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2018 Annual Report of the Water Quality Monitoring Project for the Water Quality Protection Program of the Florida Keys National Marine Sanctuary

Henry O. Briceño
Southeast Environmental Research Center, Florida International University, bricenoh@fiu.edu

Joseph N. Boyer
Plymouth State University, boyerj@fiu.edu

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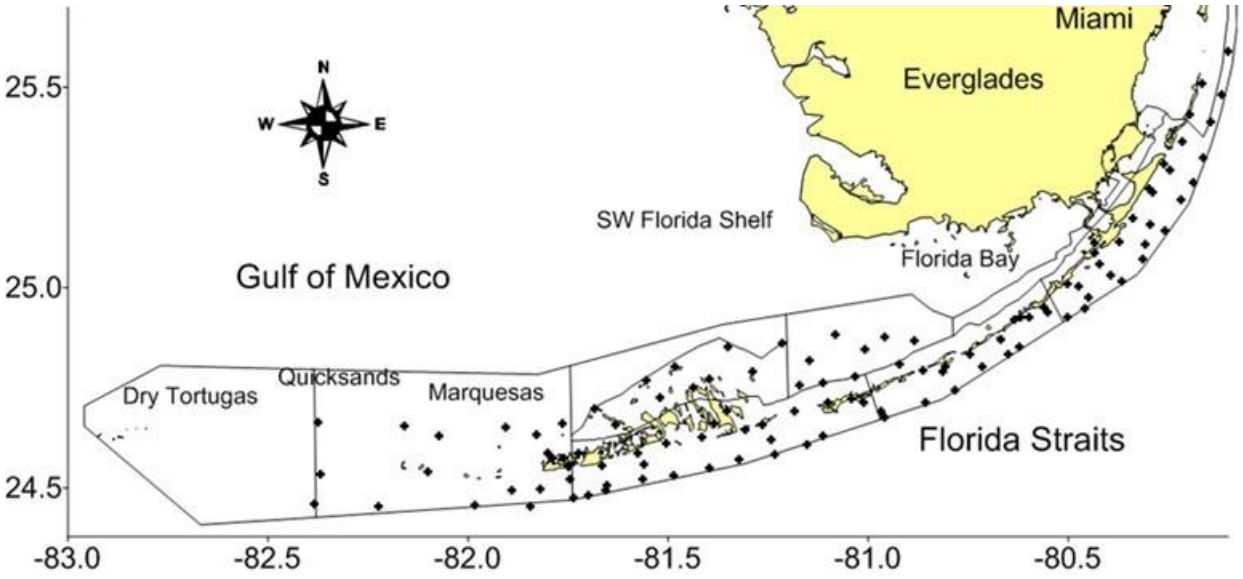
OF THE WATER QUALITY MONITORING PROJECT
FOR THE WATER QUALITY PROTECTION PROGRAM
OF THE FLORIDA KEYS NATIONAL MARINE SANCTUARY



Principal Investigators:
Henry O. Briceño[1] & Joseph N. Boyer[2]

[1]Southeast Environmental Research Center
OE-148, Florida International University
Miami, FL 33199. http://serc.fiu.edu/wqmnetwork/

[2]Center for Research & Innovation, Plymouth State University,
MSC 03, 17 High St., Plymouth, NH 03264

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Henry O. Briceño & Joseph N. Boyer
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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 Apr. 1995 – Dec. 2018 and includes data from 94 quarterly sampling events within the FKNMS (24 years).

Field parameters measured at each station (surface and bottom at most sites) include salinity (practical salinity scale), temperature (°C), 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}). All variables are reported in ppm (mg l^{-1}) unless otherwise noted.

The EPA developed Strategic Targets for the Water Quality Monitoring Project (SP-47) which state that beginning in 2008 through 2018, 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 2018.

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 Water Quality 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 and percentage 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				
	REEF Stations		All Stations (excluding SHORE sites)	
Year	CHLA ≤ 0.35 µg l^{-1}	K_d ≤ 0.20 m^{-1}	DIN ≤ 0.75 µM (0.010 mg l^{-1})	TP ≤ 0.25 µM (0.008 mg l^{-1})
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 1,000 (84.3%)	738 of 1,003 (73.6%)
2011	146 of 215 (67.9%)	156 of 213 (73.2%)	813 of 1,012 (80.3 %)	911 of 1,013 (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%)
2015	122 of 172 (70.9%)	135 of 172 (78.5%)	487 of 688 (70.8%)	613 of 688 (89.1%)
2016	131 of 172 (76.2%)	129 of 170 (75.9%)	427 of 687 (62.2%)	549 of 688 (79.8%)
2017	106 of 172 (61.6%)	120 of 170 (70.6%)	440 of 575 (76.5 %)	581 of 683 (85.1 %)
2018	92 of 170 (54.1%)	108 of 152 (71.7%)	558 of 689 (81.0 %)	573 of 689 (82.3 %)

