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South Florida Coastal Water Quality Monitoring Network FY2006 Cumulative Report to the South Florida Water Management District (Contract No. C-15397 and 4600000352)

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Recommended Citation

Boyer, Joseph N. and Briceño, Henry O., "South Florida Coastal Water Quality Monitoring Network FY2006 Cumulative Report to the South Florida Water Management District (Contract No. C-15397 and 4600000352)" (2006). *SERC Research Reports*. Paper 65.
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SOUTH FLORIDA COASTAL WATER QUALITY MONITORING NETWORK

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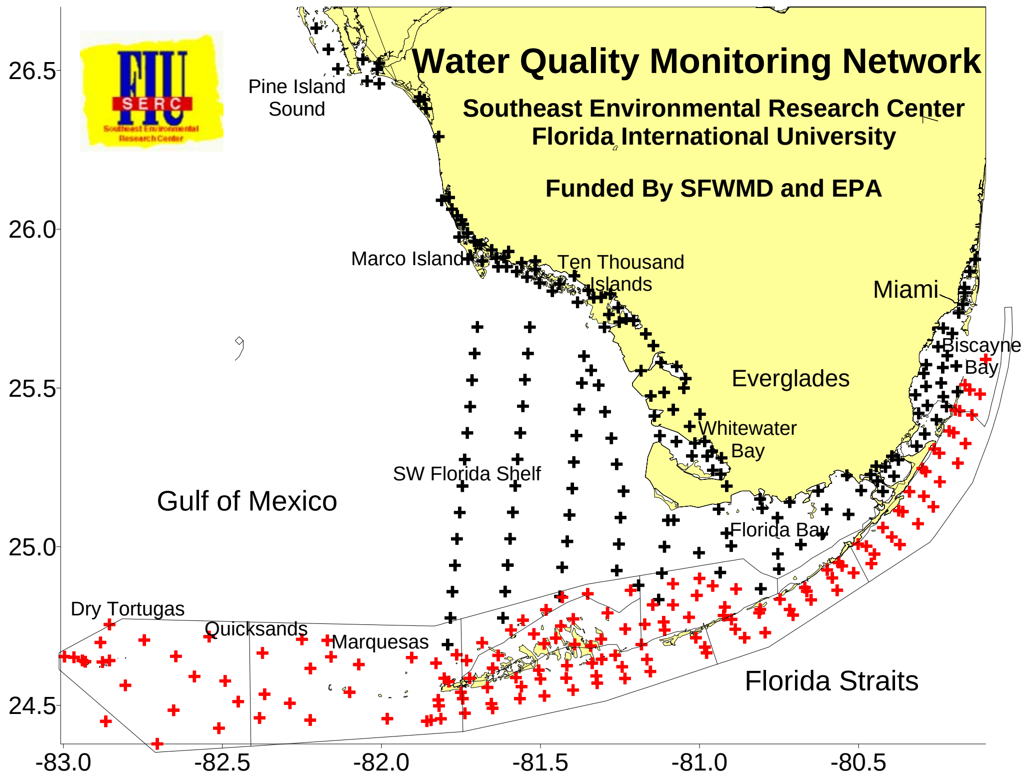

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SOUTH FLORIDA COASTAL WATER QUALITY MONITORING NETWORK

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(Contract No. C-15397 and 4600000352)

Joseph N. Boyer & Henry O. Briceño, Southeast Environmental Research Center, OE-148,
Florida International University, Miami, FL 33199 http://serc.fiu.edu/wqmnetwork/

EXECUTIVE SUMMARY

This report summarizes the existing data from the FIU South Florida Coastal Water Quality Monitoring Network for calendar year 2006. This includes water quality data collected from 28 stations in Florida Bay, 22 stations in Whitewater Bay, 25 stations in Ten Thousand Islands, 25 stations in Biscayne Bay, 49 stations on the Southwest Florida Shelf (Shelf), and 28 stations in the Cape Romano-Pine Island Sound area. Each of the stations in Florida Bay were monitored on a monthly basis with monitoring beginning in March 1991; Whitewater Bay monitoring began in September 1992; Biscayne Bay monthly monitoring began September 1993; the SW Florida Shelf was sampled quarterly beginning in spring 1995; and monthly sampling in the Cape Romano-Pine Island Sound area started January 1999.

We have continued our systematic analysis and interpretation starting with the most extensive dataset: Florida Bay. We have analyzed the data for spatial trends, temporal trends, and for freshwater loading effects. Spatial analysis can be performed on data of relatively short period of record, however, time series analysis usually requires a minimum 5 years before significant trends can be recognized over the background noise of inter-annual variability. Therefore, the type of analysis performed on each estuary is determined by the length of the record.

Trend analysis is an ongoing process; ecosystems change with climate and management strategy, therefore, analytical results may change as more data is collected. It is also important to understand that trend analysis alone will not necessarily provide cause and effect relationships. One of the purposes of any monitoring program should be to use the data gained by routine sampling to extend our understanding of the system by developing new hypotheses as to the underlying driving processes. Much inference into the behavior of South Florida estuaries can be made from the observed magnitude and distribution of water quality parameters. This type of multivariate approach should prove useful to scientists and managers faced with the task of interpreting large water quality datasets. This monitoring program has been very useful in helping to define restoration targets and will be even more valuable in determining whether these goals are met.

Florida Bay

2006 was the third driest year since 1991, however hypersalinity was not as pronounced as for the previous wet year. This points out the impact that the long water residence time has on Eastern and Central Bay. The presence of lower salinity water from 2005 carried over into 2006. There were no direct hurricane impacts to Florida bay during 2006.

DIN and TON were generally lower than the grand median for most regions of the bay, but especially in Western Bay. On the other hand, TOC was higher than normal in the Eastern Bay, about the same for Central Bay, and lower in the Western Bay. This is very interesting because we usually think of the DOM pool as having a relatively consistent C:N ratio. The decoupling of the two pools implies that they come from separate sources.

