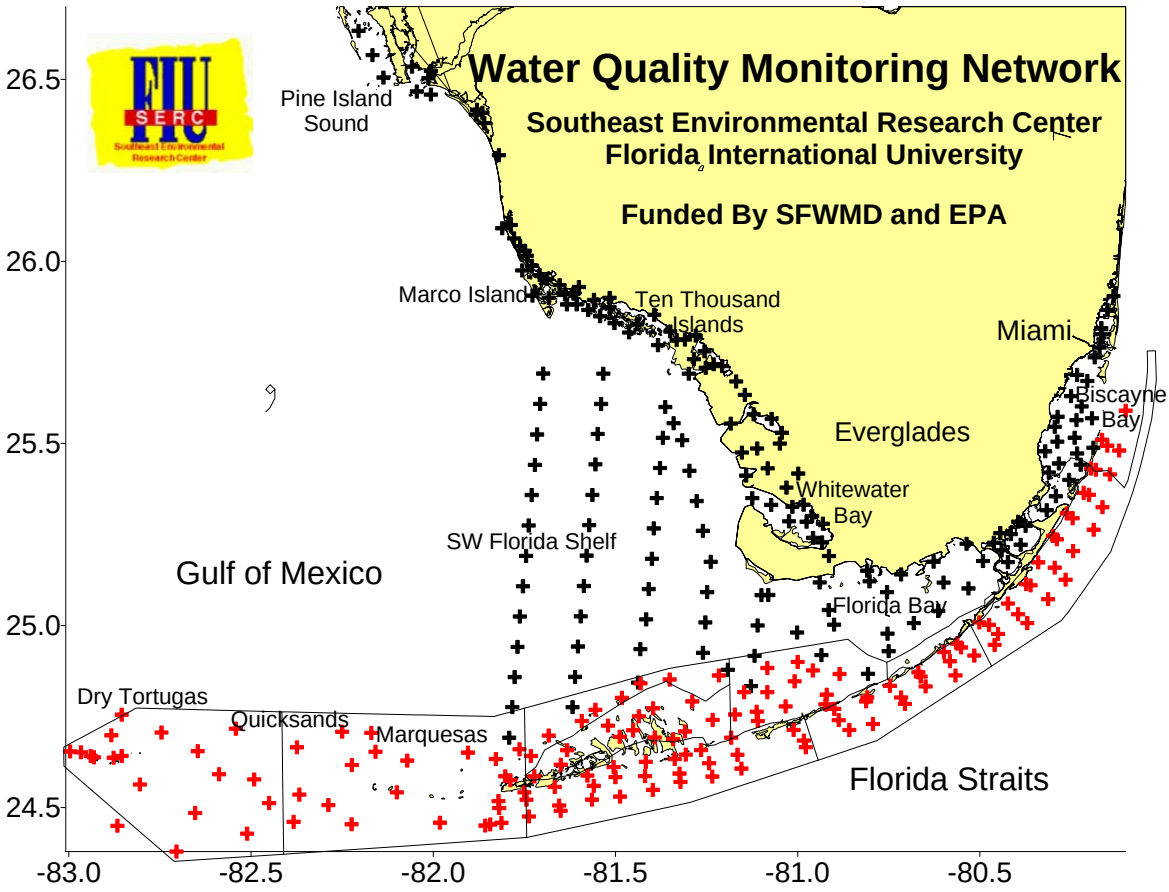
2006 ANNUAL REPORT OF THE WATER QUALITY MONITORING PROJECT

FOR THE WATER QUALITY PROTECTION PROGRAM

OF THE FLORIDA KEYS NATIONAL MARINE SANCTUARY



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EXECUTIVE SUMMARY

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 – Dec. 2006 and includes data from 46 quarterly sampling events at 154 stations within the FKNMS including the Dry Tortugas National Park.

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 (SiO_2) 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}).

