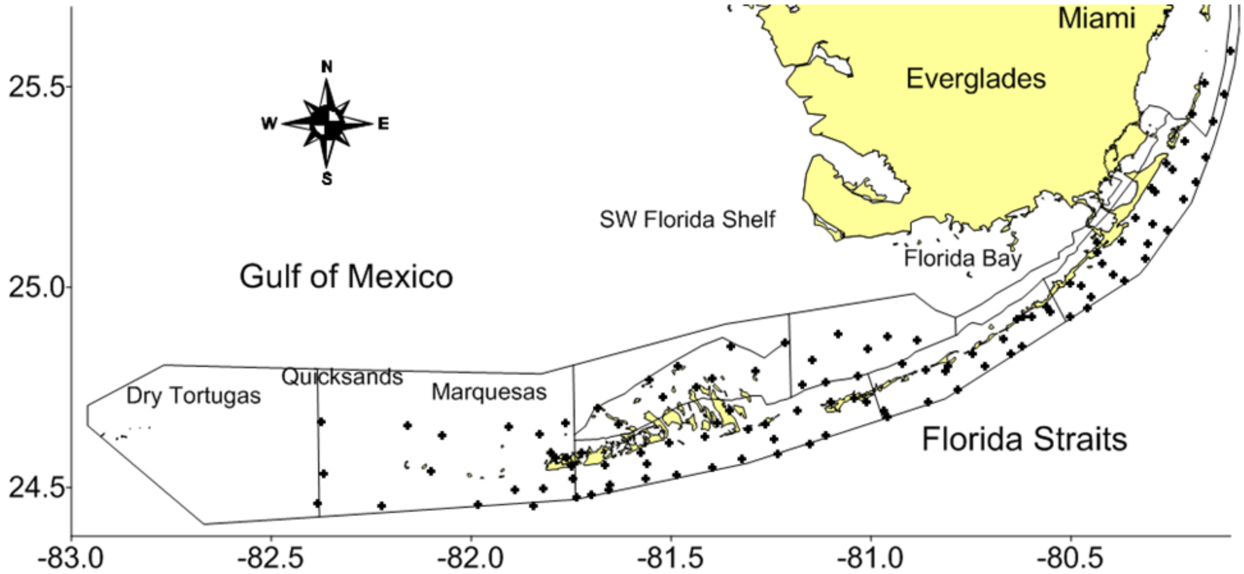
2014 ANNUAL REPORT
OF THE WATER QUALITY MONITORING PROJECT
FOR THE WATER QUALITY PROTECTION PROGRAM
OF THE FLORIDA KEYS NATIONAL MARINE SANCTUARY



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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. 2014 and includes data from 78 quarterly sampling events within the FKNMS. This annual report reflects funding cutbacks in 2012 resulting in reduction of spatial sampling from 155 to 112 sites.

Field parameters measured at each station (surface and bottom at most sites) 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 quality variables include the dissolved nutrients nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+), and soluble reactive phosphorus (SRP). Total unfiltered concentrations include those of nitrogen (TN), organic carbon (TOC), phosphorus (TP), silicate (SiO_2) and chlorophyll *a* (CHLA, µg l^{-1}).

The EPA developed Strategic Targets for the Water Quality Monitoring Project (SP-47) which state that beginning in 2008 through 2012, they shall annually maintain the overall water quality of the near shore and coastal waters of the FKNMS according to 2005 baseline. For reef sites, chlorophyll *a* should be less than or equal to 0.35 µg l^{-1} and the vertical attenuation coefficient for downward irradiance (K_d, i.e., light attenuation) should be less than or equal to 0.20 m^{-1}. For all monitoring sites in FKNMS, dissolved inorganic nitrogen should be less than or equal to 0.75 µM (0.010 ppm) and total phosphorus should be less than or equal to 0.25 µM (0.0077 ppm). Table 1 shows the number of sites and percentage of total sites exceeding these Strategic Targets for 2014.

We must recognize that the reduction of sampling sites in western FKNMS (less human-impacted sites) and the increase in inshore sites (heavily human-impacted sites) introduces a bias to the dataset which results in a reporting problem, perhaps requiring a revision of SP-47 to correct this deviation. To avoid such complications, we have not included the recently added locations (#500 to #509) in the calculation of compliances.