TP was elevated in Eastern Bay throughout all of the year as a result of the previous hurricane and road construction interaction (Rudnick et al. 2006). TP was normal for the rest of the bay. As a result of elevated TP, CHLA was higher than the grand median in Eastern Bay as well. CHLA declined during the spring as the bloom abated somewhat. In Central Bay, an increase in CHLA occurred during the fall season. Salinity, temperature, and DO were unremarkable except in Western Bay where DO seemed higher than normal for most of the year.

Whitewater Bay-Ten Thousand Islands

The influence of freshwater input from the Everglades is very significant to this region. Large salinity variations are the norm, being driven by both climactic events and water management practices. Although 2006 was relatively dry, salinity patterns were generally not different from the grand medians. The exception was Whitewater Bay which exhibited elevated salinities until the onset of the wet season.

DIN concentrations in Whitewater Bay, Mangrove Rivers, and Inner Waterway were elevated relative to the median while those of the other zones were not. Significant spikes in DIN occurred in the Inner Waterway, Gulf Islands, and Blackwater River occurred in the fall season as a result of freshwater loading.

TON in all regions was lower than the grand median. This is the result of the system-wide long term decline in TON output from the Everglades. TOC was slightly lower for most areas, but like DIN, increased during large freshwater inputs.

TP was consistently higher than the grand median throughout the year for all regions. We are not sure as to the cause but the effects on CHLA were consistent with P increases after the 2005 hurricane season. For the Gulf Islands, Inner Waterway, and Blackwater River, CHLA was highest during the wet season while in Whitewater Bay and Mangrove Rivers, CHLA was elevated all year.

Annual patterns in temperature and DO were unremarkable with values generally fluctuating around the median for all areas, however some elevated DO was observed in the late fall at many sites.

Biscayne Bay

Salinity in Biscayne Bay is strongly modulated by its large tidal exchange with the ocean. Nevertheless, canal inputs do have a significant impact on the ecosystem, as evidenced by the reduced nearshore salinity patterns. As 2006 was relatively dry, some areas of Biscayne Bay experience hypersalinity prior to the onset of the wet season. Unlike other zones, the Main Bay experienced hypersalinity above usual levels for almost the whole year. The largest intra-annual variations in salinity in this area are typically driven by freshwater releases from the canal system. Interestingly, salinity at the Inshore and Alongshore regions were not different than long term median.

DIN loads and concentrations in Biscayne Bay are driven by canal inputs. Drops in salinity in the Alongshore and Inshore regions coincided with increases in DIN. Fluctuations in DIN concentrations in the Main Bay were damped by its large volume. DIN in the Main Bay and South Card Sound were lower than the grand median.

Overall TP concentrations were higher than normal throughout the bay and also showed a strong increasing trend for 2006, especially for the last two months of the year. We have no explanation for this trend but will have to wait for further data to see if it continues.

CHLA in the Alongshore, Inshore, and Main Bay were slightly elevated relative to the grand median. They also exhibited a spike during the August sampling which corresponded with a depression in DO at the same time. CHLA in South Card Sound was much higher than normal, especially during the wet season. One of the reasons for this may have been the advection of the Florida Bay bloom organisms to this part of Biscayne Bay by wind forcing.

Otherwise, annual patterns in temperature and DO were unremarkable with values generally fluctuating around the median for all areas. Turbidity was highly variable during 2006, much more so than the grand median.

Southwest Florida Shelf

Since this component of the monitoring program began in 1995 and is only sampled quarterly, there is not as much trend data to analyze as for other components. Although these analyses are preliminary it is possible to speculate that the clusters are formed as a function of hydrology and circulation patterns. We believe that the most inshore cluster (SHARK) clearly shows the input of freshwater from Shark River being transported south and east around the Cape. Water overlying the shoal stations probably originates somewhere in or north of the Ten Thousand Islands. Our level of resolution is very low due to the limited numbers of sampling events and by the relatively large spatial gap between coastal and Shelf sampling sites. A better understanding of local circulation patterns in addition to increased density and frequency of sampling in the nearshore region may help define the coupling between freshwater inflow and Shelf water quality

Overall, 2006 was relatively unremarkable except for a few outliers. TON was lower than normal for most of the year, CHLA was elevated in the Shark zone, and DO was lower for most areas prior to the wet season.

Cape Romano-Pine Island Sound

Overall, this part of coastal Florida has significantly higher concentrations of CHLA, TP, and DIN than the rest of the Ten Thousand Islands stations. Much of this is due to geological changes from carbonate rocks to silicates, which facilitates transport of phosphorus, and to major land use changes from the Big Cypress National Preserve to suburban and agricultural.

The largest intra-annual variations in salinity in this area are driven by freshwater releases from the Caloosahatchee River and associated pathways (Fig. 6.8-6.14). This was due to the need to lower the water table inland because of potential flooding from hurricanes and to lower the Lake Okeechobee because of structural problems with the Hover Dike.

Freshwater releases begin in June-July and cause rapid declines in salinity across the region, especially in San Carlos Bay, Rookery Bay, and the Cocohatchee River at Wiggins Pass. A large release occurred in Sept., the effect of which is clearly see in the graphs as an increase in DIN and TOC. The large freshwater inputs typically result in high DIN loads and concentrations. These large and rapid increases in N loading (and P in San Carlos Bay and Cocohatchee River) may cause large phytoplankton blooms (CHLA) across the region.

TON in most areas was below the annual median while TOC was more consistent with historical values. TP in Marco Island, Estero Bay, Naples Bay, and Pine Island Sound spiked in

June (with DIN) at the onset of the wet season. DO in most areas was elevated relative to the long term median, especially in the Cocohatchee River where is was double normal values.