Several important results have been realized from this monitoring project. First, is documentation of elevated nitrate in the inshore waters of the Keys (Fig. 1). This result was evident from out first sampling event in 1995 and continues to be a characteristic of the ecosystem. Interestingly, this gradient was not observed in a comparison transect from the Tortugas (no human impact). 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.

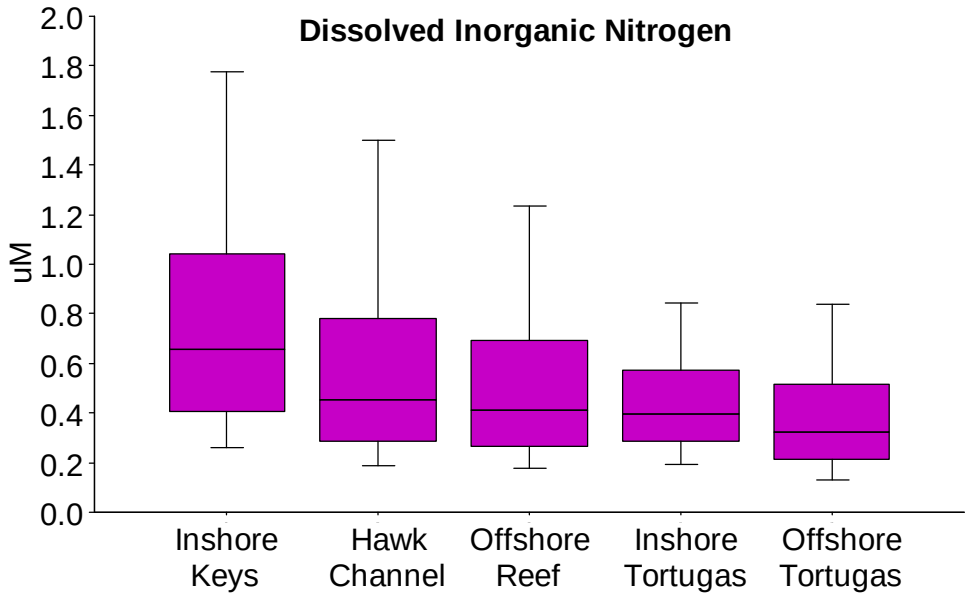

Figure 1.

Another observation is that the Backcountry exhibits elevated levels of DIN, TOC, turbidity, TP, and CHLA. We believe most of these distributions are driven by the SW 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 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. 2). This is probably the result of the benthic flux of nutrients in this very shallow water column.

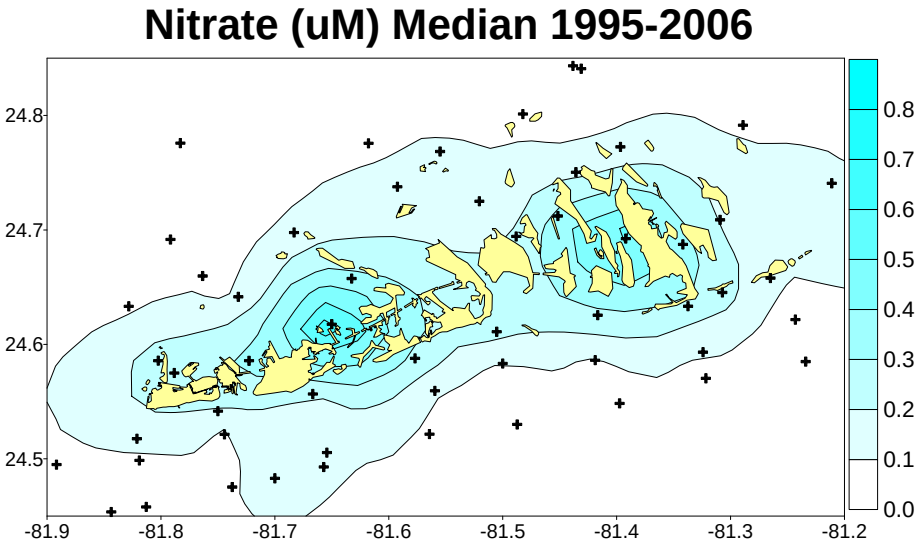

Figure 2.