Table 1: EPA WQPP WQ Targets derived from 1995-2005 Baseline

For reef stations, chlorophyll less than or equal to 0.35 micrograms liter^{-1} (ug l^{-1}) and vertical attenuation coefficient for downward irradiance (K_d, i.e., light attenuation) less than or equal to 0.20 per meter; for all stations in the FKNMS, dissolved inorganic nitrogen less than or equal to 0.75 micromolar and total phosphorus less than or equal to 0.25 micromolar; water quality within these limits is considered essential to promote coral growth and overall health. The "number of samples" exceeding these targets is tracked and reported annually. Values in green are those years with % compliance greater than 1995-2005 baseline. Values in yellow are those years with % compliance less than 1995-2005 baseline.

EPA WQPP Water Quality Targets

Year	REEF Stations		All Stations (excluding SHORE sites)	
	CHLA ≤ 0.35 µg l^{-1}	K_d ≤ 0.20 m^{-1}	DIN ≤ 0.75 µM (0.010 ppm)	TP ≤ 0.25 µM (0.0077 ppm)
1995-05	1778 of 2367 (75.1%)	1042 of 1597 (65.2%)	7826 of 10254 (76.3%)	7810 of 10267 (76.1%)
2006	196 of 225 (87.1%)	199 of 225 (88.4%)	432 of 990 (43.6%)	316 of 995 (31.8%)
2007	198 of 226 (87.6%)	202 of 222 (91.0%)	549 of 993 (55.3%)	635 of 972 (65.3%)
2008	177 of 228 (77.6%)	181 of 218 (83.0%)	836 of 1,000 (83.6%)	697 of 1,004 (69.4%)
2009	208 of 228 (91.2%)	189 of 219 (86.3%)	858 of 1,003 (85.5%)	869 of 1,004 (86.6%)
2010	170 of 227 (74.9%)	176 of 206 (85.4%)	843 of 1000 (84.3%)	738 of 1,003 (73.6%)
2011	146 of 215 (67.9%)	156 of 213 (73.2%)	813 of 1012 (80.3 %)	911 of 1013 (89.9 %)
2012	142 of 168 (84.5%)	135 of 168 (80.4%)	489 of 683 (71.6 %)	634 of 684 (92.7 %)
2013	148 of 172 (86.0%)	150 of 172 (87.2%)	496 of 688 (72.1 %)	603 of 688 (87.6 %)
2014	141 of 172 (82.0%)	133 of 172 (77.3%)	426 of 690 (61.7%)	540 of 690 (78.3%)

Important Results Realized from this Monitoring Project

1. Land-based Influence on Water Quality

We documented elevated nutrient concentrations (DIN, TN, TP, and SiO_2) in waters close to shore along the Keys, and their corresponding responses from the system, such as higher phytoplankton biomass (CHLA), turbidity, as well as lower salinity and DO in the water column. These changes, associated to human impact, have become even more obvious by the addition of 10 stations (# 500 to #509) located very close to shore, (within the so-called 500 m Halo; FDEP 2011) sampled since Nov 2011 (SHORE).

