2020 ANNUAL REPORT

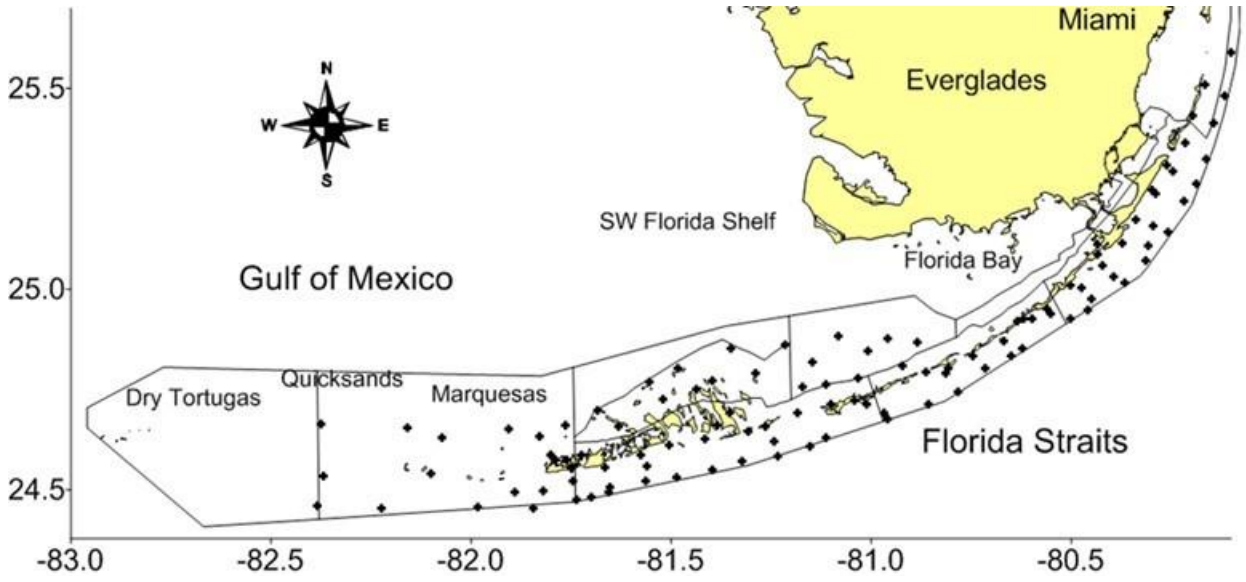
OF THE WATER QUALITY MONITORING PROJECT FOR THE WATER QUALITY PROTECTION PROGRAM OF THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Henry O. Briceño, Ph.D. & Joseph N. Boyer, Ph.D.

July 2021

This page is intentionally left blank

2020 ANNUAL REPORT
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]Institute of Environment, Freshwater Resources and Coastlines and Oceans Divisions
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

US EPA Agreement #X7-00049716-0

This is contribution number 1030 from the Southeast Environmental Research Center
in the Institute of Environment at Florida International University

2021

Cover by OlivaB©

2020 ANNUAL REPORT
OF THE WATER QUALITY MONITORING PROJECT
FOR THE WATER QUALITY PROTECTION PROGRAM
OF THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

Henry O. Briceño & Joseph N. Boyer
Funded by the Environmental Protection Agency (#X7-00049716-0)

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. 2020 and includes data from 102 quarterly sampling events within the FKNMS (26 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 2020, 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 (0.008 ppm). *Table i* shows the number of sites and percentage of total sites exceeding these Strategic Targets for 2019. In addition, *Figure i* shows percent of sites meeting the targets for DIN, TP, CHLA, and K_d.

The 2011 reduction of sampling sites in Tortugas/western FKNMS (TORT, less human-impacted sites) and addition of close in, shore sites (SHORE, heavily human-impacted sites) introduces a bias to the dataset which might require a revision of SP-47 to correct this deviation. To avoid such complications, we have not included the TORT or SHORE stations in calculation of compliances after 2010.

Table i: 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 %)
2019	112 of 171 (65.5%)	133 of 168 (79.2%)	669 of 684 (97.8 %)	587 of 686 (85.6 %)
2020	129 of 172 (75.0%)	141 of 169 (83.4%)	617 of 688 (89.7%)	466 of 688 (67.7%)

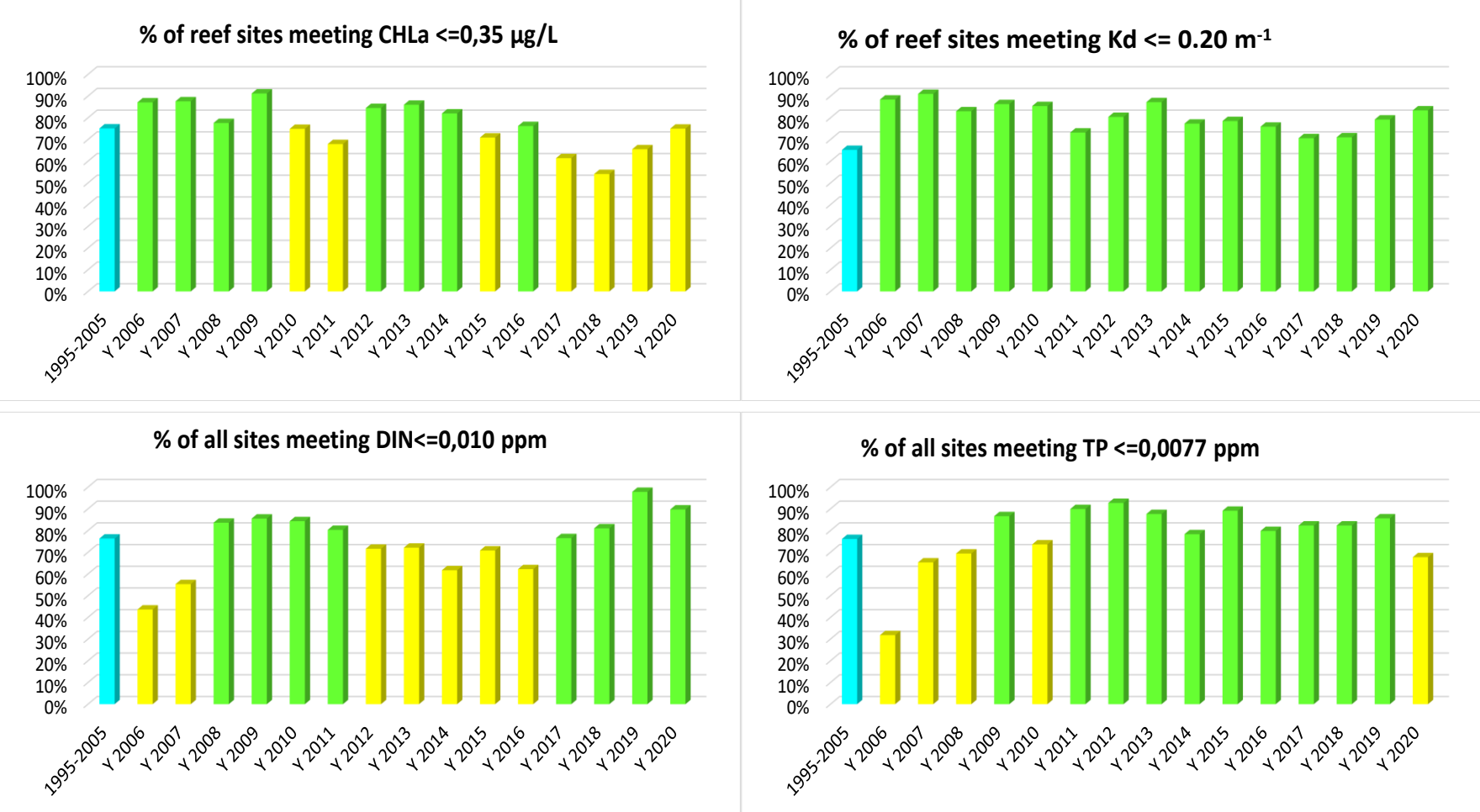


Figure i. *EPA targets expressed as percent of sites meeting baseline criteria by year. Color Code as in Table i.*

Trend Analysis – 26 years

Few statistically significant trends were observed for temperature or salinity however, there were patterns in total change for the 26 period of record across the FKNMS (*Fig. ii & iii*). The areas in red – Sluiceway, Backcountry, Upper Keys – show small increase in salinity over time, perhaps influenced by more saline water coming from Florida bay and Shelf. The offshore Lower Keys exhibited lower salinities. Small overall decreases in temperature were confined to Sluiceway and Lower Keys (<-1.0°C) while increases occurred in Upper Keys and Marquesas.

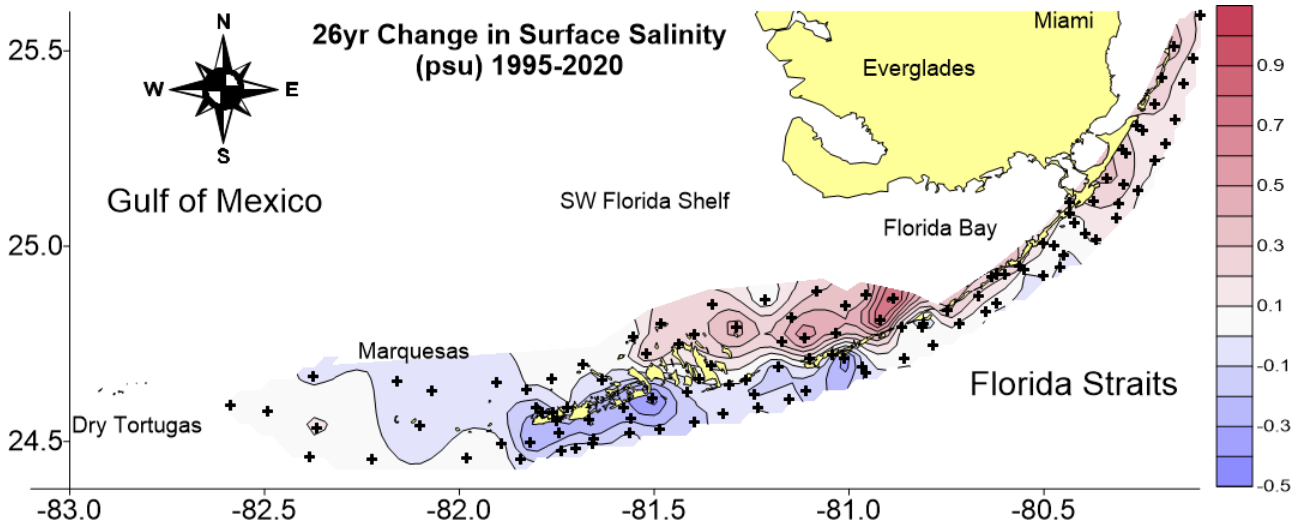


Figure ii. *Total change in salinity of surface waters for 26-year period.*

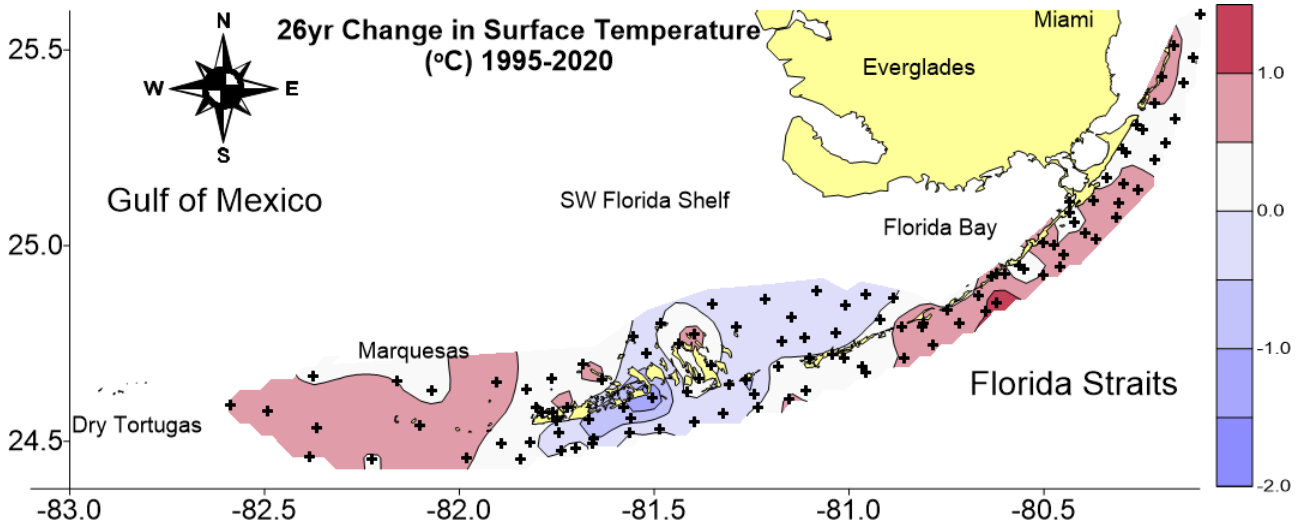


Figure ii. *Total change in temperature of surface waters for 26-year period.*

Greatest increases in DO_{sat} occurred offshore the Keys, Middle Keys passes (*Fig. iv*). Increased DO_{sat} is generally beneficial for animal life. Bottom DO_{sat} trends were similar (not shown).

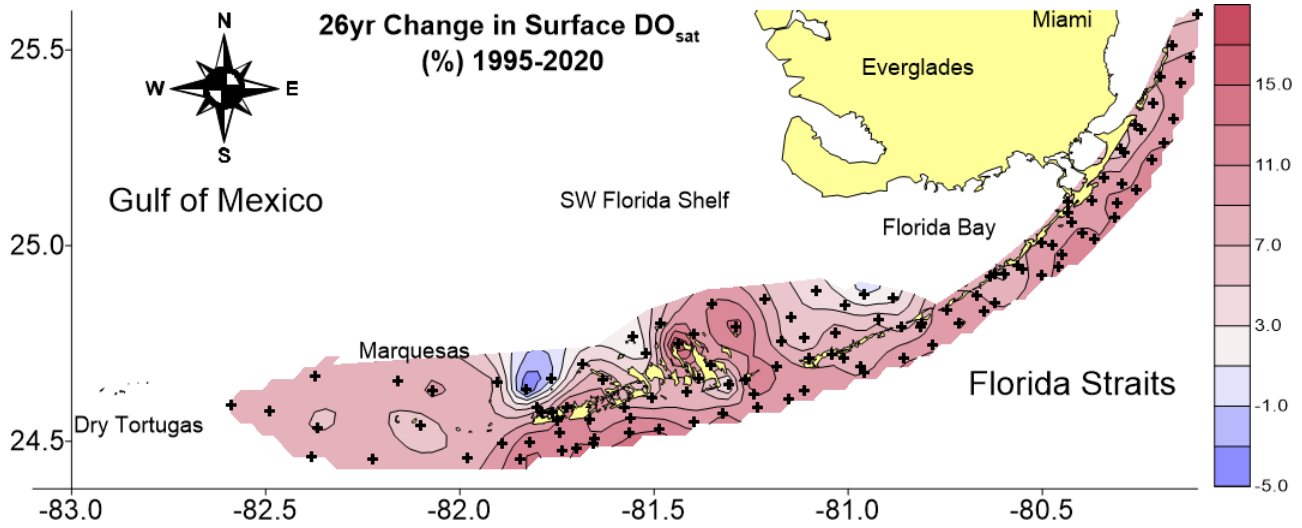


Figure iv. *Total change in DO saturation of surface waters for 26-year period.*

Water column turbidity (cloudiness) declined throughout the FKNMS during the 26-year period (a beneficial trend). The largest declines in turbidity occurred in the Sluiceway, Backcountry, and Marquesas (*Fig v*). Some small changes in turbidity also occurred in bottom waters (not shown).

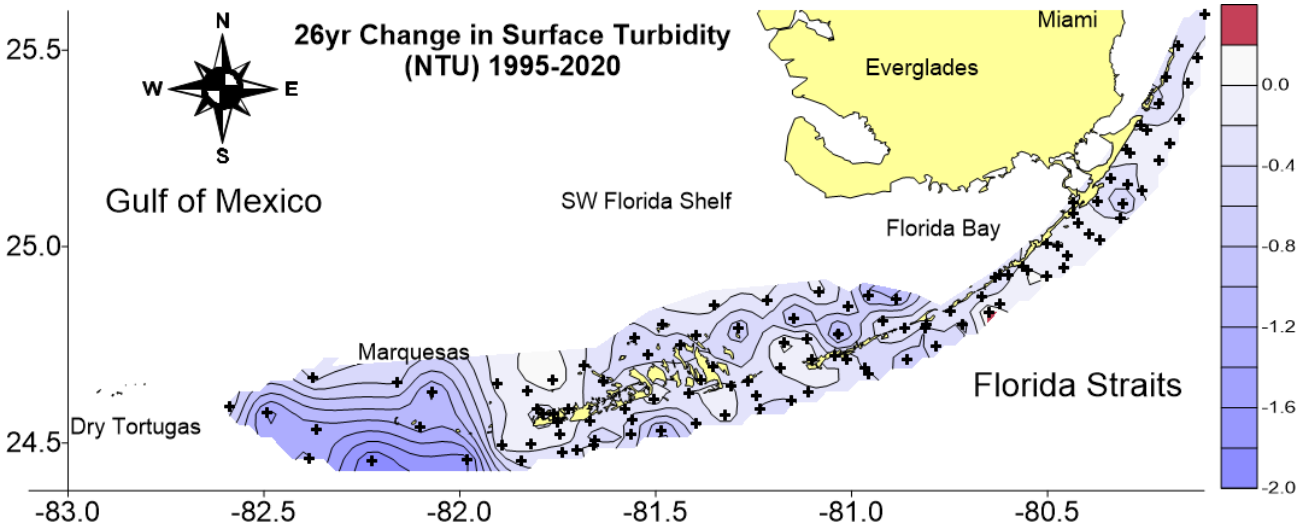


Figure v. *Total change in turbidity in surface waters for 26-year period.*

Decreased turbidity influenced light extinction (K_d) through the water column (*Fig. vi*) but not to a great extent. This inversely affected the percent of surface light (I_o) reaching the bottom. More light on the bottom is beneficial to corals, seagrass, and algae. Bottom light increased at most reef/offshore sites throughout the Keys and Marquesas but decreased in Backcountry, inshore sites along Keys, and Upper Keys in general (*Fig. vii*).

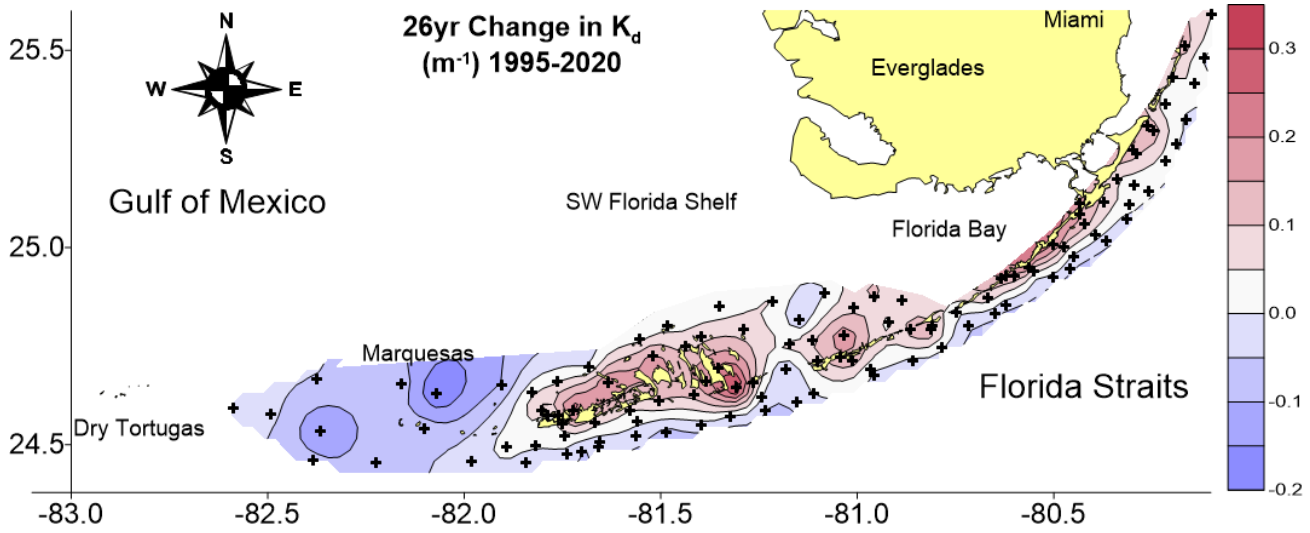


Figure vi. *Total change in K_d in surface waters for 26-year period.*

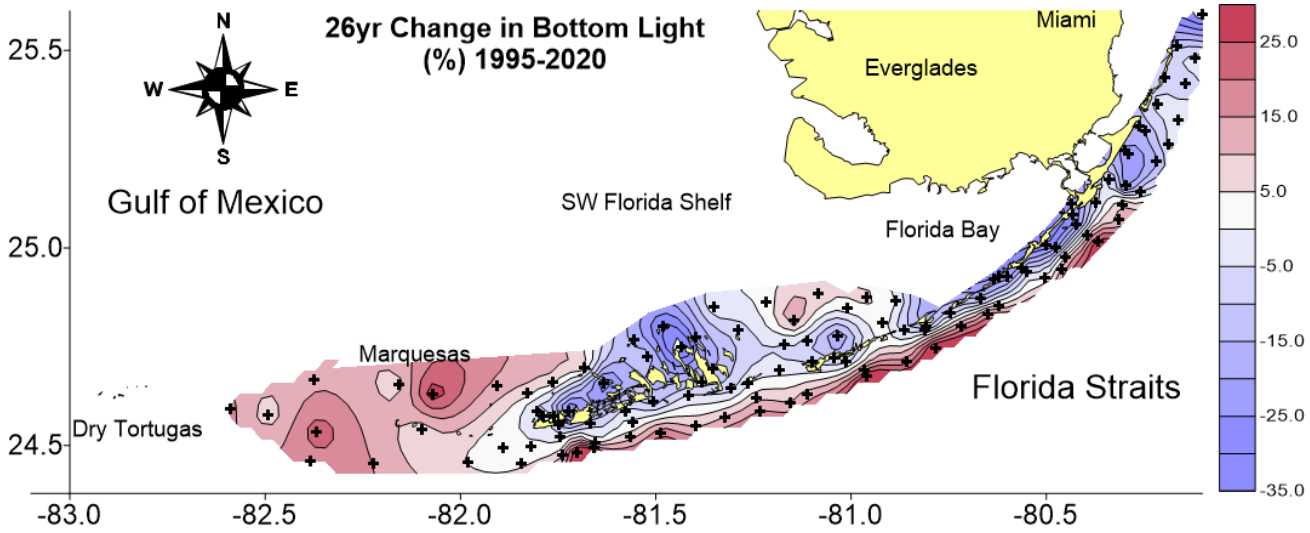


Figure vii. *Total change of incident bottom light for 26-year period.*

Significant Keys-wide trends in NH_4^+, NO_3^-, and SRP were detected but were very minor (not shown). Small declining trends in TP were observed in surface waters of the Marquesas but increases in TP occurred in all other areas of the FKNMS (Fig viii). These trends need to be watched as we expected TP to decline inshore in response to recent central sewer installation.

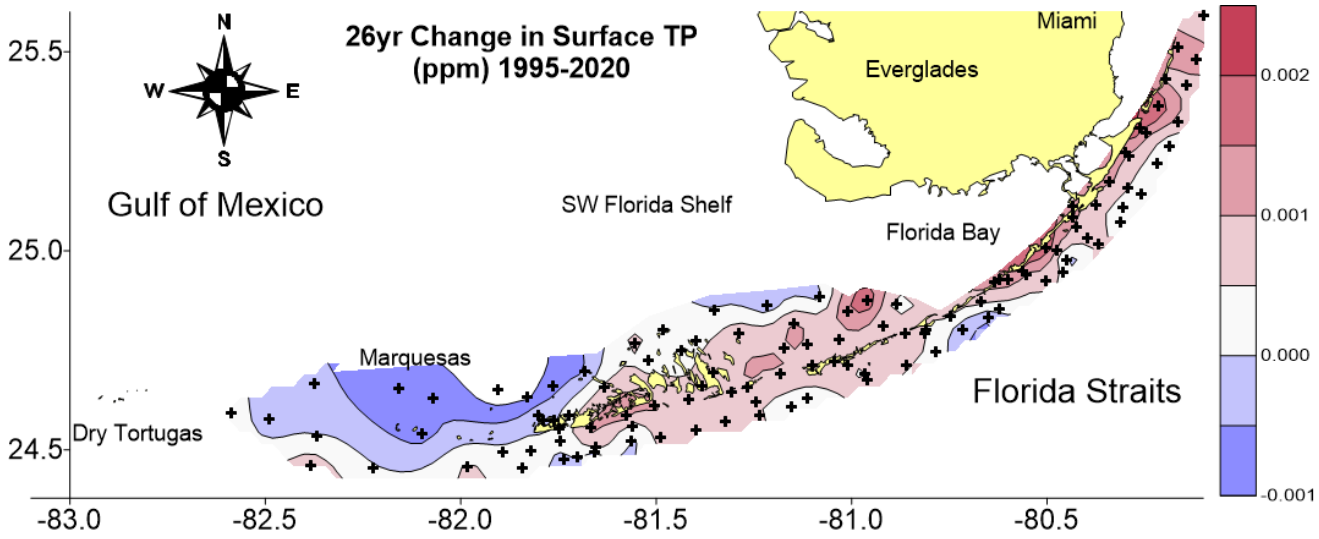


Figure viii. *Total change of TP for 26-year period.*

Chlorophyll *a* (CHLA) mirrored the spatial patterns in TP trends exhibited, declining in the Marquesas while increasing most everywhere else in the FKNMS (*Fig. ix*). Significant increases for the 26-year record ranged from 0.083 to 0.279 ppb or 28-68% increase.

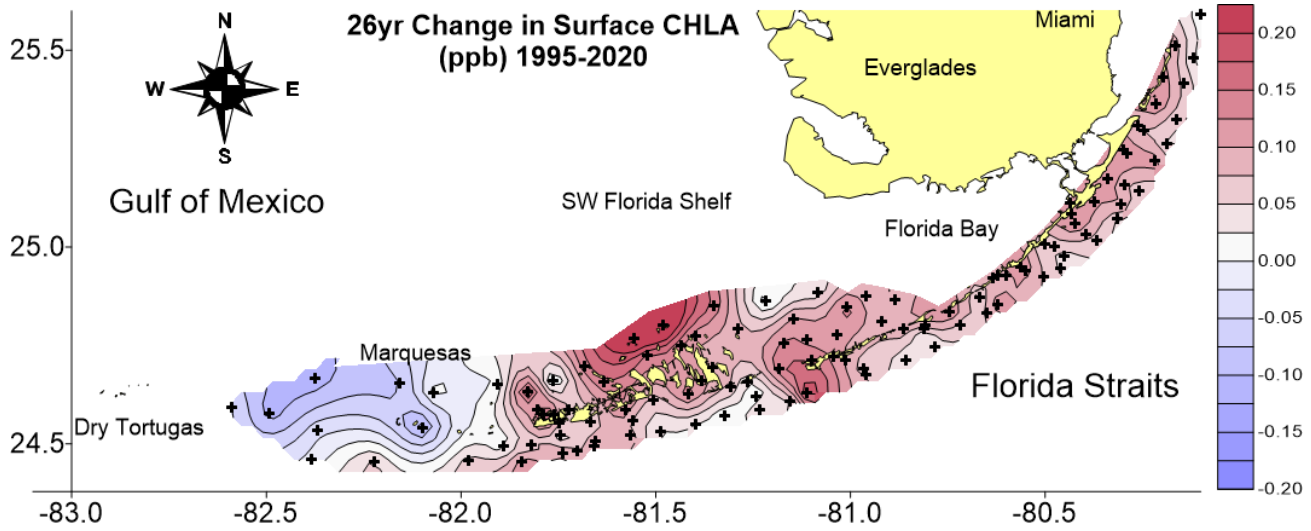


Figure ix. *Total change in CHLA in surface waters for 26-year period.*

The largest sustained trends have been the decline in surface total organic carbon (TOC) and nitrogen (TON; *Fig. x & xi*). This is part of a regional trend in TOC observed in earlier monitoring on the SW Shelf, and currently in Florida Bay, and the Everglades mangrove estuaries. This decline could be considered favorable given that TOC & TON are important components of water color and negatively affect light penetration, but could also be an indication of decreased terrestrial primary production and export. It might also be characteristic of a Gulf-wide trend.

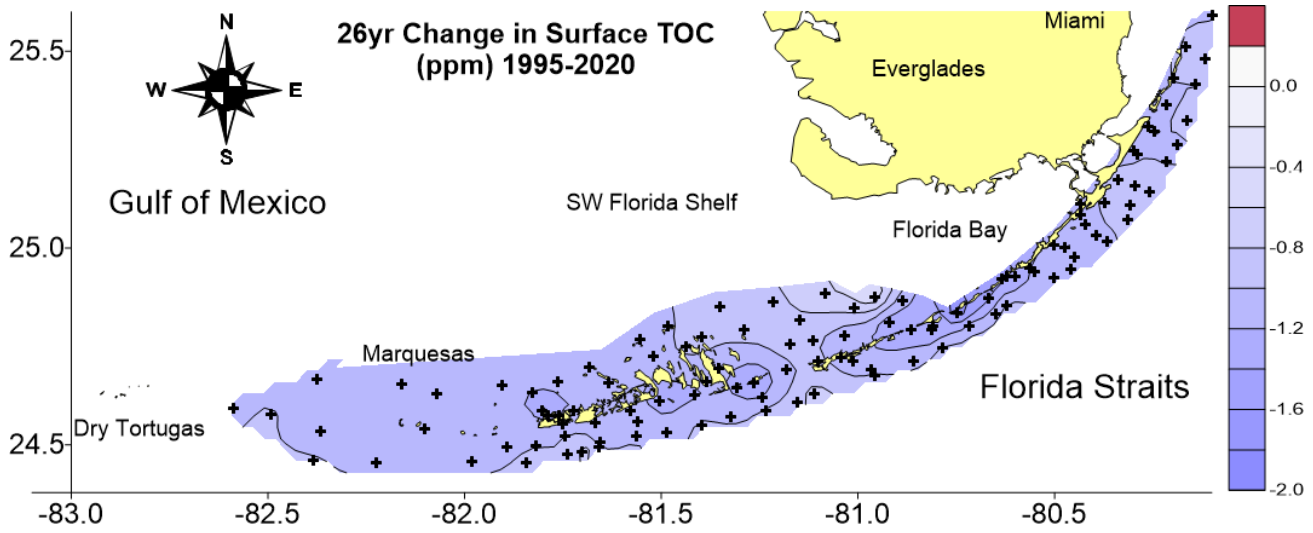


Figure x. *Total change in TOC in surface waters for 26-year period.*

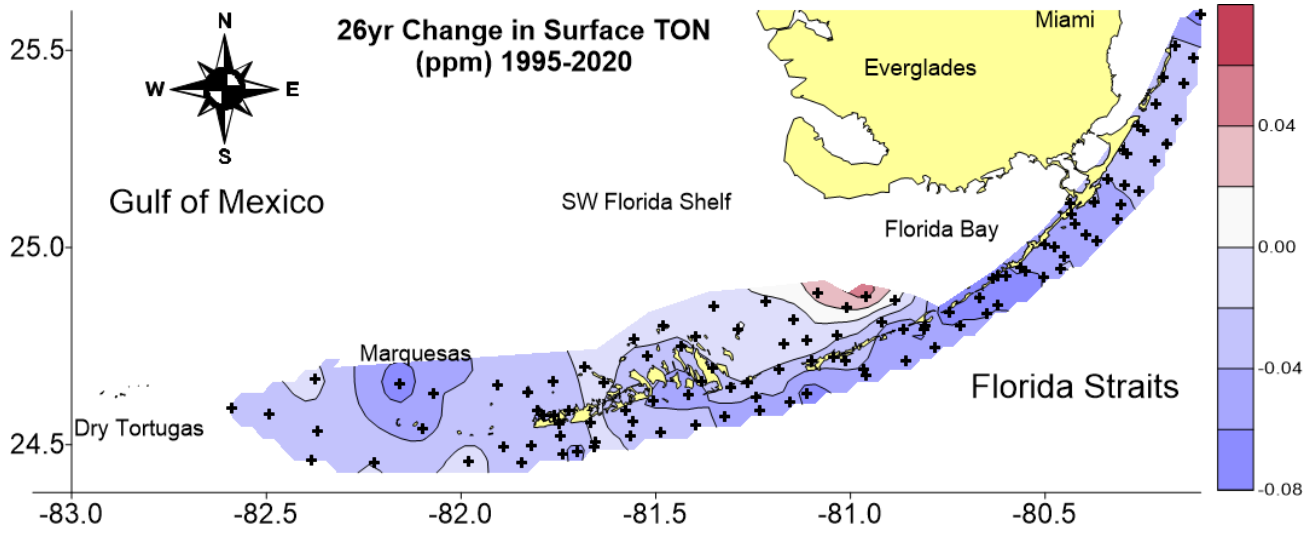


Figure xi. *Total change in TON in surface waters for 26-year period.*

The ratio between dissolved inorganic nitrogen and total phosphorus (DIN:TP) as a indicator for assessing phytoplankton nutrient limitation has also declined overall (*Fig. xii*). This implies that primary production may be becoming more N limited in the FKNMS.

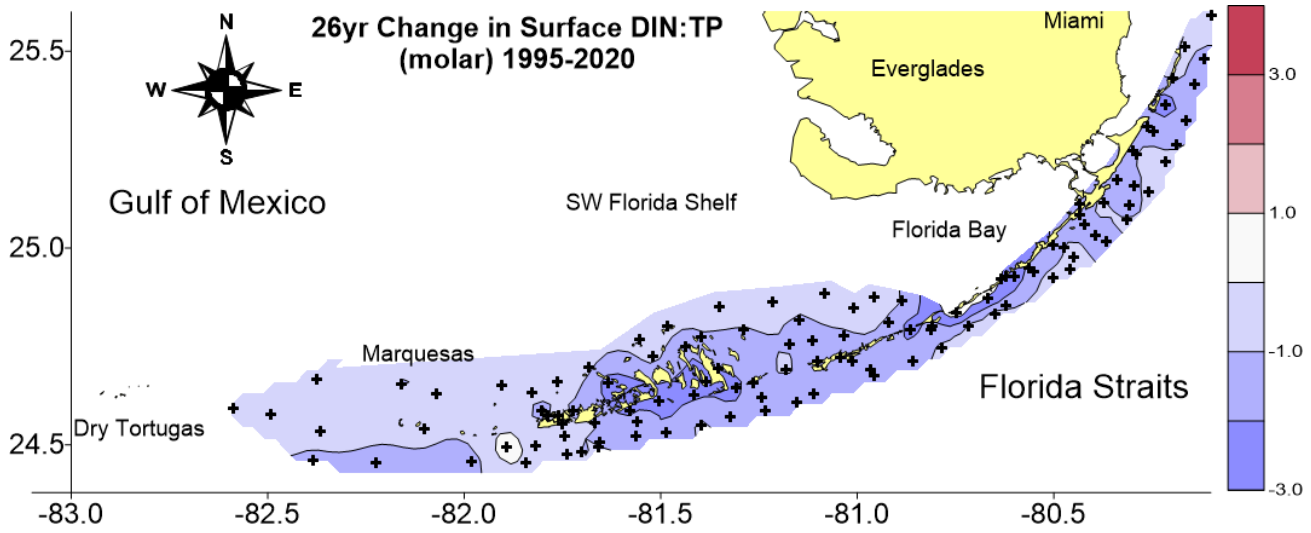


Figure xii. *Total change in DIN:TP ratio in surface waters for 26-year period.*

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 monitoring 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 this project accessible to the public.

Table of Contents

1. Project Background

The Florida Keys are an archipelago of sub-tropical islands of Pleistocene origin which extend in a NE to SW direction from Miami to Key West and out to the Dry Tortugas (Fig. 1). In 1990, President Bush signed into law the Florida Keys National Sanctuary and Protection Act (HR5909) which designated a boundary encompassing >2,800 square nautical miles of islands, coastal waters, and coral reef tract as the Florida Keys National Marine Sanctuary (FKNMS). The Comprehensive Management Plan (NOAA 1995) required the FKNMS to have a Water Quality Protection Plan (WQPP) thereafter developed by EPA and the State of Florida (EPA 1995). The original agreement for the water quality monitoring component of the WQPP was subsequently awarded to the Southeast Environmental Research Program at Florida International University and the field sampling program began in March 1995.

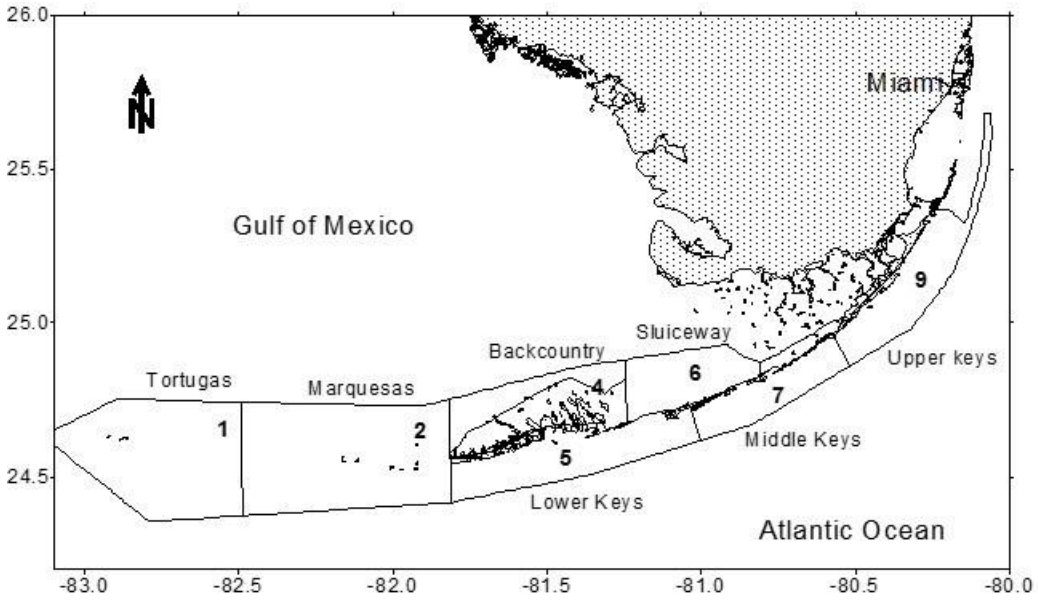


Figure 1*: Map of original FKNMS boundary including collapsed segment numbers and common names. Modified after Klein and Orlando (1994)*

The waters of the FKNMS are characterized by complex water circulation patterns over both spatial and temporal scales with much of this variability due to seasonal influence in regional circulation regimes. The FKNMS is directly influenced by the Florida Current, the Gulf of Mexico Loop Current, inshore currents of the SW Florida Shelf (SW Shelf), discharge from the Everglades through the Shark River Slough, and by tidal exchange with both Florida Bay and Biscayne Bay (Lee et al. 1994, Lee et al. 2002).

Advection from these external sources may significantly affect the physical, chemical, and biological composition of waters within the FKNMS, as may internal nutrient loading and freshwater runoff from the Keys themselves (Boyer and Jones 2002). Water quality of the

FKNMS may be directly affected by both external nutrient transport and internal nutrient loading sources (Gibson et al. 2008). Therefore, the geographical extent of the FKNMS as a political/regulatory boundary should not be thought of in any way as an enclosed ecosystem.

A spatial framework for FKNMS water quality management was proposed on the basis of geographical variation of regional circulation patterns (Klein and Orlando, 1994). The final implementation plan (EPA 1995) partitioned the FKNMS into 9 sub-areas which was collapsed to 7 for routine sampling (Fig. 1). Station locations were developed using a stratified random design along onshore/offshore transects in sub-areas 5, 7, and 9 or within EMAP grid cells in sub-areas 1, 2, 4, and 6.

Sub-area 1 (Tortugas) includes the Dry Tortugas National Park (DTNP) and surrounding waters and is most influenced by the Loop Current and Dry Tortugas Gyre. Originally, there were no sampling sites located within the DTNP as it was outside the jurisdiction of NOAA. Upon request from the National Park Service, we initiated sampling at 5 sites within the DNTP boundary. Sampling in the Dry Tortugas was discontinued in 2011 due to budget constraints.

Sub-area 2 (Marquesas) includes the Marquesas Keys and a shallow sandy area between the Marquesas and Tortugas called the Quicksands. Sub-area 4 (Backcountry) contains the shallow, hard-bottomed waters on the gulf side of the Lower Keys. Sub-areas 2 and 4 are both influenced by water moving south along the SW Shelf. Sub-area 6 can be considered as part of western Florida Bay. This area is referred to as the Sluiceway as it strongly influenced by transport from Florida Bay, SW Shelf, and Shark River Slough (Smith, 1994). Sub-areas 5 (Lower Keys), 7 (Middle Keys), and 9 (Upper Keys) include the inshore, Hawk Channel, and reef tract of the Atlantic side of the Florida Keys. The Lower Keys are most influenced by cyclonic gyres spun off the Florida Current, the Middle Keys by exchange with Florida Bay, while the Upper Keys are influenced by the Florida Current frontal eddies and to a certain extent by exchange with Biscayne Bay. All three oceanside segments are also influenced by wind and tidally driven lateral Hawk Channel transport (Pitts, 1997).

We have found that water quality monitoring programs composed of many sampling stations situated across a diverse hydroscape are often challenging to interpret due to the "can't see the forest for the trees" problem (Boyer et al. 2000). At each site, the many measured variables are independently analyzed, individually graphed, and separately summarized in tables. This approach makes it difficult to see the larger, regional picture or to determine any associations among sites. In order to gain a better understanding of the spatial patterns of water quality of the FKNMS, we attempted to reduce the complicated data matrix into fewer elements which would provide robust estimates of condition and connection. To this end we developed an objective classification analysis procedure which grouped stations according to water quality similarity (Briceño et al. 2013, Fig. 2). EPA and FDEP adopted this classification for the implementation of nutrient criteria for the Sanctuary.

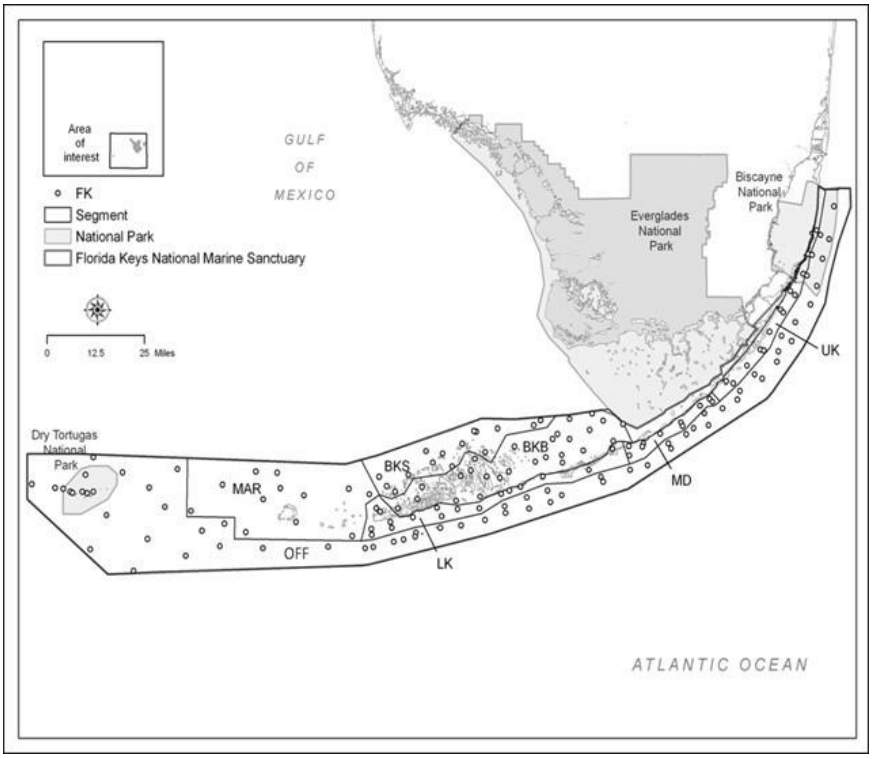


Figure 2: *Map of FKNMS showing segments derived from biogeochemical data: OFF=Offshore; MAR=Marquesas; BKS=Back Shelf; BKB= Back Bay; LK= Lower Keys; MK= Middle Keys; UK= Upper Keys*

Although the original quarterly sampling of 155 stations was cut back to 112 in 2011 (Fig. 3), it still provides a unique opportunity to explore the spatial component of water quality variability in the FKNMS, but decreases the ability of linking the Sanctuary's water quality to external sources of variability.

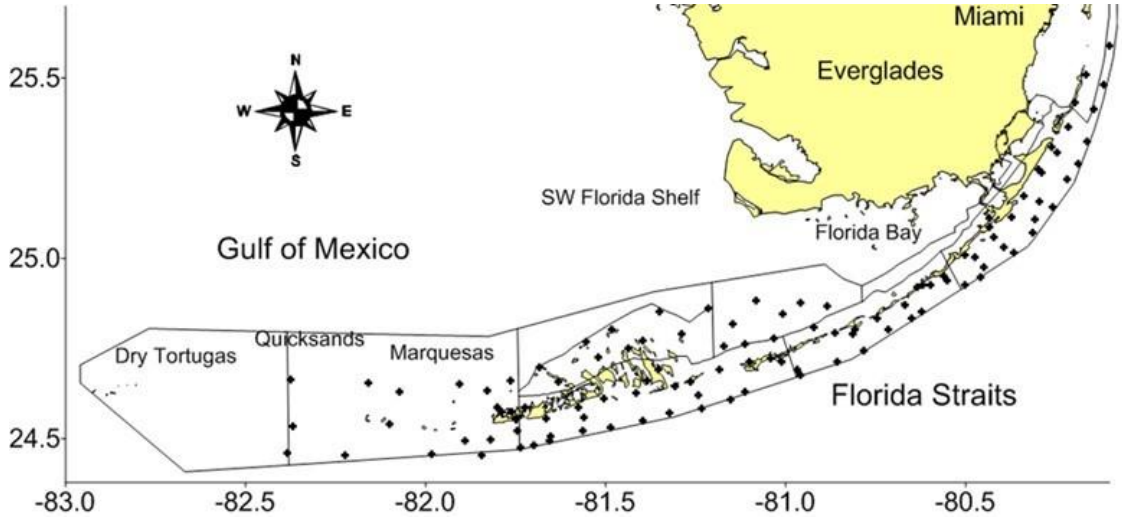


Figure 3*. The SERC Water Quality Monitoring Network showing the distribution of fixed sampling stations within the FKNMS for 2020 sampling.*

2. Methods

2.1. Field Sampling

The period of record of this study was March 1995 to December 2020, which included 102 quarterly sampling events. The 2011 reduction of sampling sites in Tortugas/western FKNMS (TORT, less human-impacted sites) and addition of close in, shore sites (SHORE, heavily human-impacted sites) introduced a bias to the dataset which might require a revision of SP-47 to correct this deviation. To avoid such complications, we have not included the TORT or SHORE stations in calculation of compliances after 2010.