The third important result is that highest CHLA concentrations occur on the Shelf and show a strong N-S gradient towards the Marquesas and Tortugas (Fig. 3). This is due to 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.

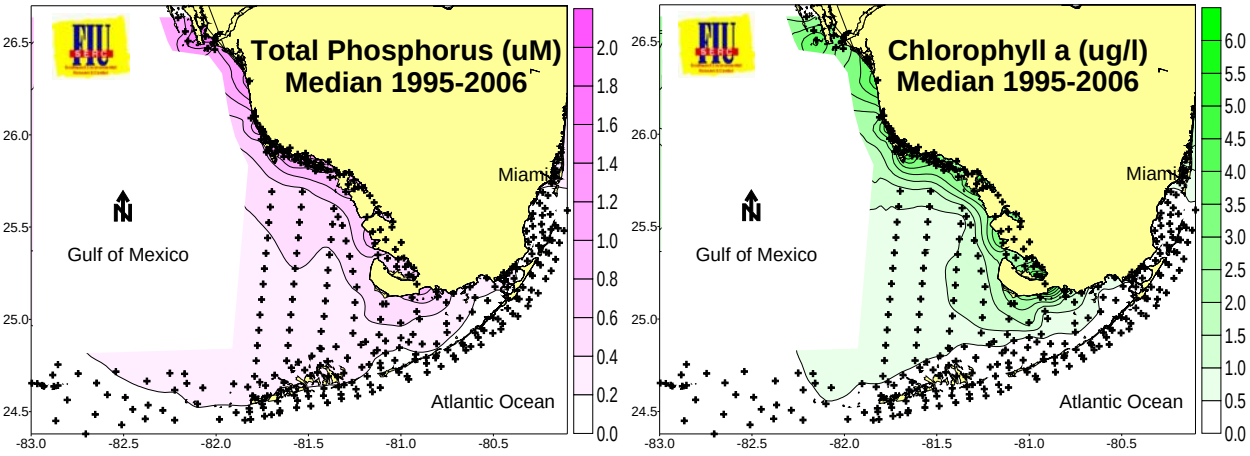

Figure 3.

The fourth result is that most variables were consistent year to year with some seasonal variability. However, some variables showed noteworthy differences over the period of record. Statistically significant **decreases** were observed for DIN, TON, TP, TOC, and DO throughout the region (Fig 4). Clearly, there have been changes in the FKNMS water quality over time, 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 the Sanctuary boundaries.