Trend Analysis – 24 years

No significant trends were observed for temperature or salinity however, surface and bottom dissolved oxygen saturation did increase in most areas of the FKNMS. Increased DO_{sat} is generally beneficial for animal life. Greatest increases in DO_{sat} occurred on the Atlantic side of the Keys, Marquesas, and in some inshore areas on the Bay side (Fig. ii). Bottom DO_{sat} trends were similar (not shown).

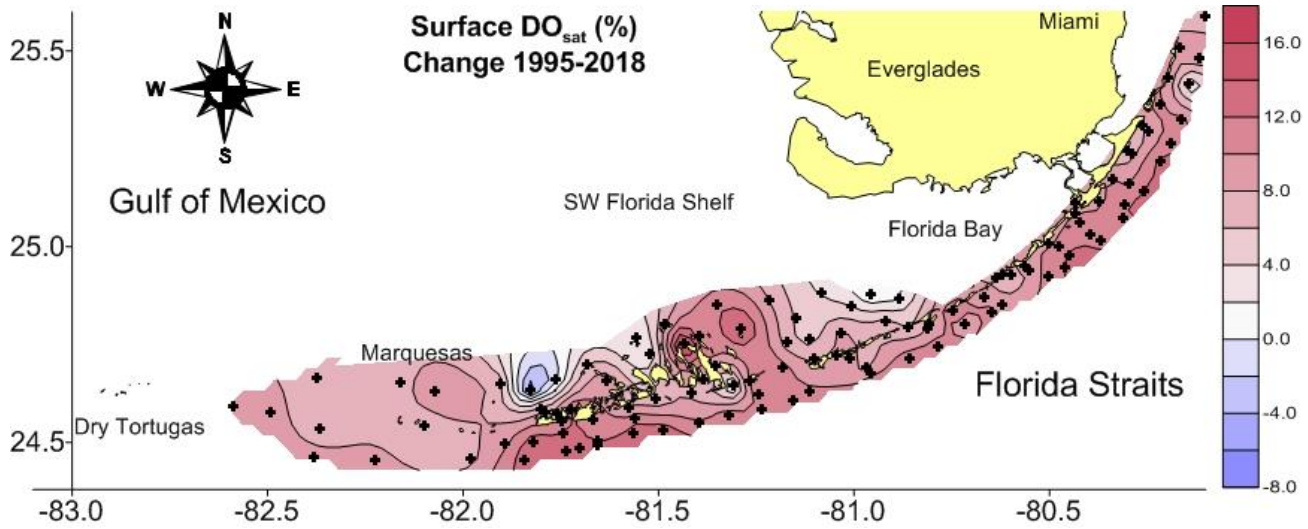

Figure ii. *Total change in DO saturation of surface waters for 24 year period.*

Water column turbidity (cloudiness) declined throughout the FKNMS during the 24 year period (beneficial trend). Some change in turbidity also occurred in bottom waters (not shown). The largest declines in turbidity occurred in northern bayside waters and the Marquesas (Fig iii).