ACKNOWLEDGMENTS

We thank all of our many field personnel, laboratory technicians, and data support staff for their diligence and perseverance in this ongoing program, especially Pete Lorenzo. This project was possible due to the continued funding by the South Florida Water Management District (District Contract No. C-15397 and 4600000352). We also thank Rookery Bay NERR/FDEP and the captain and crew of the R/V Bellows of the Florida Institute of Oceanography for their field support of the monitoring program.

This report is contribution #T-351 of the Southeast Environmental Research Center at Florida International University.

TABLE OF CONTENTS

Page

1. PROJECT DESCRIPTION

1.1. Background

One of the primary purposes for conducting long-term monitoring projects is to be able to detect trends in the measured parameters over time. These programs are usually initiated as a response to public perception (and possibly some scientific data) that "the river-bay-prairie-forest-etc. is dying". In the case of Florida Bay, the major impetus was the combination of a seagrass die-off, increased phytoplankton abundance, sponge mortality, and a perceived decline in fisheries beginning in 1987. In response to these phenomena, a network of water quality monitoring stations was established in 1989 to explicate both spatial patterns and temporal trends in water quality in an effort to elucidate mechanisms behind the recent ecological change.

This report summarizes the existing data from our South Florida Coastal Water Quality Monitoring Network through Dec. 2006 (Fig. 1.1). This network includes water quality data collected from 28 stations in Florida Bay, 22 stations in Whitewater Bay to Lostmans River, 25 stations in Ten Thousand Islands, 25 stations in Biscayne Bay, 49 stations on the Southwest Florida Shelf (Shelf), and 28 stations in the Cape Romano-Pine Island Sound area.

Each of the stations in Florida Bay were sampled on a monthly basis with monitoring beginning in March 1991 (except stations 14, 19, 22, and 23 which began April 1991). In July 1992, stations 25 through 28 were added in Florida Bay. Monthly sampling at stations 29-50 in Whitewater Bay were added to the monitoring program in September 1992. Biscayne Bay monthly monitoring began September 1993 for stations 100-125. In May 1996 an analysis of the data was performed to address the adequacy of spatial coverage. At that time, 10 station locations in the Biscayne Bay monitoring network were moved to provide coverage of North Biscayne Bay. The Ten Thousand Islands sites 51-75 were begun in Sept. 1994, the Shelf was sampled quarterly beginning in spring 1995, and the Cape Romano-Pine Island Sound area was started Jan. 1999. A summary of station locations and sampling period of record is shown in Table 1.

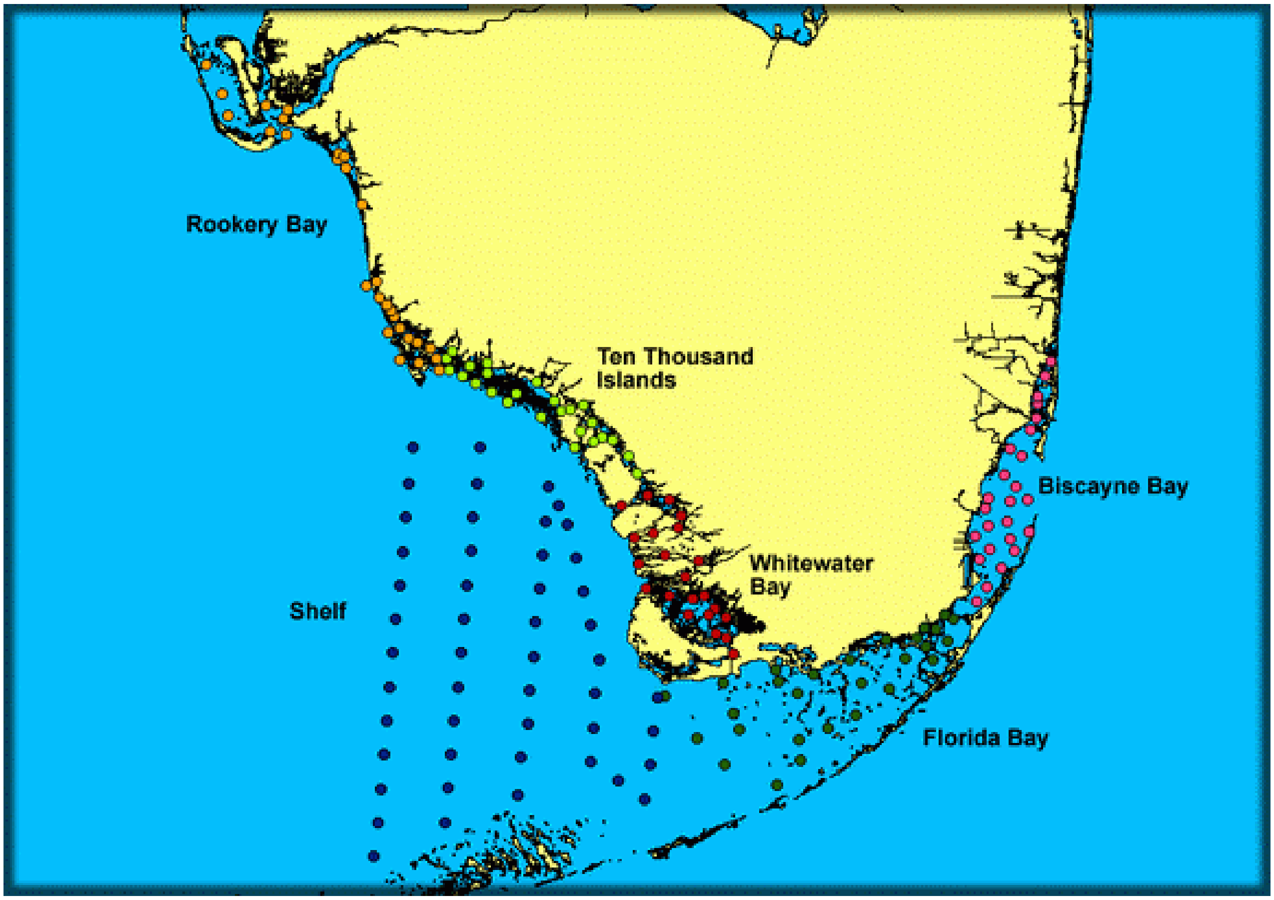


Figure 1.1. Fixed station locations for the SFWMD funded portion of the South Florida Coastal Water Quality Monitoring Network.