For this year, field measurements and grab samples were collected from 112 fixed stations within the FKNMS boundary (Fig. 3). Seabird SB19 casts were measured for depth profiles of temperature (°C), salinity (practical salinity scale), dissolved oxygen (DO, mg l^{-1}), photosynthetically active radiation (PAR, µE m^{-2} s^{-1}), turbidity (NTU), and depth (m). The sonde was equipped with internal RAM and operated in stand-alone mode at a sampling rate of 0.5 sec. The vertical attenuation coefficient for downward irradiance (K_d, m^{-1}) was calculated at 0.5 m intervals from PAR and depth using the standard exponential equation (Kirk 1994) and averaged over the station depth. This was necessary due to periodic occurrence of optically distinct layers within the water column. During these events, K_d was reported for the upper layer. To determine the extent of stratification we calculated the difference between surface and bottom density as $\Delta\sigma_t$ (kg m^{-3}) where positive values denoted greater density of bottom water relative to the surface. Values of $\Delta\sigma_t$ between 0.0 and 1.0 are considered weakly stratified, while values >1 are deemed strongly stratified. Negative $\Delta\sigma_t$ conditions occur rarely and denote a unstable water column condition where the surface is denser than the bottom.

In the Backcountry area (Sub-area 4, Fig. 1), where it is too shallow to use a CTD, surface salinity and temperature were measured using a combination salinity-conductivity-temperature-DO probe (YSI/EXO2 multi-parameter sonde). DO was automatically corrected for salinity and temperature. PAR was measured every 0.5 m using a Li-Cor LI-1400 DataLogger equipped with a 4π spherical sensor (LI-193SB). PAR data with depth was used to calculate K_d from in-air surface irradiance.

Ambient water samples were collected from approximately 0.25 m below the surface and at approximately 1 m from the bottom with a Niskin bottle (General Oceanics) except in the Backcountry and Sluiceway where surface water was collected directly into sample bottles. Duplicate, unfiltered water samples were dispensed into 3x sample rinsed 120 ml HDPE bottles for analysis of total constituents. Dissolved nutrients were defined using Whatman GF/F filters with a nominal pore size of 0.8 µm. Duplicate water samples for dissolved nutrients were dispensed into 3x sample rinsed 150 ml syringes which were then filtered by hand through 25 mm glass fiber filters (Whatman GF/F) into 3x sample rinsed 60 ml HDPE bottles. The resulting wet filters, used for chlorophyll *a* (CHLA) analysis, were placed in 1.8 ml plastic centrifuge tubes to which 1.5 ml of 90% acetone/water was added (Strickland and Parsons 1972). An additional

120 ml sample was collected directly from the Niskin bottle for analysis of total nitrogen, total phosphorus, total organic carbon, and turbidity.

All samples were kept on ice in the dark during transport to the laboratory. During overnight stays in the Lower Keys sampling, filtrates and filters (not total samples) were frozen until further analysis.

2.2. Laboratory Analysis

Samples were analyzed for ammonium (NH_4^+), nitrate + nitrite (NO_x), nitrite (NO_2^-), total nitrogen (TN), soluble reactive phosphorus (SRP), total phosphorus (TP), total organic carbon (TOC), total silicate (SiO_2), chlorophyll *a* (CHLA, µg l^{-1}), and turbidity (in NTU) using standard laboratory methods. In accordance with EPA policy, the FKNMS water quality monitoring program adhered to existing rules and regulations governing QA and QC procedures as described in EPA guidance documents. The FIU-SERC Nutrient Laboratory maintained NELAP certification during the duration of this project

NH_4^+ was analyzed by the indophenol method (Koroleff 1983), NO_2^- was analyzed using the diazo method, and NO_x was measured as nitrite after cadmium reduction (Grassoff 1983a,b). The ascorbic acid/molybdate method was used to determine SRP (Murphy and Riley 1962). High temperature combustion and high temperature digestion were used to measure TN (Frankovich and Jones 1998; Walsh 1989) and TP (Solórzano and Sharp 1980), respectively. TOC was determined using the high temperature combustion method of Sugimura and Suzuki (1988). Silicate was measured using the heteropoly blue method (APHA 1995). Samples were analyzed for CHLA content by spectrofluorometry of acetone extracts (Yentsch and Menzel 1963). Protocols are presented in EPA (1993) and elsewhere as noted. All elemental ratios discussed were calculated on a molar basis. DO saturation in the water column (DO_{sat} as %) was calculated using the equations of Garcia and Gordon (1992). Some parameters were not measured directly but calculated by difference. Nitrate (NO_3^-) was calculated as NO_x - NO_2^-; total dissolved inorganic nitrogen (DIN) as $NO_x + NH_4^+$, and total organic nitrogen (TON) as TN - DIN. All variables are reported in ppm (mg l^{-1}) unless otherwise noted.

2.3. Spatial Analysis - Contour Maps

Contour maps (SURFER, Golden Software) of specific water quality variables were used to illuminate the contribution of external factors to the water quality of the FKNMS and to visualize gradients in water quality over the region. Kriging was the geostatistical algorithm of choice because it minimizes the error variance while maintaining point pattern continuity (Isaaks & Srivastava, 1989). Kriging is a global approach which uses standard geostatistics to determine the "distance" of influence around each point and the "clustering" of similar samples sites (autocorrelation). Therefore, unlike the inverse distance procedure, kriging will not produce valleys in the contour between neighboring points of similar value.

Because quarterly field surveys often occurred over more than a one month period, we define the quarterly surveys as: Winter (Jan.-Mar.), Spring (Apr.-Jun.), Summer (Jul.-Sep.), and Fall (Oct.-Dec.).

2.4. Time Series Analysis

Least squares, linear regression as a method for measuring change over time is useful for variables that change at relatively continuous rates. The simplicity of this method makes it appealing to those who are tracking water quality, but time series dominated by non-linear drivers may be skewed by trend reversals and endmember conditions. For these reasons, we used the nonparametric Sen slope estimation to determine temporal trends (unit yr^{-1}) for each water quality variable over the 26-year period of record. The Mann-Kendall Test was used to detect monotonic trends without the requirement that the measurements be normally distributed or that the trend be linear. Trend maps were drawn using all stations regardless of whether trends were significant. To show impact of trend over time, trend maps report the additive, total change over the 26-year period of record.

While the Mann-Kendall Test tells us whether the overall trend is increasing or decreasing, it does not provide any information about short-term changers or reversing trends. To address this limitation, time series data were stratified by zone (see above) and fitted using a locally-weighted approach (LOESS, MatLab). The LOESS algorithm is a non-parametric, locally weighted least squares method which combines multiple regression models in a k-nearest-neighbor analysis (Cleveland 1979). The Epanechnikov (1969) parabolic kernel with 10% data bandwidth was used as the time series smoother, except for SHORE sites where 20% was used because of shorter period of record.

3. Results

3.1. Overall Water Quality of the FKNMS in 2020

The more recently implemented stations located very close to shore were not used for this assessment. In their short period of record they have displayed a common tendency to be nutrient-enriched and exhibit lower salinity as compared to the rest of the sites. Hence, we have grouped these ten stations as an additional zone (SHORE) for comparison and exploration of terrestrial impacts on water quality.

Summary statistics for all water quality variables (excluding SHORE) from calendar year 2020 sampling events are shown as number of samples (*n*), minimum, maximum, and median (Table 1). Overall, the region remains warm and euhaline with a median temperature of 27.8 °C and salinity of 36.0; DO_{sat} was relatively high at 96.4%. On this coarse scale, the FKNMS exhibited very good water quality with median NO_3^-, NH_4^+, TP, and SiO_2 concentrations of 0.0010, 0.0004, 0.0070, and 0.0070 mg l^{-1}, respectively. DIN comprised a small fraction (3.0%) of the TN pool (0.131 mg l^{-1}) with TON being the bulk (median 0.127 mg l^{-1}). SRP concentrations

were very low (median 0.0001 mg l^{-1}) and comprised only 1.4% of the TP pool (0.0070 mg l^{-1}). CHLA concentrations were also low overall (median 0.30 µg l^{-1}), but ranged from 0.03 to 5.67 µg l^{-1}. Median TOC was 1.24 mg l^{-1}; a value higher than open ocean levels but consistent with coastal areas.

For 2020, median turbidity was elevated (0.39 NTU) resulting in median K_d of 0.219 m^{-1}. Overall, 36.7% of incident light (I_o) reached the bottom. Molar ratios of N to P suggested a general P limitation of the water column (median TN:TP = 41.0) but this must be tempered by the fact that much of the TN may not be bioavailable. A potentially more usable DIN:TP ratio was 0.7, indicating strong potential N limitation across the region.

Table 1. *Summary statistics for water quality variables measured in the FKNMS for calendar year 2020 summarized by sampling depth as number of samples (n), minimum value (Min.), maximum value (Max.), and median value.*

Variable	Depth	n	Min.	Max.	Median
NO_3^-	Surface	440	0.0000	0.0342	0.0014
(mg l^{-1})	Bottom	271	0.0001	0.0192	0.0015
NO_2^-	Surface	446	0.0000	0.0019	0.0004
(mg l^{-1})	Bottom	282	0.0000	0.0013	0.0003
NH_4^+	Surface	448	0.0003	0.1097	0.0057
(mg l^{-1})	Bottom	282	0.0003	0.0395	0.0051
TN	Surface	448	0.0357	0.5073	0.1077
(mg l^{-1})	Bottom	282	0.0340	0.4616	0.0808
DIN	Surface	448	0.0014	0.1103	0.0079
(mg l^{-1})	Bottom	282	0.0018	0.0434	0.0072
TON	Surface	448	0.0014	0.4947	0.0984
(mg l^{-1})	Bottom	282	0.0231	0.4596	0.0696
TP	Surface	448	0.0030	0.0181	0.0051
(mg l^{-1})	Bottom	282	0.0027	0.0097	0.0043
SRP	Surface	448	0.0001	0.0040	0.0007
(mg l^{-1})	Bottom	282	0.0001	0.0034	0.0007
CHLA (µg l^{-1})	Surface	444	0.039	5.126	0.237
TOC	Surface	448	0.932	6.877	1.429
(mg l^{-1})	Bottom	282	0.962	4.146	1.236
SiO_2	Surface	448	0.000	0.842	0.009
(mg l^{-1})	Bottom	282	0.000	0.768	0.003
Turbidity	Surface	424	0.000	31.000	0.065
(NTU)	Bottom	270	0.000	7.880	0.000
Salinity	Surface	447	26.28	37.80	36.07
	Bottom	445	27.21	37.81	36.06

Temp.	Surface	448	20.08	31.94	25.88
(°C)	Bottom	446	19.97	31.88	25.69
DO	Surface	448	4.23	8.87	6.54
(mg l^{-1})	Bottom	446	4.27	8.99	6.55
K_d (m^{-1})		415	0.001	4.314	0.204
TN:TP	Surface	448	12.7	228.8	42.6
DIN:TP	Surface	448	0.47	37.7	0.7
Si:DIN	Surface	448	0.0	74.4	0.6
DO_{Sat}	Surface	448	64.6	131.9	97.4
(%)	Bottom	448	0.0	134.4	97.4
I_o (%)	Bottom	448	0.2	100.0	38.1
$\Delta\sigma_t$ (kg m^{-3})		448	-24.702	1.030	0.010

3.2. General Hydrological Drivers

Water quality is a subjective but powerful measure of ecosystem well-being. Aside from the physical-chemical composition of the water there is also a human perceptual element which varies according to our intents for use (Kruczyinski and McManus 2002). Distinguishing internal from external sources of nutrients in the FKNMS is a difficult task. The finer discrimination of internal sources into natural and anthropogenic inputs is even more difficult. Most of the important anthropogenic inputs are regulated and most likely controlled by management activities, however, earlier studies have shown that nutrients from shallow sewage injection wells may be leaking into nearshore surface waters (Corbett et al. 1999; Shinn 1999a, 1999b; Paul et al. 1995, 1997; Reich et al. 2001; Briceño et al. 2015). Stormwater inputs may be important for the halo zone (within 1,000 m of shore), but the effects are muted at best beyond this distance.

Advective transport of nutrients through the FKNMS was not measured by the existing fixed sampling plan. However, nutrient distribution patterns may be compared to the regional circulation regimes to visualize the contribution of external sources and advective transport to internal water quality of the FKNMS (Boyer and Jones 2002). Circulation in coastal South Florida is dominated by regional currents such as the Loop Current, Florida Current, and Tortugas Gyre and by local transport via Hawk Channel and along-shore SW Shelf movements (Klein and Orlando 1994). Regional currents may influence water quality over large areas by the advection of external surface water masses into and through the FKNMS (Lee et al. 1994, Lee et al. 2002) and by the intrusion of deep offshore ocean waters onto the reef tract as internal bores (Leichter et al. 1996). Local currents become more important in the mixing and transport of freshwater and nutrients from terrestrial sources (Smith 1994; Pitts 1997, Gibson et al. 2008).

Spatial patterns of salinity in coastal South Florida show these major sources of freshwater to have more than just local impacts. In Biscayne Bay, freshwater released through the canal system operated by the South Florida Water Management District may sometimes be seen to

affect northern Key Largo by causing episodic depressions in salinity at alongshore sites. Freshwater entering NE Florida Bay via overland flow from Taylor Slough and C-111 basin mix in a SW direction. The extent of influence of freshwater from Florida Bay on alongshore salinity in the Keys is less than that of Biscayne Bay but it is more episodic. Transport of low salinity water from Florida Bay does not affect the Middle Keys sites enough to depress the median salinity in this region but is manifested as increased variability. The opposite also holds true; hypersaline waters from Florida Bay may be transported through the Sluiceway to inshore sites in the Middle Keys.

On the southwest coast, the large influence of the Shark River Slough, which drains the bulk of the Everglades and exits through the Whitewater Bay - Ten Thousand Islands mangrove complex, clearly impacts the SW Shelf waters. The mixing of SW Shelf waters with the Gulf of Mexico produces a salinity gradient in a SW direction which extends out to Key West. This freshwater source may sometimes affect the Backcountry because of its shallow nature but often follows a trajectory of entering western Florida Bay and exiting out through the channels in the Middle Keys (Smith 1994). This net transport of lower salinity water from mainland to reef in open channels through the Keys is observed as an increase in the range and variability of salinity rather than as a large depression in salinity.

In addition to surface currents there is evidence that internal tidal bores regularly impact the Upper Keys reef tract (Leichter et al. 1996; Leichter and Miller 1999). Internal bores are episodes of higher density, deep water intrusion onto the shallower shelf or reef tract. They also entrain high nutrient waters from deeper ocean layers which spread over the reefs (Leichter and Miller 1999). Depending on their energy, internal tidal bores can promote stratification of the water column or cause complete vertical mixing as a breaking internal wave of sub-thermocline water.

3.3. 2020 Seasonal Trends

Surface salinity distributions in 2020 showed lower than seawater conditions in the Sluiceway during summer/fall, probably from SW Shelf transport from the GOM (Fig. 4). This pattern was not consistent with usual observed salinity but the differences were small compared to some other years.

Surface Temperature distributions (°C,Fig. 5) were relatively unremarkable except for low values in Backcountry and Marquesas during late fall sampling. These temperatures coincide with lower salinities from GOM transport.

The circulation drivers mentioned above also influence other water quality variables, such as DO saturation (DO_{sat} in %, Fig. 6). Higher levels of DO_{sat} are generally beneficial for animal life. Lowest DO_{sat} tend to develop inside the Backcountry during warmest months and is most probably due to higher salinities, and longer water residence time. This year, DO_{sat} was relatively high across the region throughout the year.

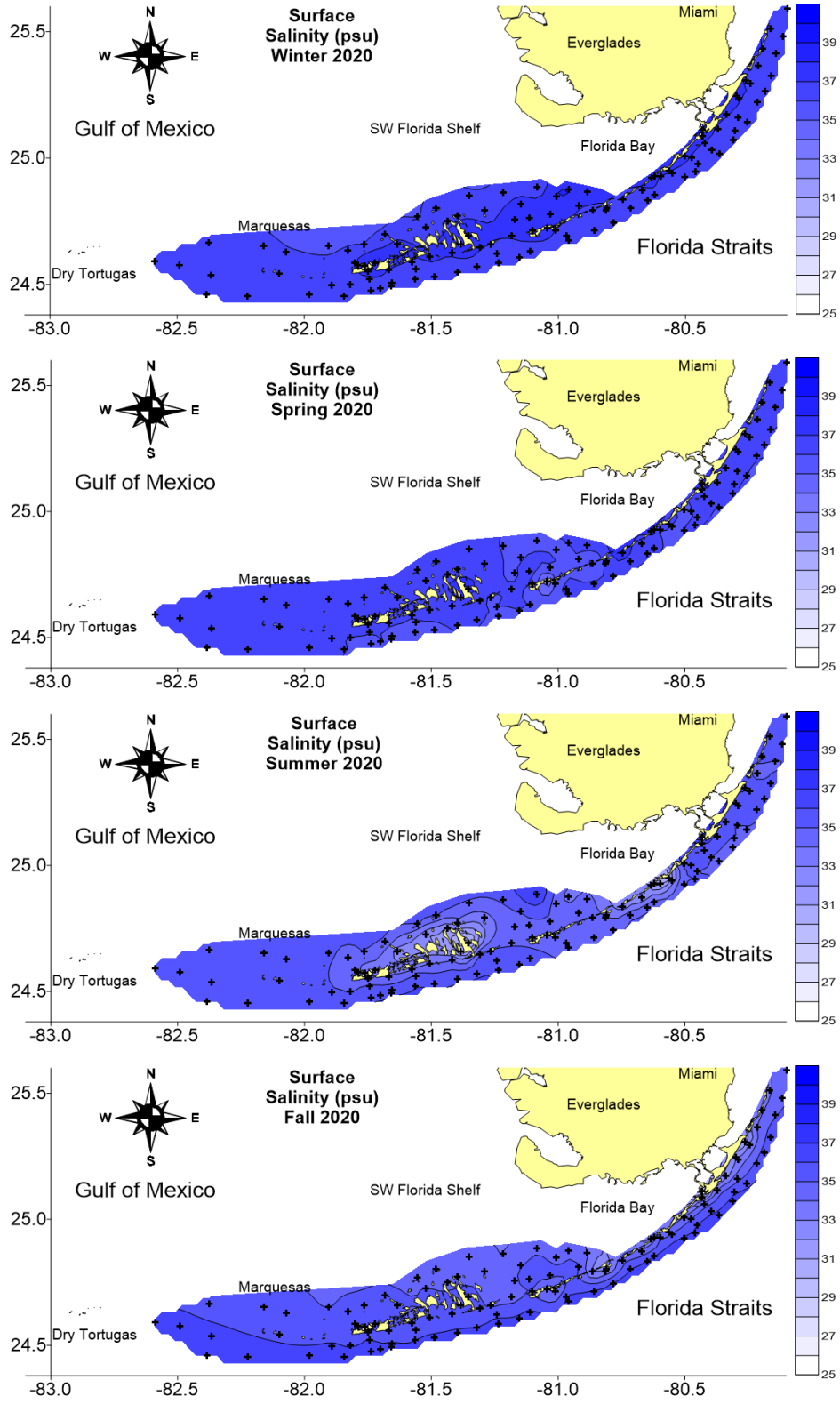


Figure 4. *Surface salinity distributions across the FKNMS during 2020.*

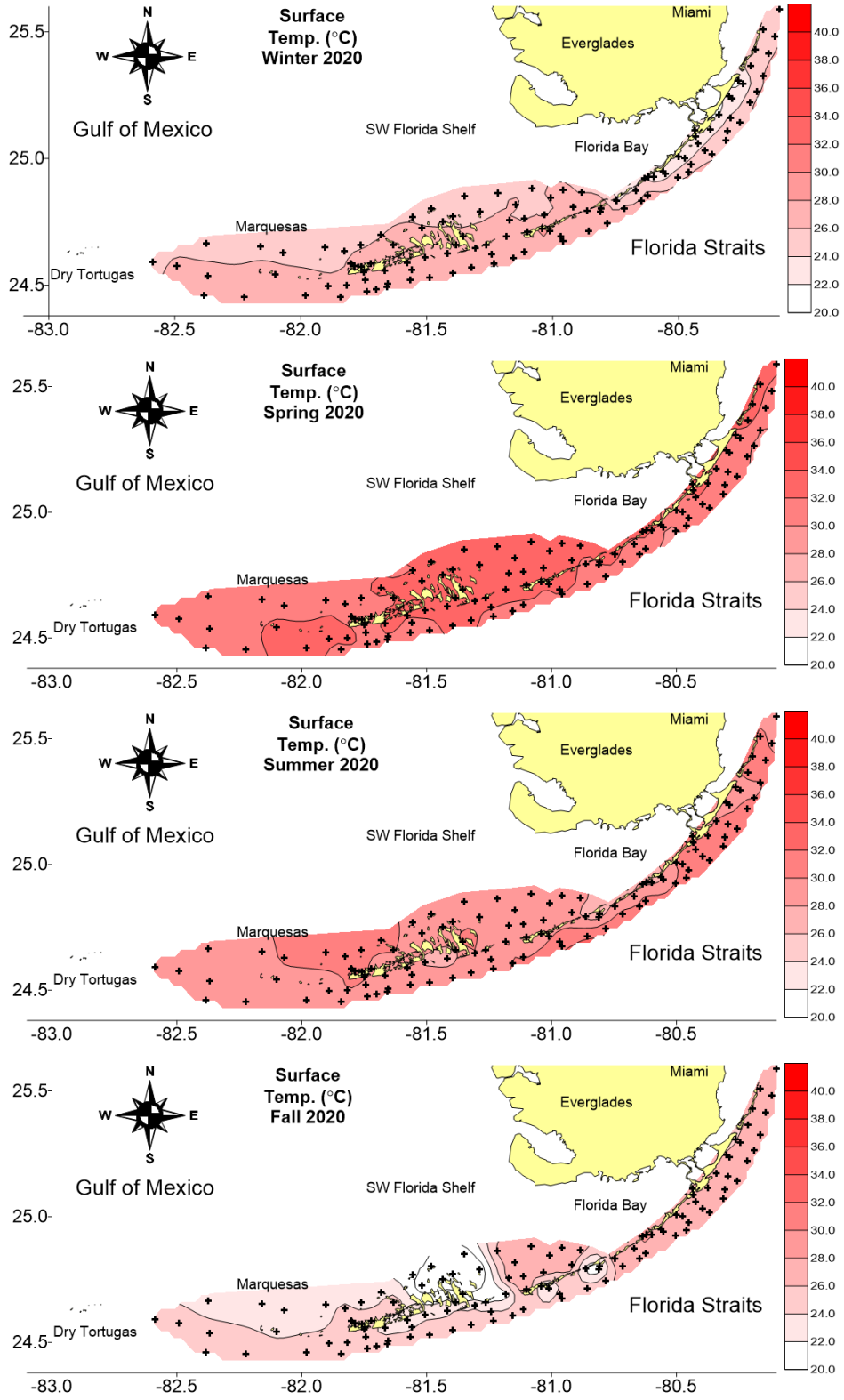


Figure 5. *Surface temperature distributions across the FKNMS during 2020.*

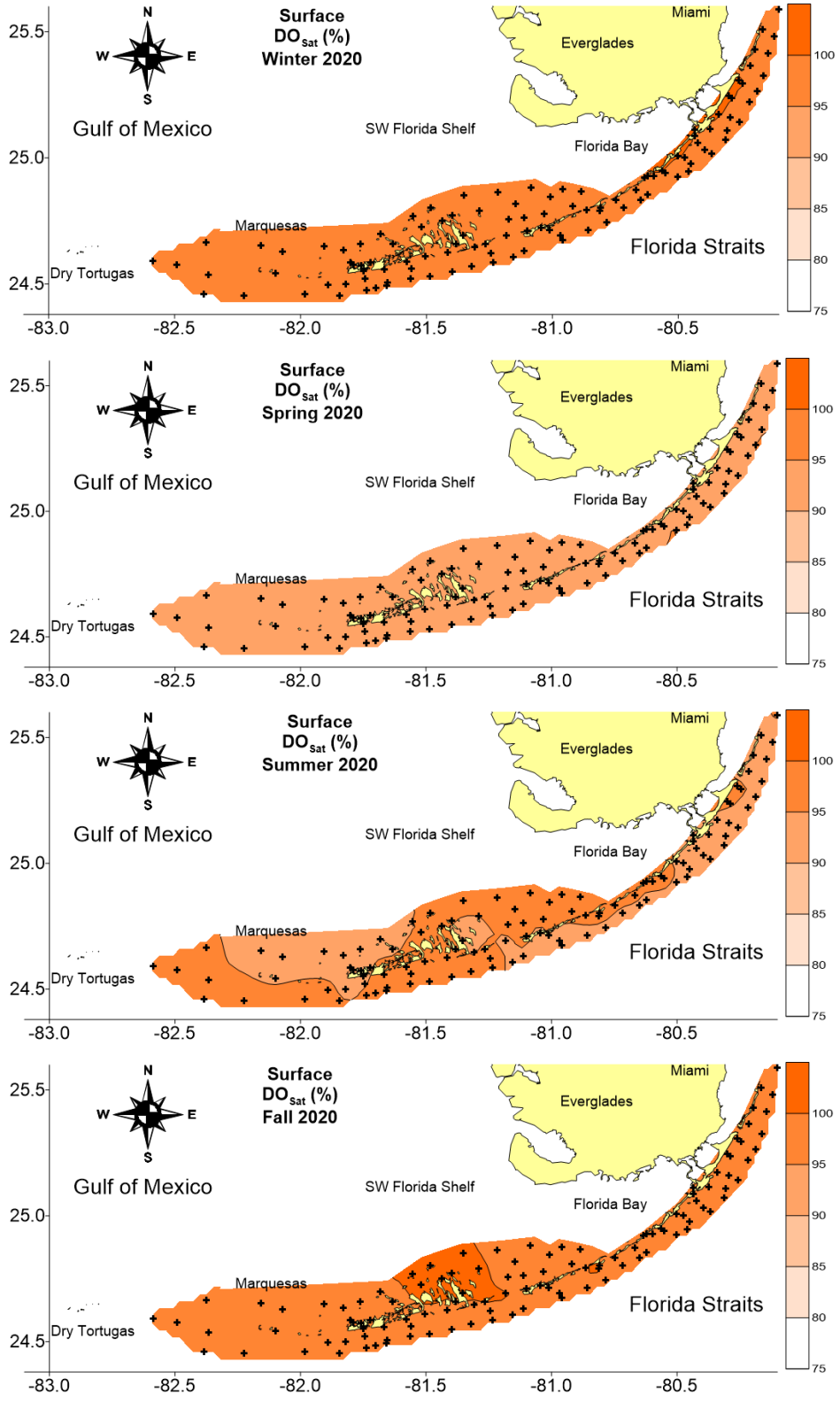


Figure 6. *Surface dissolved oxygen saturation distributions across the FKNMS during 2020.*

In many situations, independent water masses may be distinguished by difference in density (delta sigma-*t* or $\Delta\sigma_t$ in kg m^{-3}) between surface and bottom (Fig. 7). Since density is driven more by salinity than temperature, we do not always observe differences in σ_t between surface and bottom during upwelling events. However, decreased temperature of bottom waters from intrusion of deeper oceanic waters is often an indicator of elevated NO_3^- levels. These upwelling events also affect other nutrient species such as NH_4^+, TP, and SRP in bottom waters as well. Temperature will have influence on σ_t when cold fronts come through ad quickly reduce surface water temperatures.

Stratification events are typically sporadic and widespread on the Atlantic side of the Keys and Marquesas. This year the Marquesas and offshore Lower Keys had slightly elevated $\Delta\sigma_t$ during spring, summer, and fall (Fig 7) with many reef sites experiencing significant density stratification.

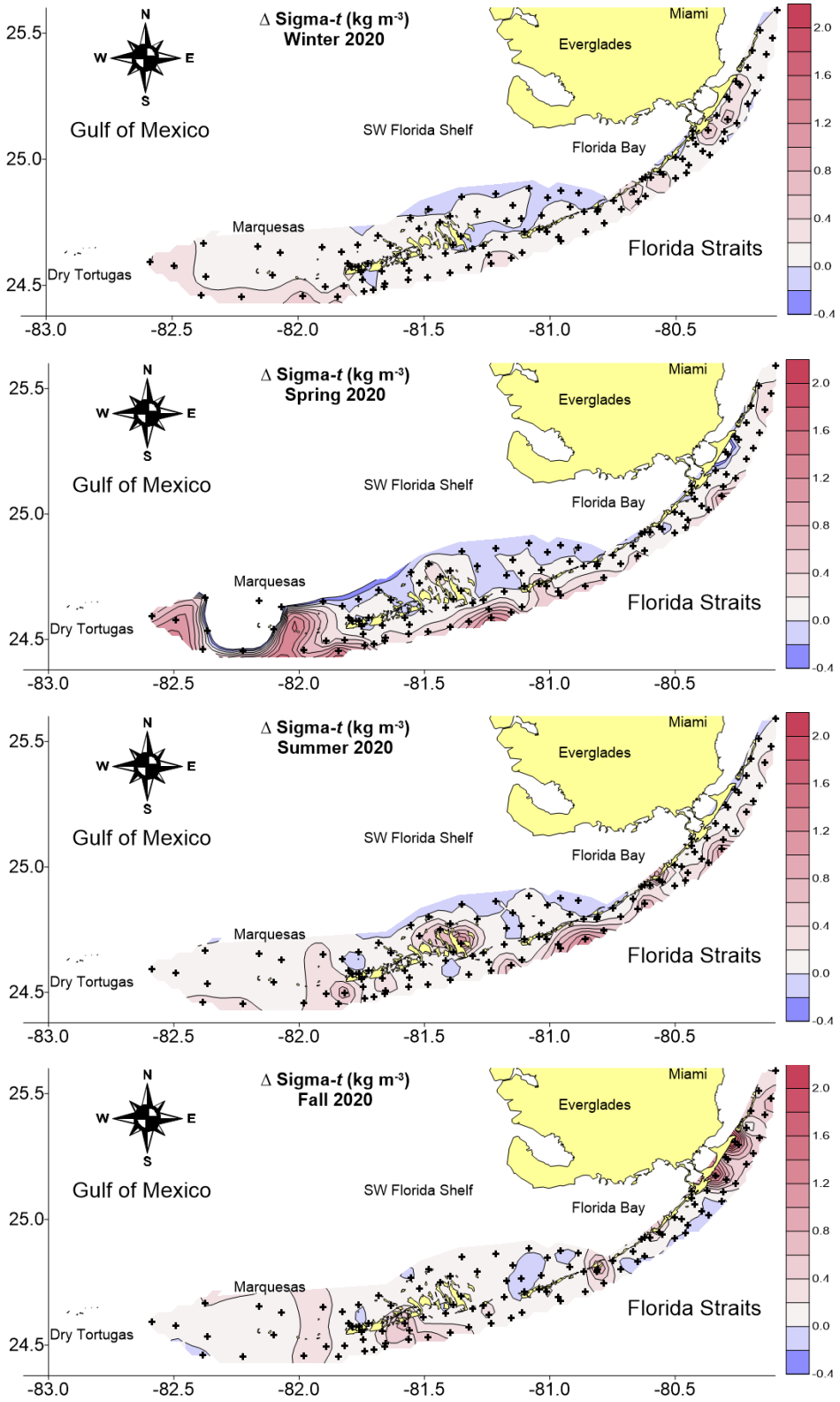


Figure 7. *Surface/bottom density differences ($\Delta\sigma_t$) across the FKNMS during 2020.*

Visualization of spatial patterns of DIN concentrations over South Florida waters provides an extended view of source gradients over the region (Fig. 8-11). The oceanside transects off the uninhabited Upper Keys (off Biscayne Bay) typically exhibit the lower NO_3^- compared to the Middle and Lower Keys (Fig. 8), but this is not always the case (see fall 2020). Similar patterns inshore-offshore gradients was observed in a previous transect surveys from these areas (Szmant and Forrester 1996).

Intensification of NO_3^- often occurs in the Backcountry region which we believe is due to a combination of anthropogenic loading, extended water residence time, benthic N_2 fixation, and most importantly, sponge-mediated benthic flux (Hoer et al. 2018). The local sources of NO_3^-, e.g., septic systems and stormwater runoff around Big Pine Key have been implicated (Lapointe and Clark 1992), however, there are uninhabited areas that also exhibit high NO_3^- which rules out the premise of septic systems being the only source of NO_3^- in this area. The Backcountry area is very shallow (~0.5 m) and hydraulically isolated from the SW Shelf and Atlantic Ocean which results in a relatively long water residence time. However, the effect of increased water residence time in DIN concentration is probably small. Salinities in this area are typically only 1-2 higher than local seawater and may actually be lower than surrounding during wet periods. Additionally, NO_3^- concentration usually declines for salinities above ~35.3 region-wide. Benthic N_2 fixation may also contribute some $NH_4^+$to the Backcountry but much of this is used by seagrass to balance their N demand (Capone & Taylor 1980).

Sponge-mediated benthic flux may have the most significant influence on water quality in the Backcountry. Sponge population densities in Florida Bay ranged from 0.08 to 21 individuals m^{-2} with biomass as high as 4.4 L sponge m^{-2} (Hoer et al. 2019). They estimated an average DIN contribution from sponge biomass of 8.3 mg L^{-1} N m^{-2} d^{-1}, with peak N fluxes of 49.0 mg L^{-1} N m^{-2} d^{-1}. The Backcountry exhibits a similar sponge density (Boyer et al. 2005) therefore, we expect that benthic fluxes might be of comparable magnitude in this region.

Surface and bottom water NO_3^- concentrations are not always coincident (Fig. 9). In some years we observed elevated NO_3^- in the bottom waters on the offshore reef tract. This has been attributed to “upwelling” (internal tidal bores) of deep water onto the reef tract (Leichter et al. 2003). This deep ocean water transport is a regular and persistent phenomenon which can deliver high nutrient waters to the offshore reef tract independent of any terrestrial source.

Interestingly, during fall 2020, intensification of NO_3^- concentrations in the Upper Keys bottom waters was from deep ocean tidal bore while high concentrations in surface waters were most probably from either stormwater runoff or southern transport from Biscayne Bay. The SHORE sites around Marathon were also elevated, probably the result of direct runoff or groundwater inputs.

Surface NH_4^+ concentrations are often distributed in a similar manner as NO_3^- but are usually lower in magnitude (Fig. 10). During 2020, intensification of NH_4^+ concentrations, similar to NO_3^-, occurred alongshore in the Upper Keys and in SHORE sites around Marathon in summer (Fig. 11).

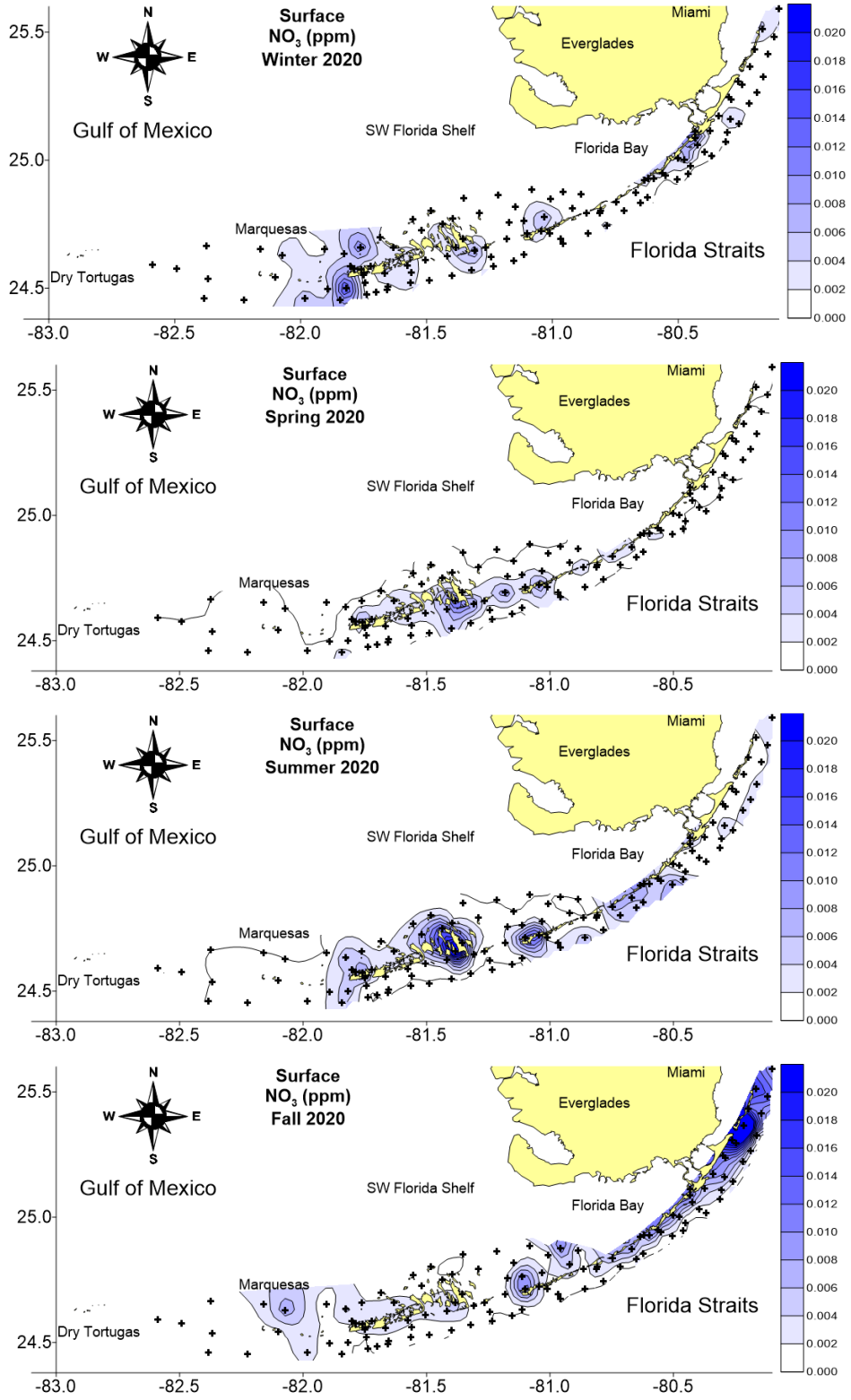


Figure 8. *Surface nitrate distributions across the FKNMS during 2020.*

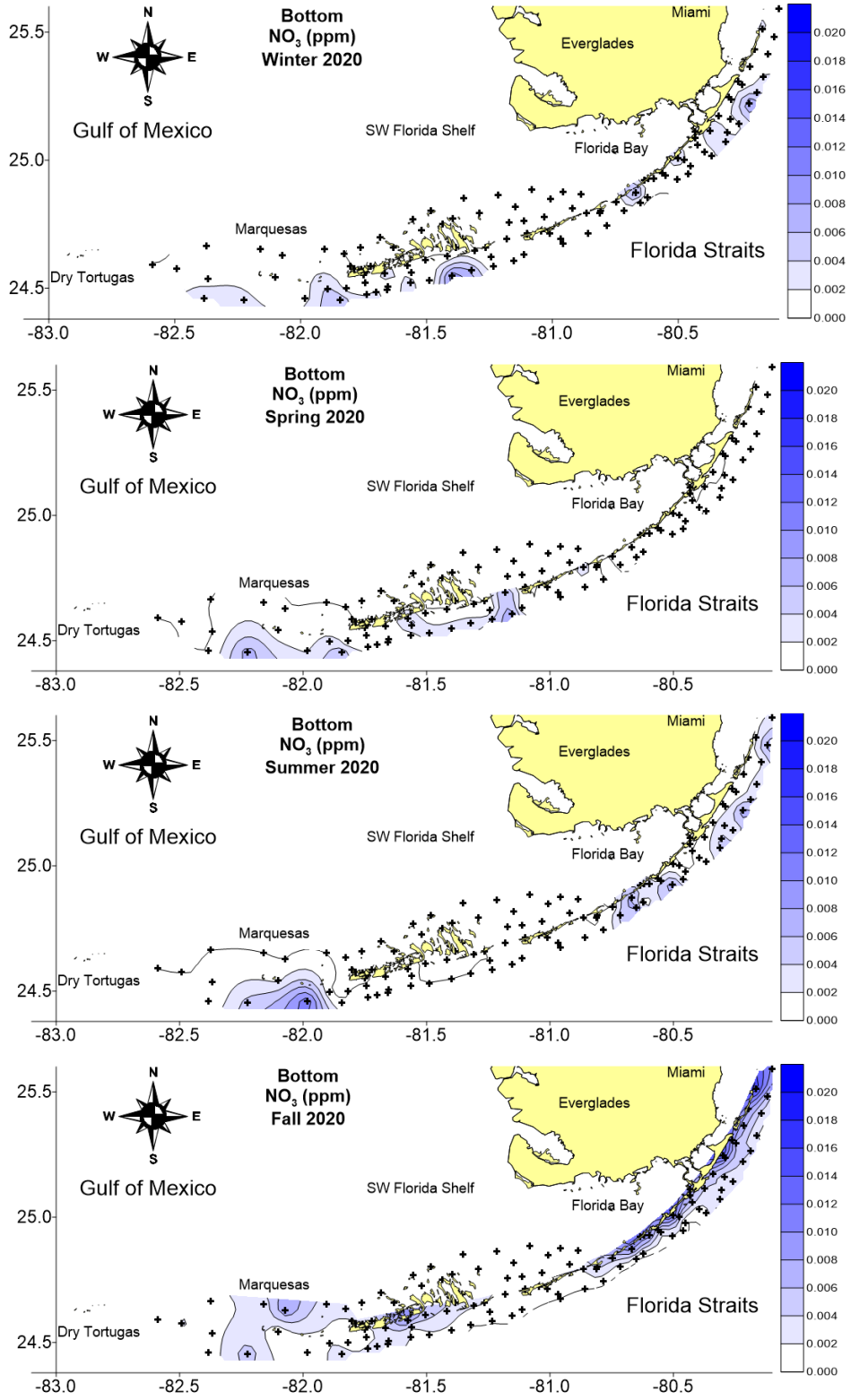


Figure 9. *Bottom nitrate distributions across the FKNMS during 2020.*

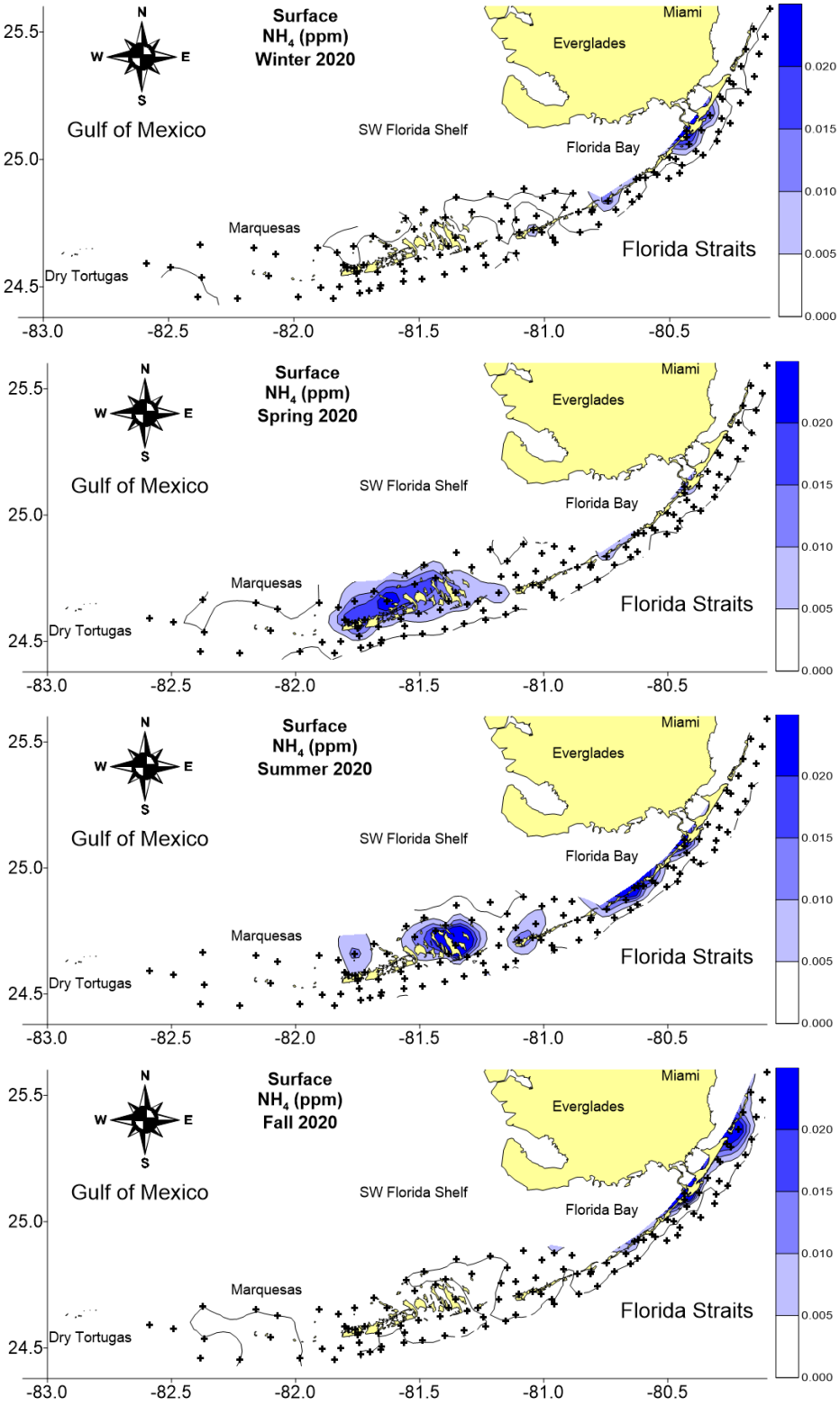


Figure 10. *Surface ammonium distributions across the FKNMS during 2020.*

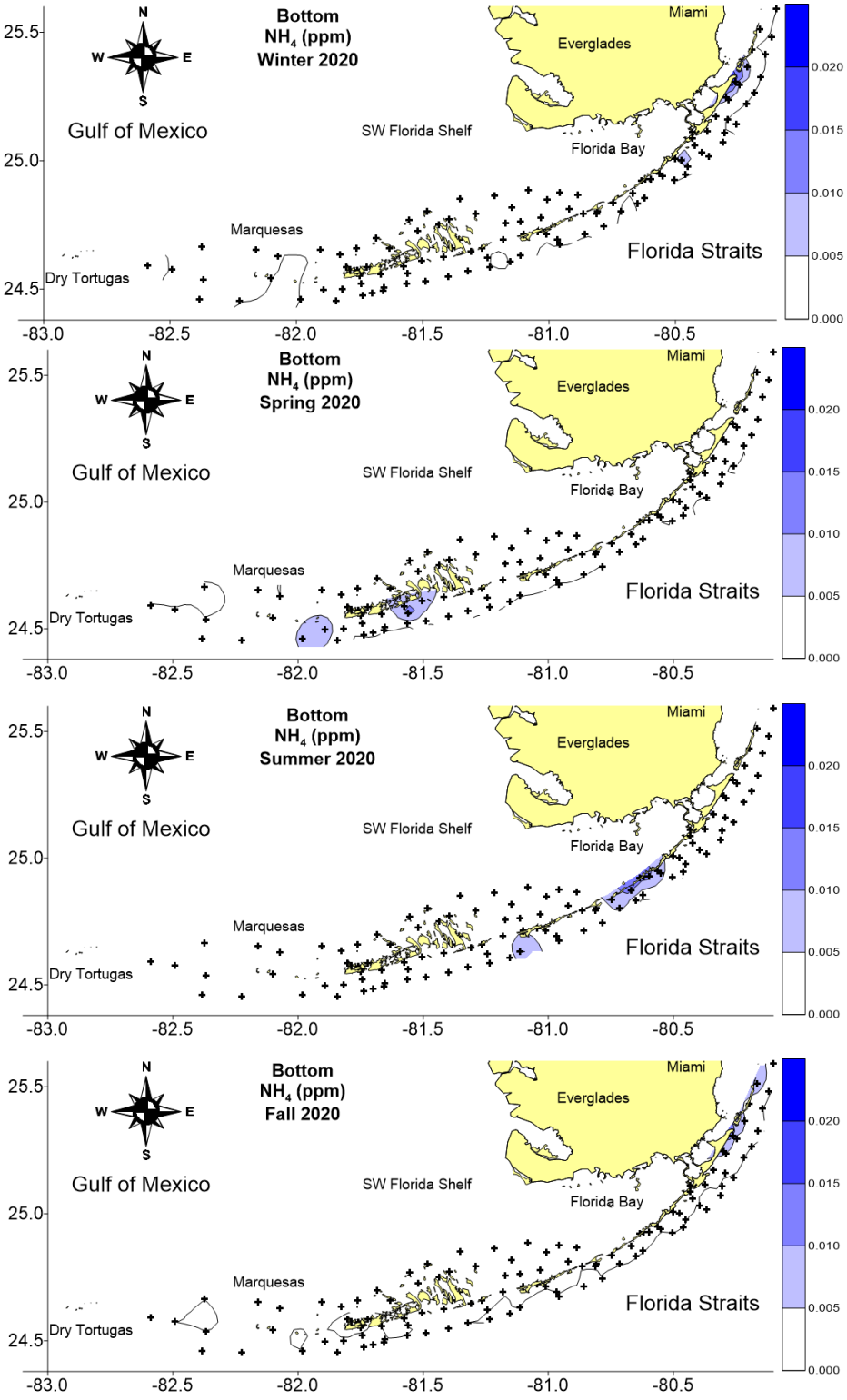


Figure 11. *Bottom ammonium distributions across the FKNMS during 2020.*

Spatial patterns in TP in South Florida coastal waters are strongly driven by SW Coastal Everglades and GOM sources (Boyer and Briceño 2007, 2011). A gradient in TP typically extends from the inshore waters of Whitewater Bay - Ten Thousand Islands mangrove complex out onto the SW Shelf and Tortugas. Gradients also usually extend from western Florida Bay to the Middle/Lower Keys. The spatial distribution of TP on the SW Shelf is driven by freshwater inputs from mangrove rivers and transport of Gulf of Mexico waters through the region. No significant evidence of significant groundwater sources exists (Corbett et al. 2000).