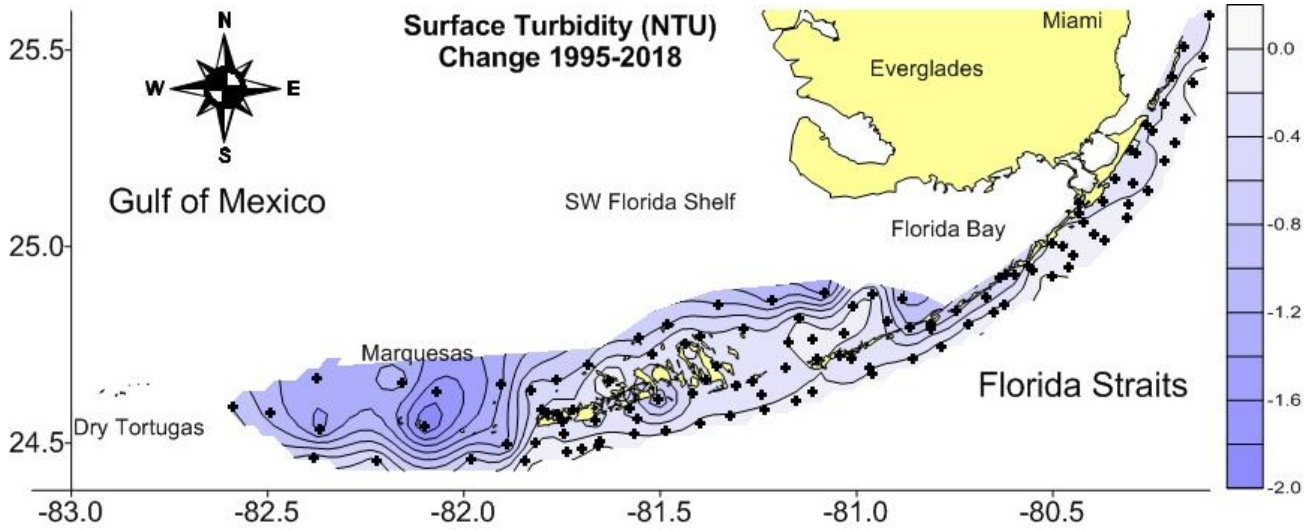

Figure iii. *Total change in turbidity in surface waters for 24 year period.*

Decreased turbidity influenced light extinction (K_d) through the water column (Fig. iv) and inversely affected the percent of surface light (I_o) reaching the bottom. Bottom light increased at most reef/offshore sites throughout the Keys and Marquesas (Fig. v). More light on the bottom is beneficial to corals, seagrass, and algae. Interestingly, the Backcountry and Sluiceway areas experienced increases in K_d with corresponding decreases in bottom light, but were not the result of increased turbidity (Fig. iii).