1.2. Field and Analytical Methods

Water samples were collected and analyzed using standard methodology outlined in the Quality Assurance Plan with prior approval from SFWMD and FDEP. Salinity, temperature (°C), dissolved oxygen (DO, mg l^{-1}), and pH were measured 10 cm below the surface and 10 cm above the bottom using a combination sonde (YSI 600XL). Sondes were calibrated prior to and after sampling to ensure accuracy.

Duplicate, unfiltered water samples were collected from 10 cm below the surface using sample rinsed 120 ml HDPE bottles and kept at ambient temperature in the dark during transport. Duplicate water samples for dissolved nutrient analysis were collected using sample rinsed 150 ml syringes. These samples were filtered by hand (25 mm glass fiber GF/F) into acetone-washed and sample rinsed 60 ml HDPE bottles, which were then capped and immediately placed on ice in the dark for transport. The wet filters, used for chlorophyll *a* analysis (CHLA), were placed in 2 ml plastic centrifuge tubes to which 1.5 ml of 90% acetone was added. They were then immediately capped and put into a dark bottle on ice for transport (APHA 1999).

Unfiltered water samples were analyzed for total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), alkaline phosphatase activity (APA), and turbidity (NTU). TOC was measured by direct injection onto hot platinum catalyst in a Shimadzu TOC-5000 after first acidifying to pH<2 and purging with CO_2-free air. TN was measured using an ANTEK 7000N Nitrogen Analyzer using O_2 as carrier gas instead of argon to promote complete recovery of the nitrogen in the water samples (Frankovich and Jones 1998). TP was determined using a dry ashing, acid hydrolysis technique (Solorzano and Sharp 1980). The APA assay measures the activity of alkaline phosphatase, an enzyme used by bacteria to mineralize phosphate from organic compounds (Hashimoto et al. 1985). This assay is performed by adding a known concentration of an organic phosphate compound (o-methylfluorescein phosphate) to an unfiltered water sample. Alkaline phosphatase in the water sample cleaves the phosphate, leaving o-methylfluorescein, a highly fluorescent compound. The fluorescence of initial and 2 hr incubations were measured using a Gilford Fluoro IV spectrofluorometer (excitation = 430 nm, emission = 507 nm) and subtracted to give APA (µM h^{-1}). APA measurements were discontinued after Sept. 30, 2006 at the request of SFWMD. Turbidity was measured using an HF Scientific model DRT-15C turbidimeter and reported in NTU.

Filtrates were analyzed for soluble reactive phosphorus (SRP), nitrate + nitrite (NO_X^-), nitrite (NO_2^-), ammonium (NH_4^+), and silicate (SiO_2) by flow injection analysis (Alpkem model RFA 300). Filters for CHLA content (µg l^{-1}) were allowed to extract for a minimum of 2 days at -20° C before analysis. Extracts were analyzed using a Gilford Fluoro IV Spectrofluorometer (excitation = 435 nm, emission = 667 nm) and compared to a standard curve of pure CHLA (Sigma).

Some parameters were not measured directly, but were calculated by difference. Nitrate (NO_3^-) was calculated as $NO_X^- - NO_2^-$. Dissolved inorganic nitrogen (DIN) was calculated as $NO_X^- + NH_4^+$. Total organic nitrogen (TON) was defined as TN - DIN. Concentrations for all of these water quality variables are reported in units of milligrams per liter (mg l^{-1}) or the equivalent parts per million (ppm), except where noted. All nutrient concentrations are based on the atomic weight of primary nutrient species (ppm-N, ppm-P, and ppm-C), not the molecular weight. All N:P ratios discussed are calculated on a molar basis.

2. STATE OF WATER QUALITY IN FLORIDA BAY

Overall Period of Record

A spatial analysis of data from our monitoring program resulted in the delineation of 3 groups of stations, which have robust similarities in water quality (Fig. 2.1). We contend that these spatially contiguous groups of stations are the result of similar hydrodynamic forcing and processing of materials, hence we call them 'zones of similar influence'. The Eastern Bay zone acts most like a 'conventional' estuary in that it has a quasi-longitudinal salinity gradient caused by the mixing of freshwater runoff with seawater. In contrast, the Central Bay is a hydrographically isolated area with low and infrequent terrestrial freshwater input, a long water residence time, and high evaporative potential. The Western Bay zone is the most influenced by the Gulf of Mexico tides and is also isolated from direct overland freshwater sources.