During 2020, highest TP concentrations occurred mostly along the northern boundary of the Sluiceway, and Marquesas with occasional hits at individual offshore sites (Fig 12). Bottom TP was generally less than 0.02 ppm although there was slight intensification in Marquesas and one site in northernmost Keys during winter/spring (Fig 13, note different scale than surface TP).

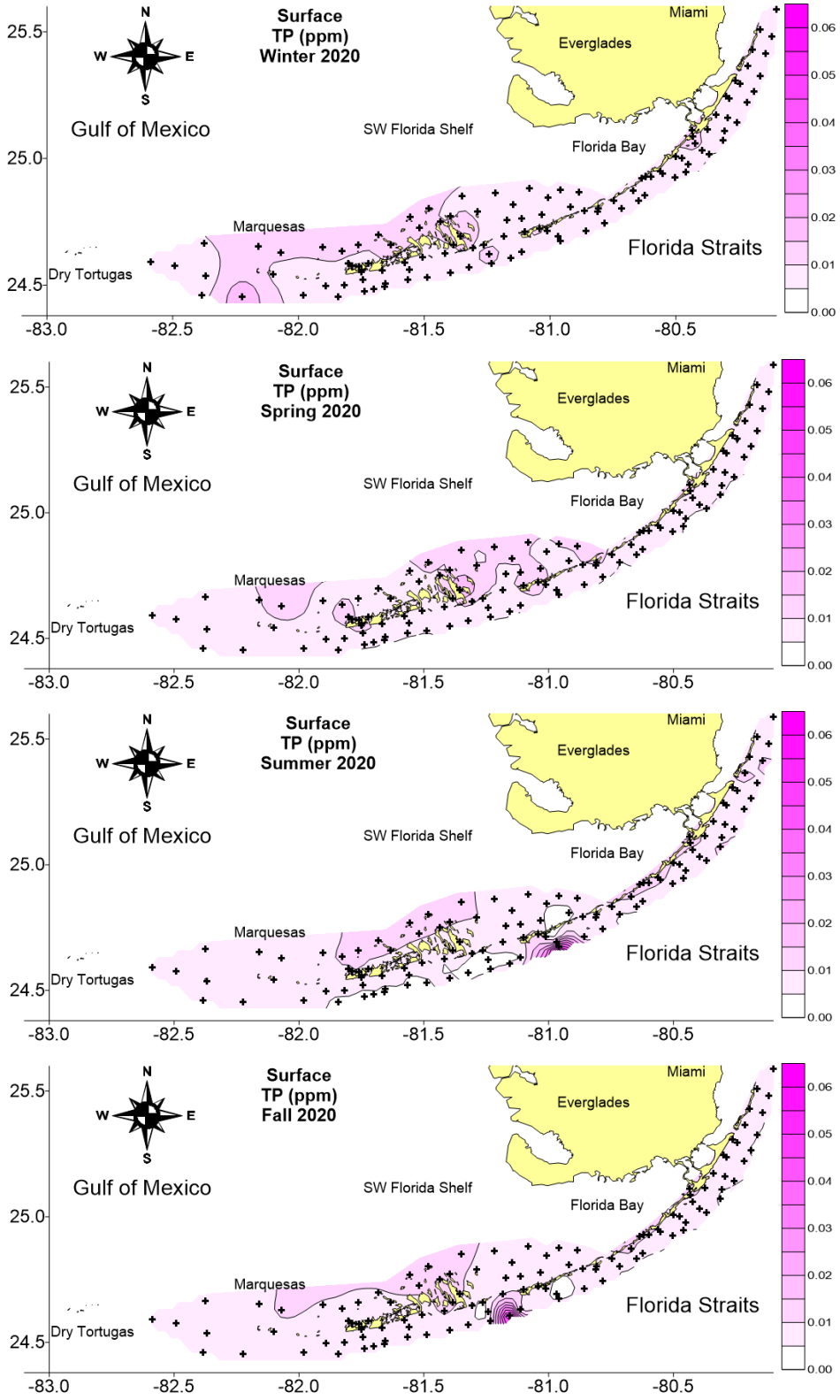


Figure 12. *Distributions of surface total phosphorus across the FKNMS during 2020.*

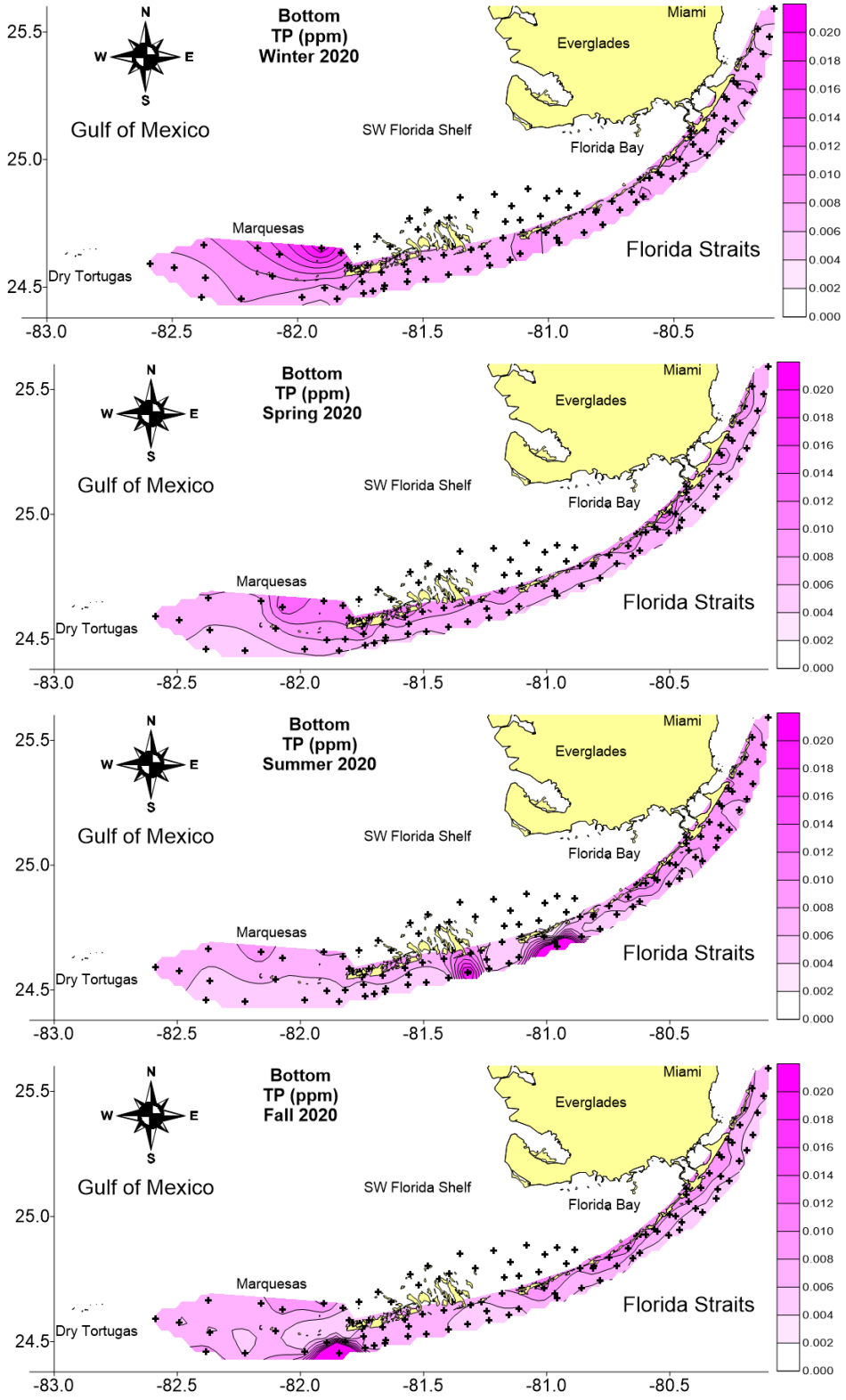


Figure 13. *Distributions of bottom total phosphorus across the FKNMS during 2020.*

Concentrations of surface and bottom TOC (Fig. 14 & 15) and TON (Fig. 16 & 17) are similar in pattern of distribution across the South Florida coastal hydroscape. Most of the TN is organic in nature so we expect this. Deviations from this common pattern are due to differences in sources of dissolved organic matter. Our past data from this area showed that concentrations of TOC and TON increase from the Everglades headwaters through the mangrove zone and then decrease with distance offshore. The high concentrations of TOC and TON in Florida Bay were due to a combination of terrestrial loading (Boyer and Jones, 1999), in situ production by seagrass and phytoplankton, and evaporative concentration (Fourqurean et al. 1993, Boyer et al. 1997).

Advection of SW Shelf and Florida Bay waters through the Sluiceway and passes accounted for this region and the inshore area of the Middle Keys as having highest TOC and TON of the FKNMS. Strong offshore gradients in TOC and TON existed for all mainland Keys segments. The higher concentrations of TOC and TON in the inshore waters of the Keys may have a terrestrial source (anthropogenic) or may be derived from decomposition of seaweed rack rather than simply benthic production and sediment re-suspension. Main Keys reef tract concentrations of TOC and TON were consistently the lowest in the FKNMS.

During Fall 2020, elevated TON was observed in one surface station and multiple bottom stations in the oceanside Islamorada area. We are not sure what caused this anomaly but the fact that it was most extensive in bottom waters implicates a benthic source.

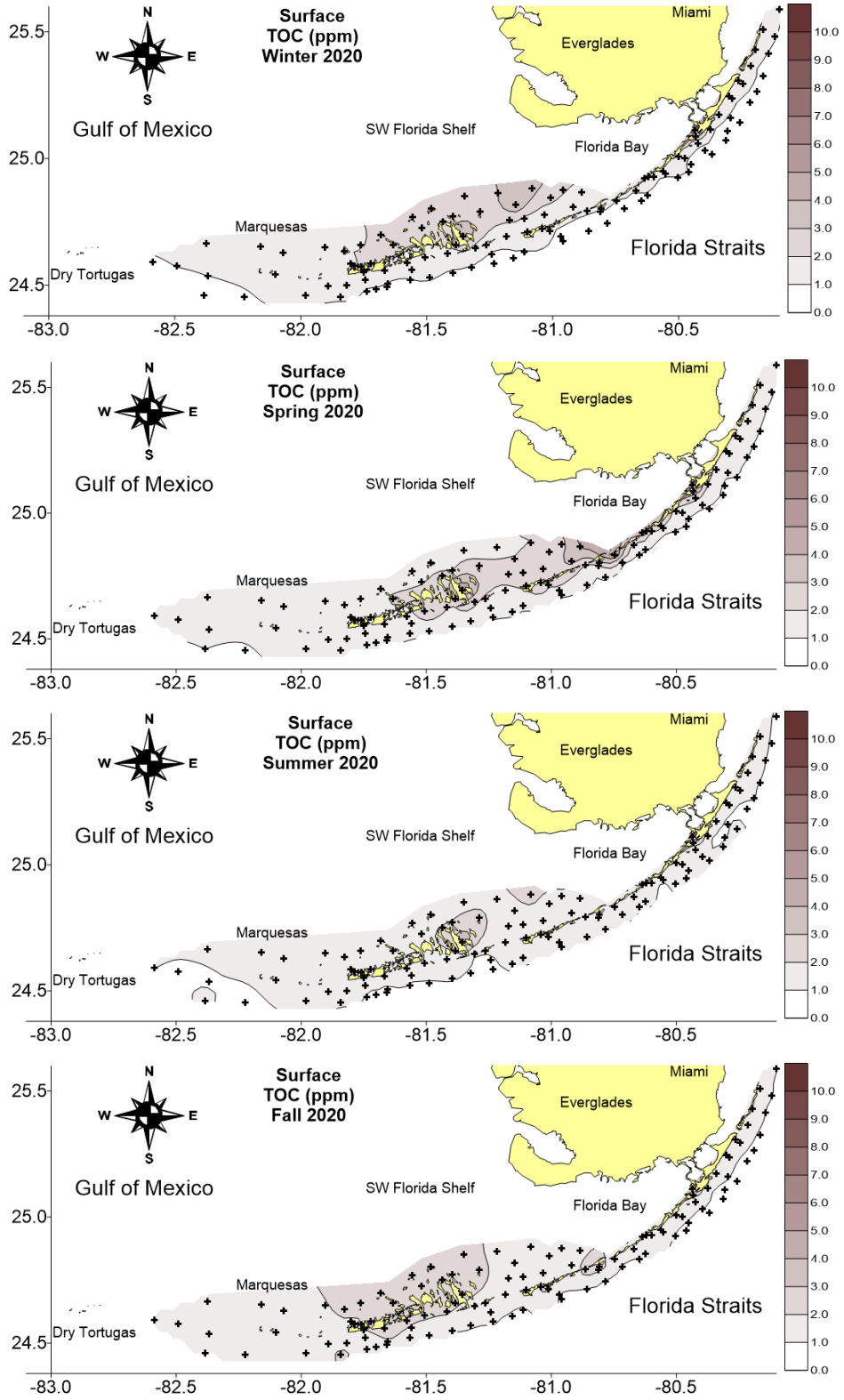


Figure 14. *Distributions of surface total organic carbon across the FKNMS during 2020.*

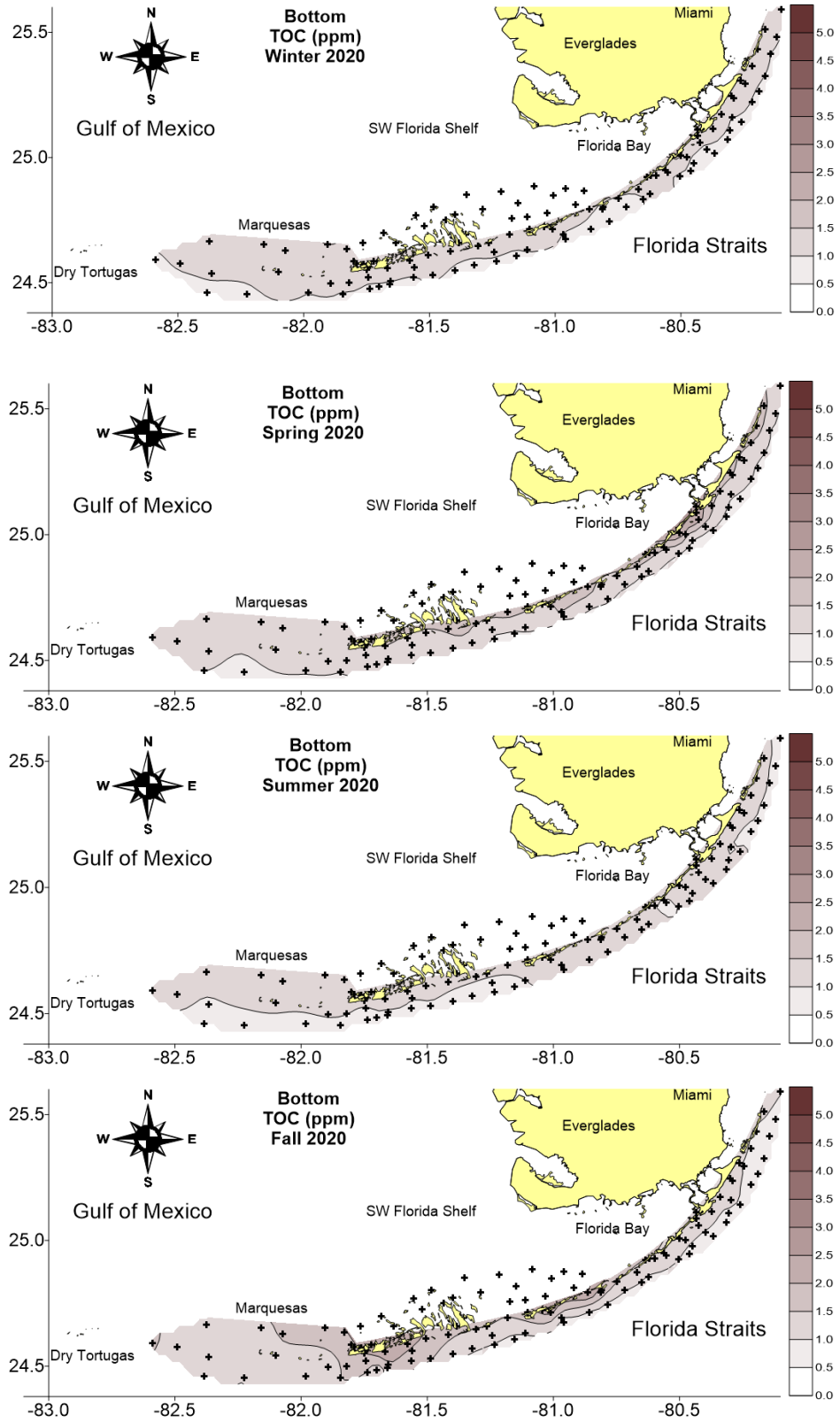


Figure 15. *Distributions of surface total organic carbon across the FKNMS during 2020.*

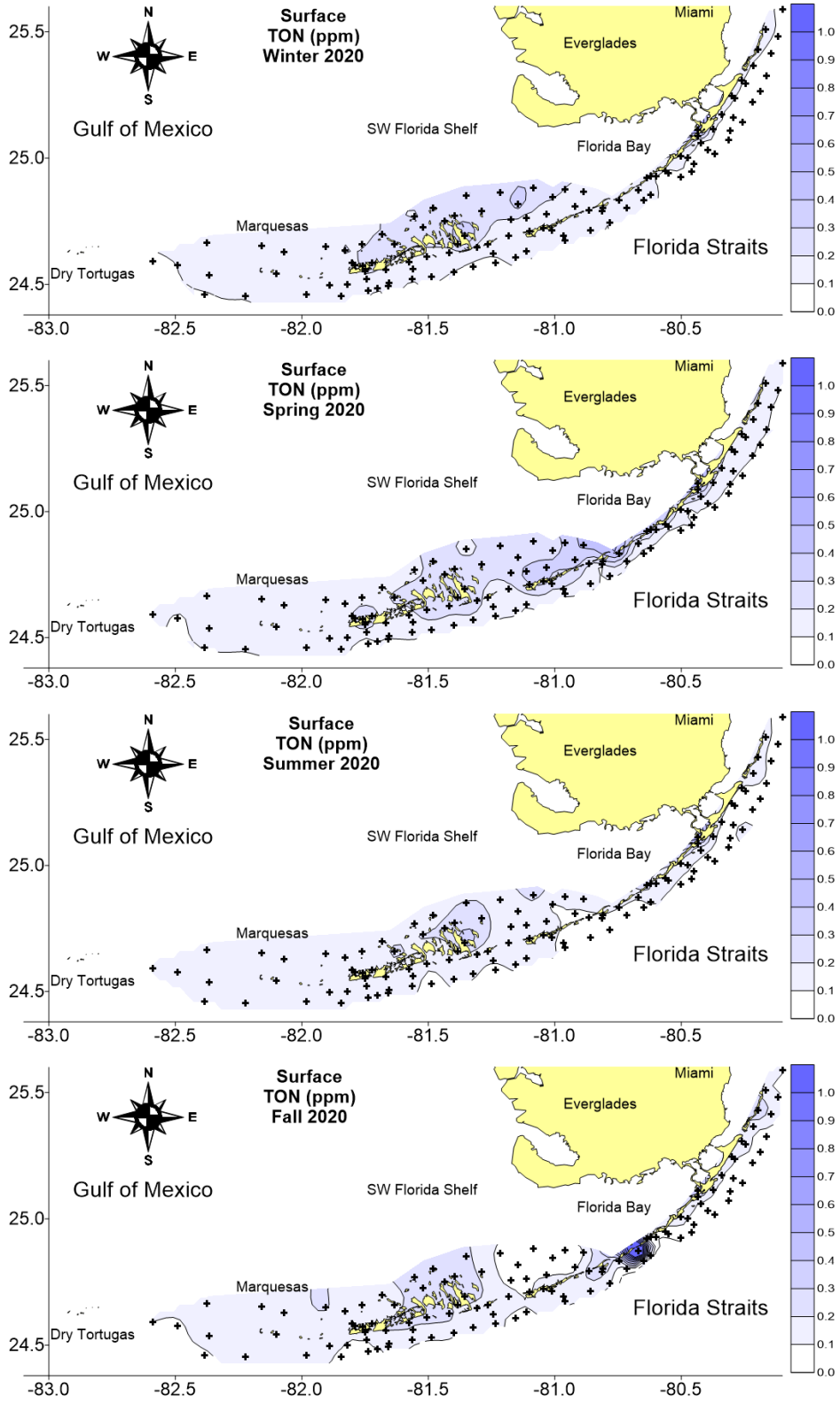


Figure 16. *Distributions of surface total nitrogen across the FKNMS during 2020.*

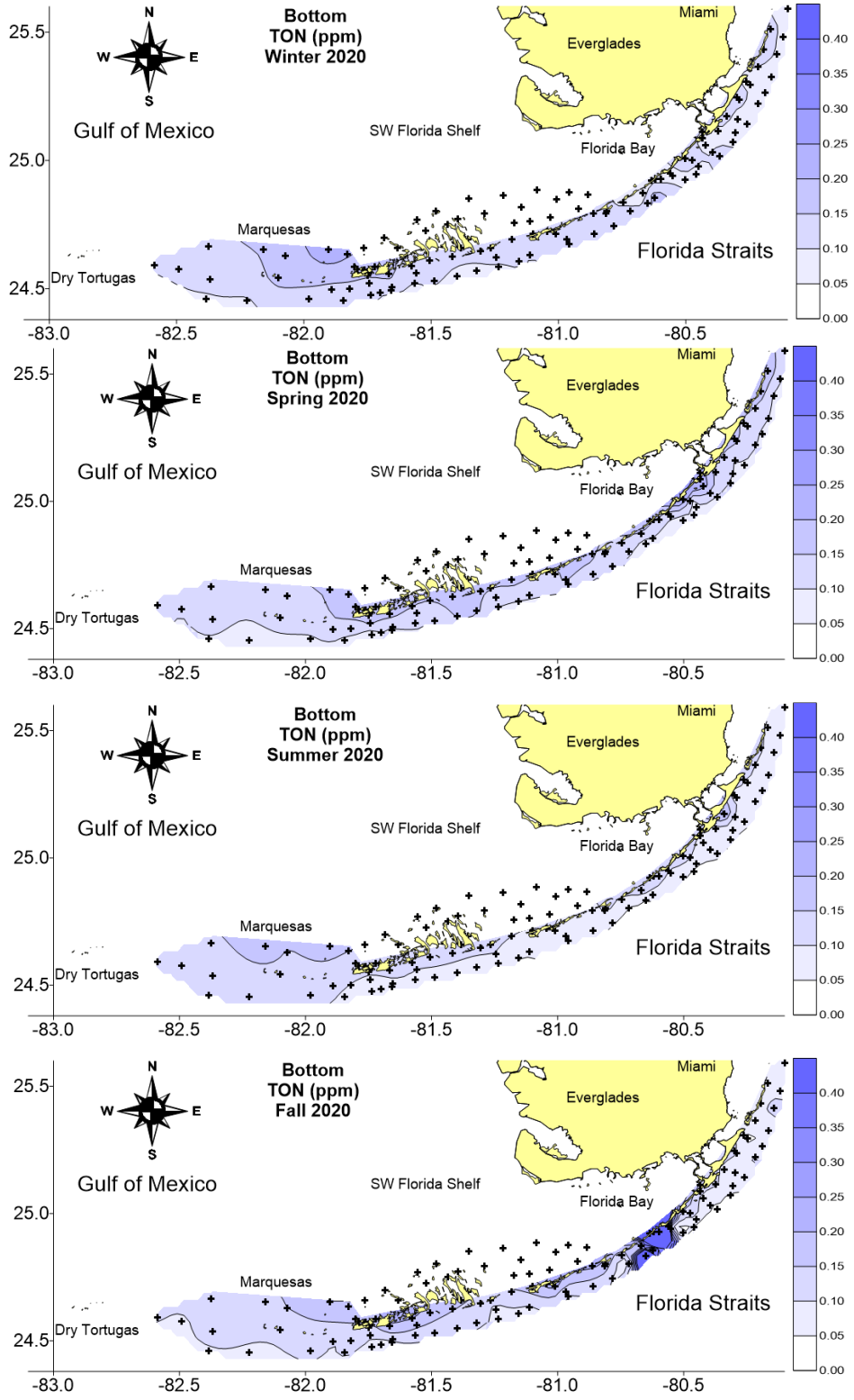


Figure 17. *Distributions of bottom total nitrogen across the FKNMS during 2020.*

Much emphasis has been placed on assessing the impact of episodic phytoplankton blooms in Florida Bay on the offshore reef tract environment. In the past, spatial patterns of CHLA concentrations showed that the SW Shelf, Northern Florida Bay, and the Ten Thousand Islands exhibited higher CHLA levels relative to the FKNMS. The oceanside transects in the Upper Keys exhibited the lowest overall CHLA concentrations of any area in the FKNMS. Transects off the Middle and Lower Keys showed that a drop in CHLA occurred at reef tract sites; there was no linear decline with distance from shore. Inshore and Hawk Channel CHLA concentrations among Middle Keys, and Lower Keys sites were not significantly different.

Historical data also showed that CHLA concentrations were typically higher in the Marquesas than in other areas of the FKNMS. When examined in context with the whole South Florida ecosystem, it is obvious that the Marquesas zone should be considered a continuum of the SW Shelf rather than a separate management entity. This shallow sandy area (often called the Quicksands) acts as a physical mixing zone between the SW Shelf and the Atlantic Ocean and is a highly productive area for other biota as well as it encompasses the historically rich Tortugas shrimping grounds. CHLA concentrations of 2 $\mu g\ l^{-1}$ in the water column of a reef tract might be considered an indication of eutrophication, but a similar CHLA level in the Quicksands indicates a productive ecosystem which feeds a valuable shrimp fishery.

CHLA levels during 2020 were relatively low, highest CHLA values occurred mostly along the northern boundary of the Backcountry and Lower Keys, suggesting an important contribution from the SW Shelf (Fig. 18). In addition, spring 2020 saw a short CHLA elevation around Big Pine Key.

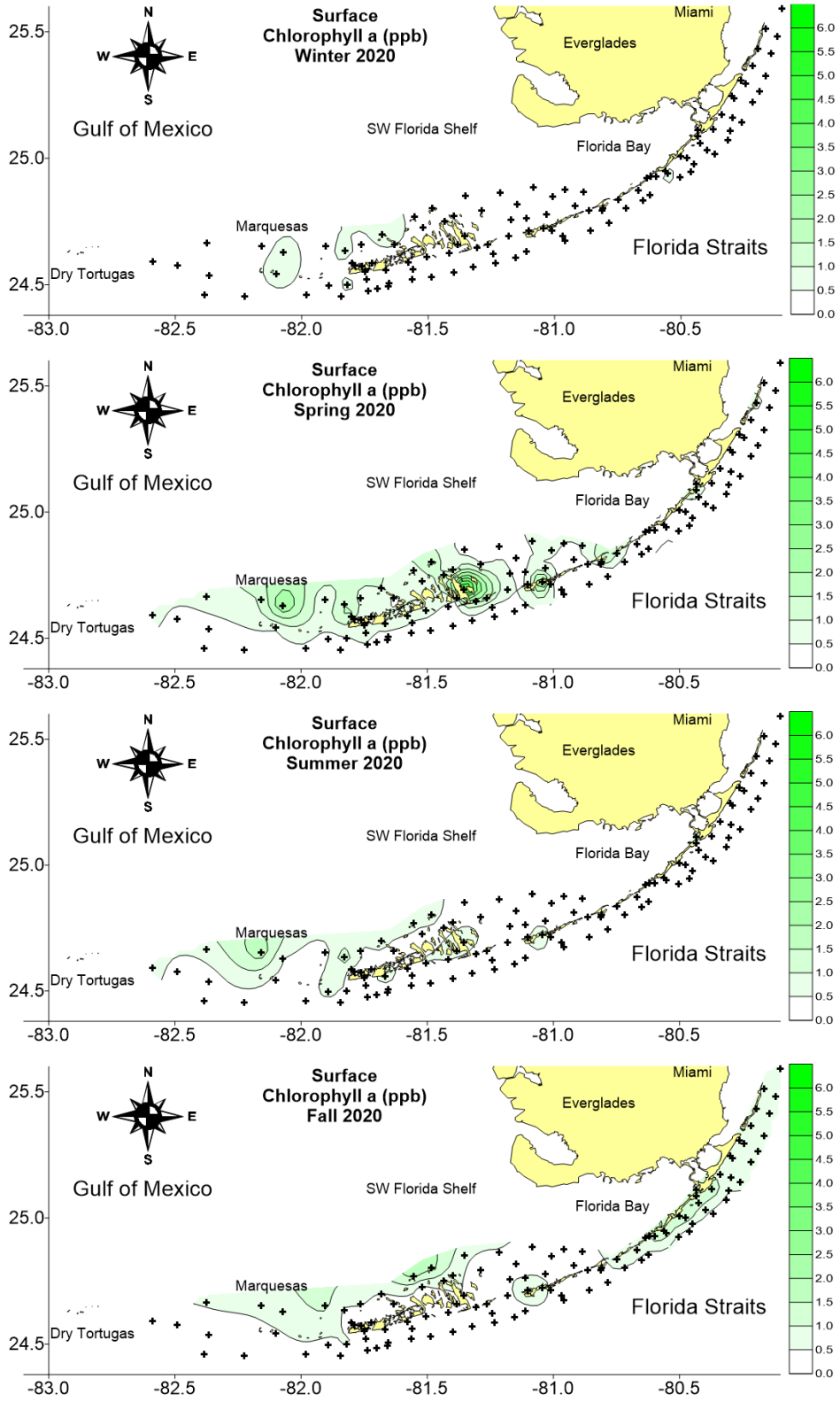


Figure 18*. Distributions of surface chlorophyll a across the FKNMS during 2020.*

Along with TP and CHLA, turbidity is probably the second most important determinant of local ecosystem health. The fine grained, low density carbonate sediments are easily re-suspended, rapidly transported, and have high light scattering potential. Sustained high turbidity indirectly affects benthic community structure by decreasing light penetration and thereby limiting seagrass and coral growth. Regional-scale observations of turbidity clearly show patterns of onshore-offshore gradients which extend out onto the SW Shelf to the Marquesas (Stumpf et al. 1999). Strong turbidity gradients have been observed on the SW Shelf but reef tract levels remain remarkably low regardless of inshore levels. Elevated turbidity in the Backcountry is most probably due to the shallow water column being easily re-suspended by wind and wave action. In 2020, highest turbidity values typically occurred in the Backcountry during the and mostly along the northern boundary with the SW Shelf (Fig. 19). There was also a large turbidity event in the Islamorada area during fall which may have been the cause of elevated TON as described previously.

Light extinction (K_d) is typically highest alongshore where waters are easily stirred up and loaded w/ colored dissolved organic matter (CDOM) from plant decomposition and improves with distance from land as water column becomes deeper and land-based sources are diluted. In Keys waters, CDOM may be a more important driver of light penetration than turbidity, thus the saying by divers that the visibility is “clean and green”. For 2020, K_d was generally under 0.01 m^{-1}. (Fig. 20), however some high, site-specific K_d observations mostly in the Backcountry tended to obscure low level patterns on the contour maps. Surprisingly, the high turbidity event around Islamorada did mot manifest as increased light extinction, as expected.

Turbidity and CDOM affect K_d , while site depth also affects the percent of ambient light reaching the bottom (I_o, Fig. 21). More light on the bottom is beneficial to corals, seagrass, and algae. Even when the water column is clear, the deeper the water depth, the less light there will be relative to surface. For 2020, lowest bottom light was observed in the deeper waters of the Marquesas. Interestingly, the low I_o levels in fall corresponded with the elevated turbidity event around Islamorada.

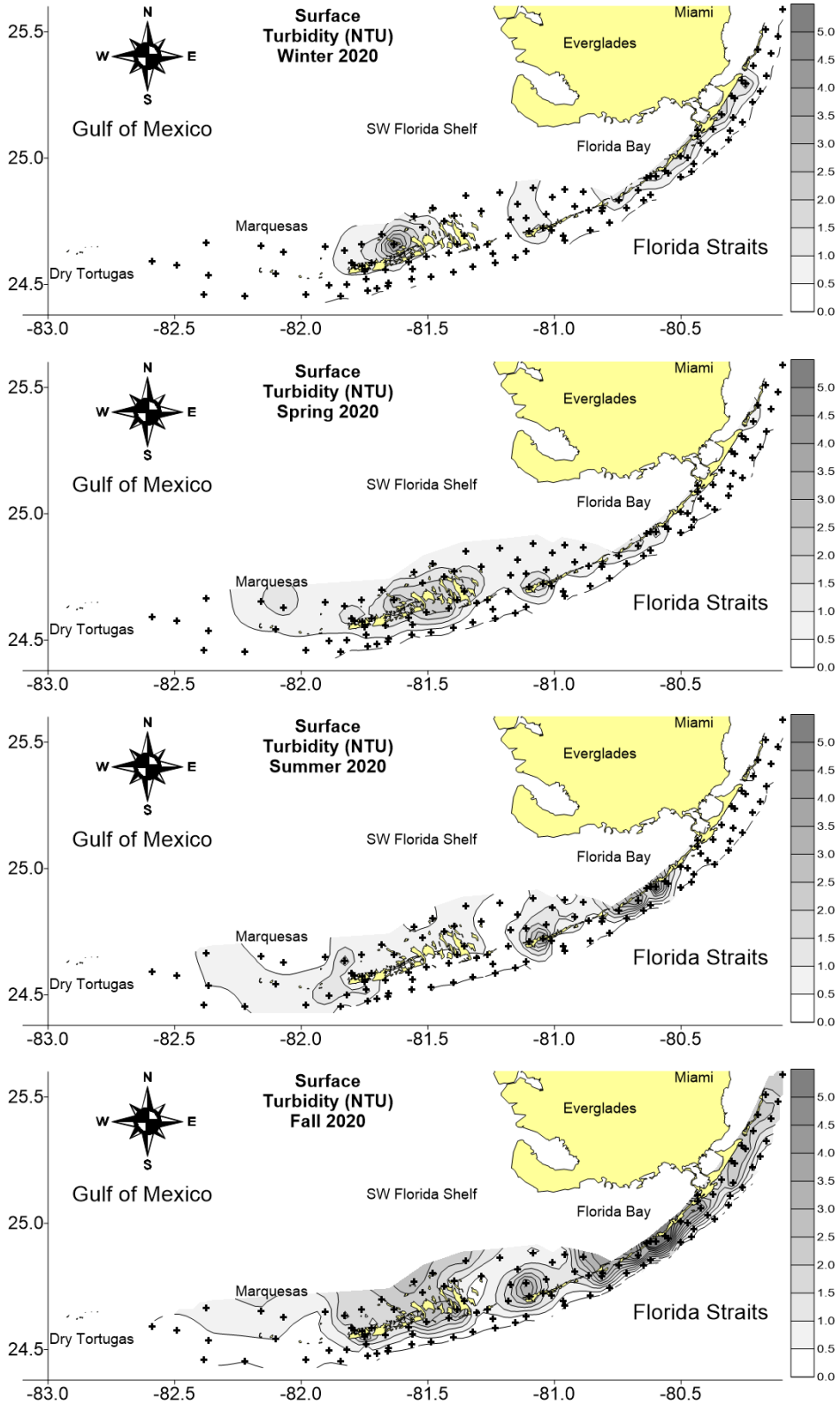


Figure 19. *Distributions of surface turbidity across the FKNMS during 2020.*

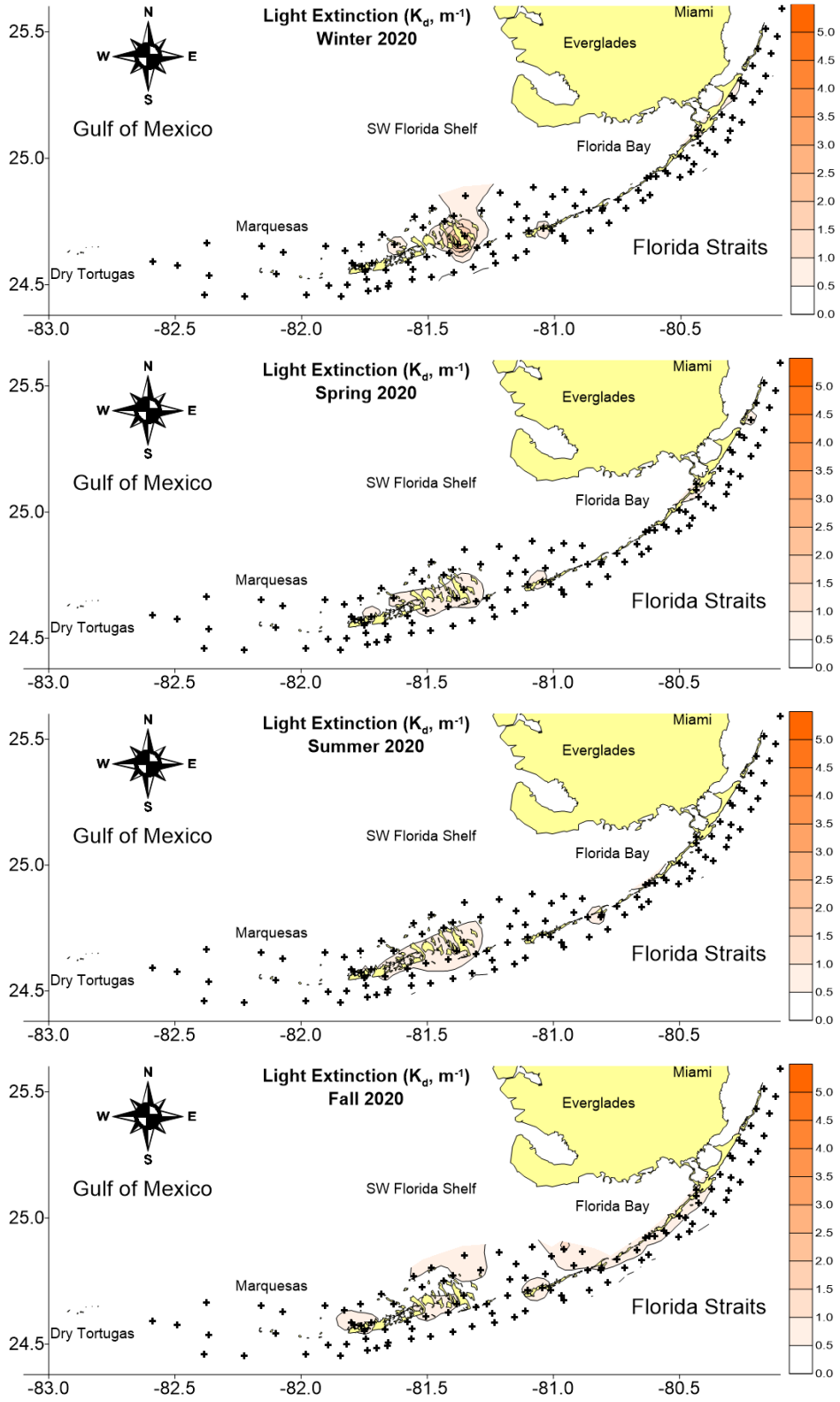


Figure 20. *Distributions of light extinction across the FKNMS during 2020.*

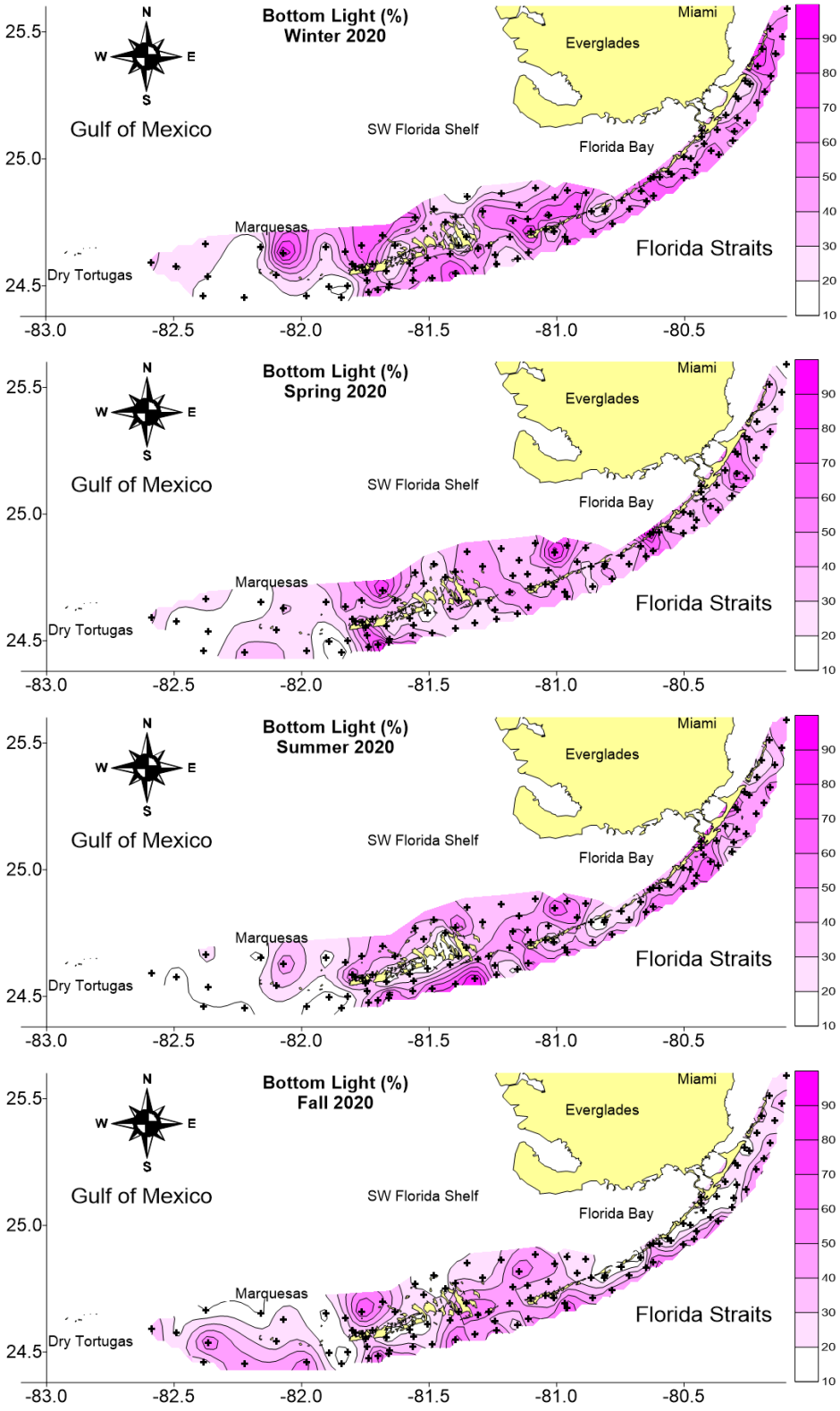


Figure 21. *Distributions of bottom light across the FKNMS during 2020.*

Surface SiO_2 concentrations usually exhibit a pattern similar to salinity. The source of SiO_2 in this geologic area of carbonate rock and sediments is from siliceous periphyton (diatoms) growing in the Shark River Slough, Taylor Slough, and C-111 basin watersheds. Unlike the Mississippi River plume with CHLA concentrations of 76 $\mu g\ l^{-1}$ (Nelson and Dortch 1996), phytoplankton biomass on the SW Shelf (1-2 $\mu g\ l^{-1}$ CHLA) was not sufficient to account for the depletion of SiO_2 in this area. Therefore, SiO_2 concentrations on the SW Shelf are depleted mostly by mixing (although we no longer have data from the SW Shelf), allowing SiO_2 to be used as a semi-conservative tracer of freshwater in this system (Ryther et al. 1967; Moore et al. 1986). In 2020, SiO_2 concentrations were very low, relative to other years with no coherent pattern. (Fig. 22).