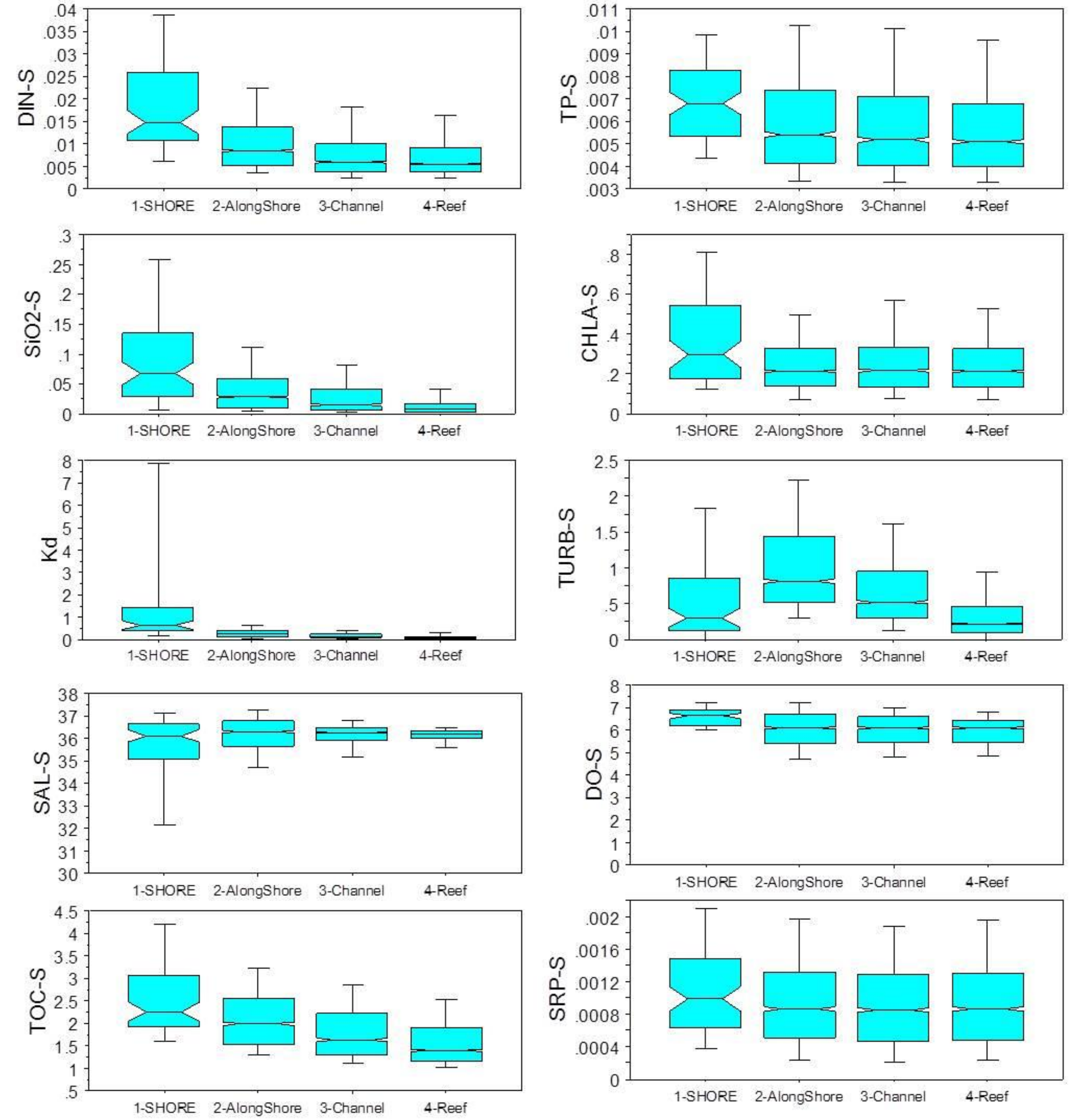

Figure i. *Nutrient and response changes along transect from shore sites to reef-track*

This trend, especially for DIN was evident from our first sampling event in 1995 and was not observed in a comparison transect from the Tortugas (no human impact). This pattern suggests a land-bound, freshwater end-member as the main nutrient source. In summary, this type of distribution would imply a relatively nutrient-rich land source which is diluted by low nutrient Atlantic Ocean waters.

2. Trend analysis

Surface DO has increased in all areas of the FKNMS (Fig. ii). Greatest increases in surface DO were generally observed on the Atlantic side of the Keys and in some inshore areas on the Atlantic side. Bottom DO trends showed a similar pattern as surface with more increased DO than surface sites (Fig. iii). Increased DO is beneficial for animal life.