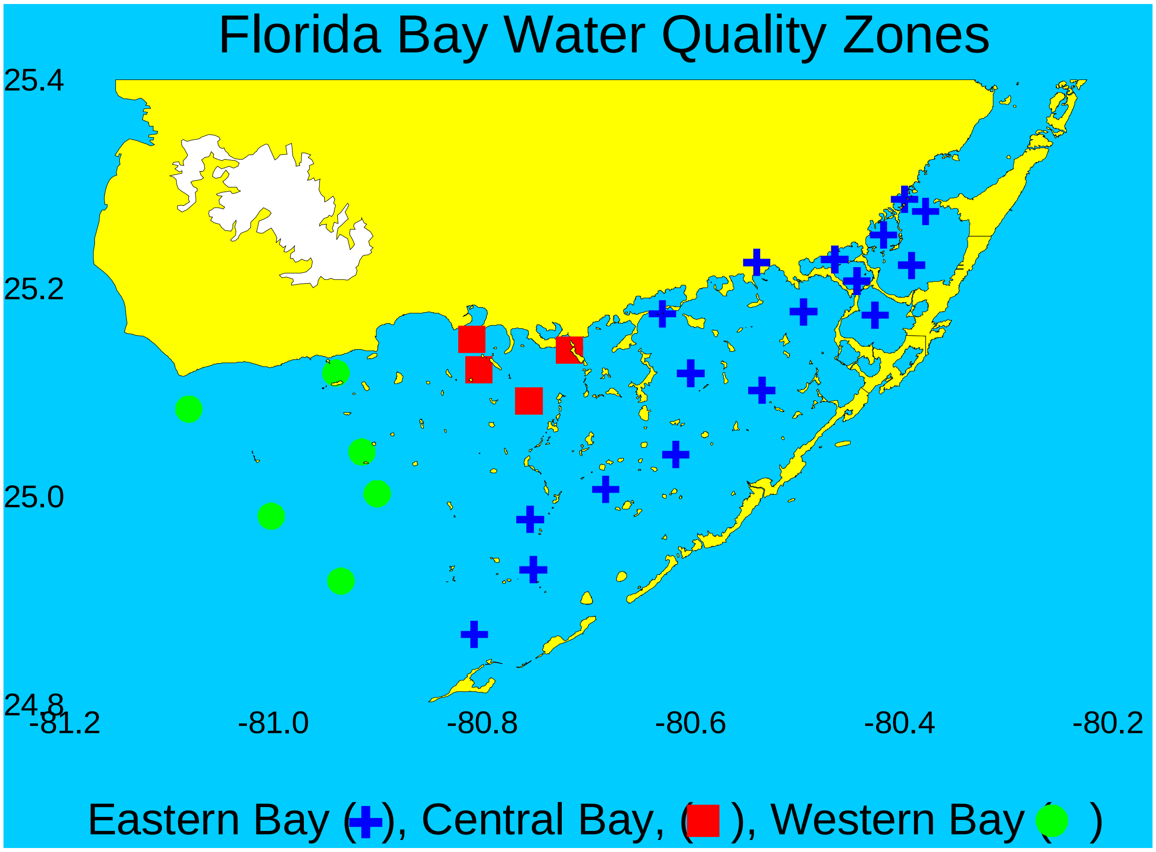


Figure 2.1. Zones of similar water quality in Florida Bay

Climactic changes occurring over the data collection period of record had major effects on the health of the bay. Precipitation rebounded from the drought during the late 1980's being equal to or greater than the long term average (141.9 cm yr^{-1}) for 11 of the last 16 years (Fig 2.2.). Total precipitation for 2006 was 120.4 cm yr^{-1} making it the third driest year since 1991.

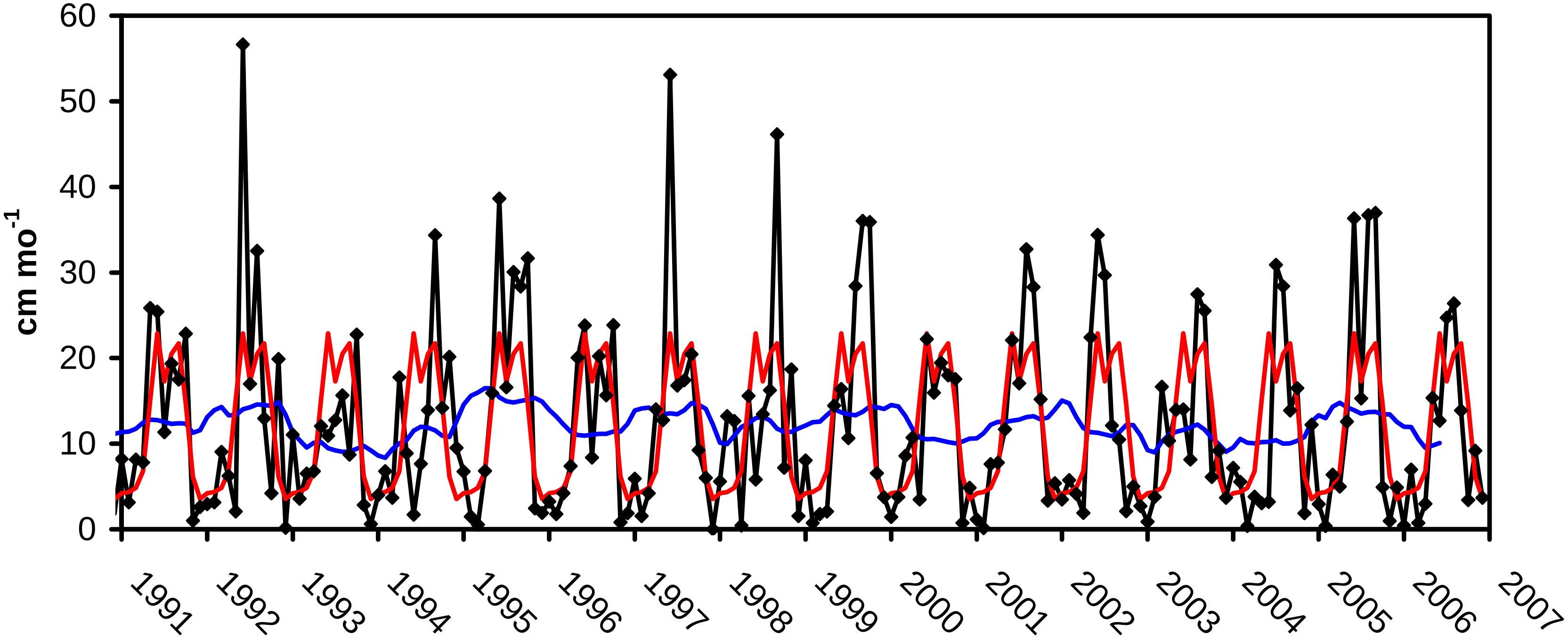


Figure 2.2. Monthly rainfall in the Florida Bay area. The red line is long term monthly average (since 1948); the blue line is 12 month moving average.