The TN:TP ratio has been used as a relatively simple method of estimating potential nutrient limitation status of phytoplankton (Redfield 1967). Most of the South Florida hydroscape has TN:TP values >> 16:1, indicating the potential for phytoplankton to be limited by P in most of the FKNMS (Fig. 23). Potential N limitation typically occurrs in the southern Marquesas in fall and potentially along the Upper Keys reef tract. Note the high fall 2020 TN:TP around Islamorada as a result of episodic TON/turbidity event.

Most TN occurs in the form of organic N (TON) and is not bioavailable to phytoplankton while much of the organic fraction of TP is labile (as ester-bonded P). Therefore, the TN:TP ratio overestimates P limitation and should be recognized as such. A better estimate of phytoplankton nutrient limitation may be the DIN:TP ratio (Fig. 24) which assumes that most of the TON is refractory and that all TP is bioavailable. Given these assumptions, the FKNMS would be considered more of an N-limited system (<16), notwithstanding the DIN pulse in the Upper Keys during fall 2020. This becomes moot when the ambient nutrient concentrations are lower than biological kinetic thresholds for uptake, which often occurs. It is also important to recognize that ambient nutrient concentrations are the result of competing processes: advection, biological uptake, and remineralization. Barring external source/sink, nutrient levels increase when remineralization exceeds uptake and vice versa.

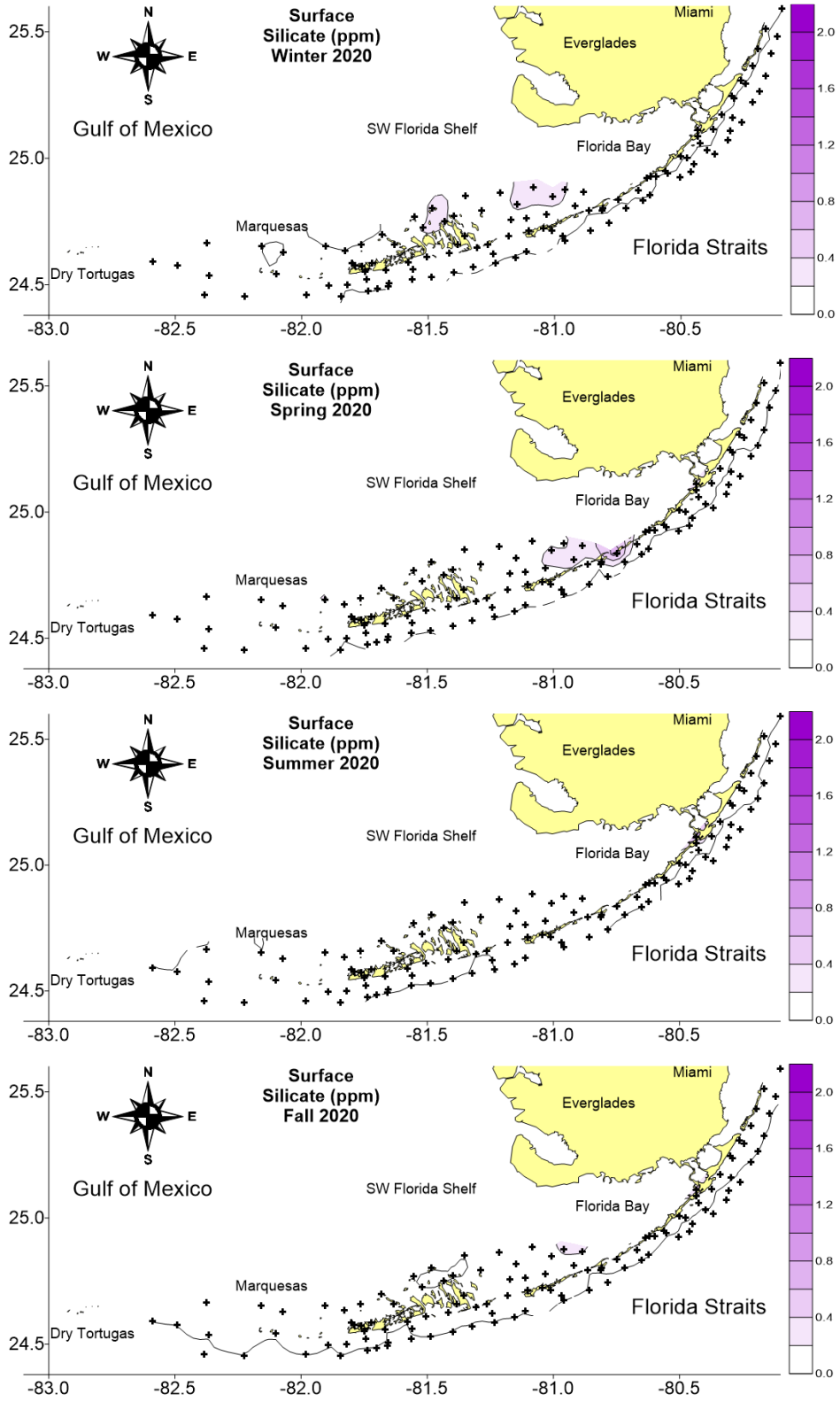


Figure 22. *Distributions of surface silicate across the FKNMS during 2020.*

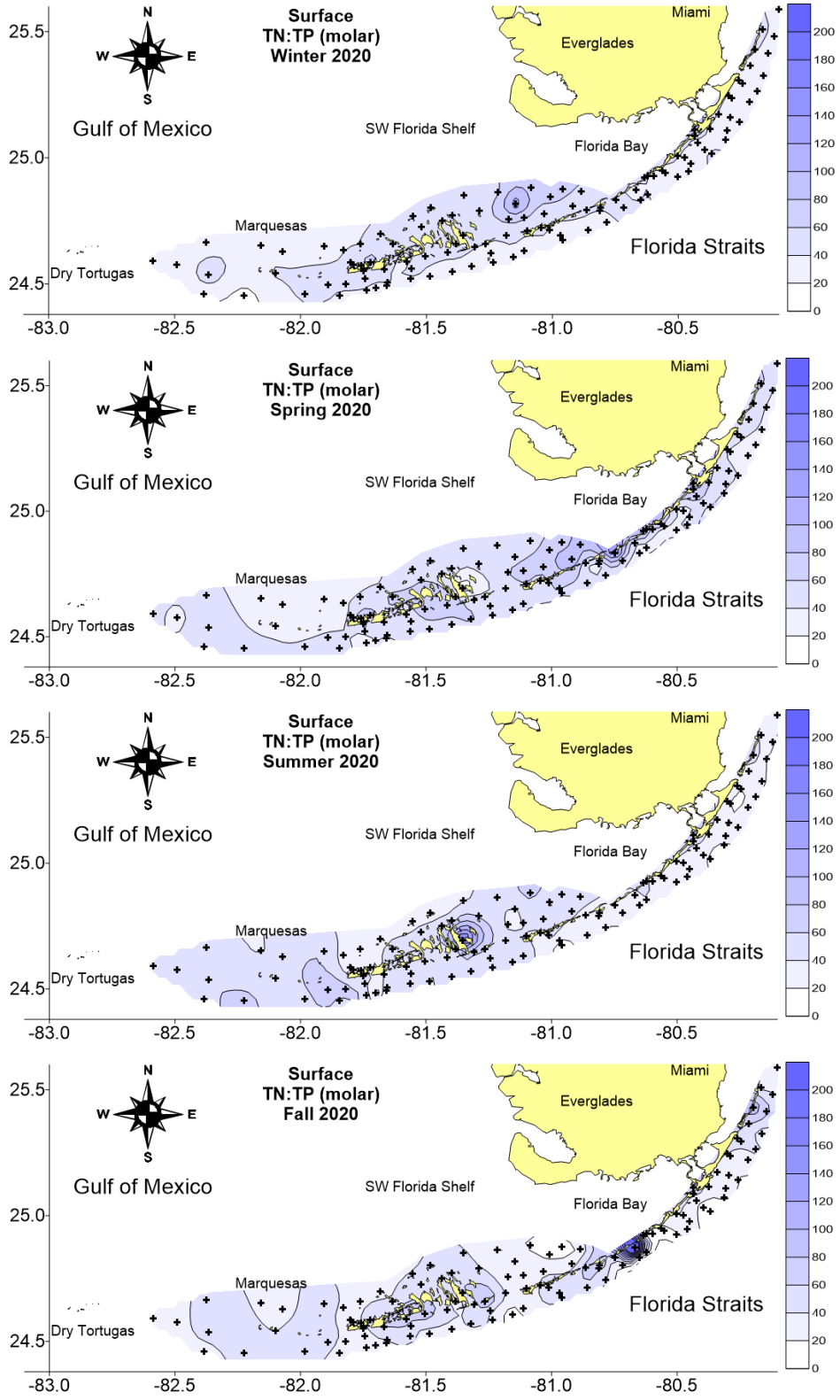


Figure 23. *Distributions of surface TN:TP ratio across the FKNMS during 2020.*

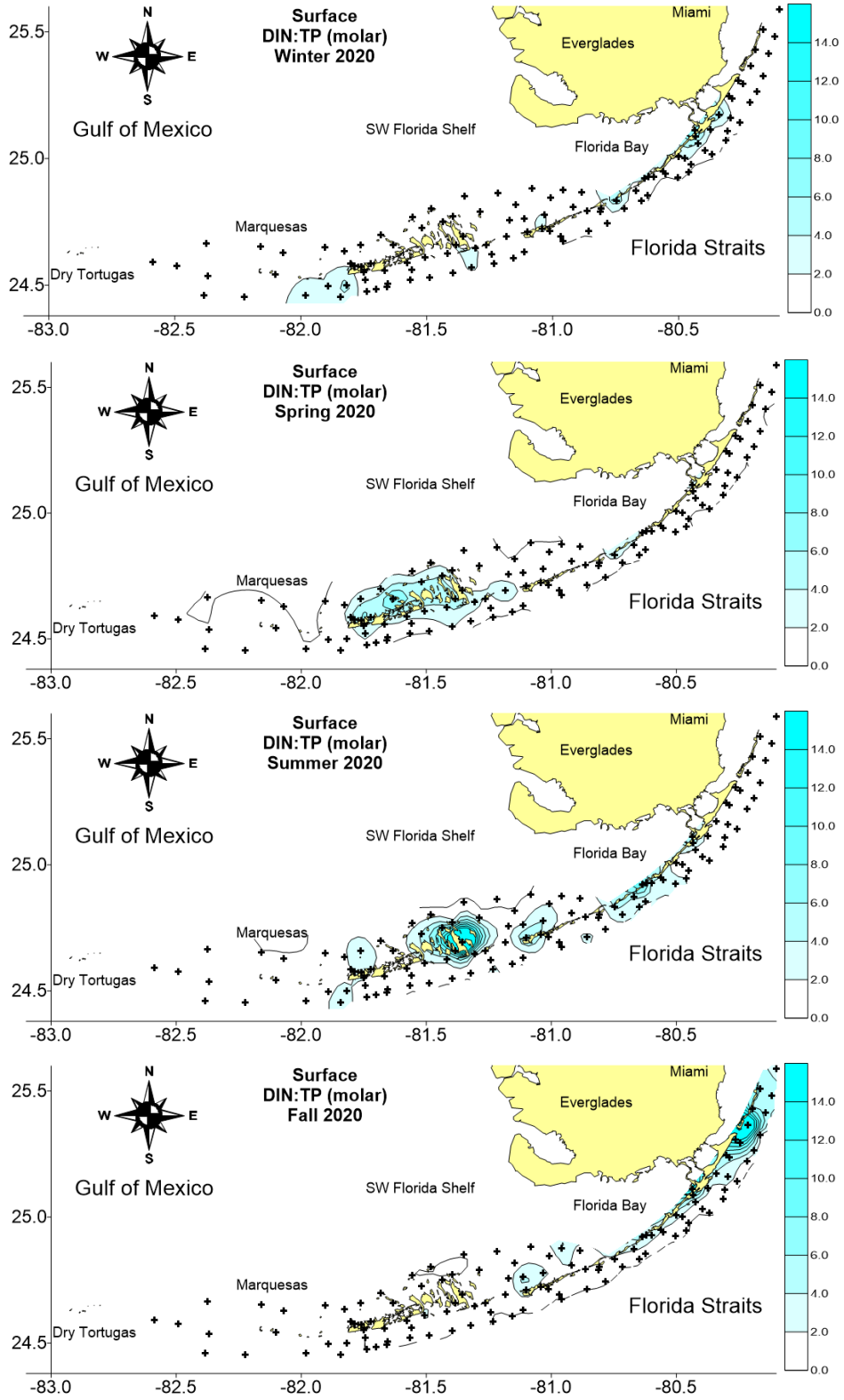


Figure 24*. Distributions of surface DIN:TP ratio across the FKNMS during 2020.*

3.4. Temporal Trends and Dynamics

Clearly, there have been changes in the FKNMS water quality over time, some sustained monotonic trends have been observed. However, we must always keep in mind that trend analysis is limited to the window of observation and method of analysis. In addition, when looking at what are perceived to be local trends, we may find that they occur across the whole region at more subtle levels. 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 climate forcing. Clearly, trends observed inside the FKNMS are influenced by regional conditions and by drivers from outside the Sanctuary boundaries.

As mentioned, time series analysis is limited to the window of observation and trends may change with continued data collection. In addition, water quality in the Keys is largely driven by external influences and may fluctuate according to climatic or disturbance events of long or short periodicity. Examples of the types of trends observed in environmental systems shown below are 1) monotonic (Fig. 25), 2) episodically driven with no net trend (Fig. 26) and 3) reversing or discontinuous with change point (Fig. 27).

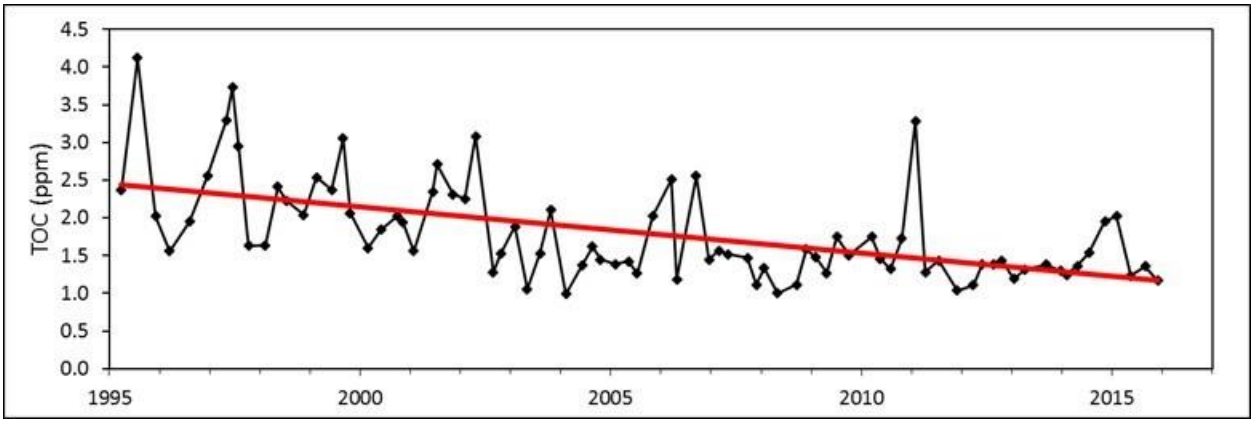


Figure 25. *Monotonic trend in TOC at Carysfort Reef.*

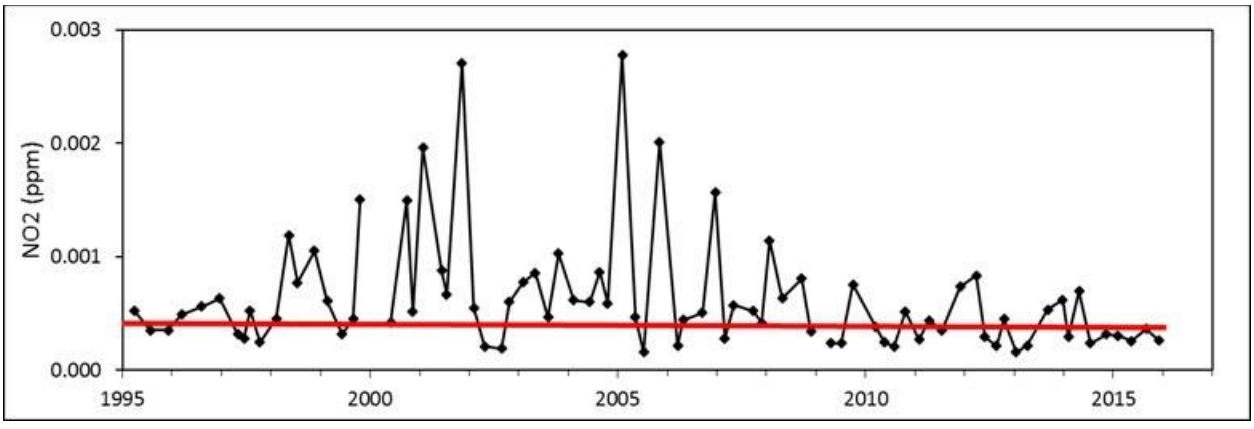


Figure 26. *Episodically driven pattern in NO_2^- with no net trend at Carysfort Reef.*

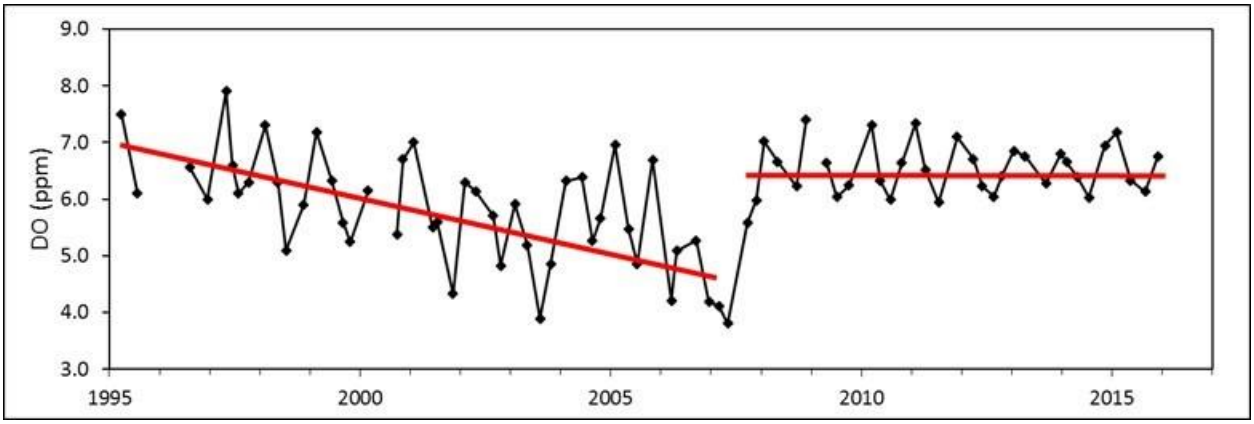


Figure 27. *Discontinuous trend in DO at Carysfort Reef.*

Linear regression approaches shown above may not be optimal for analyzing long term time series influenced by fluctuating conditions or disturbance events. Instead, locally weighted regressions, such as LOESS, are more useful for visualizing trend reversals and cycles in those time series (Fig 28).

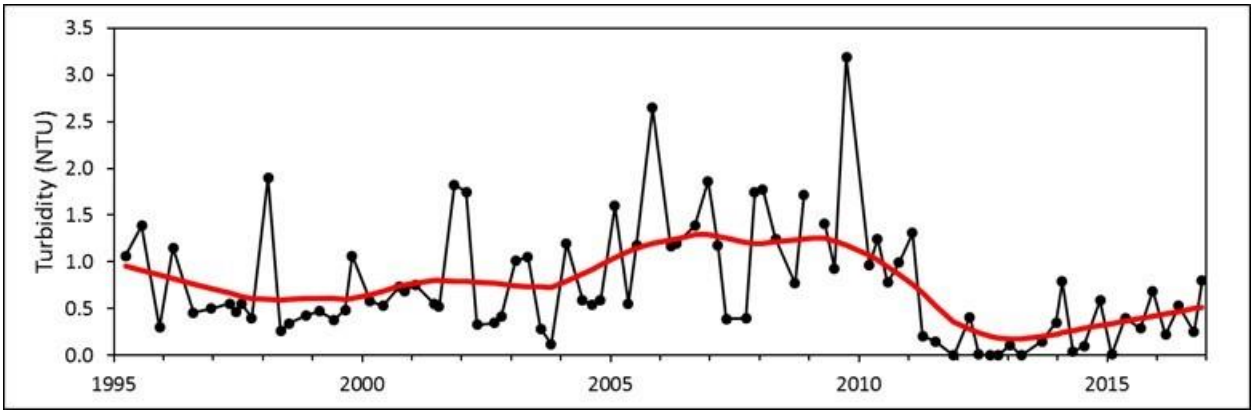


Figure 28. *LOESS fitting of trend in turbidity at Carysfort Reef.*

To quantify trends, we used Sen slope regressions for each water quality variable for the 25-year period of record. Statistical significance was tested using the nonparametric Mann-Kendall T_b. Some of the Sen slopes were very small, so to get a better idea of change over the period of record, the annualized slopes were multiplied by the number of years sampled and plotted as contour maps of total change for the record. For the 26-year period of record, most variables exhibited some significant trends but not at all sites. We chose to map all the projected total changes regardless of significance in order to show directional tendencies in variables across the FKNMS. A table of all variable trends by station, showing statistical significance, is provided in Appendix A.

Surface salinity did not exhibit many significant long-term trends, nonetheless, the change maps (Fig. 29) show differences among regions. Both surface and bottom salinity in the bayside area of the Middle Keys and oceanside Upper Keys increased over time, while the Oceanside

Lower Keys declined. The time series of salinity on the Reef and Inshore areas was most consistent (Fig 30) with LOESS curve being smooth and consistent. Largest variations occurred in the Bay and Backcountry, areas that are most influenced by mainland freshwater sources and because of their shallow waters are more sensitive to high evaporation rates (salinity increase) or heavy rains (salinity decrease). The Backcountry displayed some salinity cycles lasting 4-5 years (Fig. 30). Note the large depression in salinity in the Marquesas during 2005-7. We believe this was legacy of the 2005 hurricane season, which affected salinity in the Gulf of Mexico for an extended period afterwards (Briceño & Boyer 2010). SHORE stations have increased salinity since 2011.

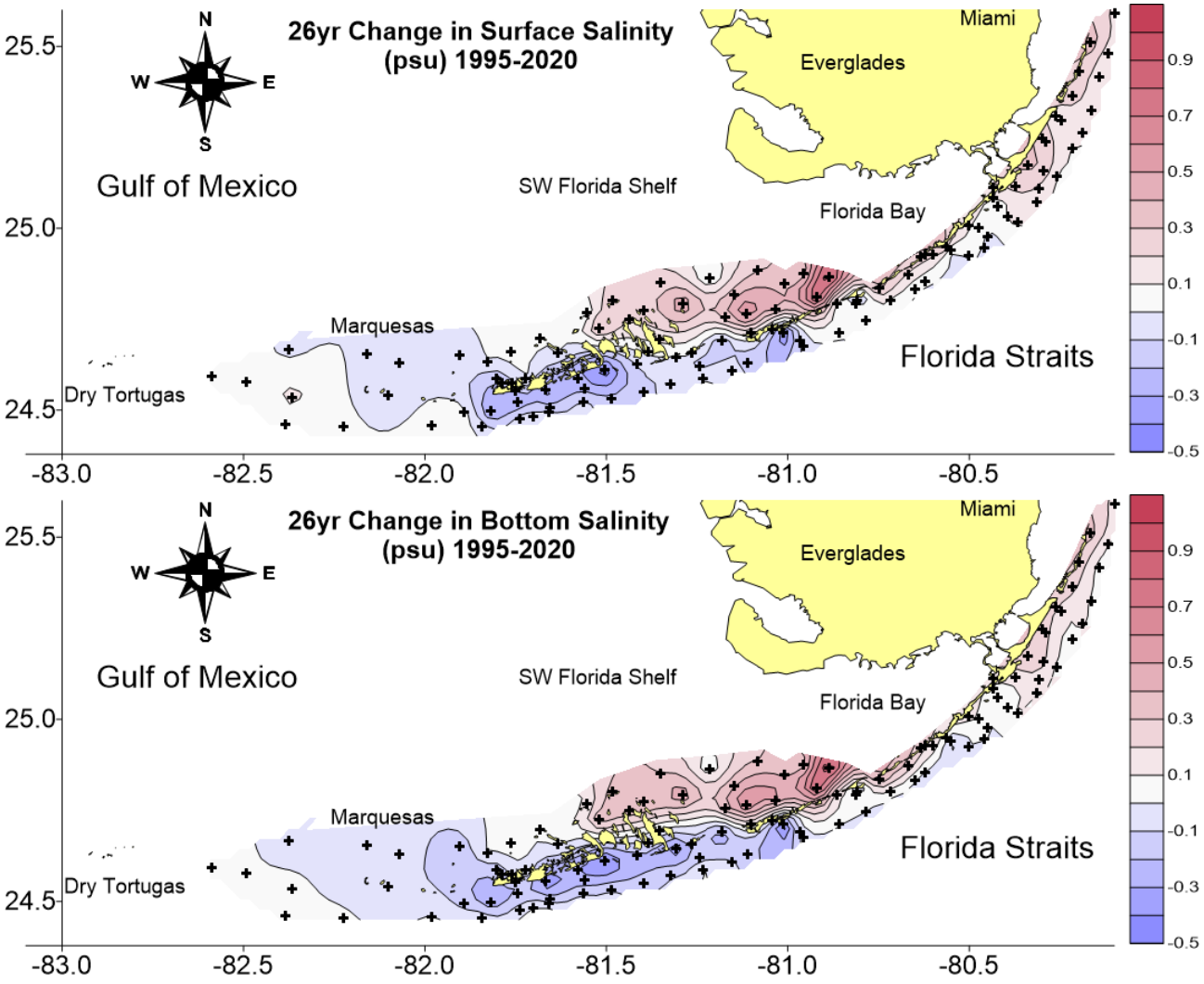


Figure 29. *Total change in surface and bottom salinity for 26-year period.*

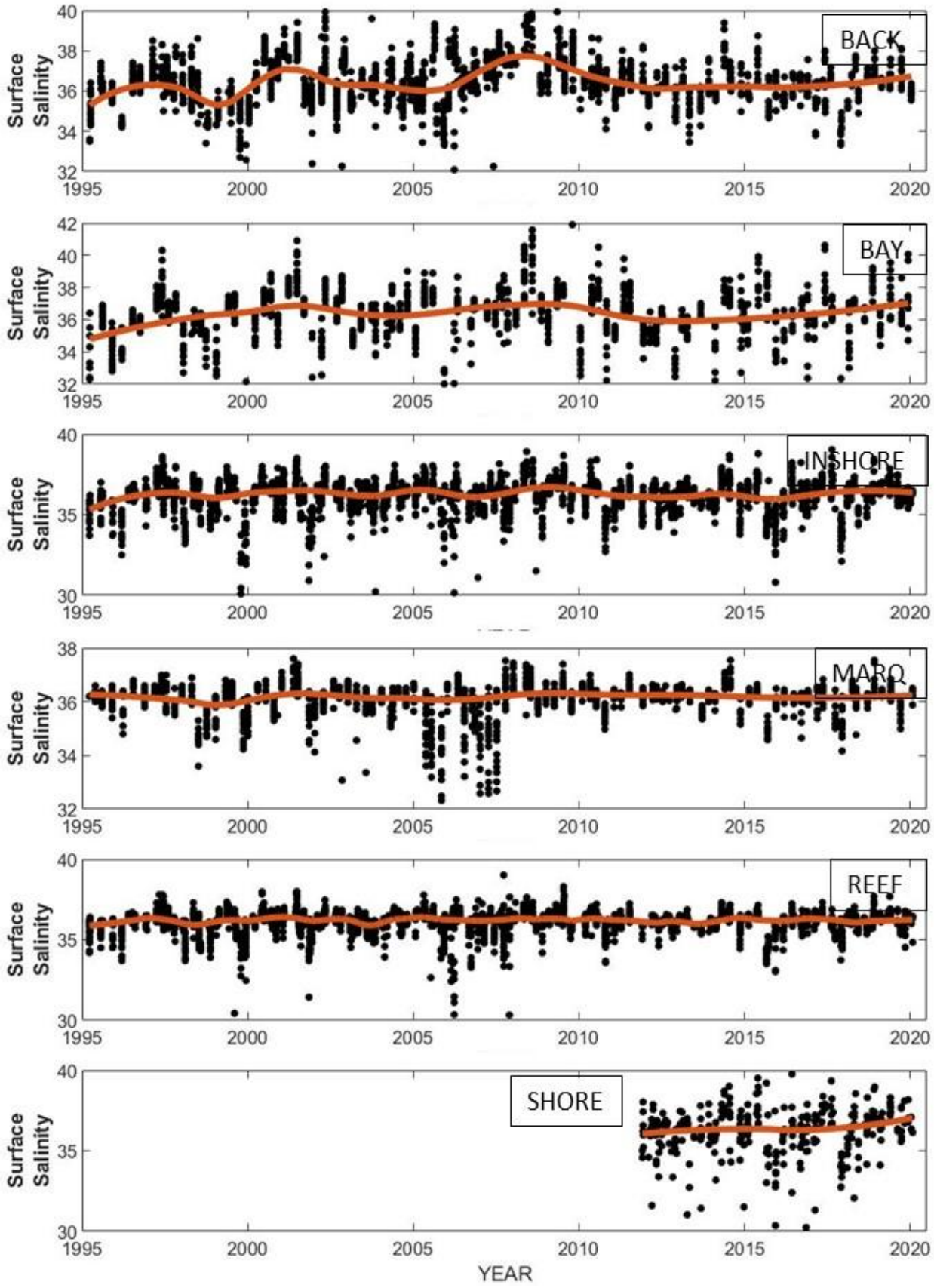


Figure 30. *Time series of surface salinity by zone. The line is LOESS fit.*

Temperature also did not exhibit a statistically significant long-term trends but the change maps show relative differences in direction of tendency across regions (Fig. 31). The Bay and Lower Keys zones tended to decline while the oceanside Upper Keys and Marquesas tended to increase. The temperature time series also show that the most variability occurred in the shallowest areas such as the Backcountry and Bay (Fig. 32).

Quarterly collection of temperature over 26 years cannot be expected to resolve the small changes in subtropical waters expected under global climate change. Nevertheless, the spatial consistency of temperatures in this program suggests increases in the Middle and Upper Keys, which may affect coral reefs. Daily temperature measurements from three separate programs have shown that the waters of the Florida Keys have warmed ~0.8°C for the period 1878-2012 (Kuffner et al. 2015). SHORE stations have increased temperature since 2011.

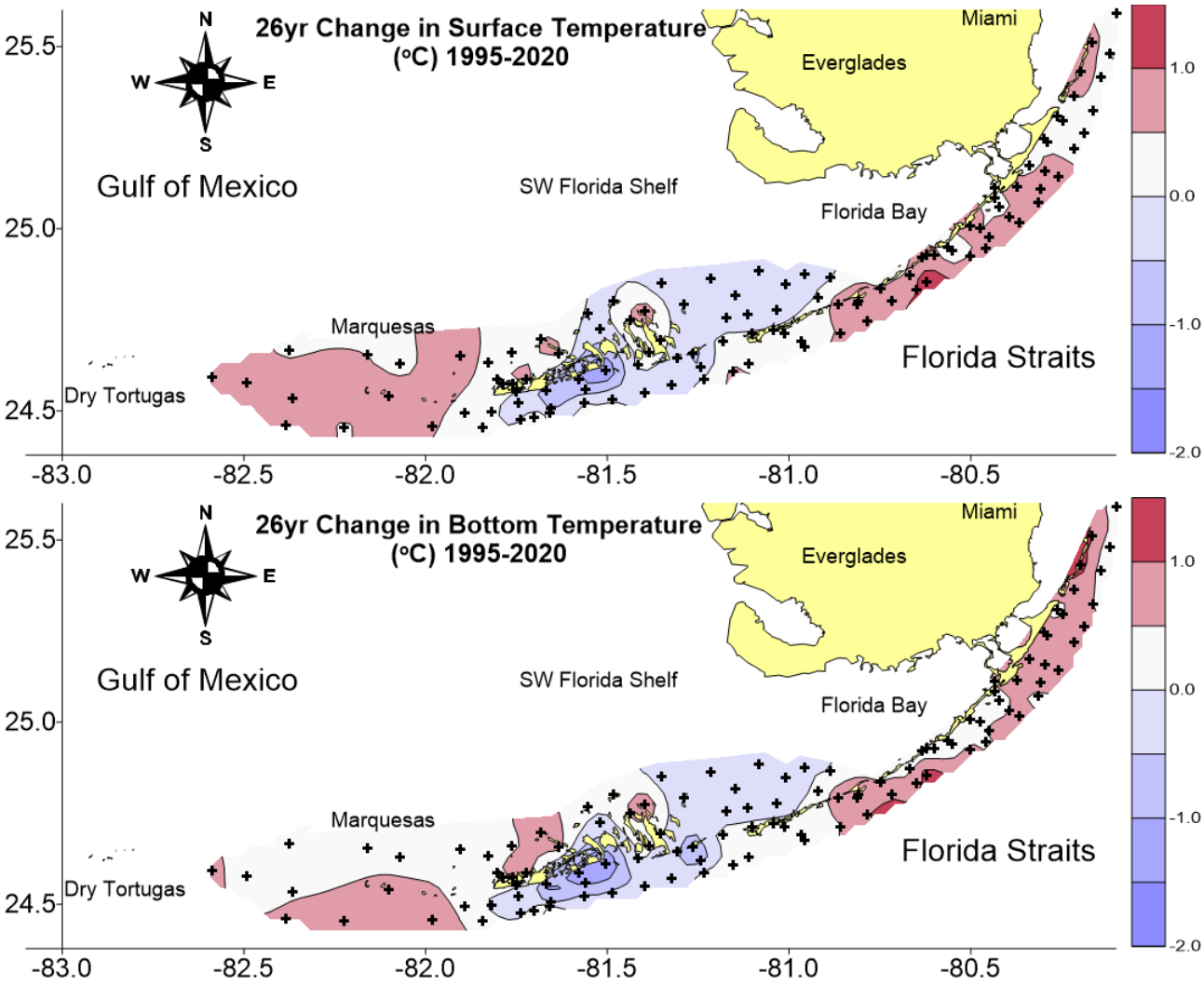


Figure 31. *Total change in surface and bottom temperature for 26-year period.*

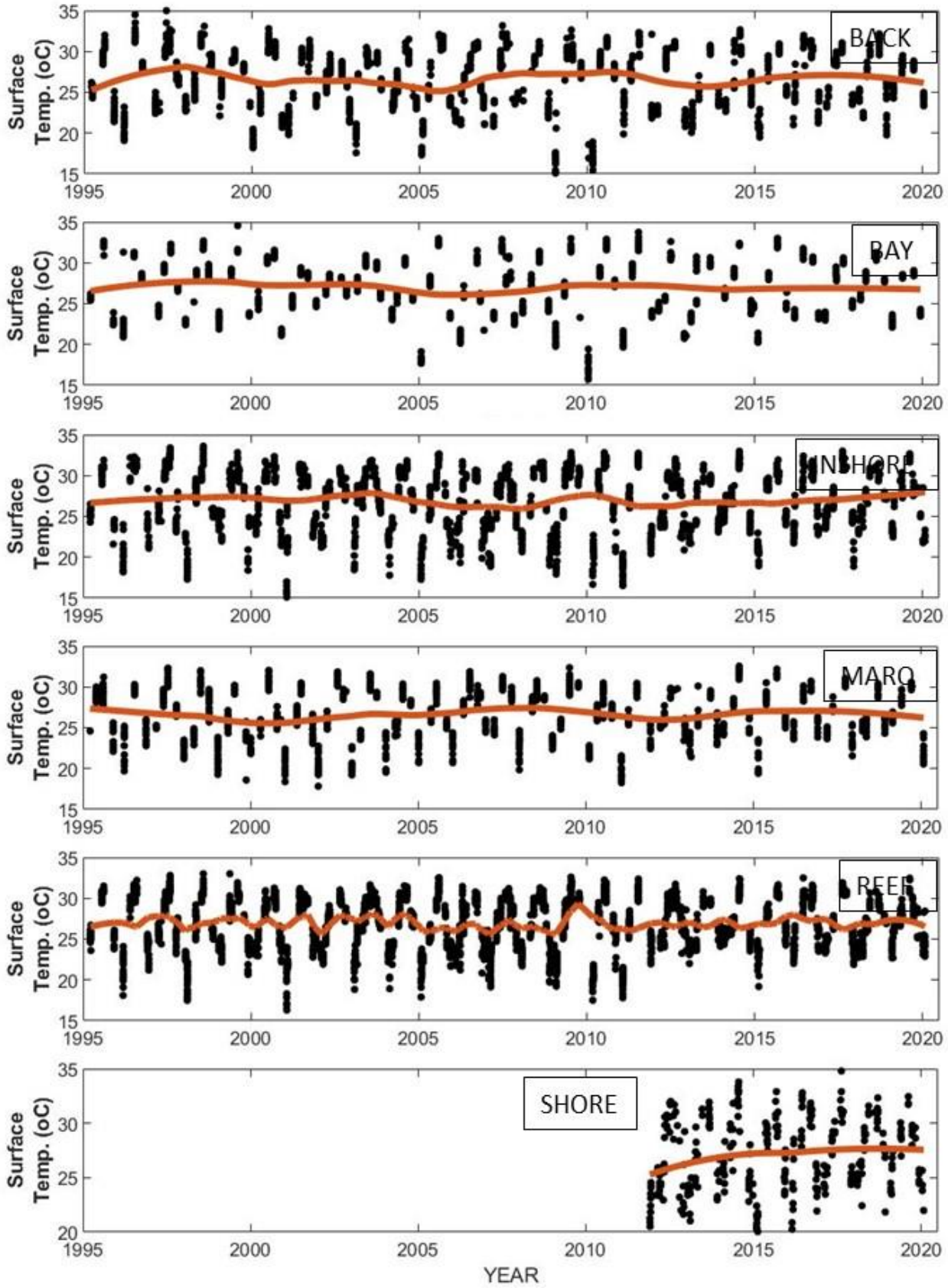


Figure 32. *Time series of surface temperature by zone. The line is LOESS fit.*

Surface DO saturation increased at most sites the FKNMS (Fig. 33). Increased DO_{sat} is beneficial for animal life. Greatest increases in DO_{sat} were generally observed on the Atlantic side of the Keys. A few sites in the Sluiceway areas closest to Florida Bay and north Backcountry sites showed decreasing trends. Trends in bottom DO_{sat} were similar to surface sites.

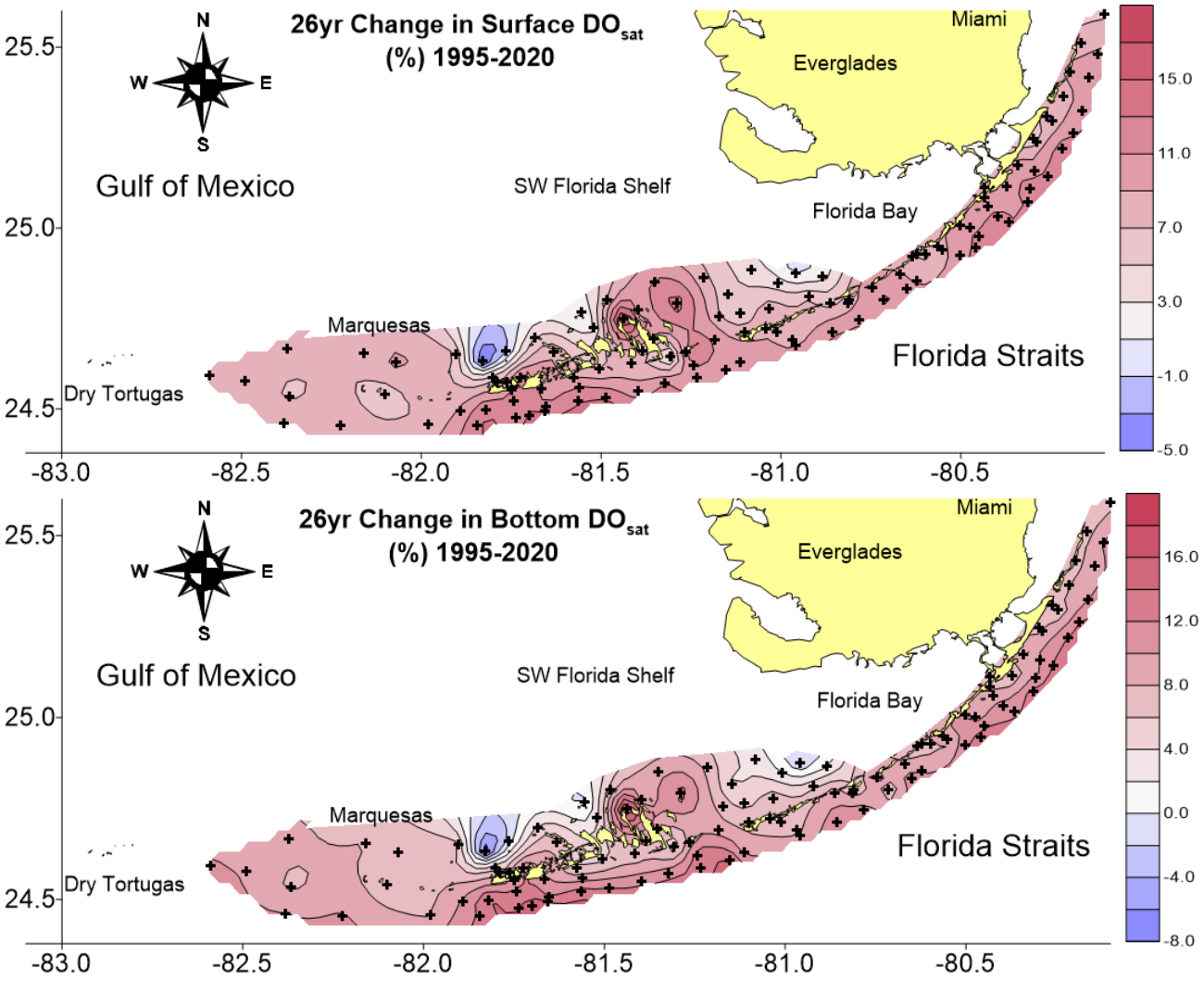


Figure 33. *Total change in surface and bottom DO saturation for 26-year period.*

By looking at the map, one might assume that DO_{sat} has experienced a slow, incremental increase of over the 26-year period. However, the LOESS regression of surface DO_{sat} showed a small decline in most zones (Fig. 34) and then a rapid decline from 2004 to early 2007 with strong rebound in late 2007 to levels slightly higher than pre-2004. The DO_{sat} drop seems to be linked to eight major hurricane impacts during 2004 (Charley, Frances, Ivan and Jeanne) and 2005 (Dennis, Katrina, Rita, and Wilma) whose effects lasted until 2007. Interestingly, DO_{sat} in the Backcountry was relatively stable for the period of record and was not affected like other areas. Net DO_{sat} changes over the 26-year period were small but significant; the range of internal variability during those impacted years was larger and significant.