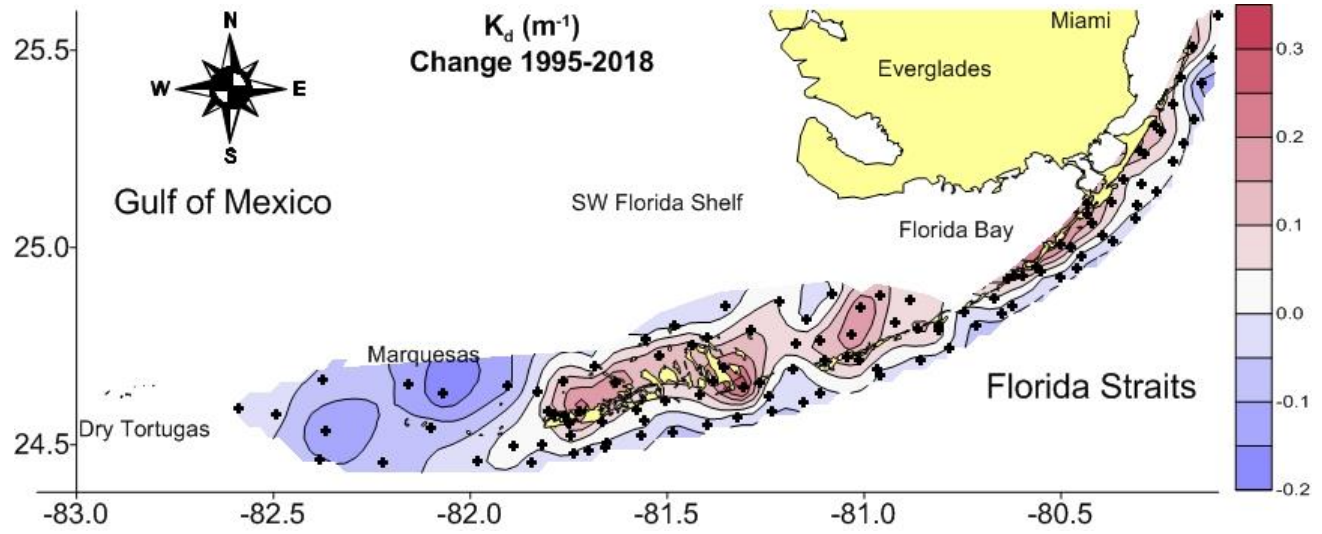

Figure iv. *Total change in K_d in surface waters for 24 year period.*

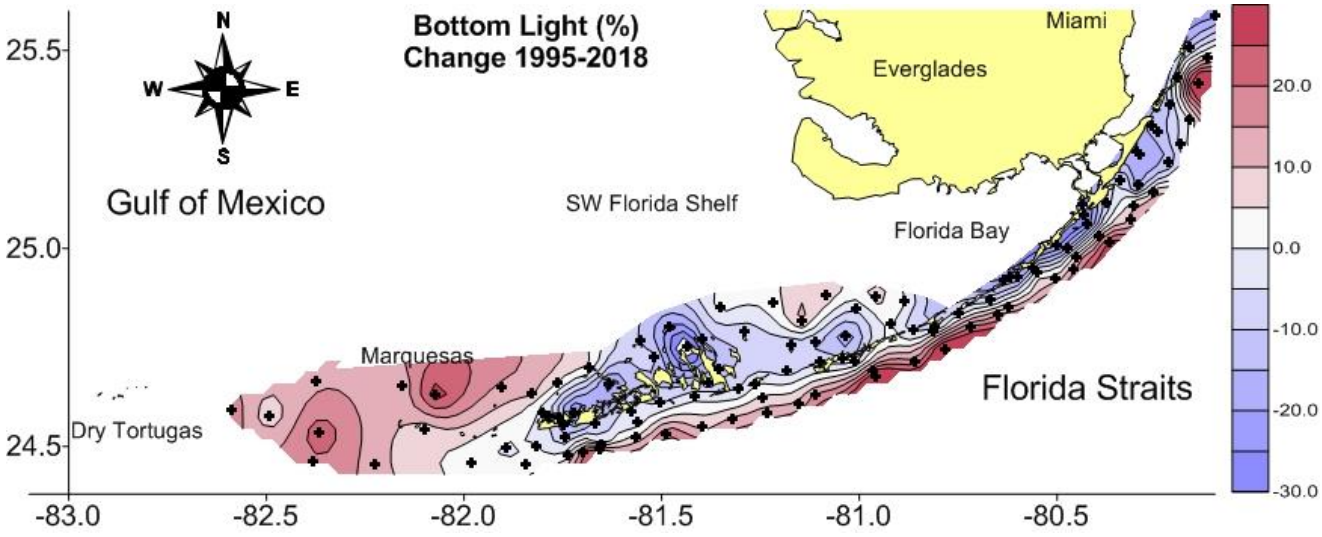

Figure v. *Total change of incident bottom light for 24 year period.*

Significant Keys-wide trends in NH_4^+, NO_3^-, TP, and SRP were detected but were very minor (not shown). However, chlorophyll *a* exhibited variable trends, declining in the Marquesas while increasing in Backcountry, Sluiceway, and some Keys areas (Fig. vi). The absolute changes were relatively small compared to normal concentrations (5-20% increase over 24 yr), but should be watched for continued trends.