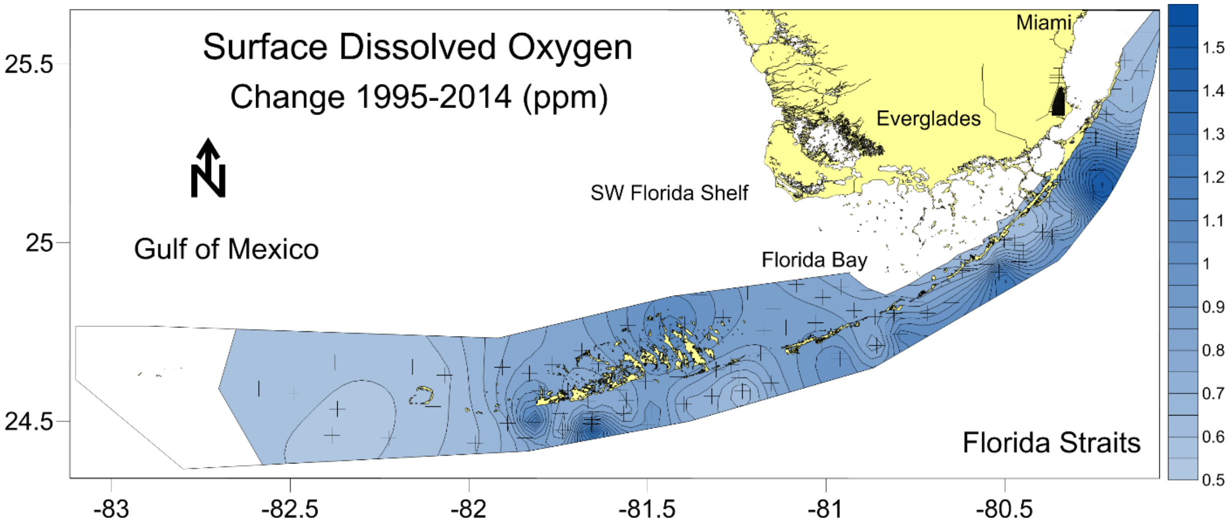

Figure ii. *Total change in DO of surface waters for 20 year period calculated from significant trends (p<0.10).*

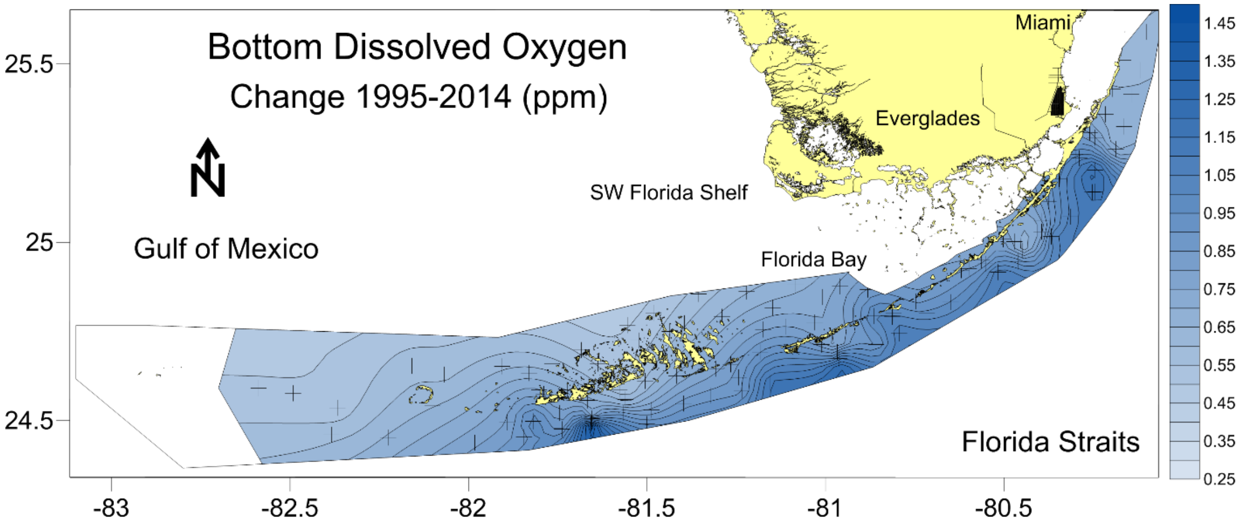

Figure iii. *Total change in DO of bottom waters for 20 year period calculated from significant trends (p<0.10).*

Water column turbidity, or cloudiness, declined throughout the FKNMS during the 20 year period (Fig iv). There was no significant change in turbidity in bottom waters. The largest declines in turbidity occurred in western Florida Bay and Marquesas.