Early in the record, salinity and total phosphorus (TP) concentrations declined baywide while turbidity (cloudiness of the water) increased dramatically. The salinity decline in Eastern and Central Florida Bay was dramatic early on and has since stabilized into a regular seasonal cycle (Fig. 2.3-2.5). The box-and-whisker plots presented in this and following figures show the range (boxes are quartiles; whiskers include 90% of data) and median (line in box) of the monthly data. Some of this decrease in Eastern Bay could be accounted for by increased freshwater flows from the Everglades but declines in other areas point to the climactic effect of increased rainfall during this period. The Central Bay continues to experience hypersaline conditions (>35) during the summer but the extent and duration of the events is much smaller.

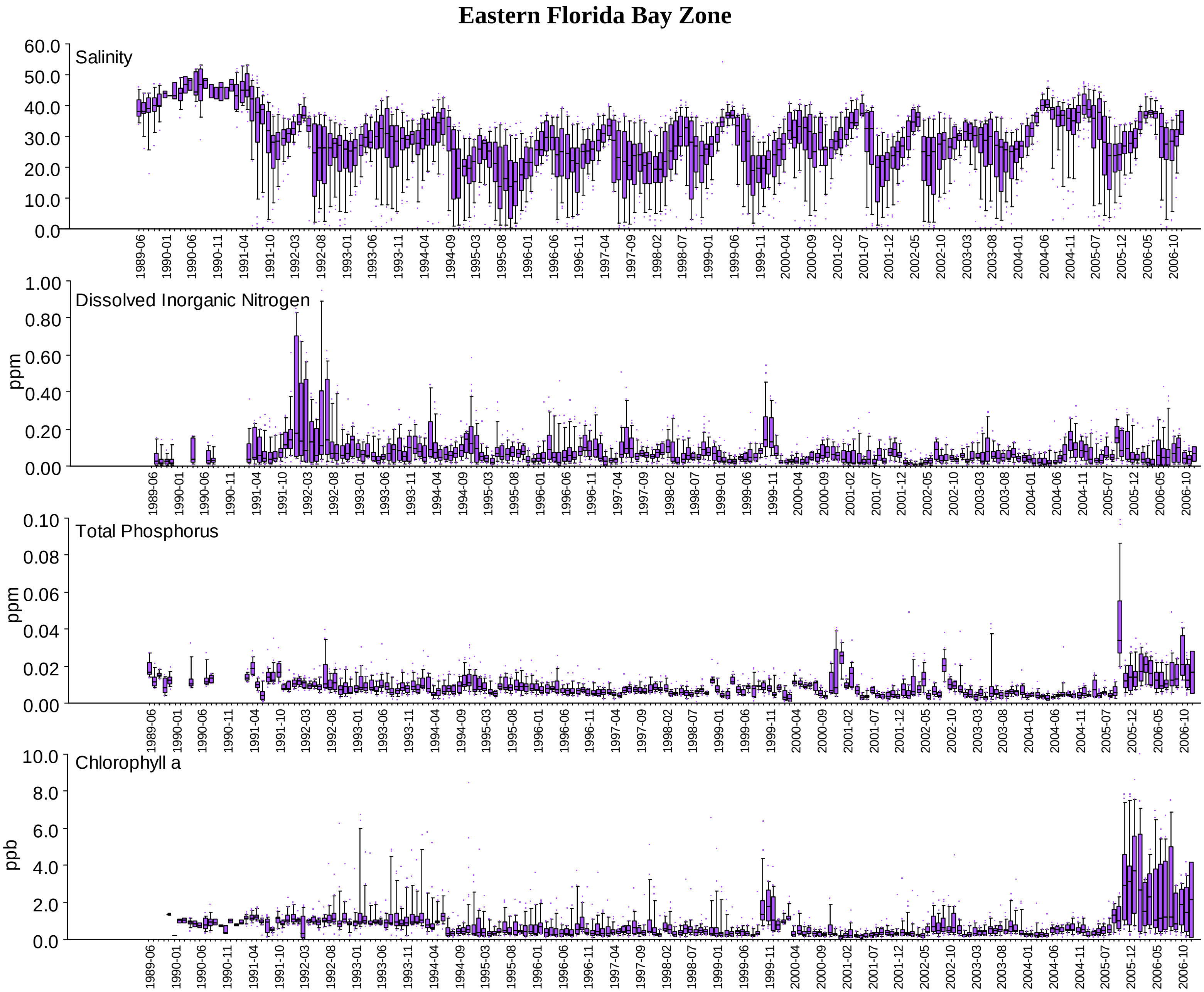
Chlorophyll *a* concentrations (CHLA), a proxy for phytoplankton biomass, were particularly dynamic and spatially heterogeneous (Fig. 2.3-2.5). The Eastern Bay generally has the lowest CHLA while the Central Bay is highest. In the Eastern Bay, which makes up roughly half of the surface area of Florida Bay, CHLA has declined by 0.9 $\mu g\ l^{-1}$ or 63%. Most of this decline occurred over a few months in the spring/summer of 1994 and had remained relatively stable until the hurricanes of 2005. Since then a large cyanobacterial bloom has been present in this region. As of this writing, CHLA levels have finally returned to pre-bloom concentrations

The isolated Central Bay zone underwent a 5-fold increase in CHLA from 1989-94 then rapidly declined to previous levels by 1996. In Western Florida Bay, there was a significant increase in CHLA, yet median concentrations remained modest (2 $\mu g\ l^{-1}$) by most estuarine standards. There were significant blooms in Central and Western Bay immediately following Hurricanes Georges (Nov. 1998) but it was Hurricane Irene's large rainfall input (Oct. 1999) which spiked the largest blooms in this region of the bay. It is important to note that these changes in CHLA (and turbidity) happened years after the poorly-understood seagrass die-off in 1987. It is possible that the death and decomposition of large amounts of seagrass biomass might partially explain some of the changes in water quality of Florida Bay but the connections are temporally disjoint and the processes indirect and not well understood.