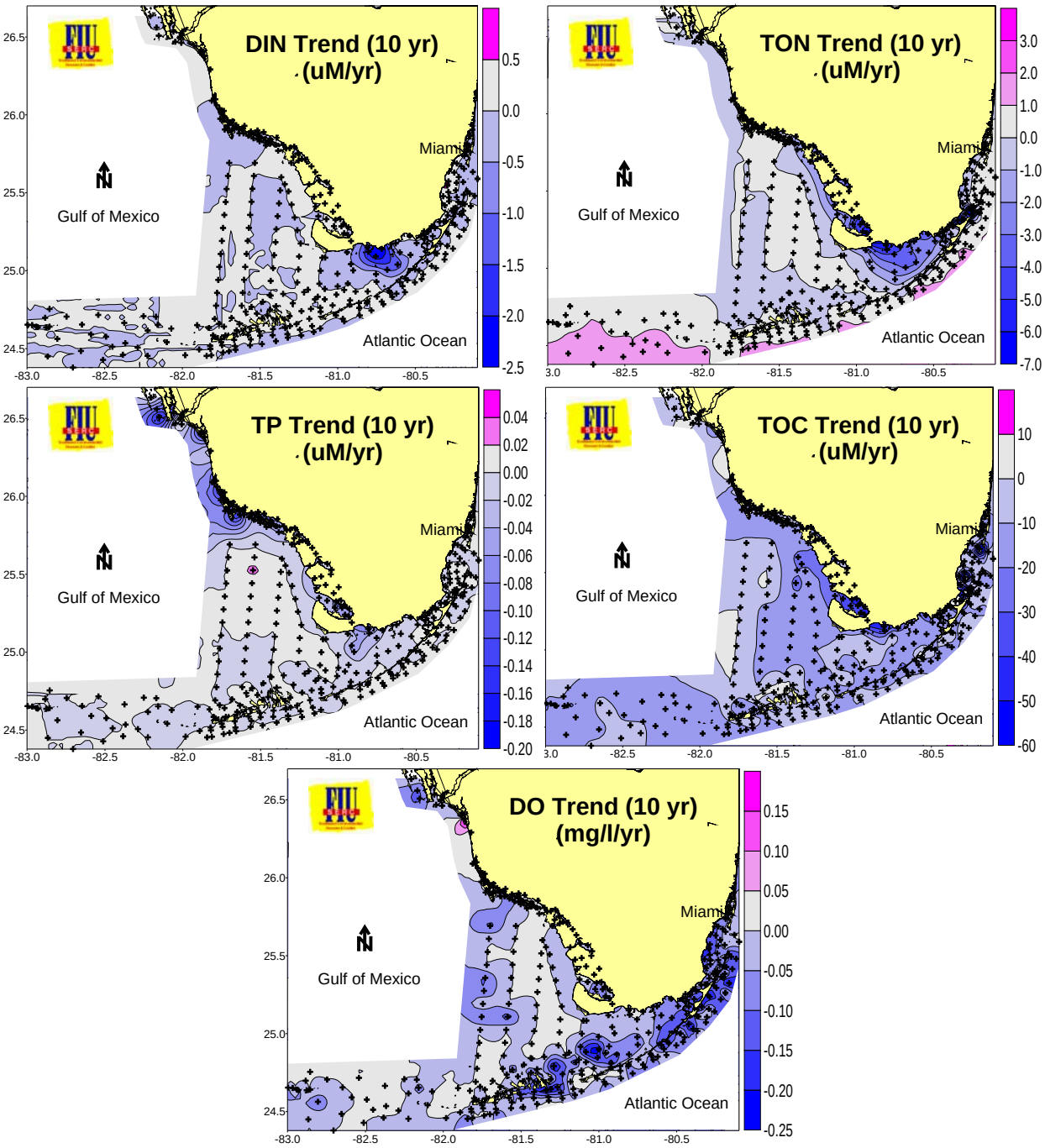

Figure 4.

Precipitation for 2006 was 120.4 cm yr^{-1} making it the third driest year since 1991. In contrast, 2005 was the third wettest year since 1995. Hurricanes were not an issue during this year. In all regions of the FKNMS, DIN (mostly as NH_4^+), TP, and turbidity were elevated relative to the long term median, while DO and CHLA were lower (Fig. 5). The changes were

small but significant. Overall, TOC and TON were lower than the long term median mostly because they have been declining over the years. Salinity and temperature showed little variation from the median.