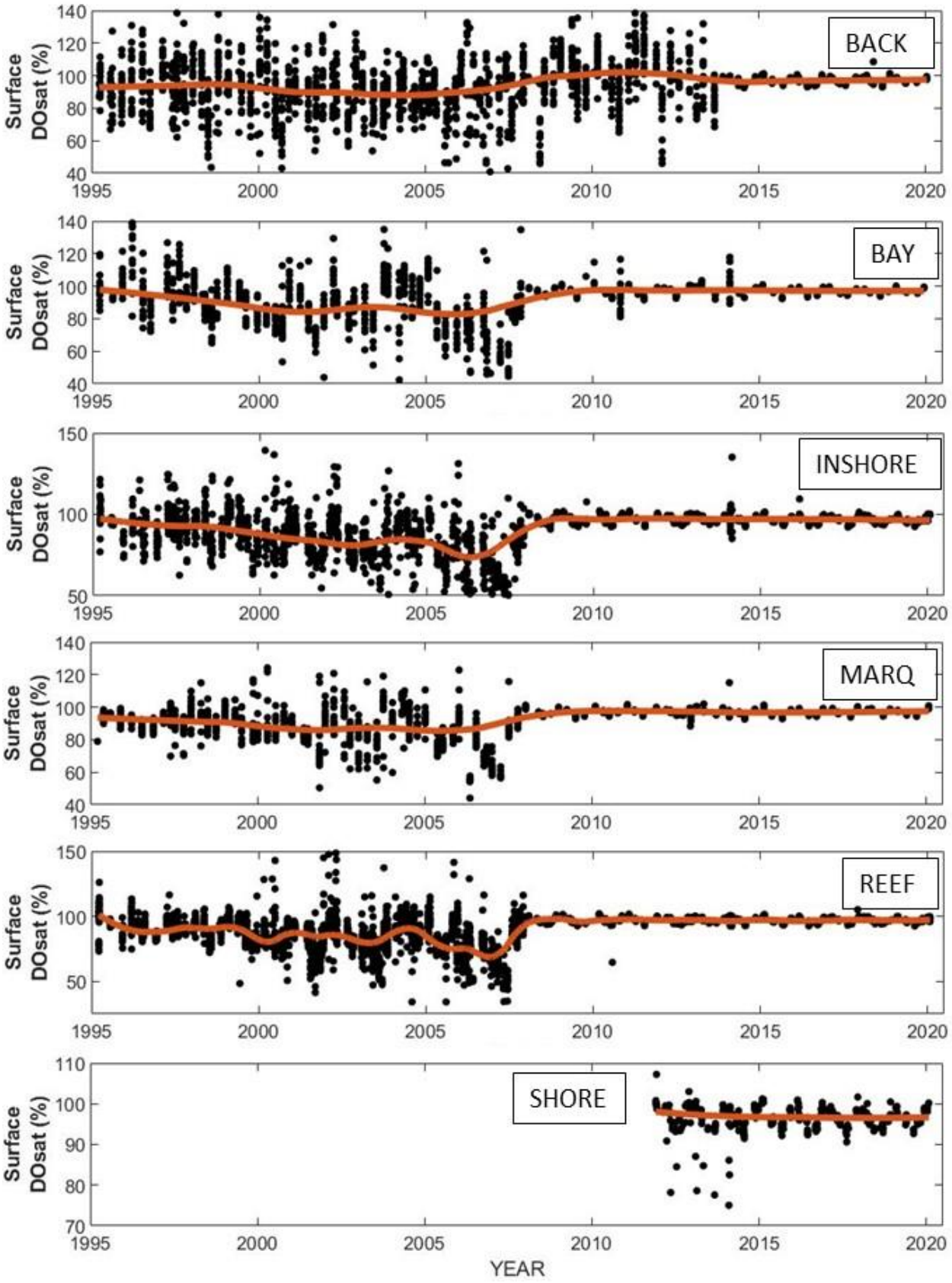


Figure 34. *Time series of surface DO saturation by zone. The line is LOESS fit.*

Another interesting pattern in DO data is the relatively high dispersion of values in shallow waters of the Backcountry and SHORE sites until 2014, while in deeper waters of Marquesas, Reef, Inshore and Bay high variance lasted until 2007.

Water column turbidity declined throughout the FKNMS (a beneficial result) during the 26-year period (Fig 35). The largest declines in turbidity occurred in western Florida Bay and Marquesas. There were small increases in bottom water turbidity at sites along northern boundary of Sluiceway and Backcountry.

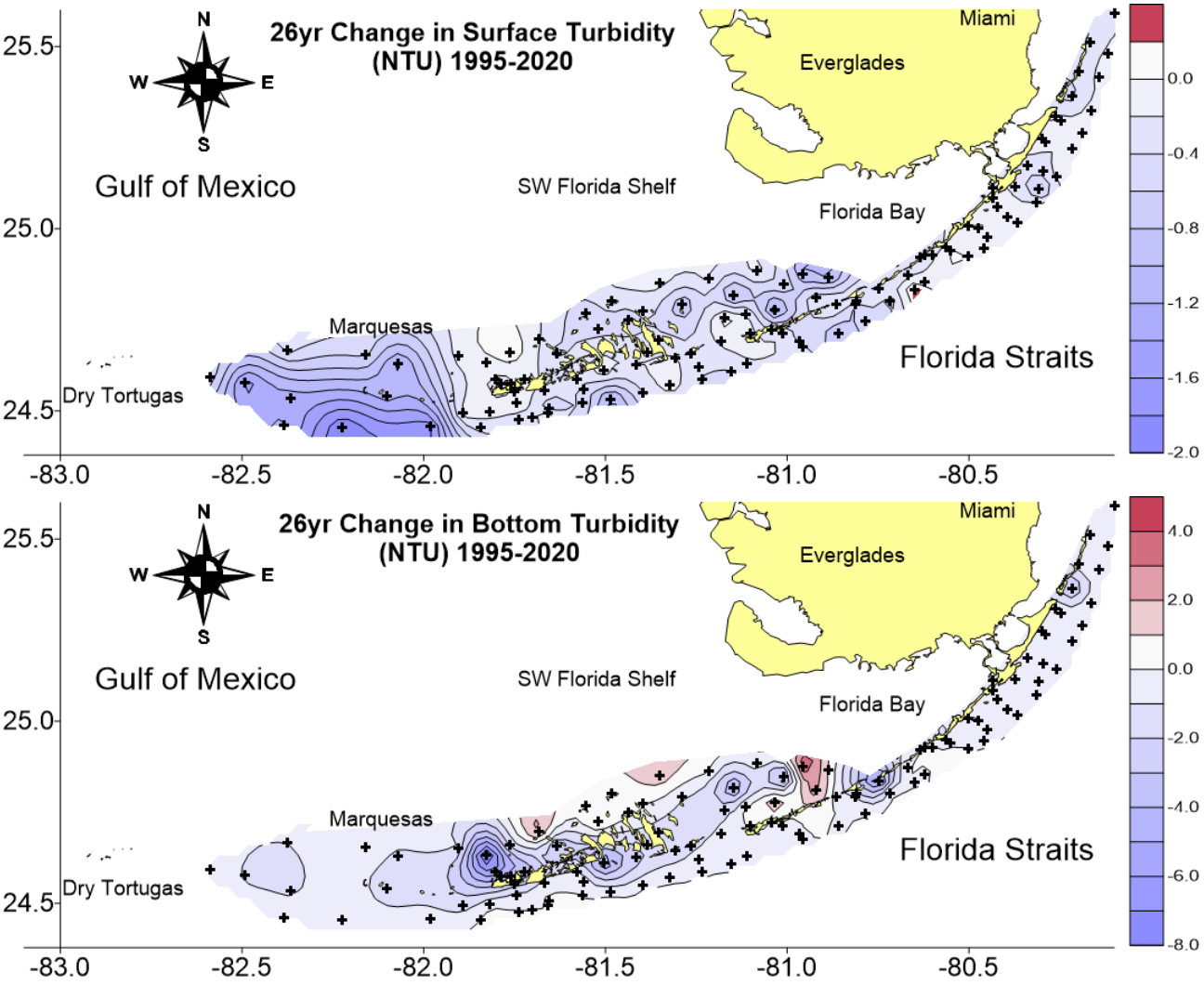


Figure 35. *Total change in surface and bottom turbidity for 26-year period.*

The time series plots of surface turbidity (Fig. 36) gives more information on the nature of the trend. Turbidity was relatively consistent for the period 1995-2005, increased during the 2005 hurricane season, then rapidly returned to previous levels. Around 2012, turbidity across the region had dropped to lower levels than before the 2005 disturbances, and have remained so, although a slight increasing tendency began in 2014.

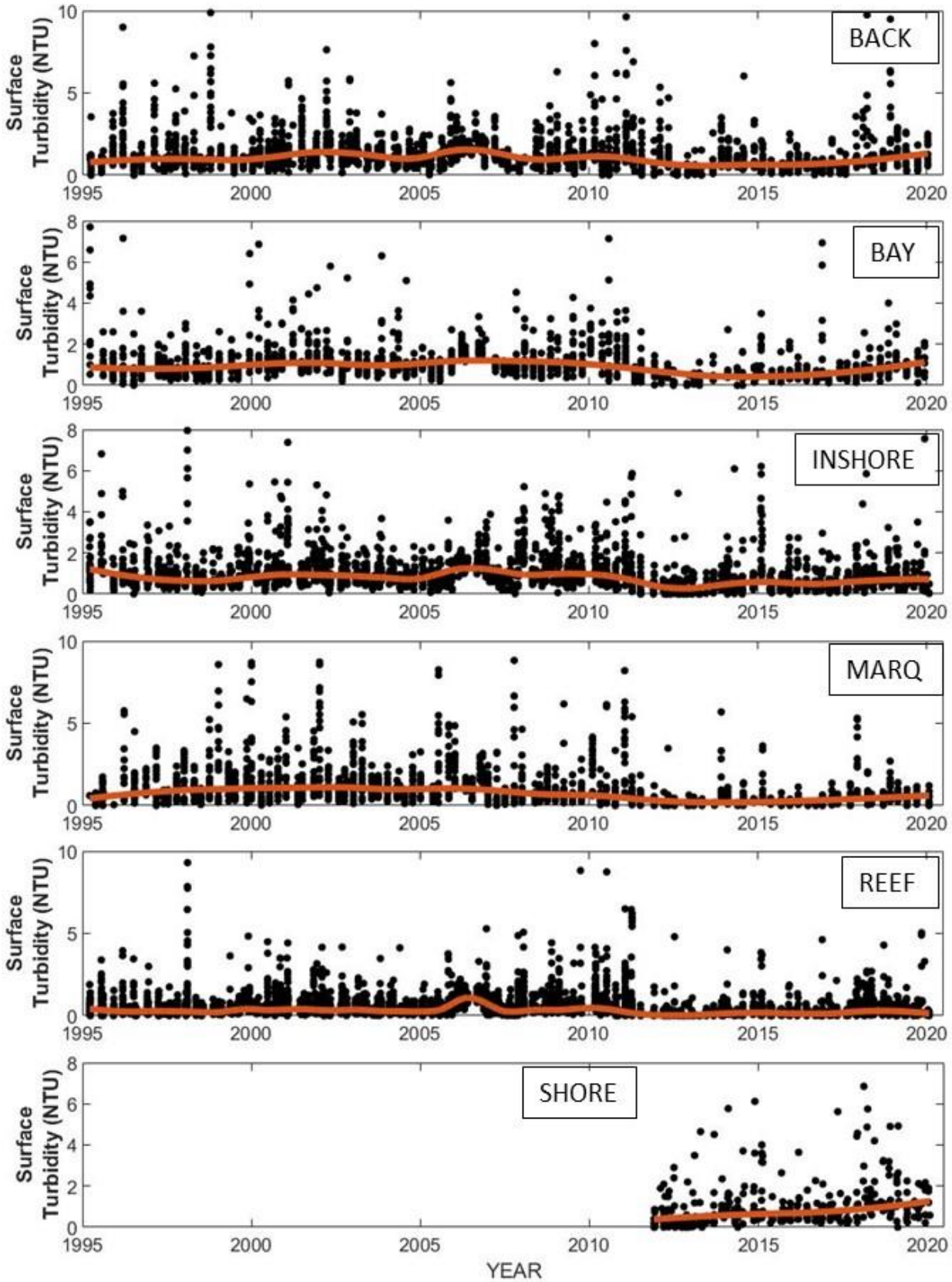


Figure 36. *Time series of surface turbidity by zone. The line is LOESS fit.*

Light extinction (K_d) also showed significant declining trend, a positive result, offshore and in the Marquesas but increased in the Backcountry, Sluiceway, and inner Upper Keys (Fig. 37). Lower K_d tends to increase the amount of light reaching the bottom (I_o in %). More bottom light is beneficial to corals, seagrass, and algae. I_o increased mostly at offshore reef sites throughout the Keys but decreased inshore and in the Upper Keys (Fig. 38). The Backcountry also experienced increases in K_d with decreases in I_o, resulting in less light on the bottom.

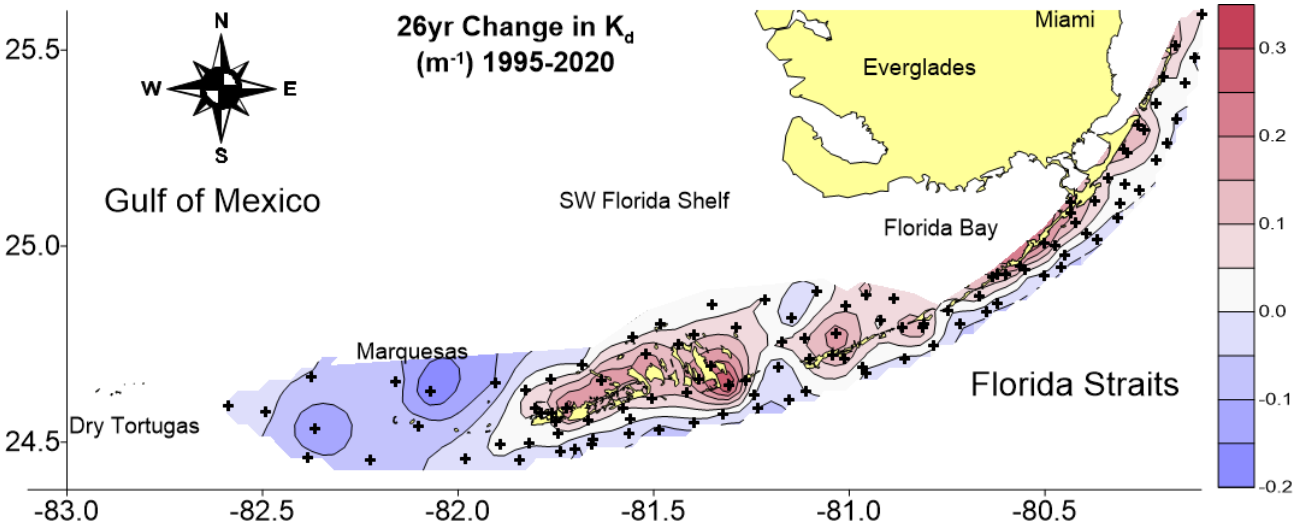


Figure 37. *Total change in bottom K_d for 26-year period.*

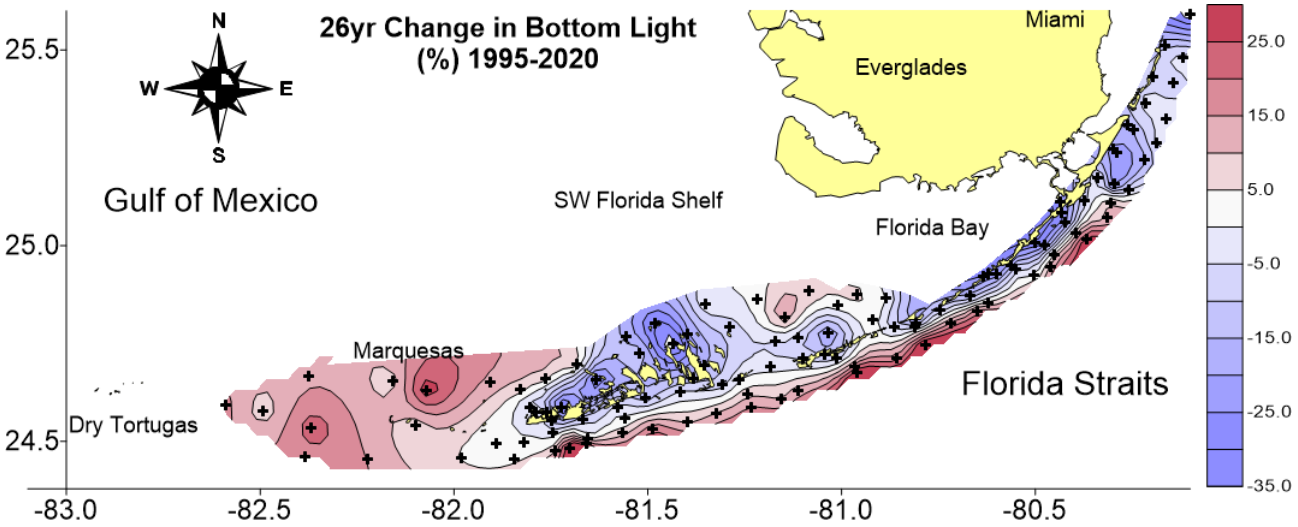


Figure 38. *Total change in bottom I_o for 26-year period.*

The time series of K_d (Fig. 39) and I_o (Fig. 40) show a region-wide increase in I_o since 2004. In Marquesas values have remained relatively constant since 2007. Light reaching bottom I_o has oscillated widely, experiencing a strong decline in 1999-2000 and a sharp increase in 2001-2002, especially in REEF, INSHORE and BAY sites. BACK sites experienced a significant drop from 2006 to 2008, and SHORE since 2011. Finally, MARQ sites increased markedly their I_o in 2011

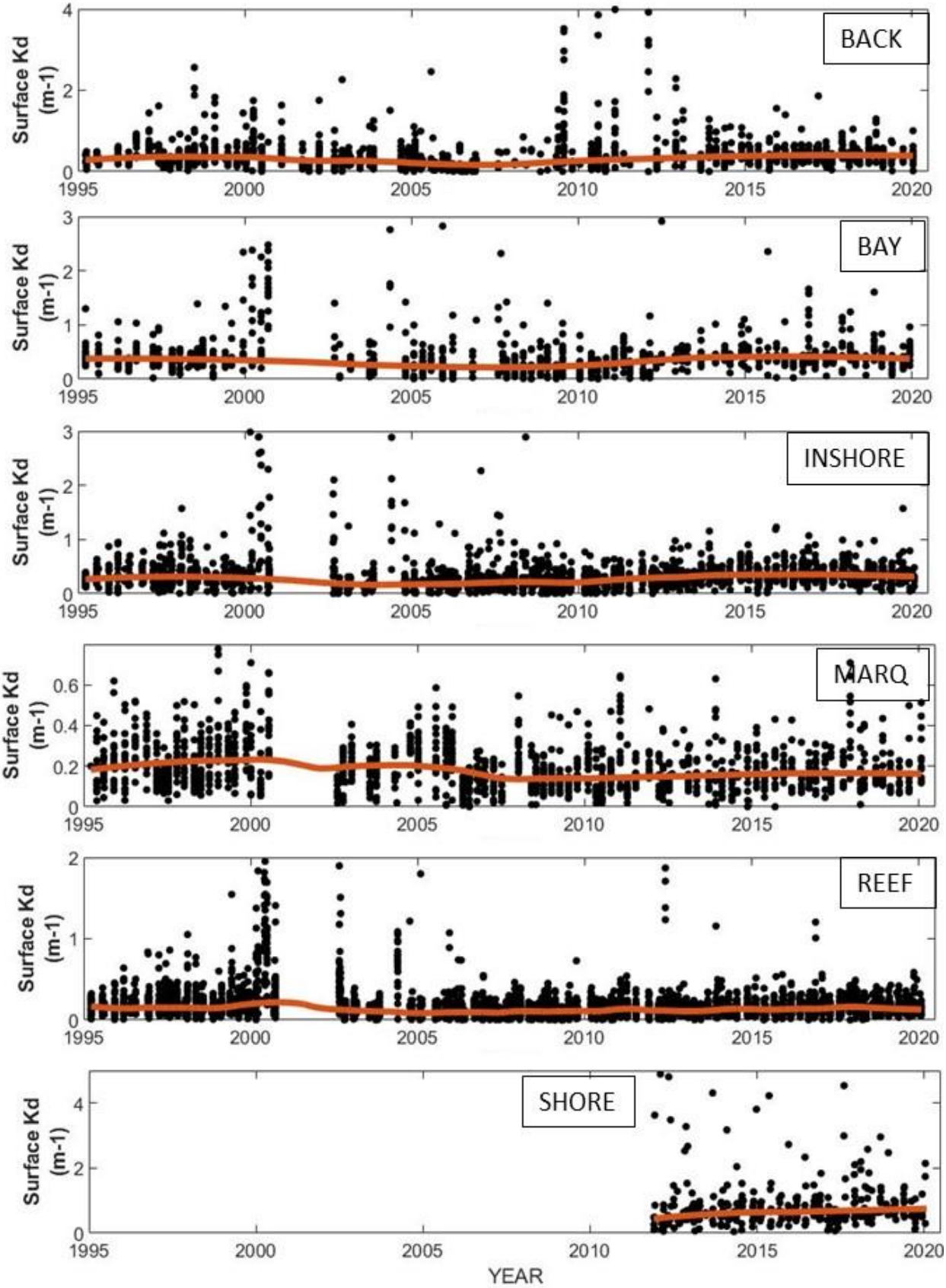


Figure 39. *Time series of Light Extinction (K_d) by zone. The line is LOESS fit.*

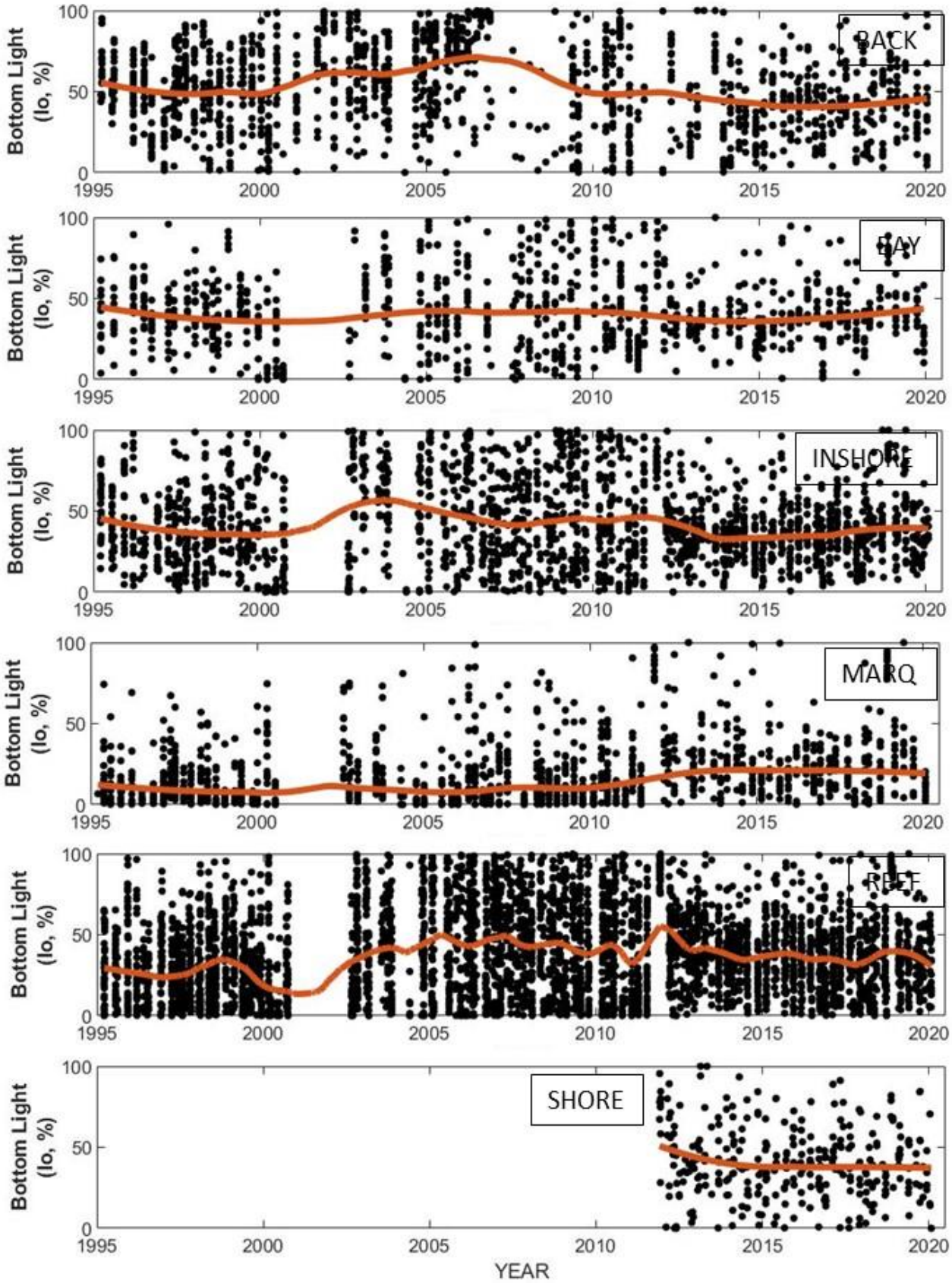


Figure 40. *Time series of % of surface light reaching the bottom (I_o) by zone. The line is LOESS fit.*

Small declining trends in TP characterize surface waters of the Marquesas (Fig. 41) but increases in TP occurred in all other areas of the FKNMS. These trends need to be watched as we expected TP to decline inshore as in response to recent central sewering. This is important because trends for bottom waters in Middle and Upper Keys, and some sites Offshore, reached FDEP out of compliance levels of 0.007 mg TP/L.

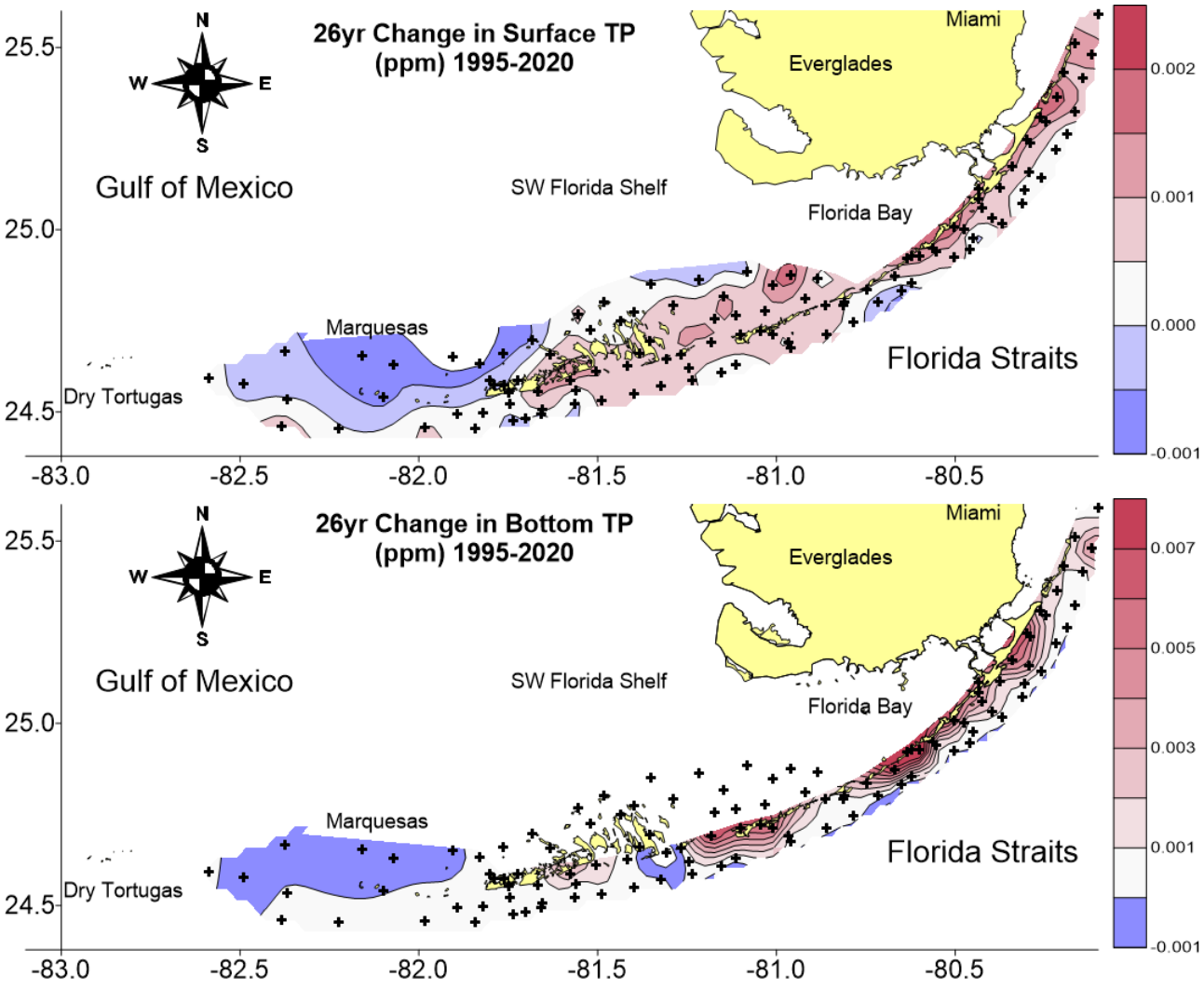


Figure 41. *Total change in surface and bottom TP for 26-year period.*

The TP time series (Fig. 42) shows some elevated periods in the record, especially during 2000 and 2006-7 time period. As described for DO_{sat} changes, TP positive deviations seems to be linked to major hurricane impacts during 1998-1999 and 2004-2005 whose effects lasted until 2000 and 2007 respectively. We believe the bay and land-based disturbance from hurricanes Mitch and Georges (1998) and Irene (1999) lasted until 2001, and those of Katrina-Rita-Wilma persistent until 2007 (Briceño & Boyer 2010). Otherwise, TP is consistently low (<0.01 ppm).

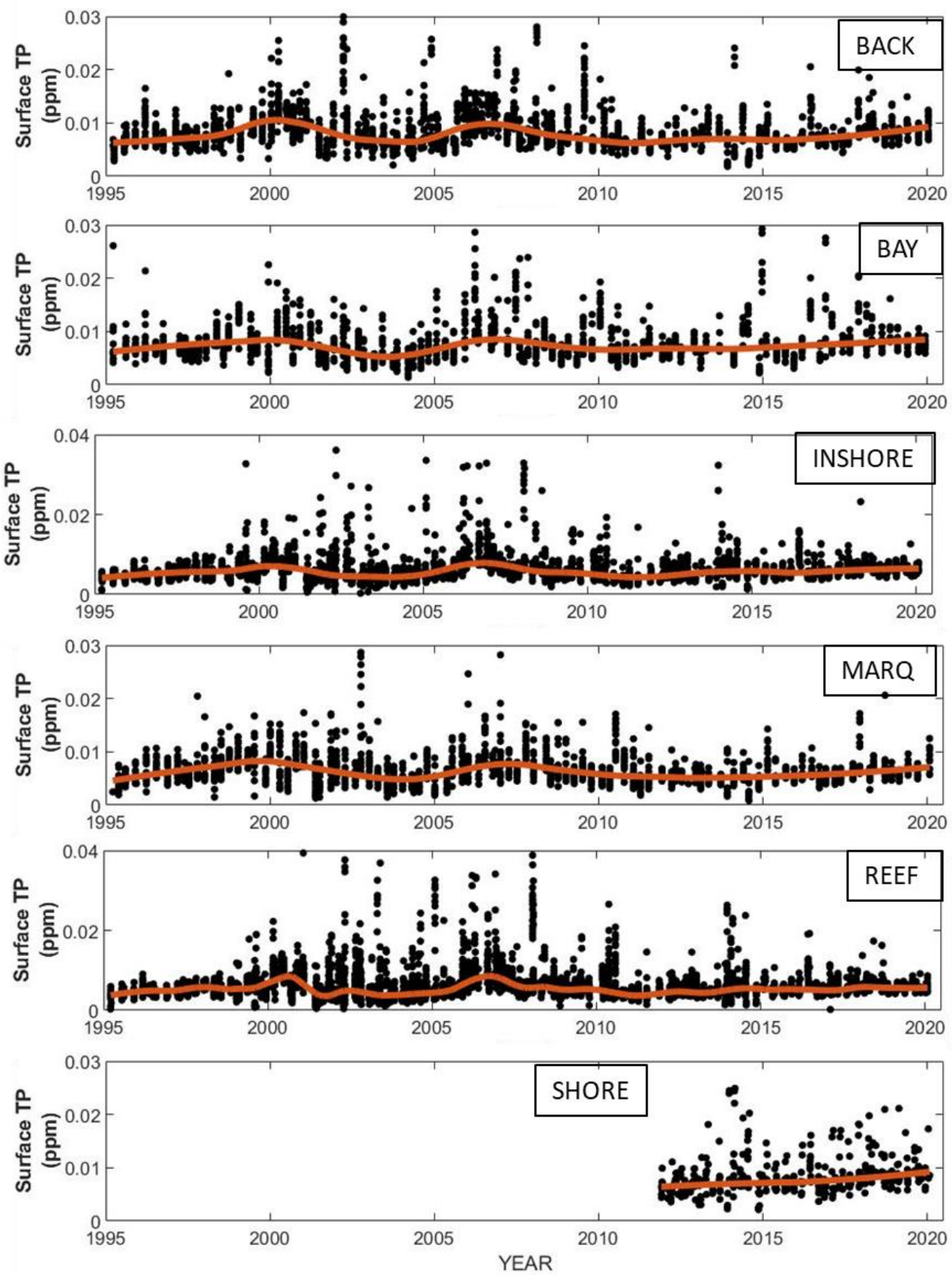


Figure 42. *Time series of surface TP by zone. The line is LOESS fit.*

Since2010-2011 the number of times TP exceeded the EPA target of 0.008 mg/L has been increasing region wide, especially in 2020 due to the impact of hurricanes Sally and Eta.

Very small decreases in SRP were observed (Fig. 43) but these trends were not statistically significant. Concentrations of SRP are generally an order of magnitude lower than TP and may be below the threshold of kinetic uptake for phytoplankton, meaning that not all SRP is accessible to phytoplankton.

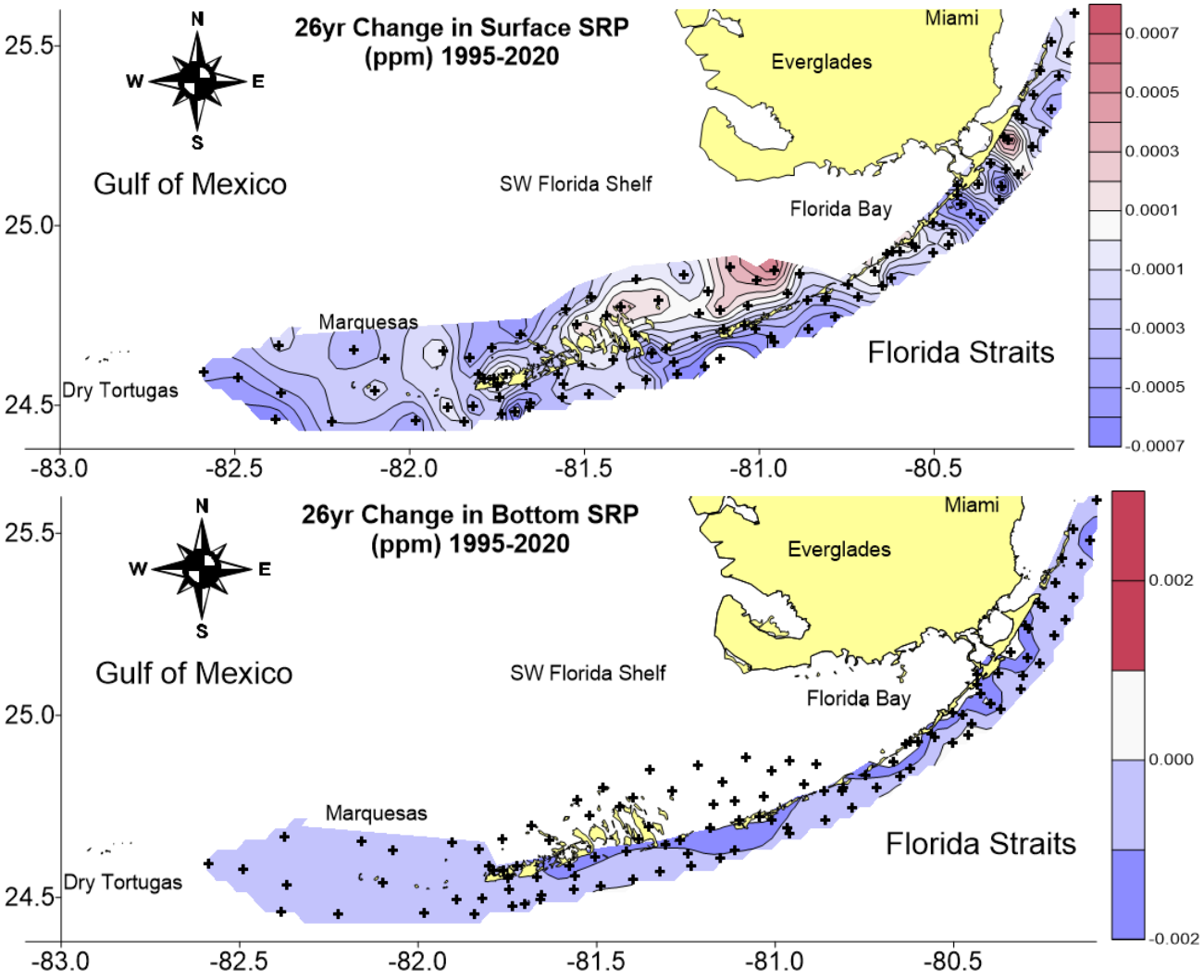


Figure 43. *Total change in surface and bottom SRP for 26-year period.*

The SRP time series (Fig. 44) shows 2-3 year cyclical fluctuations in concentrations at REEF sites. However, the concentrations are very low and may not be biologically relevant.

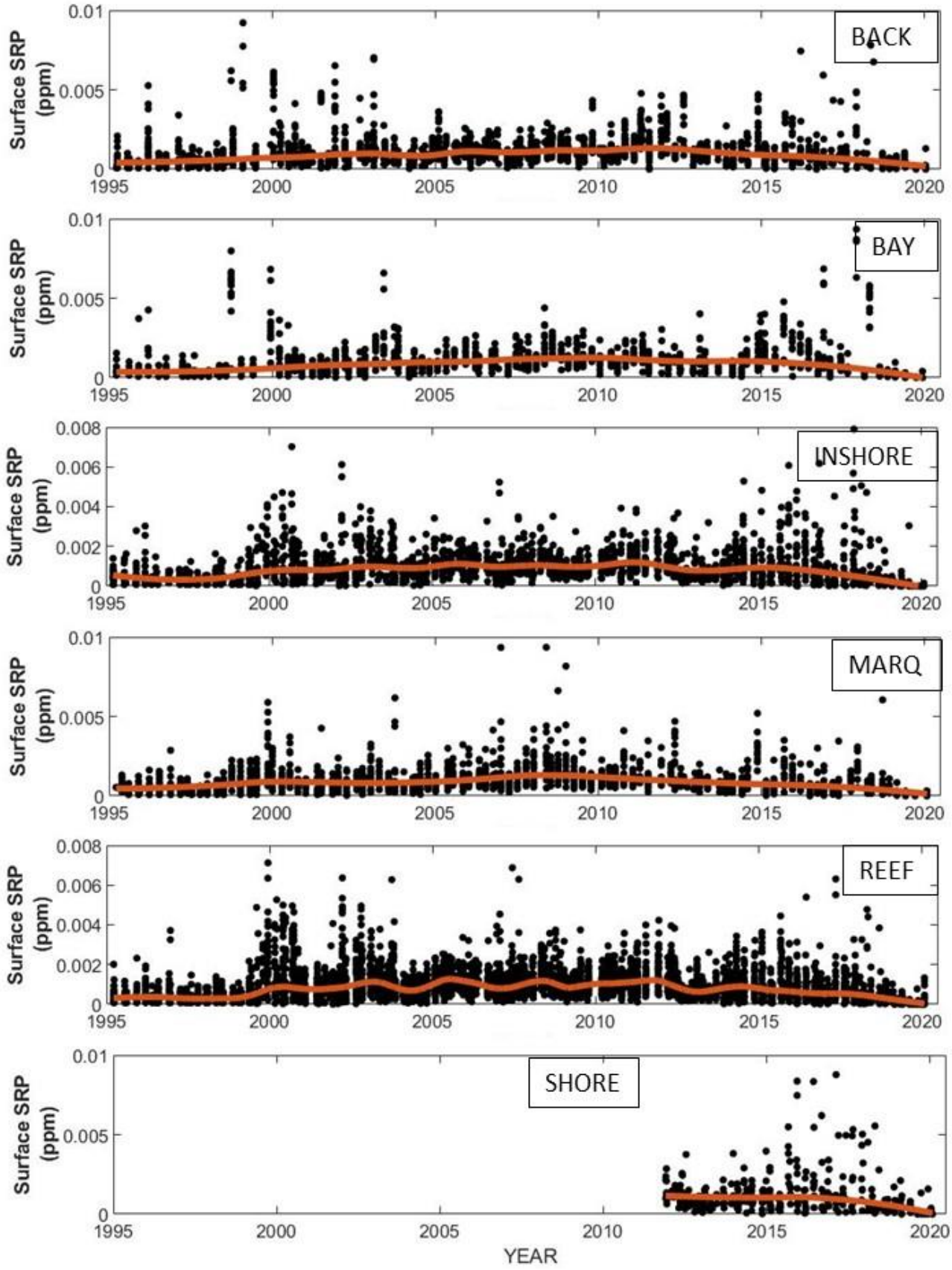


Figure 44. *Time series of surface SRP by zone. The line is LOESS fit.*

Nitrate showed small declines over most of the FKNMS for the record, a beneficial result (Fig. 45). The increase observed in bottom NO_3^- in Islamorada area was probably caused by Hurricane Eta, which landed on Lower Matecumbe on November 9th, 2020.

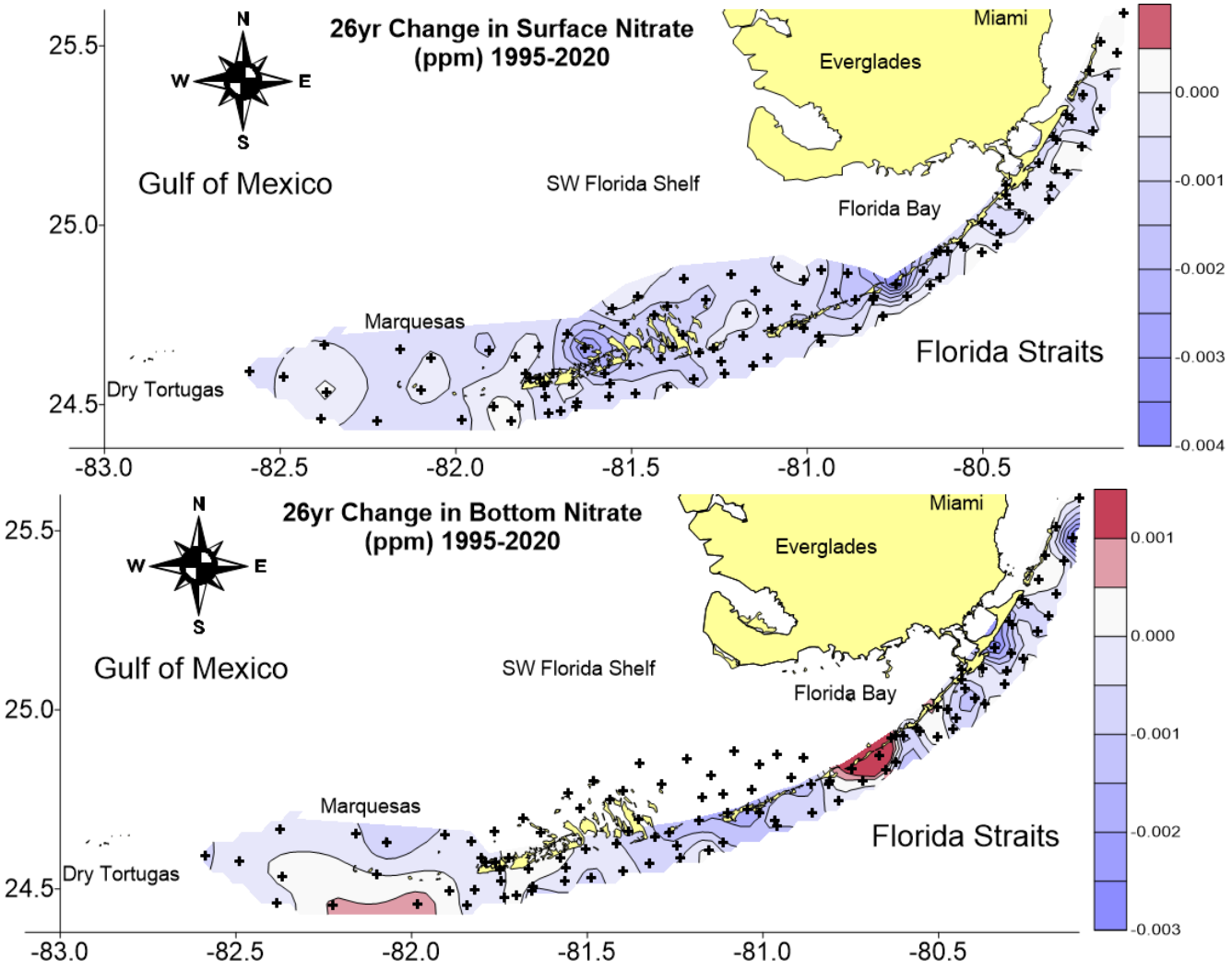


Figure 45. *Total change in surface and bottom NO_3^- for 26-year period.*

Decreasing trends in NH_4^+ were also small but wide-ranging across the FKNMS (Fig. 46). Interestingly, the larger, decreasing trends in bottom NH_4^+ were observed at many of the same oceanside inshore sites off the Upper and Middle Keys where TP was increasing. We are not sure if such trends are stoichiometrically related or not. Did increases in TP drive down NH_4^+ through biological uptake? Or did declines in NH_4^+ allow TP to be released to the water column?