As mentioned previously, TP concentrations have declined baywide over the 14 year period of record (until the 2005 hurricane season). As with salinity, most of these declines occurred early in the record. Unlike most other estuaries, increased terrestrial runoff may have been partially responsible for the decrease in TP concentrations in the Eastern Bay. This is because the TP concentrations of the runoff are at or below ambient levels in the bay. It is also important to understand that almost all the phosphorus measured as TP is in the form of organic matter which is less accessible to plants and algae than inorganic phosphate. The elevated TP in the Central Bay is mostly due to concentration effect of high evaporation. Recently, there have been significant peaks during the fall season in both Eastern and Western Bays. The 2005 hurricane season impacted the Eastern Bay with large loading of TP. In addition, the Route 1 road construction may have had a n impact as well (Rudnick et al. 2006).

The dissolved inorganic nitrogen assemblage (DIN) is made up of ammonium (NH_4^+), nitrate (NO_3^-), and nitrate (NO_2^-). The Western Bay is lowest in DIN; phytoplankton in this region may be limited by N availability on a regular basis. DIN in the Eastern Bay is a little higher and is mostly in the form of NO_3^- while highest levels are found in the Central Bay as NH_4^+.

Turbidity in the Central and Western Bays have increased greatly since 1991 (not shown). Turbidity in Eastern Bay increased 2-fold from 1991-93, while Central and Western Bays increased by factors of 20 and 4, respectively. Turbidity across the bay has since stabilized and possibly declined but certainly not to previous levels. In general, the Eastern Bay has the clearest water, which is due to a combination of factors such as high seagrass cover, more protected basins, low tidal energy, and shallow sediment coverage. We are unsure as to the cause, but the loss of seagrass coverage may have destabilized the bottom so that it is more easily disturbed by wind events.


Eastern Florida Bay Zone

Salinity

Dissolved Inorganic Nitrogen

Total Phosphorus

Chlorophyll a

Figure 2.3. Box-and-whisker plots of water quality in Eastern Florida Bay by survey.

Central Florida Bay Zone

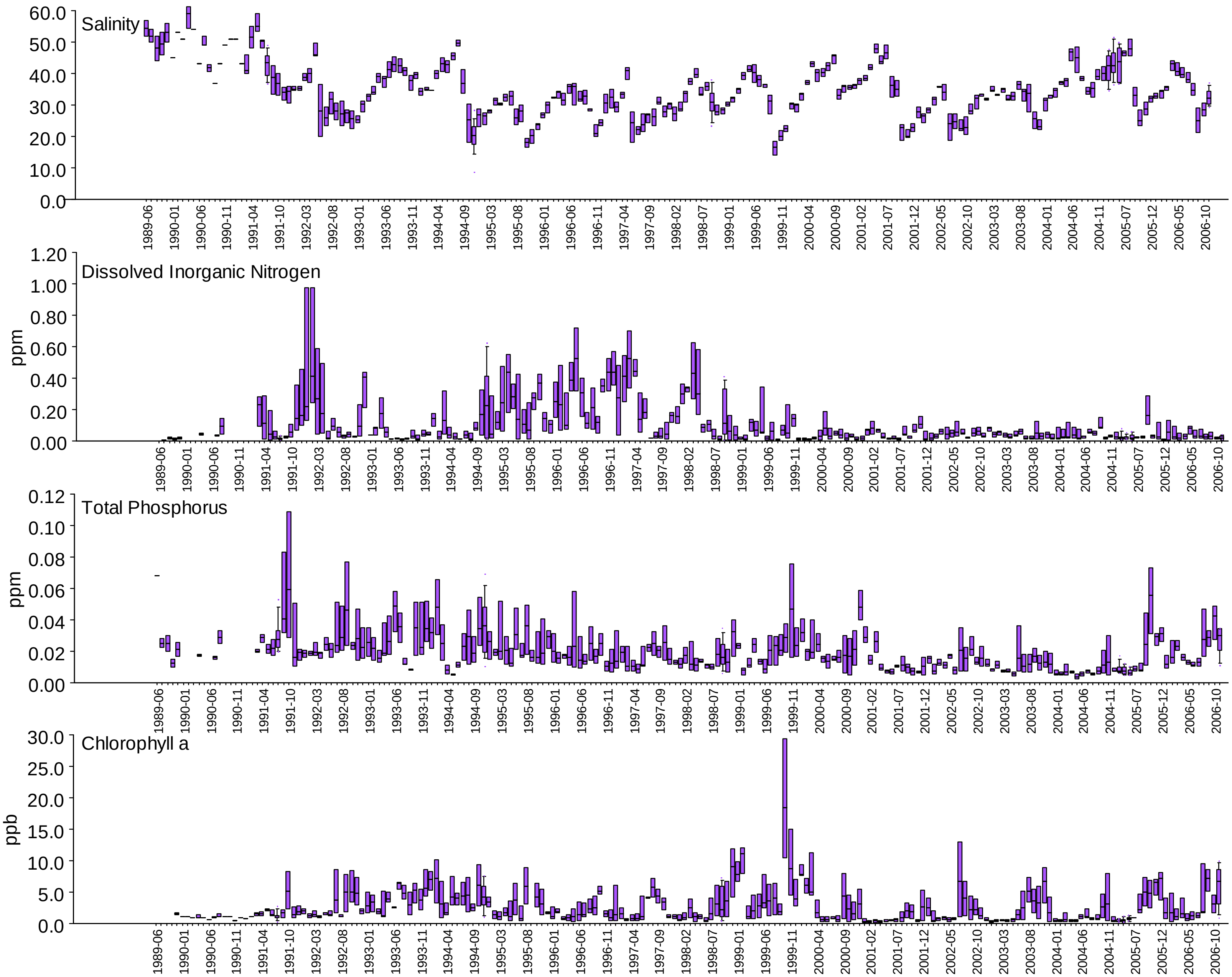


Figure 2.4. Box-and-whisker plots of water quality in Central Florida Bay by survey.