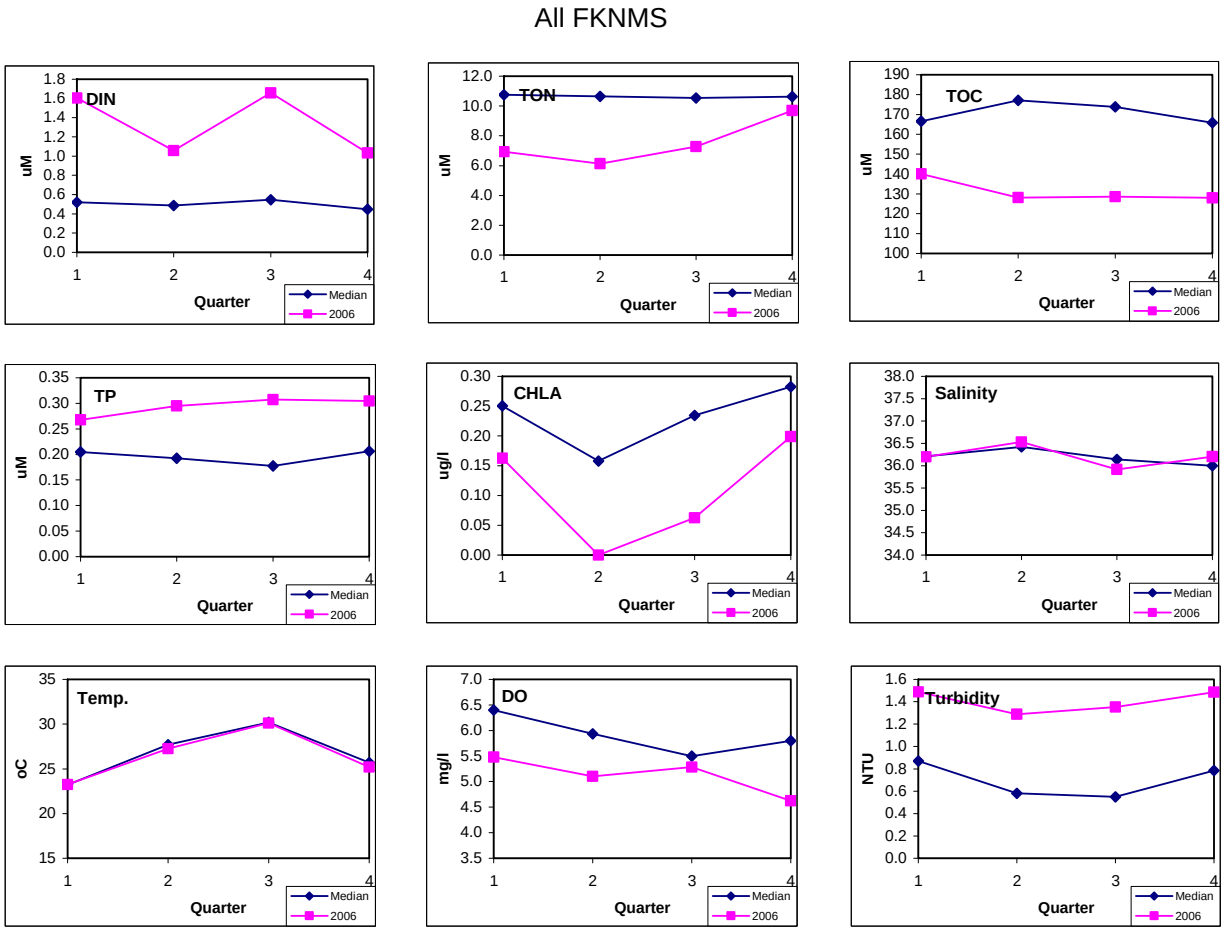

Figure 5.

It is interesting that last year we saw no sustained effect of hurricane activity on the water quality in these areas, but that this year, there should be so much of a difference. Our only explanation for this is that during 2006, the FKNMS experienced very different water masses than seen in previous years. Because the deviations from long term conditions were greatest on the oceanside of the Keys, we believe that these differences were due to a change in the oceanic waters, not from SW Shelf water moving through the passes. This is not to say that the Gulf of Mexico was not an influence. Gulf waters transported south by the Loop Current west of the Tortugas could have been entrained in the Florida Current. Better integration with physical

circulation models of the Gulf of Mexico and South Atlantic Basin may provide some clues as to the source.

Finally, we would have expected that such large increases in DIN and TP should have caused increases in CHLA by stimulating phytoplankton growth and production. That we saw declines in CHLA is especially puzzling.

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 have 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.

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