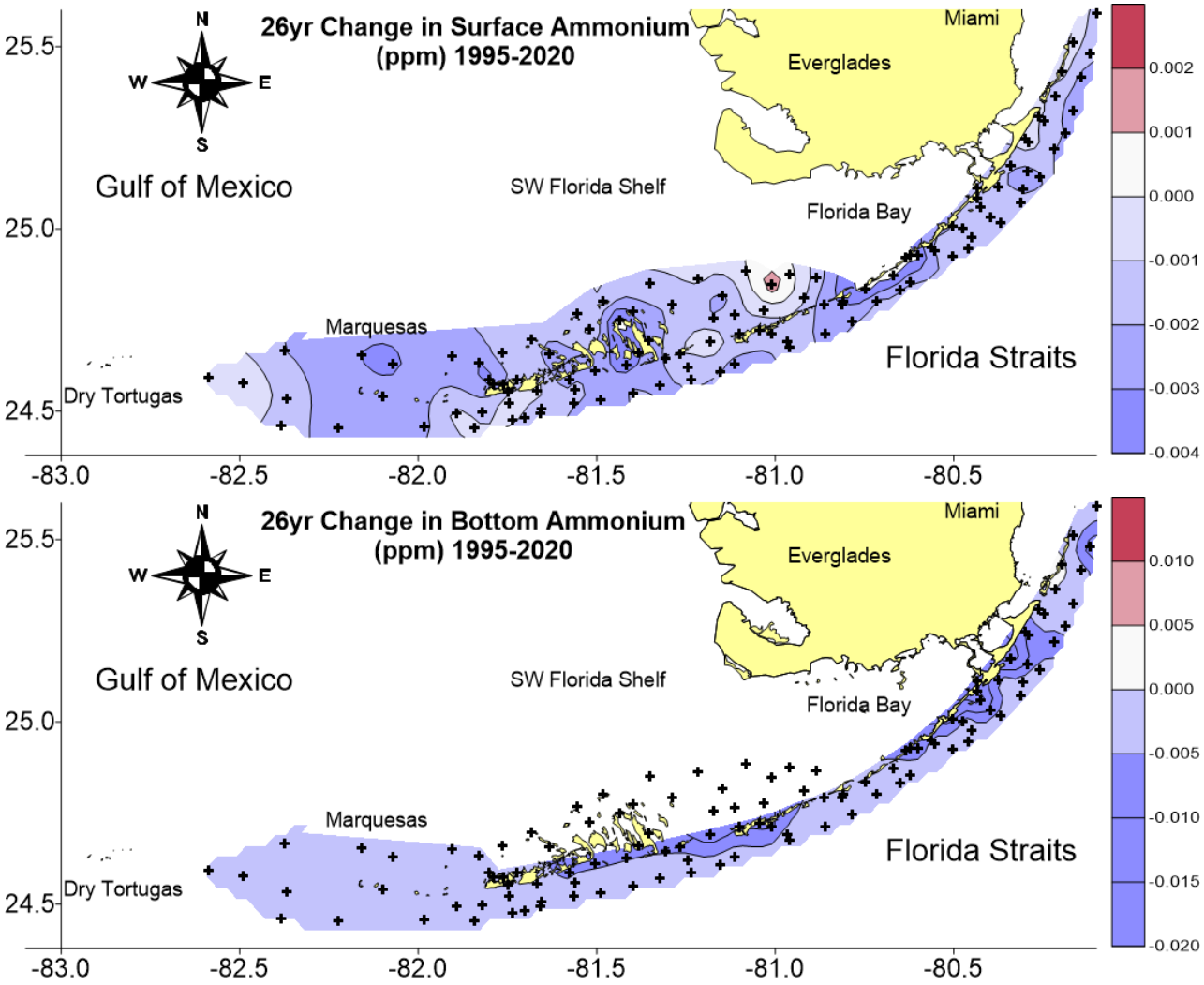


Figure 46. *Total change in surface and bottom NH_4^+ for 26-year period.*

The NO_3^- time series was relatively consistent with a distinct elevation across the FKNMS during 2000 and smaller ones during 2003-4 and 2006-7 (Fig. 47). The 1999-2000 NO_x high coincides with elevated concentrations in Florida Bay, which have been linked to hurricane Irene impacts, exacerbated by extreme freshwater discharges (Briceño and Boyer 2010).

The NH_4^+ time series was interesting as it showed large elevation in concentrations during 2006-7, the year following the Fall 2005 hurricane season (Fig. 48). We believe the land-based disturbance from Katrina-Rita-Wilma had a persistent effect on the FKNMS for the following two years.

In SHORE stations the NO_3^- and NH_4^+ concentrations have declined since 2017.

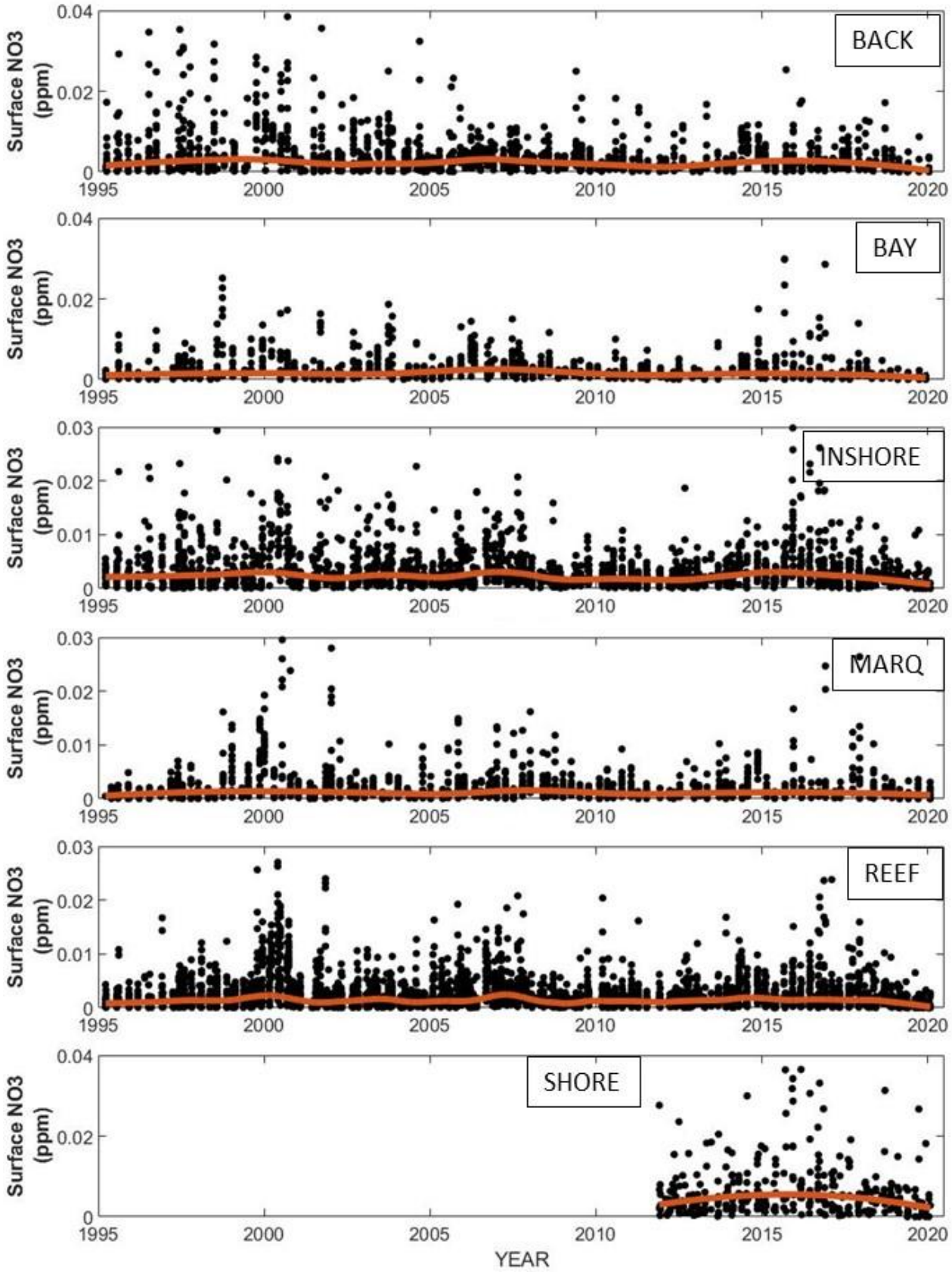


Figure 47. *Time series of surface NO_3^-+NO_2^- by zone. The line is LOESS fit.*

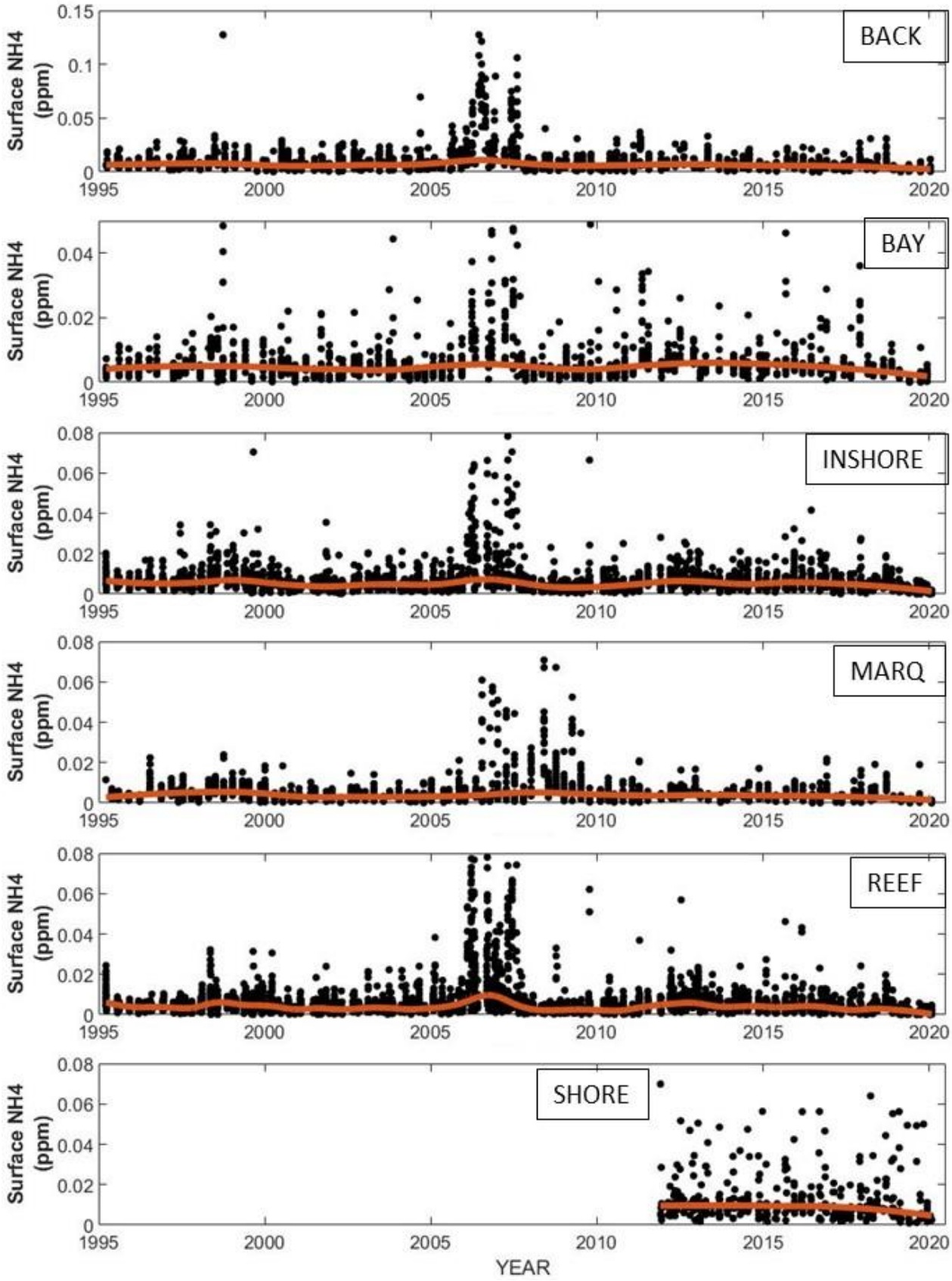


Figure 48. *Time series of surface NH_4^+ by zone. The line is LOESS fit.*

Total nitrogen continued to decline overall with exception of Sluiceway contiguous to Florida Bay (Fig. 49). Most of this is due to decline in the organic N fraction as it makes up ~96% of the TN pool.

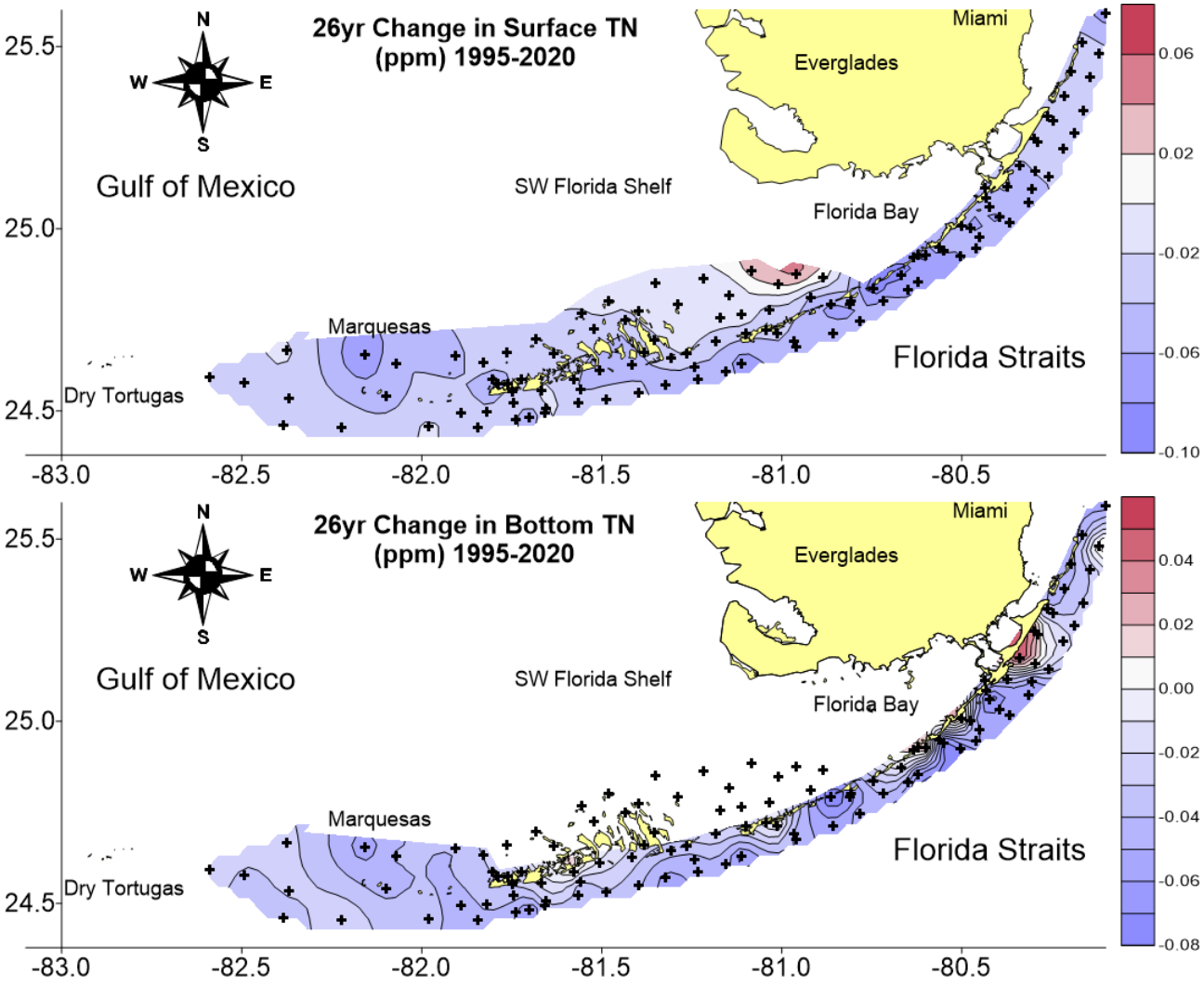


Figure 49. *Total change in surface and bottom TN for 26-year period.*

The TN time series shows elevated concentrations across the region during 2003-4 and 2010 (Fig. 50). The long-term decline in TN is especially evident in inshore waters of the Keys. SHORE stations have increased their TN concentrations since 2015, probably following some cyches observed in other zones within the Sanctuary.

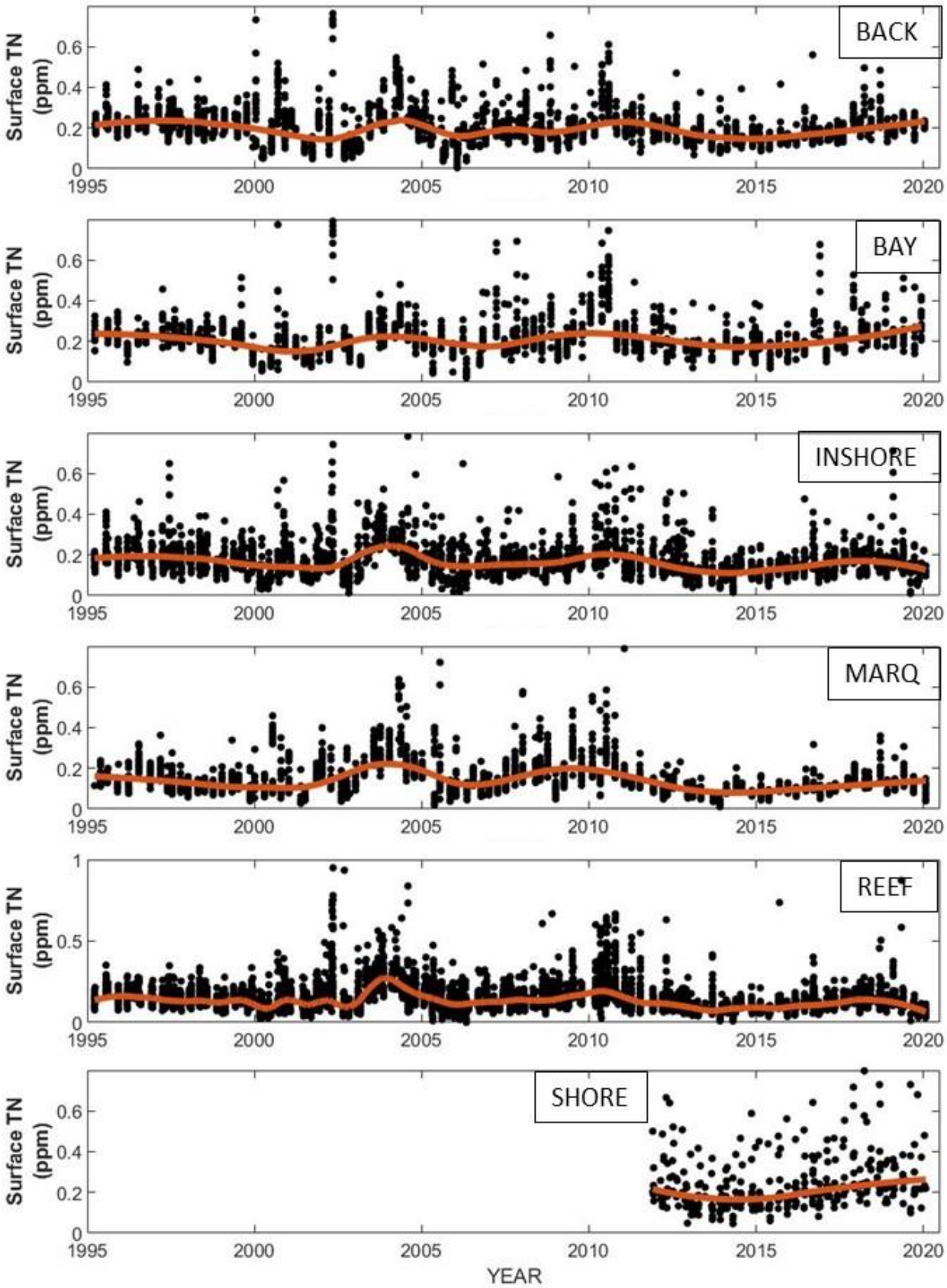


Figure 50. *Time series of surface TN by zone. The line is LOESS fit.*

The largest sustained monotonic trend has been the decline in surface TOC concentration throughout the FKNMS (Fig. 51). This decline could be considered favorable given that TOC corresponds with CDOM (an important driver of light penetration) but may also be an indication of decreased terrestrial inputs to the region.

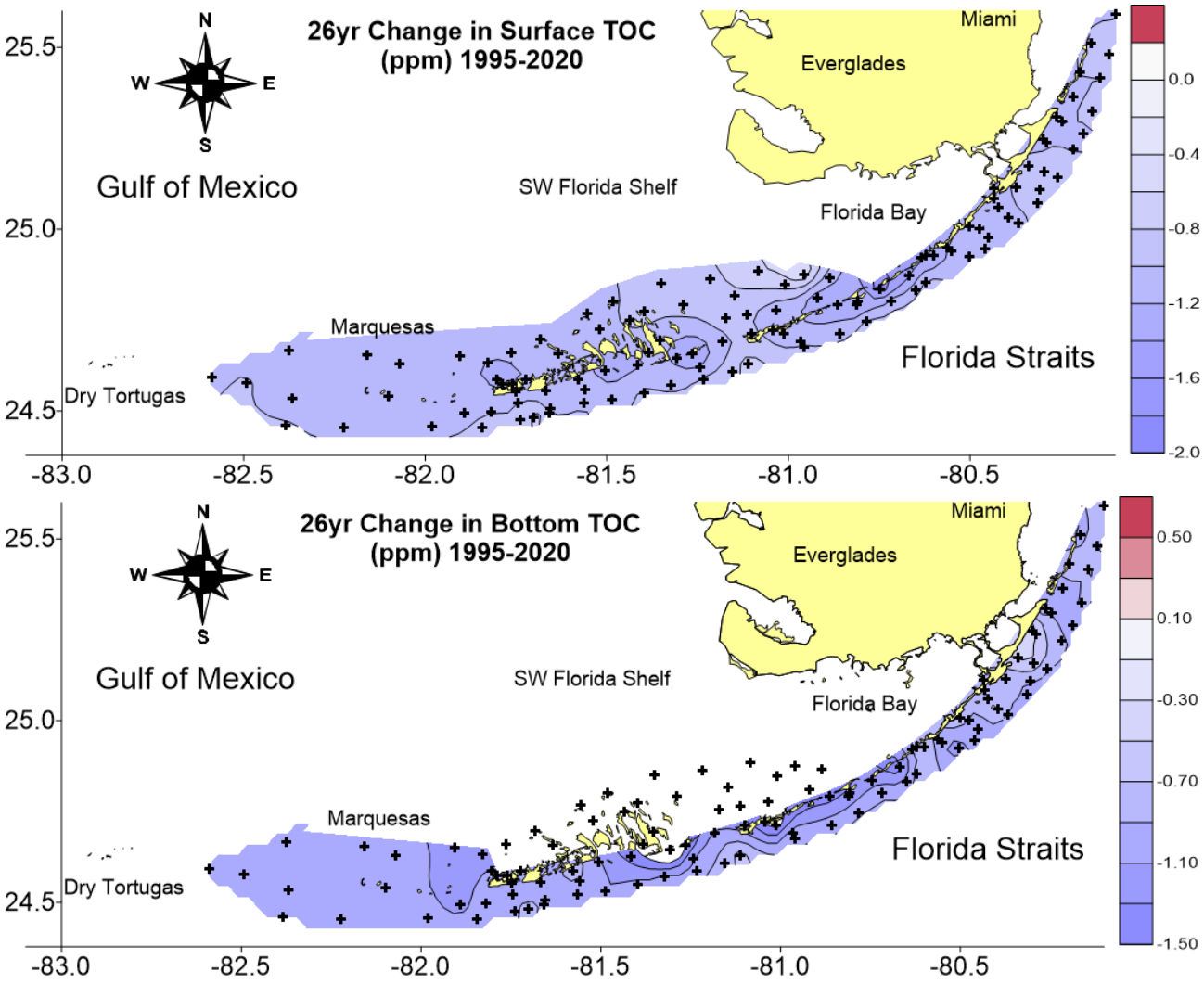


Figure 51. *Total change in surface and bottom TOC for 26-year period.*

The TOC time series show relatively steep declines in the beginning with a leveling out around 2005 (Fig. 52). This declining trend has been observed also on SW Shelf, west coast mangrove estuaries and Florida Bay (Briceño and Boyer 2007), highlighting the importance of a regional contribution of organic matter from the Everglades to Florida Bay and SW Shelf. Regier et al. (2016) found that dissolved organic carbon (DOC) fluxes from the Everglades were primarily controlled by hydrology but also by seasonality and long-term climate patterns (AMO) as well as episodic weather events. Lowest DOC concentrations in water coincide with extended droughts in 2007 and 2010-2011.

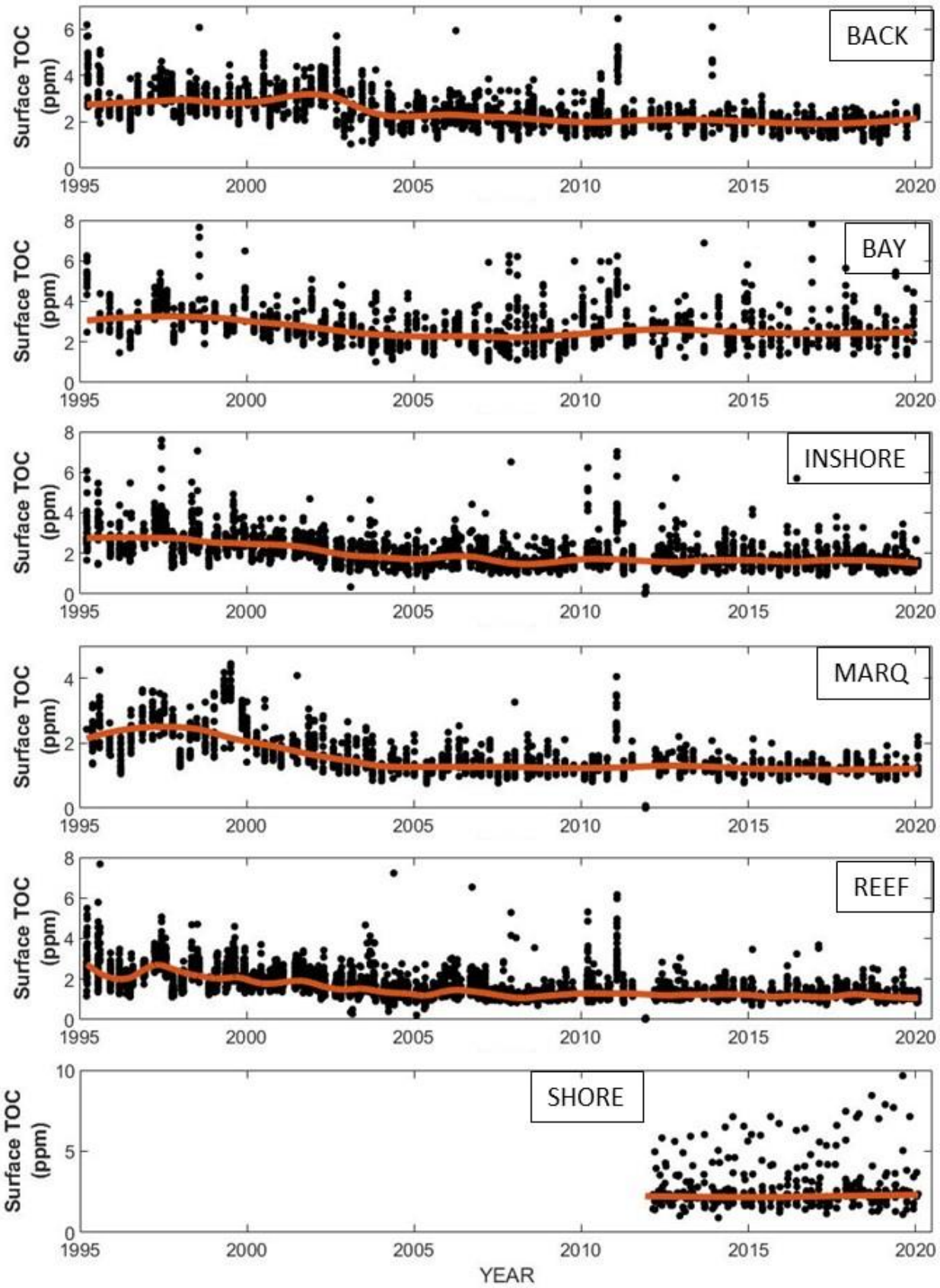


Figure 52. *Time series of surface TOC by zone. The line is LOESS fit.*

SiO_2 declined throughout the FKNMS except at two sites in the Sluiceway adjacent to Florida Bay (Fig. 53). We expect these increases are from a more Florida Bay-wide trend but do not have data to show this. The SiO_2 time series shows small declines in the beginning with bump around 2010 for most regions (Fig. 54).

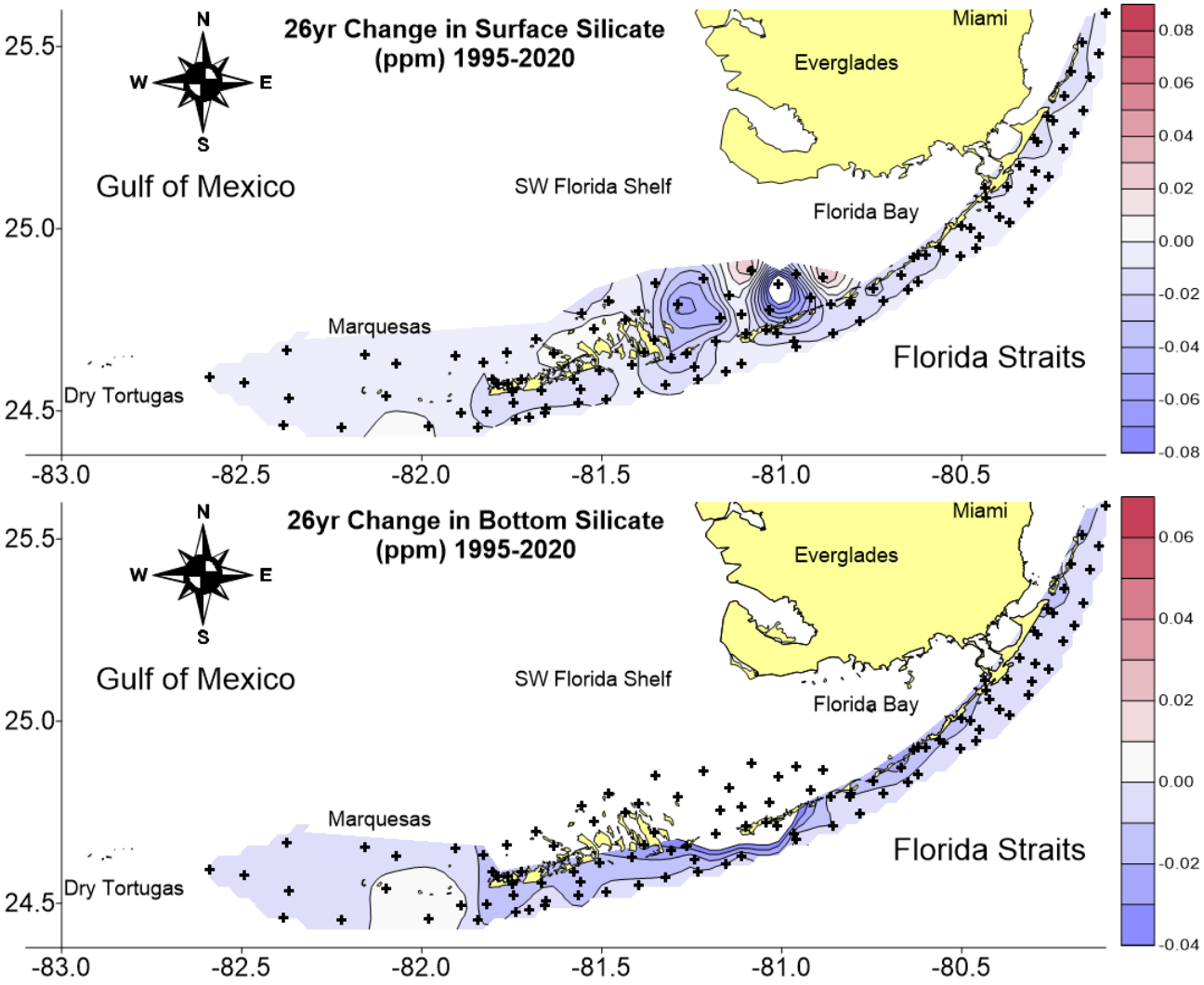


Figure 53. *Total change in surface and bottom SiO2 for 26-year period.*

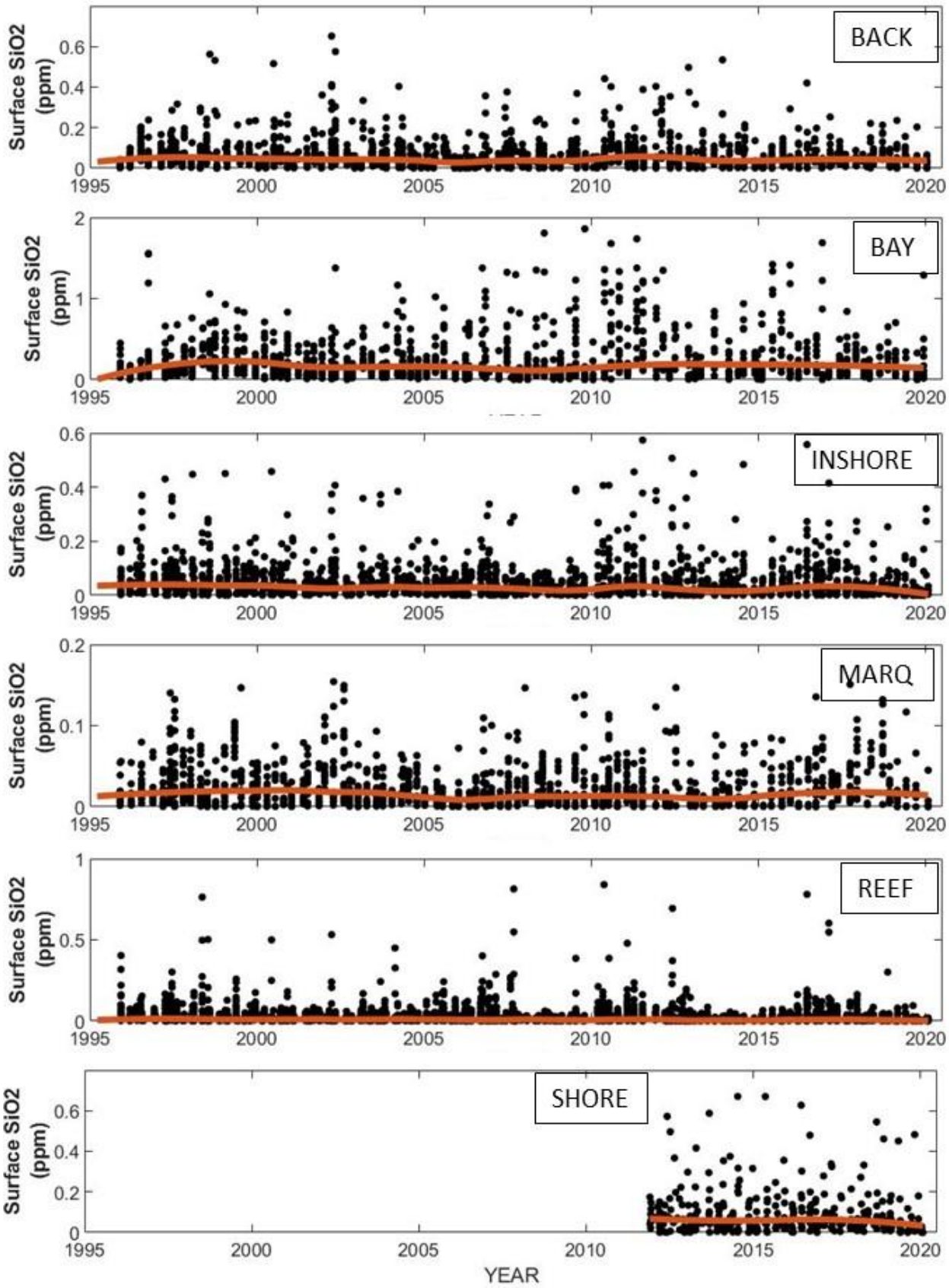


Figure 54. *Time series of surface SiO_2 by zone. The line is LOESS fit.*

CHLA concentrations increased across much of the Keys (Fig. 55), many of which showed statistical significance (Appendix A). Significant increases for the 26-year record ranged from 0.083 to 0.279 ppb or 28-68% increase. Some declines in CHLA were observed in the Marquesas but were not significant, and not displayed on the LOESS fit of Fig. 56.

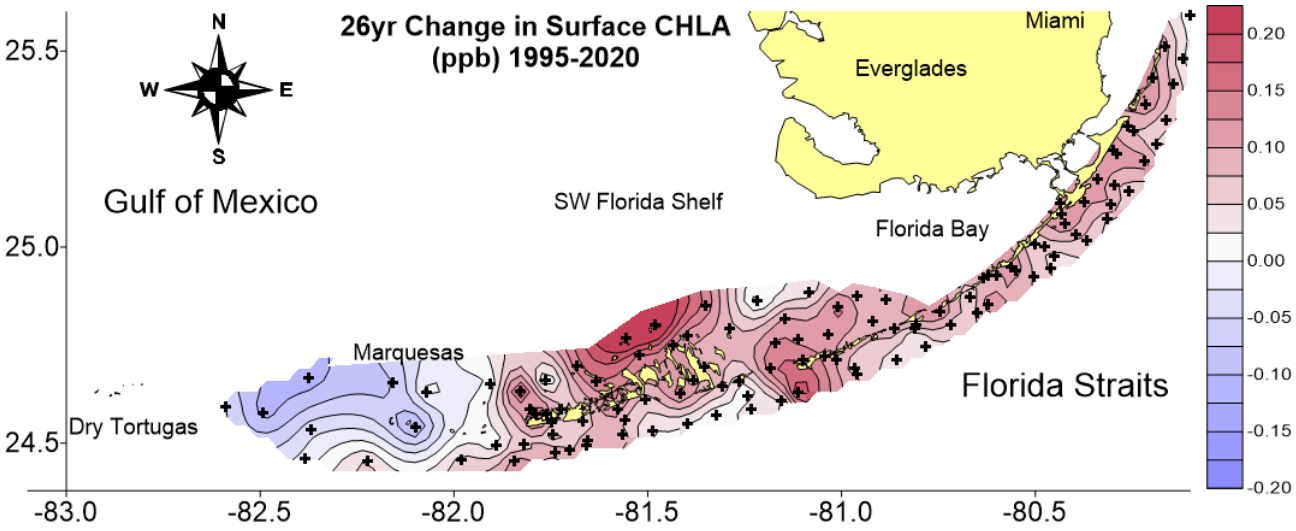


Figure 55. *Total change in chlorophyll a in surface waters for 26-year period calculated from trends.*

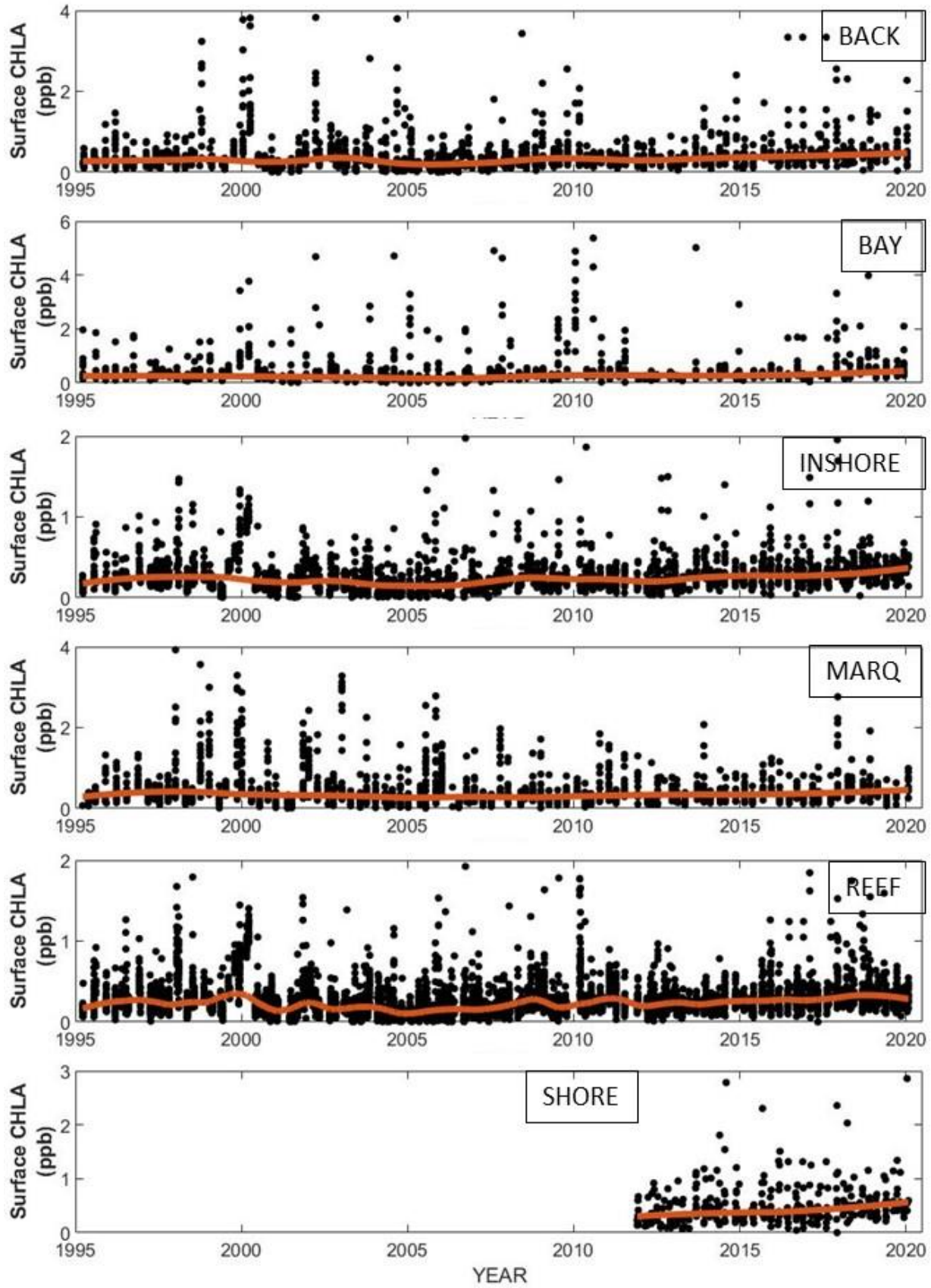


Figure 56. *Time series of surface Chlorophyll a by zone. The line is LOESS fit.*

4. Strategic Targets

The EPA developed Strategic Targets for the Water Quality Monitoring Project which state that beginning in 2008, to 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 0.2 micrograms/l and the vertical attenuation coefficient for downward irradiance (K_d, i.e., light attenuation) should be less than or equal to 0.13 per meter. For all monitoring sites in FKNMS, dissolved inorganic nitrogen should be less than or equal to 0.75 µM (0.010 mg l^{-1}) and total phosphorus should be less than or equal to 0.2 µM (0.0077 mg l^{-1}). Table 3 shows the number of sites and percentage of total sites exceeding these Strategic Targets for the period of record to 2020. In addition, Figure 57 shows the percent of sites meeting the targets in relation to baseline for DIN, TP, CHLA, and K_d.

Table 3: 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 µM and total phosphorus less than or equal to 0.25 µM; 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 %)
2019	112 of 171 (65.5%)	133 of 168 (79.2%)	669 of 684 (97.8 %)	587 of 686 (85.6 %)
2020	129 of 172 (75.0%)	141 of 169 (83.4%)	617 of 688 (89.7%)	466 of 688 (67.7%)

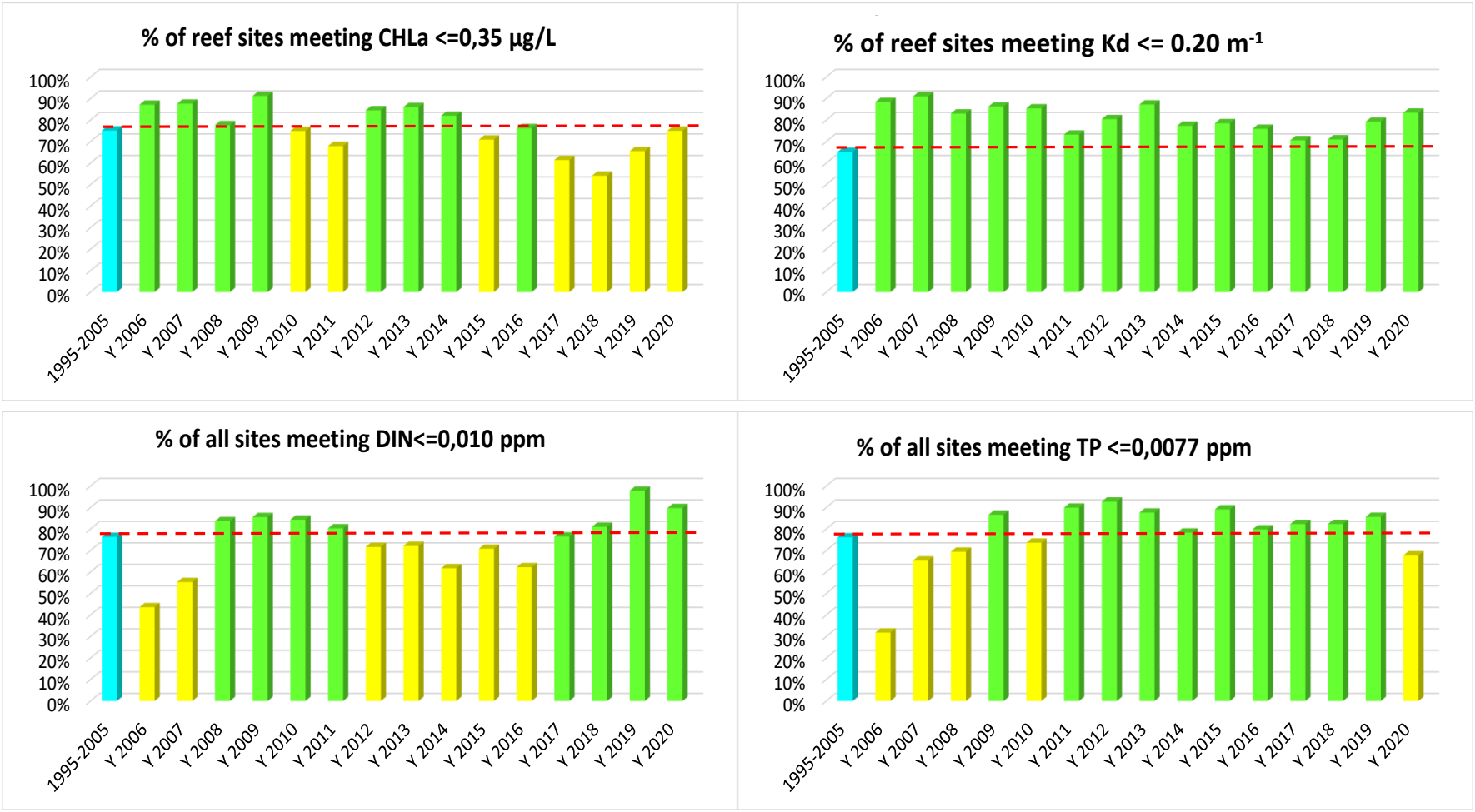


Figure 57. *EPA targets expressed as percent of sites meeting baseline criteria (red stippled line) by year.*

5. Acknowledgements

We thank all the many field and laboratory technicians involved with this project over the past 25 years. Special thanks go out to Pete Lorenzo, Jeff Absten, Tom Frankovich, Mark Kershaw, Rafael Gonzales-Collazo, Pierre Sterling, Scott Kaczynski, Sandro Stumpf, Pura Rodriguez de la Vega, Ruth Justiniano, Dania Sancho, Frank Tam, Omar Beceiro, Bill Gilhooly, Breege Boyer, Ingrid Ley, Milagros Timiraos and Haley Kilgour. Kudos to Steve Blackburn, and the FKNMS Steering Committee for continued support and funding. Finally, we thank Fred McManus, Billy Causey, and Ron Jones for kickstarting the whole enchilada. This project was possible due to continued funding by the FIU/US-EPA Agreement #X7-00049716-0. This is contribution # **1030** from the Southeast Environmental Research Center in the Institute of the Environment at Florida International University

6. References

APHA. 1995. Automated method for molybdate-reactive silica. In A. D. Eaton, L. S. Clesceri, and A. E. Greenberg (Eds.), Standard Methods for the Examination of Water and Wastewater

BOYER, J. N. 2006. Shifting N and P limitation along a north-south gradient of mangrove estuaries in South Florida. Hydrobiologia 269: 167-177.