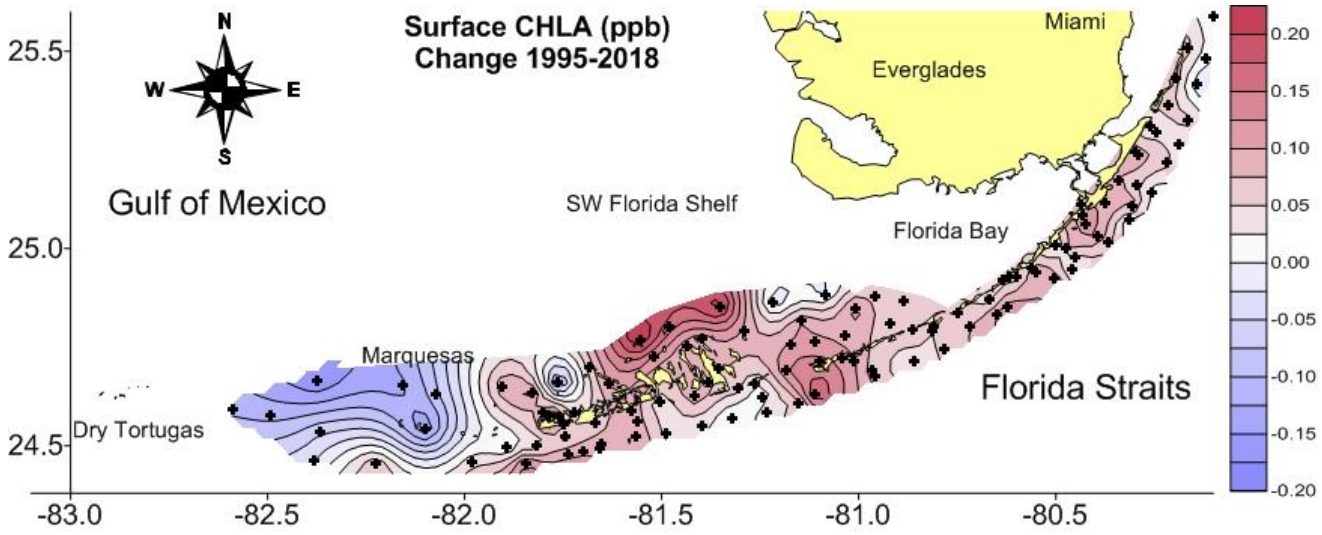

Figure vi. *Total change in CHLA in surface waters for 24 year period.*

The largest sustained monotonic trends have been the decline in surface total organic carbon and nitrogen, especially in the Backcountry and the Marquesas (Fig. vii & viii). This is part of a regional trend in TOC observed in earlier monitoring on the SW Shelf, Florida Bay, and the Everglades mangrove estuaries. This decline could be considered favorable given that TOC is an important component of water color and negatively affects light penetration, but could also be an indication of decreased terrestrial primary production and export. It might also be characteristic of a Gulf-wide trends