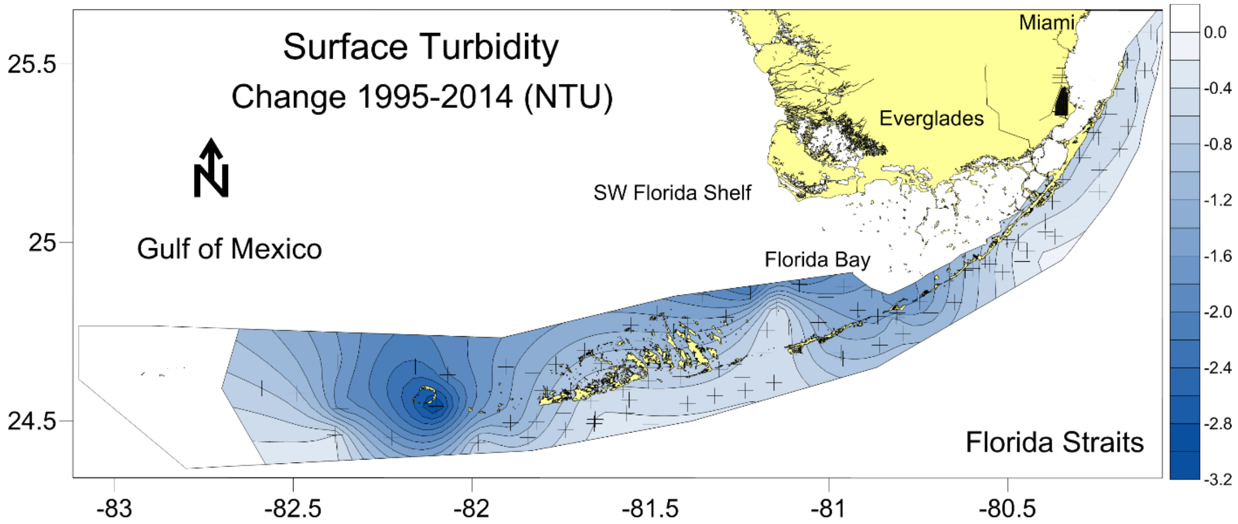

Figure iv. *Total change in Turbidity in surface waters for 20 year period calculated from significant trends (p<0.10).*

Although K_d did not show significant trend, decreased turbidity affected the amount of light reaching the bottom (I_o in %). I_o increased at most reef sites throughout the Keys (Fig. v). More light on the bottom is beneficial to corals, seagrass, and algae. Interestingly, the Backcountry area of the lower Keys experienced increases in K_d which lead to corresponding decreases in I_o.

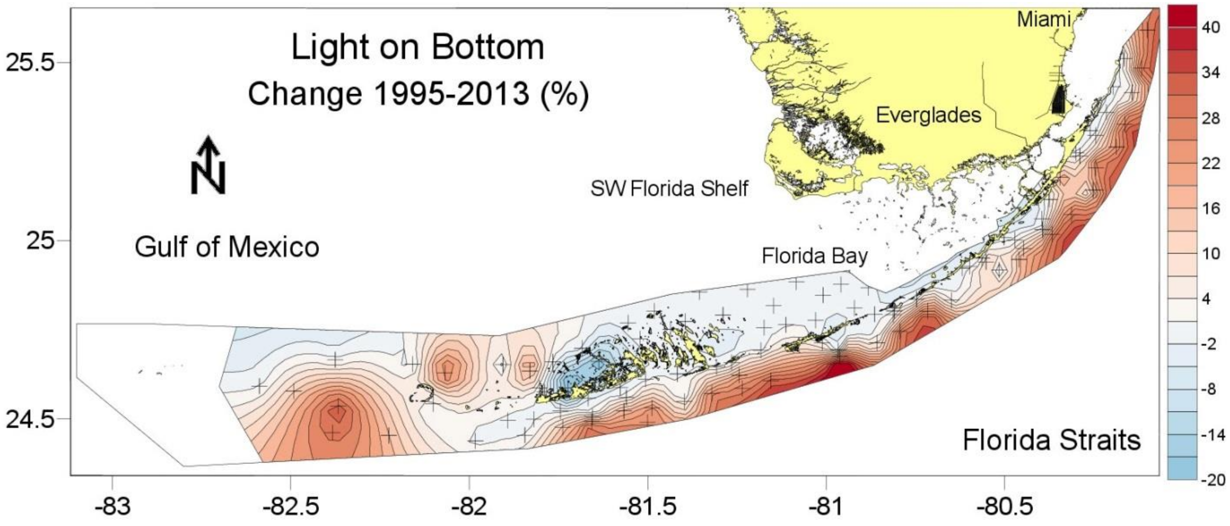

Figure v. *Total change in bottom I_o for 20 year period calculated from significant trends (p<0.10).*