BOYER, J. N. AND H. O. BRICEÑO. 2007. FY2006 Annual Report of the South Florida Coastal Water Quality Monitoring Network. SFWMD/SERC Cooperative Agreement #4600000352. SERC Tech. Rep. T-351.

BOYER, J. N. AND H. O. BRICEÑO. 2011. 2010 Annual Report of the Water Quality Monitoring Project for the Water Quality Protection Program of the Florida Keys National Marine Sanctuary. US EPA/FIU Agreement #X7-96410604-6. SERC Tech. Rep. T-536

BOYER, J. N., J. W. FOURQUREAN, AND R. D. JONES. 1997. Spatial characterization of water quality in Florida Bay and Whitewater Bay by multivariate analysis: Zones of similar influence (ZSI). Estuaries 20: 743-758.

BOYER, J. N., AND R. D. JONES. 1999. Effects of freshwater inputs and loading of phosphorus and nitrogen on the water quality of Eastern Florida Bay, p. 545-561. *In* K. R. Reddy, G. A. O'Connor, and C. L. Schelske (eds.) Phosphorus biogeochemistry in sub-tropical ecosystems. CRC/Lewis Publishers, Boca Raton, Florida.

BOYER, J. N., AND R. D. JONES. 2002. A view from the bridge: External and internal forces affecting the ambient water quality of the Florida Keys National Marine Sanctuary, p. 609-628. *In* J. W. Porter and K. G. Porter (eds.), The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook. CRC Press.

BOYER, J. N., B. J. PETERSON, AND D. MIR-GONZALEZ. 2005. Water Quality Monitoring and Analysis for the Florida Keys National Wildlife Refuge. Final Report to the US Fish and Wildlife Services. SERC Tech. Rep. #T-244.

BOYER, J. N., P. STERLING, AND R. D. JONES. 2000. Maximizing information from a water quality monitoring network through visualization techniques. Estuarine, Coastal and Shelf Science 50: 39-48.

BRICEÑO, H. O., AND J. N. BOYER. 2007. SERC-WQMN: Long-term Declines in TOC, TON and TP export from the Everglades Mangrove Forest. Annual Science Meeting SFC CESU, Miami, Fl.

BRICEÑO, H. O., AND J. N. BOYER. 2010. Climatic controls on nutrients and phytoplankton biomass in a sub-tropical estuary, Florida Bay, USA. Estuaries and Coasts 33: 541–553.

BRICEÑO, H. O. AND J. N. BOYER. 2018. FY2017 Annual Report of the Water Quality Monitoring Project for the Florida Keys National Marine Sanctuary. EPA Agreement #X7-00049716-0. SERC Tech. Report #T-887.

BRICEÑO, H. O., J. N. BOYER AND P. HARLEM. 2010. Proposed Methodology for the Assessment of Protective Numeric Nutrient Criteria for South Florida Estuaries and Coastal Waters. White paper submitted to Environmental Protection Agency Science Advisory Board. Dec 6 2010. FIU/SERC Contribution # T-501

BRICEÑO, H.O. J.N. BOYER, J. CASTRO, AND P. HARLEM. 2013. Biogeochemical classification of south Florida's estuarine and coastal waters. Marine Pollution Bulletin 75: 187–204.

BRICEÑO, H., R. GARCIA, P. GARDINALI, K. BOSWELL, A. SERNA AND E. SHINN. 2015. Design and implementation of dye-tracer injection test, Cudjoe Key, Florida Keys. FINAL REPORT. Submitted to CH2M Hills on behalf of Florida Keys Aqueduct Authority. FIU/SERC TR# T-723. 68 p

CAPONE, D. G., AND B. F. TAYLOR. 1980. Microbial nitrogen cycling in a seagrass community, p. 153-161. *In* V. S. Kennedy (ed.), Estuarine Perspectives. Academic.

CLEVELAND, WILLIAM S. 1979. Robust locally weighted regression and smoothing scatterplots. J. Amer. Stat. Assoc. 74: 829–836.

CORBETT, D. R., K. DILLON, W. BURNETT, AND J. CHANTON. 2000. Estimating the groundwater contribution into Florida Bay via natural tracers ^{222}Rn and CH_4. Limnology and Oceanography 45:1546-1557.

EPA. 1979. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA 600/4-79-019. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH.

EPA. 1993. Water Quality Protection Program for the Florida Keys national Marine Sanctuary: Phase II Report. Battelle Ocean Sciences, Duxbury, MA and Continental Shelf Associates, Inc., Jupiter, FL.

EPA. 1995. Water quality protection program for the Florida Keys National Marine Sanctuary: Phase III report. Final report submitted to the Environmental Protection Agency under Work Assignment 1, Contract No. 68-C2-0134. Battelle Ocean Sciences, Duxbury, MA and Continental Shelf Associates, Inc., Jupiter FL.

EPA-REGION 2. 1997. Non-Detect Policy. CENAN-OP-SD 28 February 1997

EPANECHNIKOV, V. A. 1969. Non-parametric estimation of a multivariate probability density. Theory Probab. Appl. 14:153–158. doi:10.1137/1114019

FRANKOVICH, T. A., AND R. D. JONES. 1998. A rapid, precise, and sensitive method for the determination of total nitrogen in natural waters. Mar. Chem. 60:227-234.

FOURQUREAN, J.W., M.D. DURAKO, M.O. HALL AND L.N. HEFTY. 2002. Seagrass distribution in south Florida: a multi-agency coordinated monitoring program, p. 497-522. *In* J. W. Porter and K. G. Porter (eds.), The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook. CRC Press.

FOURQUREAN, J. W., R. D. JONES, AND J. C. ZIEMAN. 1993. Processes influencing water column nutrient characteristics and phosphorus limitation of phytoplankton biomass in Florida Bay, FL, USA: Inferences from spatial distributions. Estuarine, Coastal and Shelf Science 36:295-314.

GIBSON, P. J., J. N. BOYER, AND N. P. SMITH. 2008. Nutrient Mass Flux between Florida Bay and the Florida Keys National Marine Sanctuary. Estuaries and Coasts 31: 21–32.

HOER, D. R., J. P. TOMMERDAHL, N. L. LINDQUIST, AND C. S. MARTENS. 2018. Dissolved inorganic nitrogen fluxes from common Florida Bay (U.S.A.) sponges. Limnology and Oceanography 63: 2563–2578.

HOER, D. R., W. SHARP, G. DELGADO, N. L. LINDQUIST, AND C. S. MARTENS. 2019. Sponges represent a major source of inorganic nitrogen in Florida Bay (U.S.A.). Limnology and Oceanography 65:1235–1250.

ISAAKS, E. H., AND R. M. SRIVASTAVA. 1989. An Introduction to Applied Geostatistics. Oxford Press, 561 pp.

KAISER, H. F. 1958. The varimax criterion for analytic rotation in factor analysis". Psychometrika 23 (3).

KLEIN, C. J., AND S. P. ORLANDO JR. 1994. A spatial framework for water-quality management in the Florida Keys National Marine Sanctuary. Bulletin of Marine Science 54: 1036-1044.

Koroleff, F. 1983. Determination of ammonia. In K. Grasshoff, M. Erhardt, and K. Kremeling (Eds.), Methods of Seawater Analysis. Verlag Chemie, Weinheim, Germany.

KUFFNER, I. B., B. H. LIDZ, J. H. HUDSON, AND J. S. ANDERSON 2015. A century of ocean warming on Florida Keys coral reefs: Historic in situ observations. Estuaries and Coasts 38: 1085-1096. DOI 10.1007/s12237-014-9875-5

MURPHY, J., AND J. P. RILEY. 1962. A modified single solution method for the determination of phosphate in natural water. Anal. Chim. Acta 27: 31-36.

LAPOINTE, B. E., AND M. W. CLARK. 1992. Nutrient inputs from the watershed and coastal eutrophication in the Florida Keys. Estuaries 15: 465-476.

LAPOINTE, B. E., AND W. R. MATZIE. 1996. Effects of stormwater nutrient discharges on eutrophication processes in nearshore waters of the Florida Keys. Estuaries 19: 422-435.

LEE, T. N., M. E. CLARKE, E. WILLIAMS, A. F. SZMANT, AND T. BERGER. 1994. Evolution of the Tortugas gyre and its influence on recruitment in the Florida Keys. Bulletin of Marine Science 54: 621-646.

LEE, T. N., E. WILLIAMS, E. JOHNS, D. WILSON, AND N. P. SMITH. 2002. Transport processes linking South Florida ecosystems, p. 309-342. *In* J. W. Porter and K. G. Porter (eds.), The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook. CRC Press.

LEICHTER, J. J., S. R. WING, S. L. MILLER, AND M. W. DENNY. 1996. Pulsed delivery of subthermocline water to Conch Reef (Florida Keys) by internal tidal bores. Limnology and Oceanography 41: 1490-1501.

LEICHTER, J. J. , AND S. L. MILLER. 1999. Predicting high-frequency upwelling: Spatial and temporal patterns of temperature anomalies on a Florida coral reef. Continental Shelf Research 19: 911-928.

LEICHTER, J. J., H. L. STEWART, AND S. L. MILLER. 2003. Episodic nutrient transport to Florida coral reefs. Limnology and Oceanography 48:1394-1407.

MOORE, W. S., J. L. SARMIENTO, AND R. M. KEY. 1986. Tracing the Amazon component of surface Atlantic water using ^{228}Ra, salinity, and silica. Journal of Geophysical Research 91: 2574-2580.

NELSON, D. M., AND Q. DORTCH. 1996. Silicic acid depletion and silicon limitation in the plume of the Mississippi River: evidence from kinetic studies in spring and summer. Marine Ecology Progress Series 136: 163-178.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION. 1995. Florida Keys National Marine Sanctuary Draft Management Plan/Environmental Impact Statement.

OVERLAND, J. E. AND R. W. PREISENDORFER. 1982. A significance test for principal components applied to cyclone climatology. Monthly Weather Review 110:1-4.

PAUL J. H., ROSE J. B., BROWN J., SHINN E. A., MILLER S. AND FARRAH S. R. 1995. Viral tracer studies indicate contamination of marine waters by sewage disposal practices in Key Largo, Florida. Appl. Environ. Microbiol.61,2230-2234.

PAUL, J.H., J.B. ROSE, S.C. JIANG, X. ZHOU, P. COCHRAN, C. KELLOGG, J.B. KANG, D. GRIFFIN, S. FARRAH AND J. LUKASIK. 1997. Evidence for groundwater and surface marine water contamination by waste disposal wells in the Florida Keys. Water Research 31.

PITTS, P. A. 1997. An investigation of tidal and nontidal current patterns in Western Hawk Channel, Florida Keys. Continental Shelf Research 17: 1679-1687.

REDFIELD, A. C. 1958. The biological control of chemical factors in the environment. American Scientist 46: 205-222.

REGIER, P., H. BRICEÑO AND R. JAFFE. 2016. Long-term environmental drivers of DOC fluxes: Linkages between management, hydrology and climate in a subtropical coastal estuary. Estuarine, Coastal and Shelf Science 182, 112-122

REICH, C., E.A. SHINN, C. HICKEY AND A.B. TIHANSKY. 2001. Tidal and Meteorological Influences on Shallow Marine Groundwater Flow in the Upper Florida Keys in J. Porter and K.C Porter (Editors) The Everglades, Florida Bay,and Coral reefs of the Florida Keys. An Ecosystem Handbook. CRC Press. 1022 p.

RUDNICK, D., Z. CHEN, D. CHILDERS, T. FONTAINE, AND J. N. BOYER. 1999. Phosphorus and nitrogen inputs to Florida Bay: the importance of the Everglades watershed. Estuaries 22: 398-416.

RYTHER, J. H., D. W. MENZE, AND N. CORWIN. 1967. Influence of the Amazon River outflow on the ecology of the western tropical Atlantic, I. Hydrography and nutrient chemistry. Journal of Marine Research 25: 69-83.

SHINN, E.A., C. REICH, D. HICKEY AND A.B. TIHANSKY. 1999a. Determination of Groundwater-Flow Direction and Rate Beneath Florida Bay, the Florida Keys and Reef Tract. http://sofia.usgs.gov/projects/index.php?project_url=grndwtr_flow. Accessed Oct 2014

SHINN, E.A., R.S. REESE AND C.D. REICH. 1999b. Fate and Pathways of Injection-Well Effluent in the Florida Keys. http://sofia.usgs.gov/publications/ofr/94-276/index.html Downloaded Oct 2014

SMITH, N. P. 1994. Long-term Gulf-to-Atlantic transport through tidal channels in the Florida Keys. Bulletin of Marine Science 54: 602-609.

SOLÓRZANO, L., AND J. H. SHARP. 1980. Determination of total dissolved phosphorus and particulate phosphorus in natural waters. Limnology and Oceanography 25:754-758.

STUMPF, R. P., M. L. FRAYER, M. J. DURAKO, AND J. C. BROCK. 1999. Variations in water clarity and bottom albedo in Florida Bay from 1985-1997. Estuaries 22: 431-444.

SZMANT, A. M., AND A. FORRESTER. 1996. Water column and sediment nitrogen and phosphorus distribution patterns in the Florida Keys, USA. Coral Reefs 15: 21-41.

WALSH, T. W. 1989. Total dissolved nitrogen in seawater: a new high temperature combustion method and a comparison with photo-oxidation. Mar. Chem. 26: 295-311.

YENTSCH, C. S., AND D. W. MENZEL. 1963. A method for determination of phytoplankton chlorophyll and phaeophytin by fluorescence. Deep Sea Res. 10: 221-231.

7. Appendix A. – Total Change in Measured Variables for 1995-2020

Time series trends were analyzed for all variables by station using Mann-Kendall *t* test. Sen Slope estimates (unit/yr) were multiplied by number of years sampled to give total changes over the period of record. Significant trends ($p < 0.05$) are highlighted in **green** for beneficial trends, **red** for degrading trends, and **blue** for trends in non-determinate variables, such as N:P ratios. Variable names appended with **-S** denote surface sampling while those with **-B** were collected on the bottom.

STATION	SITE	LATDEC	LONDEC	ZONE	CHLA-S	DIN-B	DIN-S	DIN:TP-B	DIN:TP-S	DO-B	DO-S	dSIG-t	Io	Kd
200	Fowey Rocks	25.59000	-80.10000	REEF	0.0003	-0.0001	0.0000	-0.0228	-0.0152	0.0239	0.0213	0.0004	-1.5027	0.0019
201	Sands Key	25.51000	-80.16500	INSHORE	0.0034	0.0000	0.0000	-0.0387	-0.0266	0.0203	0.0247	0.0002	-0.4069	0.0050
203	Triumph Reef	25.48053	-80.11768	REEF	0.0008	-0.0007	-0.0001	-0.2688	-0.0528	0.0319	0.0288	0.0001	-0.0158	-0.0007
204	Elliott Key	25.43080	-80.19550	INSHORE	0.0043	0.0001	0.0000	0.0012	-0.0259	0.0247	0.0303	0.0010	-0.2767	0.0018
206	Ajax Reef	25.41500	-80.14300	REEF	0.0026	-0.0001	-0.0001	-0.0634	-0.0547	0.0290	0.0309	0.0008	-0.3568	0.0022
207	Old Rhodes Key	25.36443	-80.21508	INSHORE	0.0050		-0.0001		-0.1044	0.0228	0.0243	0.0000	-0.1112	0.0008
209	Channel Key	24.58570	-81.72270	BACK	0.0028		-0.0001		-0.0442	0.0285	0.0310	0.0000	-1.3117	0.0094
210	Old Rhodes Key Reef	25.32500	-80.16360	REEF	0.0023	-0.0001	-0.0001	-0.0683	-0.0467	0.0295	0.0306	0.0024	-0.0937	-0.0003
211	Pennekamp G27	25.30788	-80.26165	INSHORE	0.0024	0.0000	0.0000	-0.0517	-0.0494	0.0291	0.0274	0.0002	-0.5119	0.0045
212	Turtle Harbor	25.29450	-80.24540	REEF	0.0029	-0.0001	-0.0001	-0.0458	-0.0514	0.0203	0.0256	0.0000	-0.5558	0.0052
213	Turtle Reef	25.26312	-80.18773	REEF	0.0018	-0.0001	-0.0001	-0.0526	-0.0410	0.0345	0.0300	0.0013	-0.1542	0.0001
214	Port Elizabeth	25.24620	-80.29918	INSHORE	0.0048	-0.0005	-0.0001	-0.3669	-0.0642	0.0258	0.0181	0.0003	-0.7795	0.0060
215	Carysfort Channel	25.23667	-80.28897	REEF	0.0045	-0.0002	0.0000	-0.1586	-0.0208	0.0244	0.0257	0.0000	-0.9351	0.0037
216	Carysfort Reef	25.22000	-80.21700	REEF	0.0045	-0.0003	-0.0001	-0.1391	-0.0337	0.0356	0.0358	-0.0001	-0.6208	0.0013
217	Rattlesnake Key	25.17332	-80.33985	INSHORE	0.0044	-0.0009	-0.0001	-0.4417	-0.0780	0.0295	0.0333	0.0002	-0.0099	0.0018
218	White Bank	25.15897	-80.29455	REEF	0.0030	-0.0004	-0.0001	-0.2330	-0.0533	0.0279	0.0278	0.0004	-1.1142	0.0010
219	The Elbow	25.14200	-80.25800	REEF	0.0021	-0.0001	-0.0001	-0.0288	-0.0192	0.0346	0.0342	-0.0001	-0.1399	0.0005
220	Radabob Key	25.11355	-80.37342	INSHORE	0.0040	-0.0001	-0.0001	-0.0524	-0.0272	0.0155	0.0227	0.0000	-0.2558	0.0034
222	Dixie Shoal	25.07237	-80.31277	REEF	0.0016	-0.0001	-0.0001	-0.0508	-0.0266	0.0377	0.0311	0.0037	0.2733	-0.0009
223	Mosquito Bank	25.06018	-80.42312	INSHORE	0.0051	-0.0007	-0.0001	-0.3523	-0.0486	0.0227	0.0280	0.0002	-0.9474	0.0050
224	Molasses Reef Channel	25.03082	-80.39527	REEF	0.0031	-0.0004	-0.0001	-0.2456	-0.0470	0.0305	0.0320	0.0002	0.3433	0.0007
225	Molasses Reef	25.01700	-80.36740	REEF	0.0027	-0.0001	-0.0001	-0.0386	-0.0624	0.0343	0.0312	0.0000	1.1727	-0.0012
226	Tavernier Harbor	25.00840	-80.50148	INSHORE	0.0019	-0.0005	-0.0001	-0.3459	-0.0779	0.0291	0.0257	0.0005	-1.1623	0.0086
227	Triangles	25.00167	-80.47490	REEF	0.0025	-0.0001	-0.0001	-0.0393	-0.0313	0.0222	0.0281	0.0000	-0.9260	0.0032
228	Conch Reef	24.97667	-80.45000	REEF	0.0014	-0.0001	-0.0001	-0.0508	-0.0273	0.0313	0.0313	0.0011	0.3695	-0.0007
229	Plantation Point	24.95012	-80.56218	INSHORE	0.0052		-0.0001		-0.0676	0.0315	0.0281	0.0001	-0.6943	0.0078
230	The Rocks	24.93965	-80.55162	REEF	0.0042	-0.0001	-0.0001	-0.0394	-0.0528	0.0225	0.0274	0.0001	-0.0925	0.0010
231	Davis Reef	24.92500	-80.50300	REEF	0.0027	-0.0001	-0.0001	-0.0325	-0.0252	0.0347	0.0325	-0.0002	-0.0435	-0.0005
232	Upper Matecumbe Key	24.92703	-80.59852	INSHORE	0.0034	-0.0004	-0.0002	-0.2565	-0.1008	0.0213	0.0161	0.0002	-0.8707	0.0053
235	Lower Matecumbe Key	24.87123	-80.66865	INSHORE	0.0020	0.0002	-0.0003	-0.0792	-0.1257	0.0238	0.0273	0.0003	-0.6416	0.0032
237	Alligator Reef	24.83265	-80.64907	REEF	0.0030	0.0000	-0.0001	-0.0001	-0.0166	0.0336	0.0287	0.0005	0.7306	-0.0013
238	Matecumbe Harbor	24.83440	-80.74680	INSHORE	0.0051		-0.0004		-0.1498	0.0345	0.0337	0.0001	-0.3093	0.0002
239	Lower Matecumbe Channel	24.80223	-80.71620	REEF	0.0024	-0.0001	-0.0001	-0.0243	-0.0248	0.0184	0.0237	-0.0002	0.6457	-0.0017
241	Long Key	24.80247	-80.80890	INSHORE	0.0041		-0.0002		-0.0650	0.0145	0.0233	0.0002	-0.7139	0.0036
242	Long Key Channel	24.79150	-80.81225	REEF	0.0010	-0.0001	-0.0001	-0.0382	-0.0514	0.0212	0.0251	0.0000	-0.1803	0.0057
243	Tennessee Reef	24.74500	-80.78333	REEF	0.0013	-0.0001	-0.0001	-0.0411	-0.0297	0.0321	0.0331	-0.0003	1.4424	0.0000
244	Long Key Pass Inshore	24.79333	-80.86333	INSHORE	0.0039	-0.0001	-0.0002	-0.0513	-0.0972	0.0330	0.0243	0.0000	-0.3567	0.0051
246	Long Key Pass Offshore	24.71320	-80.85810	REEF	0.0013	-0.0001	-0.0001	-0.0366	-0.0565	0.0322	0.0341	0.0007	0.6239	-0.0006
247	Key Colony Beach	24.71318	-81.01115	INSHORE	0.0037	-0.0005	-0.0001	-0.3007	-0.0534	0.0248	0.0247	0.0000	-0.3027	0.0051
248	Coffins Patch Channel	24.69167	-80.96667	REEF	0.0022	-0.0001	-0.0001	-0.0406	-0.0357	0.0249	0.0198	0.0003	0.5131	0.0003
249	Coffins Patch Offshore	24.67500	-80.95830	REEF	0.0029	-0.0002	-0.0001	-0.0655	-0.0487	0.0277	0.0291	0.0000	1.4846	-0.0002
250	Seven Mile Bridge	24.69193	-81.18245	INSHORE	0.0057	-0.0006	-0.0001	-0.3699	-0.0298	0.0286	0.0316	0.0000	-0.0815	-0.0021
252	Sombrero Key	24.60693	-81.15442	REEF	0.0014	-0.0001	-0.0002	-0.0232	-0.0705	0.0412	0.0294	0.0004	0.3812	-0.0012
253	Spanish Harbor Keys	24.64540	-81.30720	INSHORE	0.0030		-0.0001	-0.1282	-0.0841	0.0221	0.0081	0.0000	-0.3166	0.0135
254	Bahia Honda Key	24.65792	-81.26502	INSHORE	0.0010		-0.0001		-0.0678	0.0285	0.0361	-0.0003	-0.0137	0.0041
255	Bahia Honda Channel	24.62168	-81.24308	REEF	-0.0002	-0.0002	-0.0001	-0.0812	-0.0528	0.0414	0.0374	0.0054	0.3204	-0.0005
256	Bahia Honda Offshore	24.58497	-81.23408	REEF	0.0022	-0.0001	-0.0001	-0.0495	-0.0440	0.0383	0.0293	0.0021	0.6252	-0.0020
259	Big Pine Shoal	24.57037	-81.32167	REEF	-0.0001	-0.0001	-0.0001	-0.0494	-0.0731	0.0378	0.0352	0.0015	0.4266	-0.0008
260	Newfound Harbor Keys	24.62550	-81.41662	INSHORE	0.0053		-0.0002		-0.0843	0.0246	0.0273	0.0000	-0.1443	0.0044
263	Looe Key	24.54843	-81.39742	REEF	0.0009	-0.0001	0.0000	-0.0304	-0.0249	0.0383	0.0338	0.0031	0.3541	-0.0010
264	Aquarius	24.94677	-80.45947	REEF	0.0018	-0.0001	-0.0001	-0.0499	-0.0343	0.0366	0.0338	0.0008	0.4563	-0.0014
266	Tarpon Creek	24.61105	-81.50527	INSHORE	0.0023		-0.0002		-0.0910	0.0189	0.0241	0.0015	-0.5328	0.0040
267	American Shoal	24.53008	-81.48730	REEF	0.0008	-0.0001	-0.0002	-0.0562	-0.0811	0.0387	0.0400	0.0050	0.8145	-0.0030
268	Saddlebunch Keys	24.58782	-81.57698	INSHORE	0.0048	-0.0003	-0.0002	-0.1909	-0.1028	0.0211	0.0260	0.0020	-0.0042	0.0016
269	West Washerwoman	24.55943	-81.55955	REEF	0.0025	-0.0001	-0.0001	-0.0271	-0.0326	0.0301	0.0380	-0.0004	-0.0221	0.0003
270	Maryland Shoal	24.52162	-81.56432	REEF	0.0035	-0.0001	-0.0001	-0.0590	-0.0435	0.0409	0.0357	0.0047	0.3015	-0.0007
271	Boca Chica Key	24.55667	-81.66667	INSHORE	0.0018	0.0000	0.0000	-0.0239	-0.0327	0.0354	0.0353	0.0019	-0.2332	0.0025
272	Eastern Sambo	24.50548	-81.65433	REEF	0.0038	0.0000	-0.0001	-0.0159	-0.0556	0.0399	0.0371	0.0028	-0.0527	-0.0012
273	Eastern Sambo Offshore	24.49290	-81.65710	REEF	0.0031	-0.0002	-0.0001	-0.0764	-0.0274	0.0426	0.0394	0.0003	1.0059	-0.0005
275	Boca Chica Mid	24.52143	-81.74422	REEF	0.0011	-0.0001	0.0000	-0.0248	-0.0181	0.0405	0.0375	0.0007	-0.1214	0.0012

STATION	SITE	LATDEC	LONDEC	ZONE	NH4-B	NH4-S	NO2-B	NO2-S	NO3-B	NO3-S	NOX-B	NOX-S	SAL-B	SAL-S
200	Fowey Rocks	25.59000	-80.10000	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0063	0.0067
201	Sands Key	25.51000	-80.16500	INSHORE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0134	0.0145
203	Triumph Reef	25.48053	-80.11768	REEF	-0.0006	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0002	0.0000	0.0036	0.0049
204	Elliott Key	25.43080	-80.19550	INSHORE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0104	0.0094
206	Ajax Reef	25.41500	-80.14300	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0060
207	Old Rhodes Key	25.36443	-80.21508	INSHORE		-0.0001		0.0000		-0.0001		-0.0001	0.0090	0.0100
209	Channel Key	24.58570	-81.72270	BACK		-0.0001		0.0000		0.0000		-0.0001	0.0000	0.0010
210	Old Rhodes Key Reef	25.32500	-80.16360	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035	0.0046
211	Pennekamp G27	25.30788	-80.26165	INSHORE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0097	0.0053
212	Turtle Harbor	25.29450	-80.24540	REEF	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0038	0.0049
213	Turtle Reef	25.26312	-80.18773	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0059
214	Port Elizabeth	25.24620	-80.29918	INSHORE	-0.0005	0.0000	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	0.0103	0.0105
215	Carysfort Channel	25.23667	-80.28897	REEF	-0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	0.0095
216	Carysfort Reef	25.22000	-80.21700	REEF	-0.0003	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0036
217	Rattlesnake Key	25.17332	-80.33985	INSHORE	-0.0007	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0002	0.0000	0.0118	0.0123
218	White Bank	25.15897	-80.29455	REEF	-0.0004	-0.0001	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0085	0.0112
219	The Elbow	25.14200	-80.25800	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0025	0.0031
220	Radabob Key	25.11355	-80.37342	INSHORE	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0089
222	Dixie Shoal	25.07237	-80.31277	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0057
223	Mosquito Bank	25.06018	-80.42312	INSHORE	-0.0007	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0010
224	Molasses Reef Channel	25.03082	-80.39527	REEF	-0.0004	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0000	0.0031	0.0045
225	Molasses Reef	25.01700	-80.36740	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044	0.0047
226	Tavernier Harbor	25.00840	-80.50148	INSHORE	-0.0005	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0057	0.0040
227	Triangles	25.00167	-80.47490	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0029	0.0031
228	Conch Reef	24.97667	-80.45000	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0005	-0.0012
229	Plantation Point	24.95012	-80.56218	INSHORE		-0.0001		0.0000		0.0000		0.0000	0.0016	0.0129
230	The Rocks	24.93965	-80.55162	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0058	-0.0019
231	Davis Reef	24.92500	-80.50300	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
232	Upper Matecumbe Key	24.92703	-80.59852	INSHORE	-0.0003	-0.0002	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0000	0.0062	0.0084
235	Lower Matecumbe Key	24.87123	-80.66865	INSHORE	-0.0001	-0.0002	0.0000	0.0000	0.0002	0.0000	0.0003	-0.0001	0.0107	0.0071
237	Alligator Reef	24.83265	-80.64907	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008
238	Matecumbe Harbor	24.83440	-80.74680	INSHORE		-0.0002		0.0000		-0.0002		-0.0002	0.0157	0.0129
239	Lower Matecumbe Channel	24.80223	-80.71620	REEF	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0029
241	Long Key	24.80247	-80.80890	INSHORE		-0.0001		0.0000		0.0000		0.0000	-0.0084	-0.0098
242	Long Key Channel	24.79150	-80.81225	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0047	0.0047
243	Tennessee Reef	24.74500	-80.78333	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041
244	Long Key Pass Inshore	24.79333	-80.86333	INSHORE	-0.0001	-0.0001	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	0.0039	0.0000
246	Long Key Pass Offshore	24.71320	-80.85810	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0006
247	Key Colony Beach	24.71318	-81.01115	INSHORE	-0.0004	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0000	-0.0189	-0.0171
248	Coffins Patch Channel	24.69167	-80.96667	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0024	-0.0037
249	Coffins Patch Offshore	24.67500	-80.95830	REEF	-0.0001	-0.0001	0.0000	0.0000	-0.0001	0.0000	-0.0001	0.0000	-0.0018	-0.0014
250	Seven Mile Bridge	24.69193	-81.18245	INSHORE	-0.0005	0.0000	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0109	-0.0076
252	Sombrero Key	24.60693	-81.15442	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0028	-0.0001
253	Spanish Harbor Keys	24.64540	-81.30720	INSHORE		-0.0001		0.0000		0.0000		0.0000	-0.0146	-0.0006
254	Bahia Honda Key	24.65792	-81.26502	INSHORE		0.0000		0.0000		0.0000		0.0000	-0.0060	0.0011
255	Bahia Honda Channel	24.62168	-81.24308	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0059	-0.0066
256	Bahia Honda Offshore	24.58497	-81.23408	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009	0.0010
259	Big Pine Shoal	24.57037	-81.32167	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0040	-0.0040
260	Newfound Harbor Keys	24.62550	-81.41662	INSHORE		-0.0001		0.0000		-0.0001	-0.0002	-0.0001	-0.0091	-0.0034
263	Looe Key	24.54843	-81.39742	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0058	-0.0042
264	Aquarius	24.94677	-80.45947	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	-0.0001
266	Tarpon Creek	24.61105	-81.50527	INSHORE		-0.0001		0.0000		0.0000		-0.0001	-0.0177	-0.0184
267	American Shoal	24.53008	-81.48730	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0033	-0.0062
268	Saddlebunch Keys	24.58782	-81.57698	INSHORE	-0.0003	-0.0001	0.0000	0.0000	0.0000	-0.0001	0.0000	-0.0001	-0.0117	-0.0119
269	West Washerwoman	24.55943	-81.55955	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0108	-0.0088
270	Maryland Shoal	24.52162	-81.56432	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0033	-0.0029
271	Boca Chica Key	24.55667	-81.66667	INSHORE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0159	-0.0137
272	Eastern Sambo	24.50548	-81.65433	REEF	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0063	-0.0062
273	Eastern Sambo Offshore	24.49290	-81.65710	REEF	-0.0001	-0.0001	0.0000	0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0006	-0.0026
275	Boca Chica Mid	24.52143	-81.74422	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0083	-0.0118

STATION	SITE	LATDEC	LONDEC	ZONE	DOsat-B	DOsat-S	Si:DIN-S	SiO2-B	SiO2-S	SRP-B	SRP-S	TEMP-B	TEMP-S	TN-B
200	Fowey Rocks	25.59000	-80.10000	REEF	0.2846	0.2579	-0.0368	-0.0003	-0.0004	0.0000	0.0000	0.0119	0.0019	-0.0022
201	Sands Key	25.51000	-80.16500	INSHORE	0.2718	0.3042	-0.0405	-0.0004	-0.0005	0.0000	0.0000	0.0415	0.0305	-0.0019
203	Triumph Reef	25.48053	-80.11768	REEF	0.4045	0.3633	-0.0201	-0.0002	-0.0002	-0.0001	0.0000	0.0048	-0.0003	0.0007
204	Elliott Key	25.43080	-80.19550	INSHORE	0.2844	0.3740	-0.0376	-0.0003	-0.0006	0.0000	0.0000	0.0486	0.0386	-0.0017
206	Ajax Reef	25.41500	-80.14300	REEF	0.3438	0.3935	-0.0314	-0.0003	-0.0004	0.0000	0.0000	0.0091	0.0093	-0.0011
207	Old Rhodes Key	25.36443	-80.21508	INSHORE	0.3038	0.2971	-0.0267		-0.0005		0.0000	0.0319	0.0205	
209	Channel Key	24.58570	-81.72270	BACK	0.4750	0.4905	0.0105		-0.0001		0.0000	0.0326	0.0306	
210	Old Rhodes Key Reef	25.32500	-80.16360	REEF	0.3809	0.3917	-0.0225	-0.0003	-0.0002	0.0000	0.0000	0.0192	0.0141	-0.0011
211	Pennekamp G27	25.30788	-80.26165	INSHORE	0.3396	0.3131	-0.0152	-0.0006	-0.0004	0.0000	0.0000	0.0110	0.0030	-0.0018
212	Turtle Harbor	25.29450	-80.24540	REEF	0.2223	0.3027	-0.0074	-0.0003	-0.0003	0.0000	0.0000	0.0191	0.0084	-0.0011
213	Turtle Reef	25.26312	-80.18773	REEF	0.4625	0.4072	-0.0170	-0.0002	-0.0002	0.0000	0.0000	0.0255	0.0135	-0.0010
214	Port Elizabeth	25.24620	-80.29918	INSHORE	0.2611	0.1775	-0.0213	-0.0001	-0.0005	-0.0001	0.0000	0.0332	0.0197	0.0018
215	Carysfort Channel	25.23667	-80.28897	REEF	0.3222	0.2988	-0.0505	-0.0002	-0.0006	0.0000	0.0000	0.0298	0.0183	0.0001
216	Carysfort Reef	25.22000	-80.21700	REEF	0.4698	0.4753	-0.0179	-0.0003	-0.0002	0.0000	0.0000	0.0209	0.0125	-0.0005
217	Rattlesnake Key	25.17332	-80.33985	INSHORE	0.4028	0.3931	-0.0048	-0.0001	-0.0003	-0.0001	0.0000	0.0208	0.0089	0.0021
218	White Bank	25.15897	-80.29455	REEF	0.3746	0.3640	-0.0146	-0.0003	-0.0003	-0.0001	0.0000	0.0359	0.0270	0.0004
219	The Elbow	25.14200	-80.25800	REEF	0.4813	0.4565	-0.0136	-0.0002	-0.0002	0.0000	0.0000	0.0382	0.0278	-0.0009
220	Radabob Key	25.11355	-80.37342	INSHORE	0.2313	0.3582	-0.0349	-0.0003	-0.0004	0.0000	0.0000	0.0388	0.0274	-0.0015
222	Dixie Shoal	25.07237	-80.31277	REEF	0.5180	0.4262	-0.0211	-0.0003	-0.0002	0.0000	0.0000	0.0066	0.0187	-0.0020
223	Mosquito Bank	25.06018	-80.42312	INSHORE	0.3330	0.3916	-0.0195	-0.0003	-0.0003	-0.0001	0.0000	0.0099	0.0142	-0.0032
224	Molasses Reef Channel	25.03082	-80.39527	REEF	0.4290	0.4498	-0.0056	-0.0002	-0.0001	-0.0001	0.0000	0.0170	0.0211	-0.0021
225	Molasses Reef	25.01700	-80.36740	REEF	0.4244	0.4159	-0.0133	-0.0002	-0.0001	0.0000	0.0000	0.0341	0.0228	-0.0019
226	Tavernier Harbor	25.00840	-80.50148	INSHORE	0.4062	0.3597	-0.0233	-0.0006	-0.0004	-0.0001	0.0000	0.0172	0.0328	0.0016
227	Triangles	25.00167	-80.47490	REEF	0.3246	0.3515	-0.0254	-0.0003	-0.0003	0.0000	0.0000	0.0092	0.0140	-0.0018
228	Conch Reef	24.97667	-80.45000	REEF	0.4573	0.4716	-0.0147	-0.0002	-0.0002	0.0000	0.0000	0.0260	0.0368	-0.0019
229	Plantation Point	24.95012	-80.56218	INSHORE	0.4145	0.3555	-0.0179		-0.0004		0.0000	0.0050	0.0125	
230	The Rocks	24.93965	-80.55162	REEF	0.2521	0.3110	-0.0152	-0.0004	-0.0003	0.0000	0.0000	0.0006	-0.0015	-0.0033
231	Davis Reef	24.92500	-80.50300	REEF	0.4512	0.4023	-0.0115	-0.0001	-0.0002	0.0000	0.0000	0.0256	0.0229	-0.0027
232	Upper Matecumbe Key	24.92703	-80.59852	INSHORE	0.2798	0.2481	-0.0146	-0.0005	-0.0006	-0.0001	0.0000	0.0031	0.0237	0.0009
235	Lower Matecumbe Key	24.87123	-80.66865	INSHORE	0.3091	0.3592	-0.0108	-0.0009	-0.0006	-0.0001	0.0000	0.0135	0.0197	-0.0002
237	Alligator Reef	24.83265	-80.64907	REEF	0.4471	0.3789	-0.0304	-0.0002	-0.0003	0.0000	0.0000	0.0254	0.0375	-0.0019
238	Matecumbe Harbor	24.83440	-80.74680	INSHORE	0.4563	0.4500	-0.0151		-0.0011		0.0000	0.0190	0.0185	
239	Lower Matecumbe Channel	24.80223	-80.71620	REEF	0.2243	0.3236	-0.0354	-0.0002	-0.0003	0.0000	0.0000	0.0382	0.0341	-0.0015
241	Long Key	24.80247	-80.80890	INSHORE	0.2086	0.3000	0.0995		-0.0004		0.0000	0.0339	0.0345	
242	Long Key Channel	24.79150	-80.81225	REEF	0.2848	0.3057	-0.0235	-0.0004	-0.0008	0.0000	0.0000	0.0250	0.0214	-0.0026
243	Tennessee Reef	24.74500	-80.78333	REEF	0.4264	0.4168	-0.0271	-0.0002	-0.0004	0.0000	0.0000	0.0394	0.0243	-0.0016
244	Long Key Pass Inshore	24.79333	-80.86333	INSHORE	0.3643	0.2355	0.0001	-0.0002	-0.0003	0.0000	0.0000	0.0358	0.0317	-0.0031
246	Long Key Pass Offshore	24.71320	-80.85810	REEF	0.4259	0.4176	-0.0205	-0.0004	-0.0004	0.0000	0.0000	0.0171	0.0198	-0.0021
247	Key Colony Beach	24.71318	-81.01115	INSHORE	0.2683	0.3396	0.0105	-0.0034	-0.0007	-0.0001	0.0000	0.0033	0.0080	0.0001
248	Coffins Patch Channel	24.69167	-80.96667	REEF	0.2838	0.2520	-0.0105	-0.0003	-0.0004	0.0000	0.0000	0.0022	0.0127	-0.0019
249	Coffins Patch Offshore	24.67500	-80.95830	REEF	0.3233	0.3736	-0.0020	-0.0002	-0.0001	0.0000	0.0000	0.0119	0.0156	-0.0015
250	Seven Mile Bridge	24.69193	-81.18245	INSHORE	0.3475	0.4190	0.0378	-0.0034	-0.0003	-0.0001	0.0000	0.0098	0.0103	-0.0007
252	Sombrero Key	24.60693	-81.15442	REEF	0.5555	0.3718	-0.0132	-0.0002	-0.0003	0.0000	0.0000	0.0091	0.0242	-0.0017
253	Spanish Harbor Keys	24.64540	-81.30720	INSHORE	0.1641	0.0607	-0.0459	-0.0013	-0.0012		0.0000	-0.0163	-0.0062	-0.0053
254	Bahia Honda Key	24.65792	-81.26502	INSHORE	0.3353	0.4481	-0.0541		-0.0009		0.0000	-0.0289	-0.0257	
255	Bahia Honda Channel	24.62168	-81.24308	REEF	0.5248	0.4366	-0.0289	-0.0004	-0.0008	0.0000	0.0000	-0.0317	-0.0176	-0.0017
256	Bahia Honda Offshore	24.58497	-81.23408	REEF	0.4868	0.3721	-0.0294	-0.0004	-0.0004	0.0000	0.0000	0.0106	0.0052	-0.0017
259	Big Pine Shoal	24.57037	-81.32167	REEF	0.4415	0.4441	-0.0300	-0.0004	-0.0005	0.0000	0.0000	-0.0184	-0.0097	-0.0021
260	Newfound Harbor Keys	24.62550	-81.41662	INSHORE	0.2584	0.2986	0.0130		-0.0003		0.0000	0.0031	0.0048	
263	Looe Key	24.54843	-81.39742	REEF	0.4473	0.3858	-0.0151	-0.0003	-0.0003	0.0000	0.0000	-0.0181	-0.0092	-0.0015
264	Aquarius	24.94677	-80.45947	REEF	0.4859	0.4317	-0.0107	-0.0001	-0.0001	0.0000	0.0000	0.0113	0.0185	-0.0018
266	Tarpon Creek	24.61105	-81.50527	INSHORE	0.2059	0.2534	0.0184		-0.0005		0.0000	-0.0637	-0.0603	
267	American Shoal	24.53008	-81.48730	REEF	0.4751	0.5092	-0.0097	-0.0002	-0.0004	0.0000	0.0000	-0.0126	0.0014	-0.0011
268	Saddlebunch Keys	24.58782	-81.57698	INSHORE	0.2127	0.3095	0.0105	-0.0004	-0.0005	-0.0001	0.0000	-0.0523	-0.0435	0.0006
269	West Washerwoman	24.55943	-81.55955	REEF	0.3521	0.4539	-0.0371	-0.0007	-0.0007	0.0000	0.0000	-0.0436	-0.0305	-0.0015
270	Maryland Shoal	24.52162	-81.56432	REEF	0.5070	0.4915	-0.0171	-0.0006	-0.0004	0.0000	0.0000	-0.0134	0.0030	-0.0013
271	Boca Chica Key	24.55667	-81.66667	INSHORE	0.3853	0.4057	-0.0416	-0.0005	-0.0009	0.0000	0.0000	-0.0426	-0.0400	-0.0006
272	Eastern Sambo	24.50548	-81.65433	REEF	0.4582	0.4163	0.0111	-0.0001	-0.0003	0.0000	0.0000	-0.0300	-0.0188	-0.0010
273	Eastern Sambo Offshore	24.49290	-81.65710	REEF	0.5675	0.5094	-0.0042	-0.0002	-0.0002	0.0000	0.0000	0.0231	-0.0085	-0.0013
275	Boca Chica Mid	24.52143	-81.74422	REEF	0.4690	0.4580	-0.0452	-0.0008	-0.0007	0.0000	0.0000	-0.0191	-0.0224	-0.0014