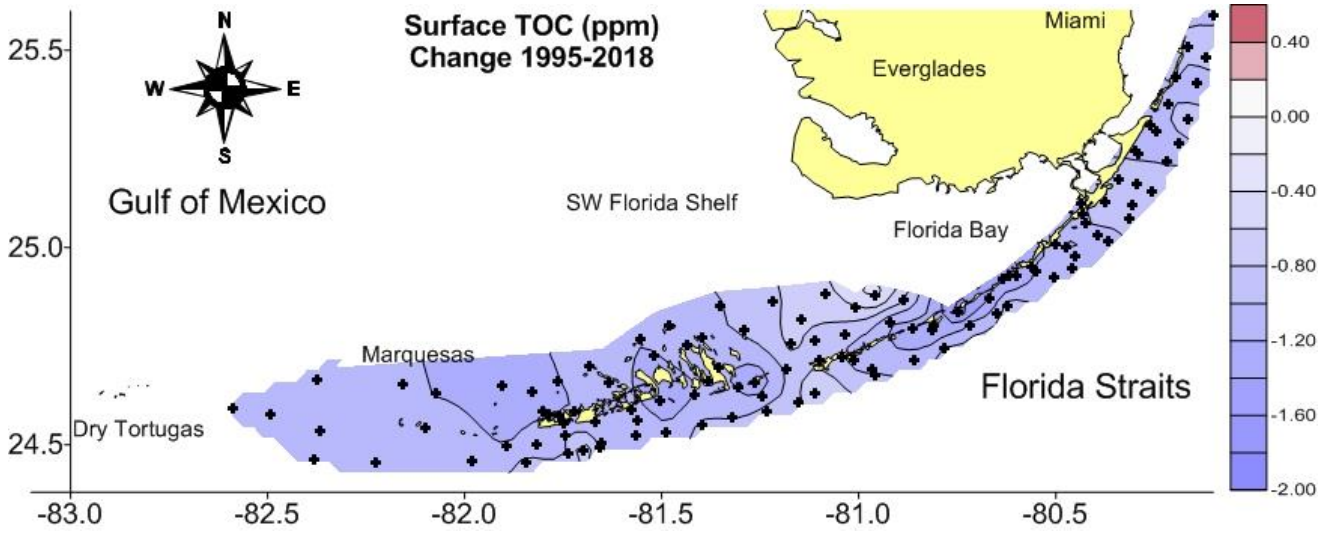

Figure vii. *Total change in TOC in surface waters for 24 year period.*

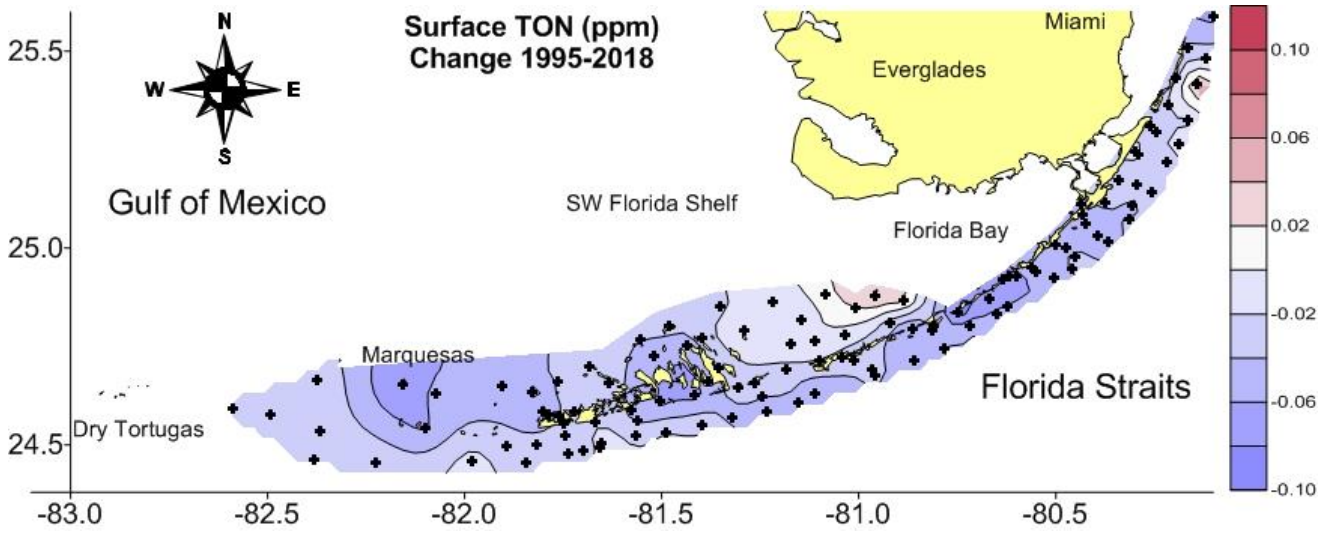

Figure viii. *Total change in TON in surface waters for 24 year period.*

The DIN:TP ratio, a way to assess phytoplankton nutrient limitation, has also declined overall (Fig. ix), especially in Upper and Lower Keys. This implies that primary production in those areas may be becoming more N limited. The influence of the SW Shelf waters moving through the Middle Keys and Marquesas has attenuated any changes in those areas.

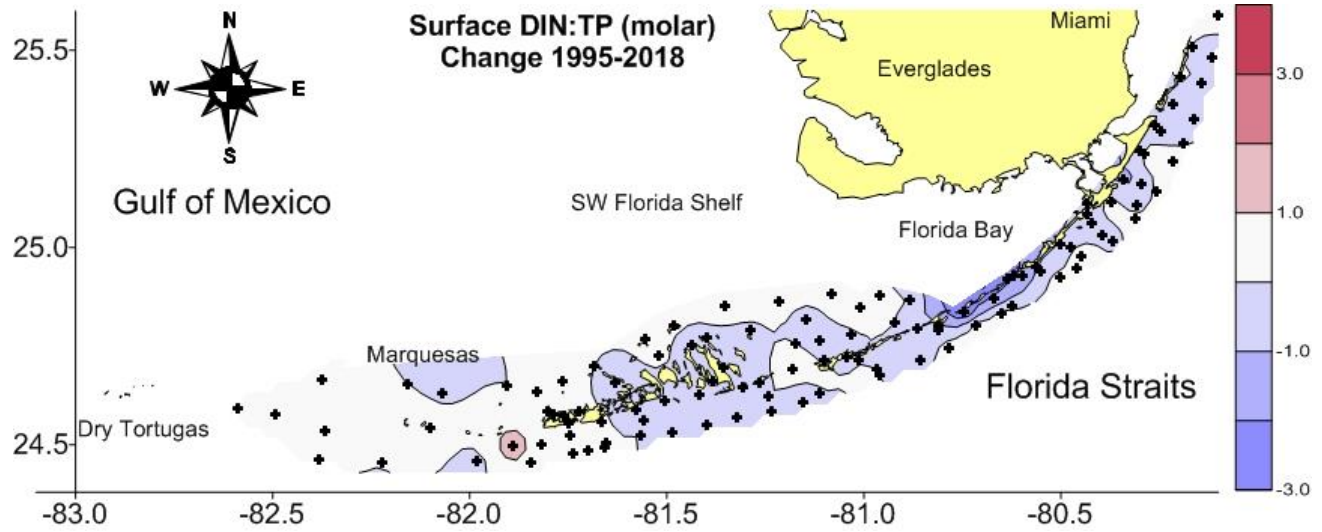

Figure ix. *Total change in DIN:TP ratio in surface waters for 24 year period calculated from significant trends.*

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 programs.