Silicate in surface waters increased in western Florida Bay but declined slightly across the region (Fig vi). The source of SiO_2 in this region is Everglades runoff (diatomaceous periphyton). No significant trend in bottom waters was evident.

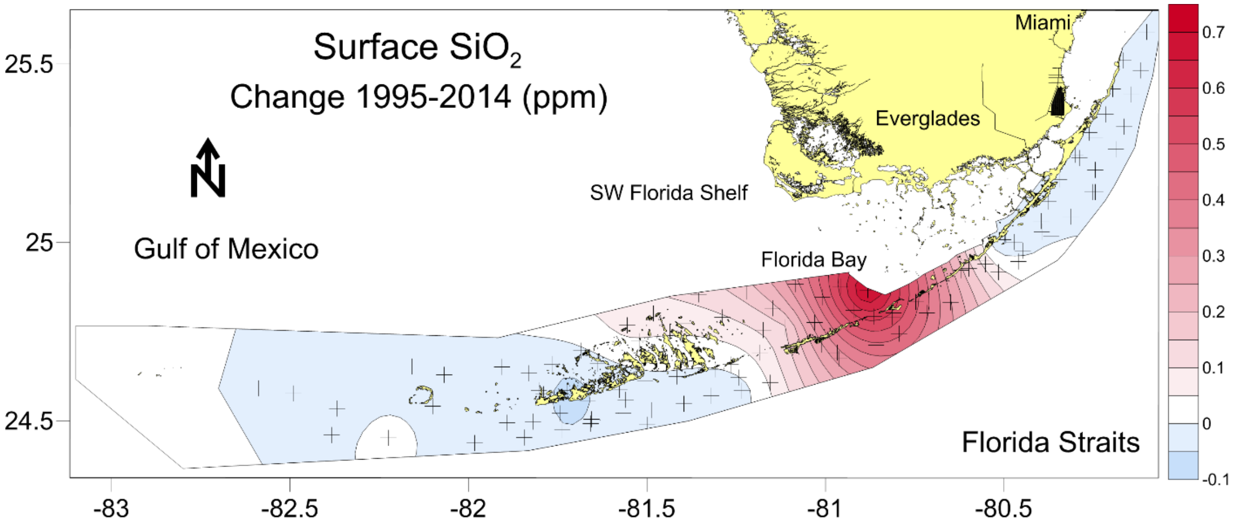

Figure vi. *Total change in SiO_2 in surface waters for 20 year period calculated from significant trends ($p<0.10$).*

No significant trends in TP were observed, however concentrations of SRP did increase in most surface waters (Fig. vii). It must be noted that concentrations of SRP are generally an order of magnitude lower than TP and are usually below kinetic uptake threshold of phytoplankton, meaning it is not all that accessible.