STATION	SITE	LATDEC	LONDEC	ZONE	TN-S	TN:TP-B	TN:TP-S	TOC-B	TOC-S	TON-B	TON-S	TP-B	TP-S	TURB-B	TURB-S
200	Fowey Rocks	25.59000	-80.10000	REEF	-0.0027	-0.8353	-1.3784	-0.0314	-0.0392	-0.0020	-0.0027	0.0000	0.0000	-0.0052	-0.0088
201	Sands Key	25.51000	-80.16500	INSHORE	-0.0012	-0.9635	-1.0671	-0.0390	-0.0372	-0.0017	-0.0013	0.0000	0.0000	-0.0159	-0.0143
203	Triumph Reef	25.48053	-80.11768	REEF	-0.0012	-0.5396	-0.8866	-0.0251	-0.0326	0.0021	-0.0011	0.0002	0.0001	-0.0231	-0.0053
204	Elliott Key	25.43080	-80.19550	INSHORE	-0.0010	-1.0815	-0.7918	-0.0313	-0.0378	-0.0016	-0.0010	0.0000	0.0000	-0.0135	-0.0121
206	Ajax Reef	25.41500	-80.14300	REEF	-0.0012	-0.5608	-0.7249	-0.0354	-0.0392	-0.0011	-0.0010	0.0000	0.0000	-0.0042	-0.0058
207	Old Rhodes Key	25.36443	-80.21508	INSHORE	-0.0009		-1.1023		-0.0423		-0.0010		0.0001	-0.1303	-0.0183
209	Channel Key	24.58570	-81.72270	BACK	-0.0013		-0.6375		-0.0459		-0.0010		0.0000	-0.1534	-0.0068
210	Old Rhodes Key Reef	25.32500	-80.16360	REEF	-0.0012	-0.6684	-0.7696	-0.0339	-0.0326	-0.0010	-0.0012	0.0000	0.0000	-0.0057	-0.0047
211	Pennekamp G27	25.30788	-80.26165	INSHORE	-0.0015	-1.7725	-1.5131	-0.0434	-0.0463	-0.0017	-0.0016	0.0001	0.0001	-0.0063	-0.0101
212	Turtle Harbor	25.29450	-80.24540	REEF	-0.0010	-0.9266	-0.7779	-0.0348	-0.0378	-0.0012	-0.0010	0.0001	0.0000	-0.0055	-0.0038
213	Turtle Reef	25.26312	-80.18773	REEF	-0.0008	-0.3685	-0.2554	-0.0407	-0.0420	-0.0009	-0.0007	0.0000	0.0000	-0.0044	-0.0054
214	Port Elizabeth	25.24620	-80.29918	INSHORE	-0.0006	-1.0363	-0.7731	-0.0107	-0.0413	0.0020	-0.0004	0.0003	0.0000	-0.0110	-0.0013
215	Carysfort Channel	25.23667	-80.28897	REEF	-0.0010	-1.3214	-0.8205	-0.0226	-0.0388	0.0003	-0.0011	0.0002	0.0000	-0.0240	-0.0084
216	Carysfort Reef	25.22000	-80.21700	REEF	-0.0012	-0.3361	-0.4988	-0.0328	-0.0391	-0.0002	-0.0012	0.0000	0.0000	-0.0070	-0.0065
217	Rattlesnake Key	25.17332	-80.33985	INSHORE	-0.0018	-1.9270	-1.3145	-0.0170	-0.0356	0.0023	-0.0017	0.0002	0.0000	-0.0139	-0.0099
218	White Bank	25.15897	-80.29455	REEF	-0.0014	-0.8804	-0.6613	-0.0193	-0.0375	0.0008	-0.0012	0.0001	0.0000	-0.0165	-0.0117
219	The Elbow	25.14200	-80.25800	REEF	-0.0011	-0.3953	-0.5732	-0.0350	-0.0322	-0.0009	-0.0010	0.0000	0.0000	-0.0037	-0.0044
220	Radabob Key	25.11355	-80.37342	INSHORE	-0.0013	-1.4020	-0.7694	-0.0345	-0.0377	-0.0014	-0.0014	0.0001	0.0000	-0.0039	-0.0080
222	Dixie Shoal	25.07237	-80.31277	REEF	-0.0014	-1.0858	-0.7413	-0.0352	-0.0354	-0.0019	-0.0016	0.0000	0.0000	-0.0035	-0.0041
223	Mosquito Bank	25.06018	-80.42312	INSHORE	-0.0021	-1.8387	-1.2286	-0.0301	-0.0403	-0.0028	-0.0021	0.0001	0.0000	-0.0113	-0.0074
224	Molasses Reef Channel	25.03082	-80.39527	REEF	-0.0025	-1.1827	-1.2322	-0.0226	-0.0393	-0.0011	-0.0023	0.0001	0.0000	-0.0069	-0.0046
225	Molasses Reef	25.01700	-80.36740	REEF	-0.0022	-0.8053	-1.0071	-0.0376	-0.0405	-0.0018	-0.0021	0.0000	0.0000	-0.0014	-0.0032
226	Tavernier Harbor	25.00840	-80.50148	INSHORE	-0.0019	-2.1569	-1.7734	-0.0246	-0.0448	0.0019	-0.0019	0.0002	0.0001	0.0002	-0.0015
227	Triangles	25.00167	-80.47490	REEF	-0.0028	-0.8405	-1.3264	-0.0396	-0.0380	-0.0017	-0.0025	0.0000	0.0000	0.0018	0.0029
228	Conch Reef	24.97667	-80.45000	REEF	-0.0016	-0.7327	-0.3487	-0.0411	-0.0393	-0.0019	-0.0014	0.0000	0.0000	-0.0046	-0.0058
229	Plantation Point	24.95012	-80.56218	INSHORE	-0.0015		-1.2942		-0.0460		-0.0016		0.0001	-0.0619	-0.0073
230	The Rocks	24.93965	-80.55162	REEF	-0.0024	-1.4023	-1.2107	-0.0440	-0.0424	-0.0031	-0.0025	0.0000	0.0000	0.0035	0.0028
231	Davis Reef	24.92500	-80.50300	REEF	-0.0024	-0.9659	-1.1612	-0.0453	-0.0443	-0.0024	-0.0023	0.0000	0.0000	-0.0021	-0.0011
232	Upper Matecumbe Key	24.92703	-80.59852	INSHORE	-0.0032	-3.4310	-1.4946	-0.0245	-0.0544	0.0014	-0.0030	0.0004	0.0000	0.0129	-0.0090
235	Lower Matecumbe Key	24.87123	-80.66865	INSHORE	-0.0033	-3.6336	-1.4020	-0.0555	-0.0559	-0.0010	-0.0029	0.0003	0.0000	0.0060	-0.0119
237	Alligator Reef	24.83265	-80.64907	REEF	-0.0025	-0.5348	-0.7680	-0.0400	-0.0413	-0.0019	-0.0023	0.0000	0.0000	-0.0057	-0.0067
238	Matecumbe Harbor	24.83440	-80.74680	INSHORE	-0.0038	-2.8187	-1.5944		-0.0677		-0.0033		0.0000	-0.2316	-0.0195
239	Lower Matecumbe Channel	24.80223	-80.71620	REEF	-0.0019	-0.7161	-0.6897	-0.0359	-0.0427	-0.0016	-0.0019	0.0000	0.0000	-0.0037	-0.0065
241	Long Key	24.80247	-80.80890	INSHORE	-0.0012		-0.6951		-0.0431		-0.0011		0.0000	-0.0832	-0.0266
242	Long Key Channel	24.79150	-80.81225	REEF	-0.0026	-1.1932	-1.0937	-0.0480	-0.0576	-0.0025	-0.0025	0.0000	0.0000	-0.0127	-0.0181
243	Tennessee Reef	24.74500	-80.78333	REEF	-0.0019	-0.8149	-0.8886	-0.0351	-0.0362	-0.0018	-0.0019	0.0000	0.0000	-0.0022	-0.0045
244	Long Key Pass Inshore	24.79333	-80.86333	INSHORE	-0.0025	-1.3579	-1.1047	-0.0535	-0.0485	-0.0029	-0.0022	0.0000	0.0000	-0.0273	-0.0316
246	Long Key Pass Offshore	24.71320	-80.85810	REEF	-0.0018	-1.0651	-0.9432	-0.0379	-0.0409	-0.0021	-0.0019	0.0000	0.0000	-0.0064	-0.0067
247	Key Colony Beach	24.71318	-81.01115	INSHORE	-0.0013	-1.4814	-0.8930	-0.0640	-0.0441	0.0013	-0.0013	0.0002	0.0000	-0.0425	-0.0200
248	Coffins Patch Channel	24.69167	-80.96667	REEF	-0.0018	-1.0576	-0.9587	-0.0353	-0.0402	-0.0020	-0.0016	0.0000	0.0000	-0.0100	-0.0108
249	Coffins Patch Offshore	24.67500	-80.95830	REEF	-0.0016	-0.8533	-1.0550	-0.0375	-0.0371	-0.0012	-0.0015	0.0000	0.0000	-0.0053	-0.0059
250	Seven Mile Bridge	24.69193	-81.18245	INSHORE	-0.0012	-1.9775	-0.8981	-0.0407	-0.0420	0.0000	-0.0009	0.0003	0.0000	-0.0306	-0.0168
252	Sombrero Key	24.60693	-81.15442	REEF	-0.0018	-0.9044	-0.9222	-0.0323	-0.0338	-0.0018	-0.0016	0.0000	0.0000	-0.0035	-0.0059
253	Spanish Harbor Keys	24.64540	-81.30720	INSHORE	-0.0010	-2.6213	-0.8907	-0.0780	-0.0475	-0.0056	-0.0009		0.0000	-0.0667	-0.0165
254	Bahia Honda Key	24.65792	-81.26502	INSHORE	-0.0007		-0.6743		-0.0545		-0.0008		0.0000	-0.0568	-0.0117
255	Bahia Honda Channel	24.62168	-81.24308	REEF	-0.0018	-0.8420	-0.9596	-0.0414	-0.0461	-0.0016	-0.0017	0.0000	0.0000	-0.0089	-0.0171
256	Bahia Honda Offshore	24.58497	-81.23408	REEF	-0.0018	-0.7750	-0.9571	-0.0392	-0.0360	-0.0016	-0.0018	0.0000	0.0000	-0.0043	-0.0038
259	Big Pine Shoal	24.57037	-81.32167	REEF	-0.0021	-0.9645	-0.9825	-0.0398	-0.0403	-0.0021	-0.0019	0.0000	0.0000	-0.0065	-0.0075
260	Newfound Harbor Keys	24.62550	-81.41662	INSHORE	-0.0019	-2.3262	-0.8600		-0.0473		-0.0020		0.0000	-0.0940	-0.0161
263	Looe Key	24.54843	-81.39742	REEF	-0.0012	-0.7672	-0.7325	-0.0395	-0.0361	-0.0013	-0.0009	0.0000	0.0000	-0.0048	-0.0066
264	Aquarius	24.94677	-80.45947	REEF	-0.0017	-0.8738	-0.7486	-0.0389	-0.0431	-0.0018	-0.0015	0.0000	0.0000	-0.0031	-0.0020
266	Tarpon Creek	24.61105	-81.50527	INSHORE	-0.0018	-3.4677	-1.2715		-0.0496		-0.0016		0.0000	-0.1985	-0.0441
267	American Shoal	24.53008	-81.48730	REEF	-0.0012	-0.7921	-0.8345	-0.0424	-0.0439	-0.0011	-0.0009	0.0000	0.0000	-0.0053	-0.0091
268	Saddlebunch Keys	24.58782	-81.57698	INSHORE	-0.0014	-0.8890	-1.1218	-0.0288	-0.0431	0.0010	-0.0013	0.0001	0.0001	-0.0292	-0.0197
269	West Washerwoman	24.55943	-81.55955	REEF	-0.0017	-0.6656	-0.8716	-0.0357	-0.0374	-0.0015	-0.0016	0.0000	0.0000	-0.0135	-0.0148
270	Maryland Shoal	24.52162	-81.56432	REEF	-0.0011	-0.7268	-0.4560	-0.0411	-0.0389	-0.0011	-0.0009	0.0000	0.0000	-0.0033	-0.0080
271	Boca Chica Key	24.55667	-81.66667	INSHORE	-0.0006	-0.4756	-0.9886	-0.0431	-0.0443	-0.0006	-0.0006	0.0000	0.0000	-0.0145	-0.0250
272	Eastern Sambo	24.50548	-81.65433	REEF	-0.0007	-0.7852	-0.7588	-0.0394	-0.0407	-0.0010	-0.0006	0.0000	0.0000	0.0080	-0.0016
273	Eastern Sambo Offshore	24.49290	-81.65710	REEF	-0.0007	-0.6693	-0.2493	-0.0387	-0.0383	-0.0012	-0.0005	0.0000	0.0000	-0.0014	-0.0026
275	Boca Chica Mid	24.52143	-81.74422	REEF	-0.0011	-0.7717	-0.6469	-0.0386	-0.0383	-0.0013	-0.0011	0.0000	0.0000	-0.0147	-0.0114

STATION	SITE	LATDEC	LONDEC	ZONE	CHLA-S	DIN-B	DIN-S	DIN:TP-B	DIN:TP-S	DO-B	DO-S	dSIG-t	Io	Kd
276	Western Sambo	24.47538	-81.73742	REEF	0.0040	-0.0001	-0.0001	-0.0362	-0.0249	0.0420	0.0357	0.0009	0.3063	-0.0004
278	Western Head	24.49862	-81.81895	REEF	0.0021	-0.0001	-0.0001	-0.0368	-0.0202	0.0443	0.0436	0.0030	0.0422	0.0002
280	Eastern Dry Rocks	24.45363	-81.84365	REEF	0.0045	-0.0001	0.0000	-0.0565	-0.0052	0.0348	0.0380	0.0030	0.1450	-0.0010
281	Middle Ground	24.49500	-81.89167	MARQ	0.0003	-0.0001	0.0000	-0.0096	0.0255	0.0298	0.0281	-0.0036	-0.0057	0.0009
282	Arsenic Bank	24.86667	-80.88500	BAY	0.0028		-0.0001		-0.0354	0.0093	0.0101		0.0724	0.0015
284	Tripod Bank	24.87667	-80.95833	BAY	0.0032		0.0000		-0.0134	-0.0057	0.0001		0.2422	0.0045
285	Channel Key Pass	24.80998	-80.92028	BAY	0.0032		-0.0001		-0.0456	0.0184	0.0253	0.0000	0.1271	0.0011
287	Bamboo Banks	24.84667	-81.00833	BAY	0.0054		0.0000		0.0005	0.0112	0.0159	0.0001	0.1235	0.0034
288	Sta 288	24.88333	-81.08333	BAY	0.0012		0.0000		-0.0033	0.0125	0.0152	0.0000	0.3507	-0.0003
289	Bamboo Key	24.77775	-81.03300	BAY	0.0042		-0.0001		-0.0494	0.0243	0.0273	0.0000	-0.8284	0.0074
290	Bluefish Bank	24.86267	-81.21623	BAY	-0.0007		-0.0001		-0.0124	0.0219	0.0260	0.0000	0.0606	0.0020
291	Bullard Bank	24.81682	-81.14678	BAY	0.0044		-0.0001		-0.0479	0.0137	0.0217	0.0001	0.6266	-0.0022
292	John Sawyer Bank	24.76312	-81.11248	BAY	0.0044		-0.0001		-0.0519	0.0182	0.0160	0.0000	-0.3321	0.0040
294	Red Bay Bank	24.75550	-81.17218	BAY	0.0050		-0.0001		-0.0406	0.0239	0.0215	0.0002	-0.2439	0.0026
295	Bullfrog Banks	24.85163	-81.35123	BACK	0.0056		-0.0001		-0.0132	0.0327	0.0367	0.0001	0.0011	0.0006
296	W. Bahia Honda Key	24.79152	-81.28908	BACK	0.0032		-0.0001		-0.0426	0.0454	0.0475	0.0000	-0.3065	0.0029
301	Cutoe Key	24.77258	-81.39665	BACK	0.0040		-0.0002		-0.0440	0.0236	0.0268	0.0001	-0.7950	0.0033
302	Content Passage	24.80128	-81.48227	BACK	0.0109		-0.0001		-0.0186	0.0203	0.0184	0.0007	-1.2090	0.0011
305	Cudjoe Key	24.76852	-81.55500	BACK	0.0101		-0.0001		-0.0241	-0.0008	0.0034	0.0000	-0.6532	0.0009
307	Tarpon Belly Keys	24.72503	-81.52052	BACK	0.0054		-0.0001		-0.0209	0.0080	0.0086	0.0004	-0.3769	0.0066
309	Marvin Key Channel	24.69772	-81.68318	BACK	0.0055		-0.0001		-0.0275	0.0120	0.0126	0.0000	0.3320	-0.0006
310	Snipe Keys	24.65752	-81.63265	BACK	0.0056		-0.0003		-0.0976	0.0182	0.0228	0.0000	-1.2221	0.0085
312	E. Harbor Key Channel	24.65978	-81.76343	BACK	-0.0007		0.0000		-0.0016	-0.0044	-0.0026	0.0000	0.2849	0.0016
314	Bluefish Channel	24.75043	-81.43578	BACK	0.0048		-0.0003		-0.0789	0.0556	0.0514	0.0021	-1.6066	0.0029
315	Calda Channel	24.63325	-81.82827	BACK	0.0072		-0.0001		-0.0216	-0.0246	-0.0200	0.0001	0.2736	0.0014
316	Man of War Harbor	24.58577	-81.80240	BACK	0.0037		-0.0002		-0.0583	0.0160	0.0168	-0.0001	-0.3484	0.0049
317	Garrison Bight	24.57500	-81.78833	BACK	0.0074		-0.0002		-0.0362	0.0132	0.0171	0.0000	0.1378	-0.0002
318	KW Northwest Channel	24.65083	-81.90467	MARQ	0.0000	-0.0001	-0.0002	-0.0251	-0.0291	0.0209	0.0214	0.0018	0.5166	-0.0038
319	N Boca Grande Channel	24.62900	-82.07133	MARQ	0.0003	-0.0001	-0.0001	-0.0485	-0.0379	0.0231	0.0287	0.0005	1.1268	-0.0079
322	Satan Shoal	24.45833	-81.98167	MARQ	0.0024	0.0000	-0.0001	-0.0259	-0.0565	0.0209	0.0200	0.0006	0.1734	-0.0008
324	Ellis Rock	24.65333	-82.15833	MARQ	-0.0030	-0.0001	-0.0002	-0.0268	-0.0393	0.0251	0.0202	0.0008	0.3021	-0.0027
325	SE Marquesas	24.54167	-82.10000	MARQ	-0.0043	-0.0001	-0.0002	-0.0252	-0.0284	0.0160	0.0132	0.0003	0.2677	-0.0027
328	Marquesas Rock	24.45400	-82.22400	MARQ	0.0022	0.0000	-0.0001	-0.0211	-0.0442	0.0270	0.0238	0.0010	0.5775	-0.0029
330	New Ground	24.66533	-82.37400	MARQ	-0.0044	-0.0001	-0.0001	-0.0297	-0.0281	0.0266	0.0243	0.0014	0.5354	-0.0020
332	S Quicksands	24.53550	-82.36733	MARQ	-0.0012	-0.0001	0.0000	-0.0185	-0.0138	0.0222	0.0208	0.0013	0.9029	-0.0058
333	Half Moon Shoal	24.57717	-82.49133	MARQ	-0.0043	-0.0001	0.0000	-0.0065	-0.0124	0.0280	0.0249	0.0032	0.2642	-0.0014
335	Sta 335	24.46083	-82.38317	MARQ	-0.0006	-0.0001	-0.0001	-0.0255	-0.0523	0.0263	0.0233	0.0014	0.6696	-0.0032
337	Rebecca Shoal	24.59133	-82.58783	MARQ	-0.0018	-0.0001	-0.0001	-0.0345	-0.0310	0.0259	0.0248	0.0007	0.6447	-0.0004
400	Grecian Rocks	25.10730	-80.30640	REEF	0.0042	-0.0001	-0.0001	-0.0535	-0.0638	0.0326	0.0409	0.0014	0.6010	0.0011
401	Alligator Reef #2	24.85300	-80.62200	REEF	0.0046	-0.0001	-0.0001	-0.0456	-0.0502	0.0290	0.0252	-0.0002	0.2521	-0.0014
402	Sombrero Key #2	24.63000	-81.11200	REEF	0.0077	-0.0001	-0.0002	-0.0385	-0.0766	0.0323	0.0335	0.0006	0.4915	0.0000
403	Western Sambo #2	24.48300	-81.70000	REEF	0.0029	0.0000	-0.0001	-0.0212	-0.0443	0.0469	0.0419	0.0011	1.4811	-0.0025
500	Lake Largo Canal	25.08535	-80.43346	SHORE	0.0313		0.0003		-0.0977	-0.0294	-0.0319	-0.0012	-2.5318	0.0406
501	Calusa Park Marina	25.11053	-80.43421	SHORE	0.0301		0.0001		-0.7746	-0.0409	-0.0385	0.0021	0.5132	-0.0172
502	Indian Key	24.92650	-80.62067	SHORE	0.0223		-0.0008		-0.4332	-0.0283	-0.0221	-0.0003	-2.8982	0.0784
503	Blackwood Dr	24.92050	-80.63477	SHORE	0.0207		0.0009		0.0023	-0.0059	-0.0159	0.0003	1.4926	-0.0099
504	Marathon - Ocean 100th St	24.72254	-81.04338	SHORE	0.0396		0.0000		-0.3419	-0.0137	-0.0058	-0.0015	2.5436	-0.0292
505	Hidden Harbor Beach	24.71208	-81.10071	SHORE	0.0074		-0.0007		-0.1684	-0.0067	-0.0145	-0.0007	-0.3026	0.0048
506	LittleTorch	24.65941	-81.38327	SHORE	0.0219		-0.0008		-0.4005	-0.0244	-0.0209	-0.0001	-0.2392	0.0140
507	Big Pine Bay	24.69309	-81.35463	SHORE	0.0676		-0.0010		-0.3713	0.0002	-0.0042	0.0036	-1.4892	0.0162
508	Marriott Beach side	24.57375	-81.76014	SHORE	0.0158		-0.0008		-0.4836	0.0474	0.0289	-0.0011	0.0810	-0.0121
509	Key West Ocean- Intl airport	24.55229	-81.74941	SHORE	0.0256		-0.0006		-0.3267	-0.0266	-0.0225	0.0000	-1.1662	0.0275

STATION	SITE	LATDEC	LONDEC	ZONE	NH4-B	NH4-S	NO2-B	NO2-S	NO3-B	NO3-S	NOX-B	NOX-S	SAL-B	SAL-S
276	Western Sambo	24.47538	-81.73742	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0012	-0.0010
278	Western Head	24.49862	-81.81895	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0117	-0.0124
280	Eastern Dry Rocks	24.45363	-81.84365	REEF	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0019
281	Middle Ground	24.49500	-81.89167	MARQ	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0054	0.0015
282	Arsenic Bank	24.86667	-80.88500	BAY		-0.0001		0.0000		-0.0001		0.0000	0.0351	0.0349
284	Tripod Bank	24.87667	-80.95833	BAY		0.0000		0.0000		0.0000		0.0000	0.0123	0.0112
285	Channel Key Pass	24.80998	-80.92028	BAY		0.0000		0.0000		-0.0001		-0.0001	0.0316	0.0323
287	Bamboo Banks	24.84667	-81.00833	BAY		0.0001		0.0000		0.0000		0.0000	0.0145	0.0135
288	Sta 288	24.88333	-81.08333	BAY		0.0000		0.0000		0.0000		0.0000	0.0117	0.0112
289	Bamboo Key	24.77775	-81.03300	BAY		0.0000		0.0000		0.0000		-0.0001	0.0203	0.0157
290	Bluefish Bank	24.86267	-81.21623	BAY		0.0000		0.0000		0.0000		0.0000	0.0005	-0.0010
291	Bullard Bank	24.81682	-81.14678	BAY		-0.0001		0.0000		0.0000		0.0000	0.0151	0.0141
292	John Sawyer Bank	24.76312	-81.11248	BAY		0.0000		0.0000		0.0000		0.0000	0.0241	0.0238
294	Red Bay Bank	24.75550	-81.17218	BAY		-0.0001		0.0000		0.0000		0.0000	0.0142	0.0139
295	Bullfrog Banks	24.85163	-81.35123	BACK		0.0000		0.0000		0.0000		0.0000	0.0112	0.0091
296	W. Bahia Honda Key	24.79152	-81.28908	BACK		-0.0001		0.0000		0.0000		0.0000	0.0187	0.0191
301	Cutoe Key	24.77258	-81.39665	BACK		-0.0001		0.0000		0.0000		-0.0001	0.0154	0.0095
302	Content Passage	24.80128	-81.48227	BACK		0.0000		0.0000		0.0000		0.0000	0.0129	0.0106
305	Cudjoe Key	24.76852	-81.55500	BACK		-0.0001		0.0000		0.0000		0.0000	0.0031	0.0003
307	Tarpon Belly Keys	24.72503	-81.52052	BACK		0.0000		0.0000		0.0000		0.0000	0.0149	0.0135
309	Marvin Key Channel	24.69772	-81.68318	BACK		-0.0001		0.0000		-0.0001		-0.0001	0.0000	0.0000
310	Snipe Keys	24.65752	-81.63265	BACK		-0.0001		0.0000		-0.0001		-0.0001	0.0017	0.0001
312	E. Harbor Key Channel	24.65978	-81.76343	BACK		0.0000		0.0000		0.0000		0.0000	0.0023	0.0017
314	Bluefish Channel	24.75043	-81.43578	BACK		-0.0002		0.0000		-0.0001		-0.0001	0.0143	0.0082
315	Calda Channel	24.63325	-81.82827	BACK		-0.0001		0.0000		0.0000		0.0000	0.0003	0.0000
316	Man of War Harbor	24.58577	-81.80240	BACK		-0.0001		0.0000		0.0000		0.0000	-0.0070	-0.0076
317	Garrison Bight	24.57500	-81.78833	BACK		-0.0001		0.0000		0.0000		0.0000	-0.0050	-0.0066
318	KW Northwest Channel	24.65083	-81.90467	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0064	-0.0032
319	N Boca Grande Channel	24.62900	-82.07133	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0014	-0.0004
322	Satan Shoal	24.45833	-81.98167	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0026
324	Ellis Rock	24.65333	-82.15833	MARQ	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0031	-0.0003
325	SE Marquesas	24.54167	-82.10000	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0042	-0.0039
328	Marquesas Rock	24.45400	-82.22400	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0014
330	New Ground	24.66533	-82.37400	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0015	-0.0009
332	S Quicksands	24.53550	-82.36733	MARQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0053
333	Half Moon Shoal	24.57717	-82.49133	MARQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0004	0.0010
335	Sta 335	24.46083	-82.38317	MARQ	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
337	Rebecca Shoal	24.59133	-82.58783	MARQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0034
400	Grecian Rocks	25.10730	-80.30640	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0063	0.0065
401	Alligator Reef #2	24.85300	-80.62200	REEF	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0009	0.0012
402	Sombrero Key #2	24.63000	-81.11200	REEF	0.0000	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0001	-0.0066	-0.0058
403	Western Sambo #2	24.48300	-81.70000	REEF	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	-0.0019
500	Lake Largo Canal	25.08535	-80.43346	SHORE		0.0002		0.0001		0.0001		0.0003	0.0741	0.0976
501	Calusa Park Marina	25.11053	-80.43421	SHORE		0.0001		0.0000		-0.0003		-0.0003	0.9187	0.8458
502	Indian Key	24.92650	-80.62067	SHORE		-0.0008		0.0000		-0.0001		-0.0001	0.0538	0.0449
503	Blackwood Dr	24.92050	-80.63477	SHORE		0.0010		0.0000		0.0002		0.0002	0.0978	0.1255
504	Marathon - Ocean 100th St	24.72254	-81.04338	SHORE		-0.0008		0.0000		0.0007		0.0008	-0.0416	-0.0481
505	Hidden Harbor Beach	24.71208	-81.10071	SHORE		-0.0005		0.0000		0.0000		0.0000	0.0486	0.0536
506	LittleTorch	24.65941	-81.38327	SHORE		-0.0007		0.0000		-0.0003		-0.0002	0.0035	0.0362
507	Big Pine Bay	24.69309	-81.35463	SHORE		-0.0007		0.0000		-0.0003		-0.0003	0.0428	0.0331
508	Marriott Beach side	24.57375	-81.76014	SHORE		-0.0007		-0.0001		0.0000		-0.0001	0.0031	-0.0066
509	Key West Ocean- Intl airport	24.55229	-81.74941	SHORE		-0.0006		-0.0001		-0.0001		-0.0002	-0.0458	-0.0503

STATION	SITE	LATDEC	LONDEC	ZONE	DOsat-B	DOsat-S	Si:DIN-S	SiO2-B	SiO2-S	SRP-B	SRP-S	TEMP-B	TEMP-S	TN-B
276	Western Sambo	24.47538	-81.73742	REEF	0.5209	0.4499	-0.0114	-0.0003	-0.0002	0.0000	0.0000	-0.0048	0.0003	-0.0018
278	Western Head	24.49862	-81.81895	REEF	0.5601	0.5002	-0.0403	-0.0007	-0.0007	0.0000	0.0000	-0.0053	0.0051	-0.0014
280	Eastern Dry Rocks	24.45363	-81.84365	REEF	0.4707	0.4922	-0.0344	-0.0004	-0.0003	0.0000	0.0000	0.0135	0.0000	-0.0018
281	Middle Ground	24.49500	-81.89167	MARQ	0.3934	0.3529	-0.0223	0.0003	-0.0002	0.0000	0.0000	0.0170	0.0137	-0.0018
282	Arsenic Bank	24.86667	-80.88500	BAY	0.0625	0.0780	0.5249		0.0014		0.0000	-0.0005	-0.0035	
284	Tripod Bank	24.87667	-80.95833	BAY	-0.0811	0.0119	0.2193		-0.0009		0.0000	0.0002	-0.0019	
285	Channel Key Pass	24.80998	-80.92028	BAY	0.2212	0.2674	0.0231		-0.0016		0.0000	0.0025	0.0011	
287	Bamboo Banks	24.84667	-81.00833	BAY	0.0817	0.1532	-0.4829		-0.0051		0.0000	-0.0076	-0.0112	
288	Sta 288	24.88333	-81.08333	BAY	0.1374	0.1585	0.2242		0.0013		0.0000	-0.0101	-0.0108	
289	Bamboo Key	24.77775	-81.03300	BAY	0.2876	0.3237	0.0159		-0.0025		0.0000	-0.0042	-0.0112	
290	Bluefish Bank	24.86267	-81.21623	BAY	0.2908	0.2932	0.1141		-0.0014		0.0000	-0.0007	0.0000	
291	Bullard Bank	24.81682	-81.14678	BAY	0.1391	0.2195	0.4198		0.0001		0.0000	-0.0039	-0.0063	
292	John Sawyer Bank	24.76312	-81.11248	BAY	0.2083	0.1957	0.0916		0.0002		0.0000	-0.0051	-0.0080	
294	Red Bay Bank	24.75550	-81.17218	BAY	0.2754	0.2703	0.0057		-0.0021		0.0000	-0.0137	-0.0167	
295	Bullfrog Banks	24.85163	-81.35123	BACK	0.3560	0.4356	0.0321		-0.0005		0.0000	-0.0112	-0.0159	
296	W. Bahia Honda Key	24.79152	-81.28908	BACK	0.5058	0.5489	0.0308		-0.0022		0.0000	-0.0219	-0.0165	
301	Cutoe Key	24.77258	-81.39665	BACK	0.3301	0.3653	0.0381		-0.0001		0.0000	0.0378	0.0331	
302	Content Passage	24.80128	-81.48227	BACK	0.2574	0.2721	-0.0150		-0.0004		0.0000	-0.0007	-0.0018	
305	Cudjoe Key	24.76852	-81.55500	BACK	-0.0165	0.0484	-0.0182		-0.0005		0.0000	0.0085	-0.0013	
307	Tarpon Belly Keys	24.72503	-81.52052	BACK	0.1007	0.0904	0.0448		0.0005		0.0000	-0.0072	-0.0098	
309	Marvin Key Channel	24.69772	-81.68318	BACK	0.1736	0.1968	-0.0007		-0.0004		0.0000	0.0271	0.0192	
310	Snipe Keys	24.65752	-81.63265	BACK	0.3022	0.3418	0.0573		0.0006		0.0000	0.0282	0.0250	
312	E. Harbor Key Channel	24.65978	-81.76343	BACK	-0.0515	-0.0603	0.0024		-0.0002		0.0000	0.0141	0.0052	
314	Bluefish Channel	24.75043	-81.43578	BACK	0.7956	0.7547	0.0648		0.0001		0.0000	0.0236	0.0212	
315	Calda Channel	24.63325	-81.82827	BACK	-0.3124	-0.2310	0.0009		-0.0003		0.0000	0.0133	0.0116	
316	Man of War Harbor	24.58577	-81.80240	BACK	0.2853	0.2824	0.0026		-0.0005		0.0000	0.0148	0.0112	
317	Garrison Bight	24.57500	-81.78833	BACK	0.2009	0.2479	0.0160		-0.0002		0.0000	0.0215	0.0190	
318	KW Northwest Channel	24.65083	-81.90467	MARQ	0.2538	0.2806	0.0190	-0.0002	0.0000	0.0000	0.0000	0.0197	0.0342	-0.0015
319	N Boca Grande Channel	24.62900	-82.07133	MARQ	0.2770	0.3729	0.0130	-0.0001	-0.0002	0.0000	0.0000	0.0108	0.0123	-0.0015
322	Satan Shoal	24.45833	-81.98167	MARQ	0.3005	0.2812	0.0097	0.0001	0.0000	0.0000	0.0000	0.0225	0.0212	-0.0013
324	Ellis Rock	24.65333	-82.15833	MARQ	0.3110	0.2789	0.0166	-0.0001	-0.0002	0.0000	0.0000	0.0112	0.0192	-0.0022
325	SE Marquesas	24.54167	-82.10000	MARQ	0.2573	0.2264	0.0142	0.0000	0.0000	0.0000	0.0000	0.0262	0.0306	-0.0017
328	Marquesas Rock	24.45400	-82.22400	MARQ	0.3940	0.3249	0.0057	-0.0001	0.0000	0.0000	0.0000	0.0258	0.0175	-0.0007
330	New Ground	24.66533	-82.37400	MARQ	0.3319	0.2975	0.0310	-0.0002	-0.0001	0.0000	0.0000	0.0062	0.0169	-0.0010
332	S Quicksands	24.53550	-82.36733	MARQ	0.2869	0.2552	-0.0066	0.0000	-0.0002	0.0000	0.0000	0.0170	0.0323	-0.0010
333	Half Moon Shoal	24.57717	-82.49133	MARQ	0.3777	0.3108	-0.0040	-0.0001	0.0000	0.0000	0.0000	0.0025	0.0235	-0.0012
335	Sta 335	24.46083	-82.38317	MARQ	0.3899	0.3288	0.0004	-0.0001	-0.0001	0.0000	0.0000	0.0237	0.0262	-0.0016
337	Rebecca Shoal	24.59133	-82.58783	MARQ	0.3919	0.3400	-0.0145	-0.0004	-0.0002	0.0000	0.0000	0.0286	0.0303	-0.0009
400	Grecian Rocks	25.10730	-80.30640	REEF	0.3703	0.4942	-0.0090	-0.0001	-0.0002	0.0000	0.0000	0.0343	0.0350	-0.0025
401	Alligator Reef #2	24.85300	-80.62200	REEF	0.3712	0.3326	-0.0113	-0.0002	-0.0003	0.0000	0.0000	0.0542	0.0599	-0.0027
402	Sombrero Key #2	24.63000	-81.11200	REEF	0.3648	0.4085	-0.0153	-0.0003	-0.0004	0.0000	0.0000	0.0125	0.0134	-0.0025
403	Western Sambo #2	24.48300	-81.70000	REEF	0.5941	0.5149	-0.0106	-0.0002	-0.0002	-0.0001	0.0000	0.0088	0.0150	-0.0025
500	Lake Largo Canal	25.08535	-80.43346	SHORE	-0.1971	-0.2042	-0.0228		-0.0008		-0.0001	0.2624	0.2760	
501	Calusa Park Marina	25.11053	-80.43421	SHORE	-0.0040	-0.0545	0.2702		0.0312		-0.0001	0.2183	0.2093	
502	Indian Key	24.92650	-80.62067	SHORE	-0.2085	-0.1697	0.0308		-0.0005		-0.0001	0.2885	0.2725	
503	Blackwood Dr	24.92050	-80.63477	SHORE	-0.0400	-0.1082	-0.1188		-0.0056		-0.0001	0.1516	0.2020	
504	Marathon - Ocean 100th St	24.72254	-81.04338	SHORE	-0.1042	-0.0871	-0.0236		-0.0050		0.0000	0.1058	0.1426	
505	Hidden Harbor Beach	24.71208	-81.10071	SHORE	-0.0931	-0.1245	-0.1397		-0.0062		-0.0001	0.1781	0.2290	
506	LittleTorch	24.65941	-81.38327	SHORE	-0.2240	-0.1915	-0.0358		-0.0031		-0.0001	0.2879	0.2972	
507	Big Pine Bay	24.69309	-81.35463	SHORE	0.0598	-0.0036	0.0573		-0.0023		-0.0001	0.1084	0.1201	
508	Marriott Beach side	24.57375	-81.76014	SHORE	0.2468	0.1670	0.0613		0.0000		-0.0001	0.3472	0.3647	
509	Key West Ocean- Intl airport	24.55229	-81.74941	SHORE	-0.1881	-0.1684	0.1061		0.0005		-0.0001	0.2755	0.2312	

STATION	SITE	LATDEC	LONDEC	ZONE	TN-S	TN:TP-B	TN:TP-S	TOC-B	TOC-S	TON-B	TON-S	TP-B	TP-S	TURB-B	TURB-S
276	Western Sambo	24.47538	-81.73742	REEF	-0.0013	-0.9170	-0.4944	-0.0375	-0.0374	-0.0018	-0.0013	0.0000	0.0000	-0.0006	-0.0050
278	Western Head	24.49862	-81.81895	REEF	-0.0015	-0.7675	-0.6242	-0.0386	-0.0388	-0.0012	-0.0015	0.0000	0.0000	-0.0046	-0.0130
280	Eastern Dry Rocks	24.45363	-81.84365	REEF	-0.0014	-1.0431	-0.6891	-0.0382	-0.0342	-0.0019	-0.0015	0.0000	0.0000	0.0024	-0.0031
281	Middle Ground	24.49500	-81.89167	MARQ	-0.0011	-0.6879	-0.4091	-0.0449	-0.0444	-0.0016	-0.0011	0.0000	0.0000	-0.0551	-0.0426
282	Arsenic Bank	24.86667	-80.88500	BAY	0.0004		-0.0537		-0.0432		0.0003		0.0000	0.0279	-0.0397
284	Tripod Bank	24.87667	-80.95833	BAY	0.0018		-0.0139		-0.0151		0.0019		0.0001	0.1653	-0.0073
285	Channel Key Pass	24.80998	-80.92028	BAY	-0.0017		-0.5847		-0.0536		-0.0014		0.0000	0.1020	-0.0158
287	Bamboo Banks	24.84667	-81.00833	BAY	0.0009		-0.3358		-0.0276		0.0009		0.0001	-0.1830	-0.0040
288	Sta 288	24.88333	-81.08333	BAY	0.0011		0.2275		-0.0243		0.0011		0.0000	-0.0108	-0.0462
289	Bamboo Key	24.77775	-81.03300	BAY	-0.0011		-0.6870		-0.0438		-0.0007		0.0000	0.0818	-0.0063
290	Bluefish Bank	24.86267	-81.21623	BAY	-0.0003		-0.0127		-0.0330		-0.0001		0.0000	0.0063	-0.0378
291	Bullard Bank	24.81682	-81.14678	BAY	-0.0008		-0.5185		-0.0320		-0.0007		0.0000	-0.1737	-0.0042
292	John Sawyer Bank	24.76312	-81.11248	BAY	-0.0002		-0.5129		-0.0374		0.0000		0.0000	0.0131	0.0032
294	Red Bay Bank	24.75550	-81.17218	BAY	-0.0004		-0.5289		-0.0316		-0.0001		0.0000	-0.0541	-0.0037
295	Bullfrog Banks	24.85163	-81.35123	BACK	-0.0008		-0.2935		-0.0359		-0.0005		0.0000	0.0682	-0.0305
296	W. Bahia Honda Key	24.79152	-81.28908	BACK	0.0001		-0.3015		-0.0345		0.0001		0.0000	-0.0375	-0.0124
301	Cutoe Key	24.77258	-81.39665	BACK	-0.0003		-0.1326		-0.0359		-0.0001		0.0000	0.0020	-0.0097
302	Content Passage	24.80128	-81.48227	BACK	0.0000		0.0215		-0.0397		-0.0001		0.0000	0.0054	-0.0209
305	Cudjoe Key	24.76852	-81.55500	BACK	-0.0009		-0.3222		-0.0439		-0.0007		0.0000	0.0031	-0.0181
307	Tarpon Belly Keys	24.72503	-81.52052	BACK	-0.0011		-0.2855		-0.0434		-0.0010		0.0000	0.0600	-0.0068
309	Marvin Key Channel	24.69772	-81.68318	BACK	-0.0008		-0.2351		-0.0392		-0.0007		0.0000	0.1003	-0.0175
310	Snipe Keys	24.65752	-81.63265	BACK	-0.0011		-0.6773		-0.0422		-0.0006		0.0000	-0.1328	0.0062
312	E. Harbor Key Channel	24.65978	-81.76343	BACK	-0.0010		-0.0973		-0.0451		-0.0011		0.0000	-0.0588	-0.0220
314	Bluefish Channel	24.75043	-81.43578	BACK	-0.0015		-0.3742		-0.0353		-0.0013		0.0000	0.0146	-0.0026
315	Calda Channel	24.63325	-81.82827	BACK	-0.0009		-0.0629		-0.0462		-0.0006		0.0000	-0.3320	-0.0094
316	Man of War Harbor	24.58577	-81.80240	BACK	-0.0021		-0.6594		-0.0470		-0.0016		0.0000	-0.2263	-0.0142
317	Garrison Bight	24.57500	-81.78833	BACK	-0.0019		-0.5432		-0.0483		-0.0016		0.0000	-0.1654	-0.0041
318	KW Northwest Channel	24.65083	-81.90467	MARQ	-0.0018	-0.3147	-0.1798	-0.0436	-0.0447	-0.0016	-0.0015	0.0000	-0.0001	-0.0373	-0.0488
319	N Boca Grande Channel	24.62900	-82.07133	MARQ	-0.0015	-0.3404	-0.3160	-0.0396	-0.0441	-0.0014	-0.0016	0.0000	0.0000	-0.0447	-0.0662
322	Satan Shoal	24.45833	-81.98167	MARQ	-0.0006	-0.6881	-0.3303	-0.0393	-0.0402	-0.0014	-0.0004	0.0000	0.0000	-0.0229	-0.0214
324	Ellis Rock	24.65333	-82.15833	MARQ	-0.0031	-0.5881	-0.6537	-0.0409	-0.0414	-0.0021	-0.0028	0.0000	0.0000	-0.0158	-0.0412
325	SE Marquesas	24.54167	-82.10000	MARQ	-0.0021	-0.5435	-0.4977	-0.0420	-0.0404	-0.0016	-0.0019	0.0000	0.0000	-0.0553	-0.0774
328	Marquesas Rock	24.45400	-82.22400	MARQ	-0.0008	-0.4635	-0.3032	-0.0386	-0.0396	-0.0007	-0.0007	0.0000	0.0000	-0.0057	-0.0129
330	New Ground	24.66533	-82.37400	MARQ	-0.0006	-0.3404	-0.0817	-0.0383	-0.0415	-0.0008	-0.0005	0.0000	0.0000	-0.0384	-0.0501
332	S Quicksands	24.53550	-82.36733	MARQ	-0.0009	-0.2511	-0.3439	-0.0414	-0.0440	-0.0009	-0.0009	0.0000	0.0000	-0.0451	-0.0579
333	Half Moon Shoal	24.57717	-82.49133	MARQ	-0.0011	-0.1942	-0.3248	-0.0397	-0.0378	-0.0012	-0.0011	0.0000	0.0000	-0.0416	-0.0435
335	Sta 335	24.46083	-82.38317	MARQ	-0.0012	-0.5975	-0.6426	-0.0379	-0.0373	-0.0015	-0.0010	0.0000	0.0000	-0.0149	-0.0171
337	Rebecca Shoal	24.59133	-82.58783	MARQ	-0.0010	-0.4654	-0.3900	-0.0399	-0.0397	-0.0007	-0.0009	0.0000	0.0000	-0.0213	-0.0304
400	Grecian Rocks	25.10730	-80.30640	REEF	-0.0026	-1.1156	-1.0316	-0.0356	-0.0338	-0.0024	-0.0021	0.0000	0.0000	-0.0043	-0.0047
401	Alligator Reef #2	24.85300	-80.62200	REEF	-0.0025	-1.2054	-1.1440	-0.0309	-0.0353	-0.0026	-0.0023	0.0000	0.0000	-0.0096	-0.0084
402	Sombrero Key #2	24.63000	-81.11200	REEF	-0.0029	-1.0282	-1.5698	-0.0234	-0.0272	-0.0023	-0.0029	0.0000	0.0000	-0.0085	-0.0092
403	Western Sambo #2	24.48300	-81.70000	REEF	-0.0024	-1.0953	-1.0852	-0.0289	-0.0258	-0.0023	-0.0022	0.0000	0.0000	-0.0010	-0.0040
500	Lake Largo Canal	25.08535	-80.43346	SHORE	0.0129		0.3271		0.0553		0.0111		0.0007		0.1291
501	Calusa Park Marina	25.11053	-80.43421	SHORE	0.0443		-0.4124		0.2539		0.0483		0.0008		0.0653
502	Indian Key	24.92650	-80.62067	SHORE	0.0033		-2.8703		-0.0273		0.0034		0.0004		0.1092
503	Blackwood Dr	24.92050	-80.63477	SHORE	0.0162		1.1917		0.0324		0.0151		0.0003		0.0804
504	Marathon - Ocean 100th St	24.72254	-81.04338	SHORE	0.0114		-1.4782		-0.0468		0.0120		0.0007		-0.0492
505	Hidden Harbor Beach	24.71208	-81.10071	SHORE	0.0073		0.3071		0.0089		0.0070		0.0003		0.1019
506	LittleTorch	24.65941	-81.38327	SHORE	0.0103		-0.5934		-0.0153		0.0120		0.0003		0.0315
507	Big Pine Bay	24.69309	-81.35463	SHORE	0.0180		-0.4445		0.0011		0.0180		0.0008		0.0491
508	Marriott Beach side	24.57375	-81.76014	SHORE	0.0101		1.0610		-0.0287		0.0114		0.0002		0.0573
509	Key West Ocean- Intl airport	24.55229	-81.74941	SHORE	0.0105		0.1795		0.0036		0.0112		0.0003		0.0937