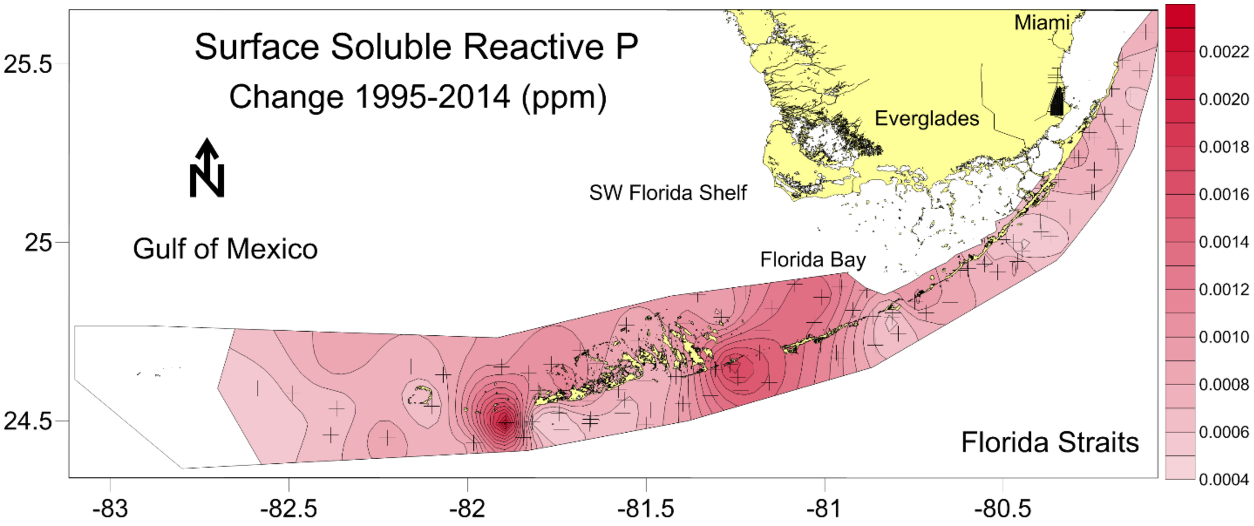

Figure vii. *Total change in SRP in surface waters for 20 year period calculated from significant trends ($p<0.10$).*

Clearly, there have been some changes in the FKNMS water quality over time, but the largest sustained monotonic trend has been the decline in surface TOC concentration. There were strong declines in surface TOC throughout the FKNMS, especially in the Backcountry and the Marquesas (Fig. viii). This is part of a regional trend in TOC observed on the SW Shelf, Florida Bay, and the mangrove estuaries draining the Everglades. This decline could be considered favorable given that TOC corresponds with CDOM (an important driver of water color and light penetration), but could also be an indication of decreased upstream primary production.

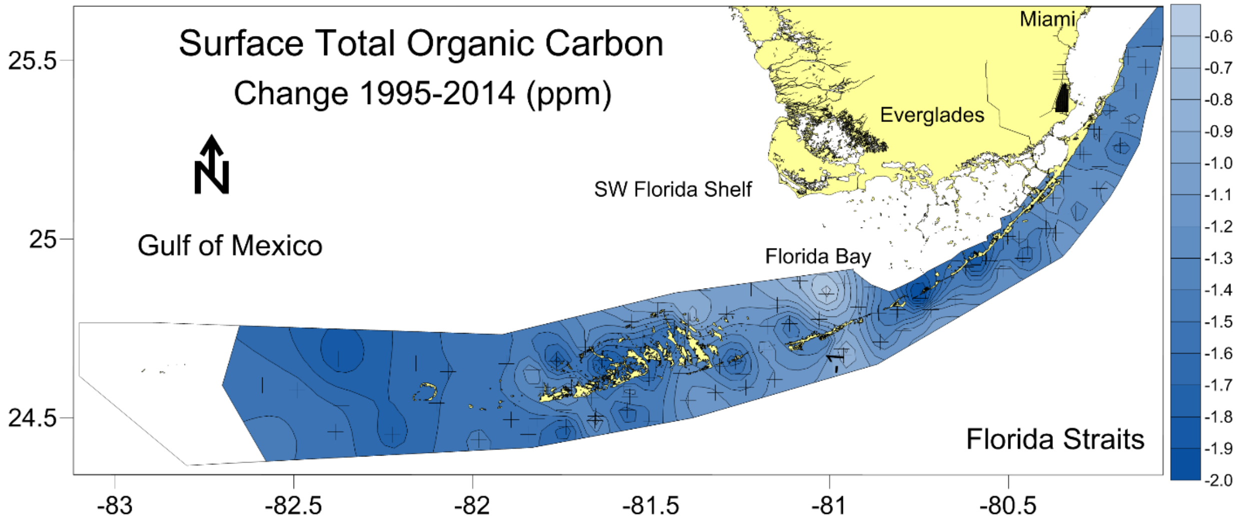

Figure viii. *Total change in TOC in surface waters for 20 year period calculated from significant trends (p<0.10).*

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. This confirms that 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 and reports from the FKNMS are integrated with other available programs.