Western Florida Bay Zone

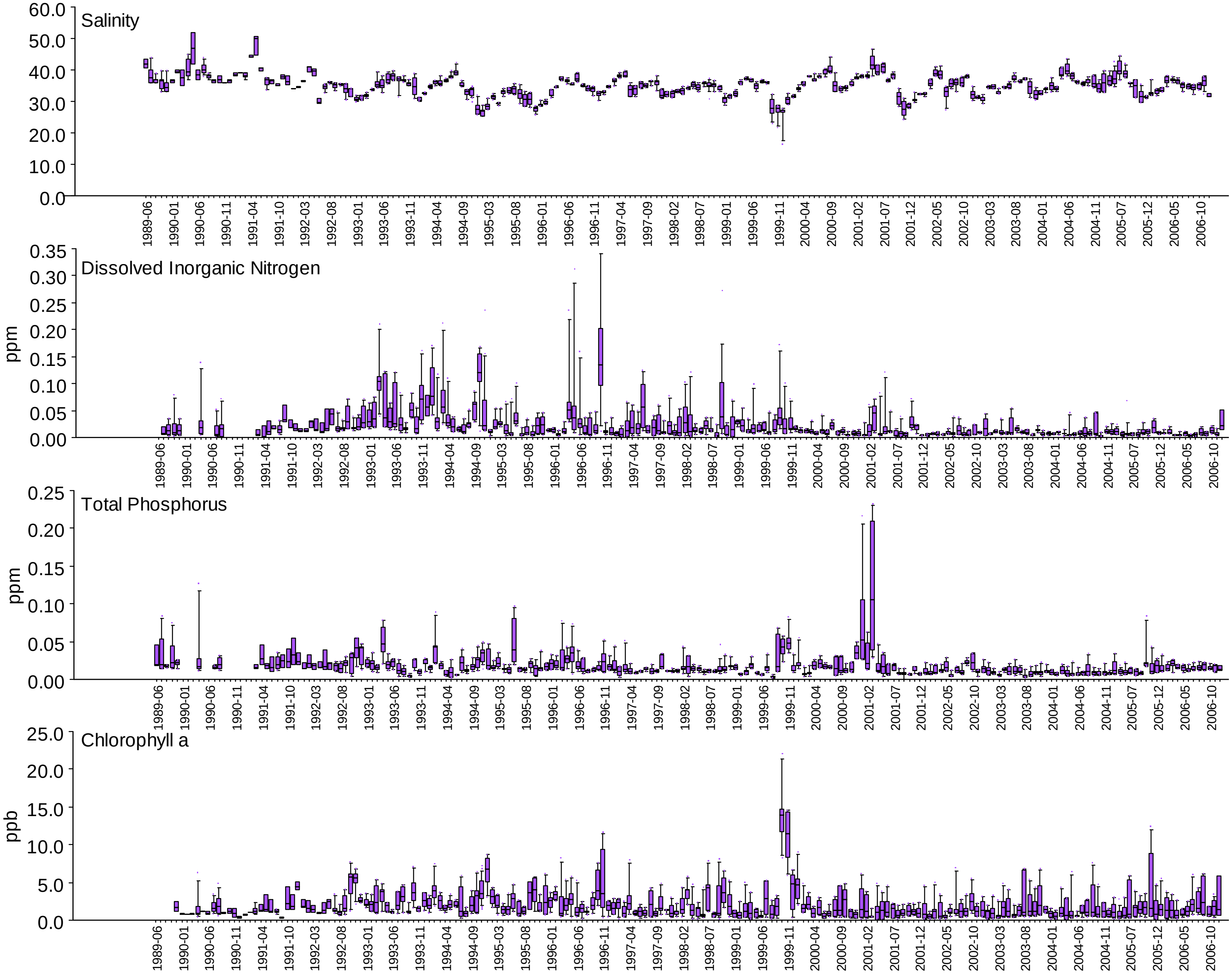


Figure 2.5. Box-and-whisker plots of water quality in Western Florida Bay by survey.

2006 Alone

The following Figures 2.6-2.8 show the monthly median of 2006 data from each zone compared to the long term median for each zone. We feel that this graphical approach is useful in pointing out anomalies and present some possible explanations for these differences.

2006 was the third driest year since 1991, however hypersalinity was not as pronounced as for the previous wet year (Fig 2.6-2.8). This points out the impact that the long water residence time has on Eastern and Central Bay. The presence of lower salinity water from 2005 carried over into 2006. There were no direct hurricane impacts to Florida bay during 2006.

DIN and TON were generally lower than the grand median for most regions of the bay, but especially in Western Bay. On the other hand, TOC was higher than normal in the Eastern Bay, about the same for Central Bay, and lower in the Western Bay. This is very interesting because we usually think of the DOM pool as having a relatively consistent C:N ratio. The decoupling of the two pools implies that they come from separate sources.

TP was elevated in Eastern Bay throughout all of the year as a result of the previous hurricane and road construction interaction (Rudnick et al. 2006). TP was normal for the rest of the bay. As a result of elevated TP, CHLA was higher than the grand median in Eastern Bay as well. CHLA declined during the spring as the bloom abated somewhat. In Central Bay, an increase in CHLA occurred during the fall season.

Salinity, temperature, and DO were unremarkable except in Western Bay where DO seemed higher than normal for most of the year.

Data, Graphs, and Figures

All data for the period of record are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/DataDL.htm
Monthly time series graphs for all measured variables for each station are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/FB.htm
Contour maps showing spatial distributions of all measured variables (quarterly) are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/ContourMaps.htm

Eastern Florida Bay (FBE)

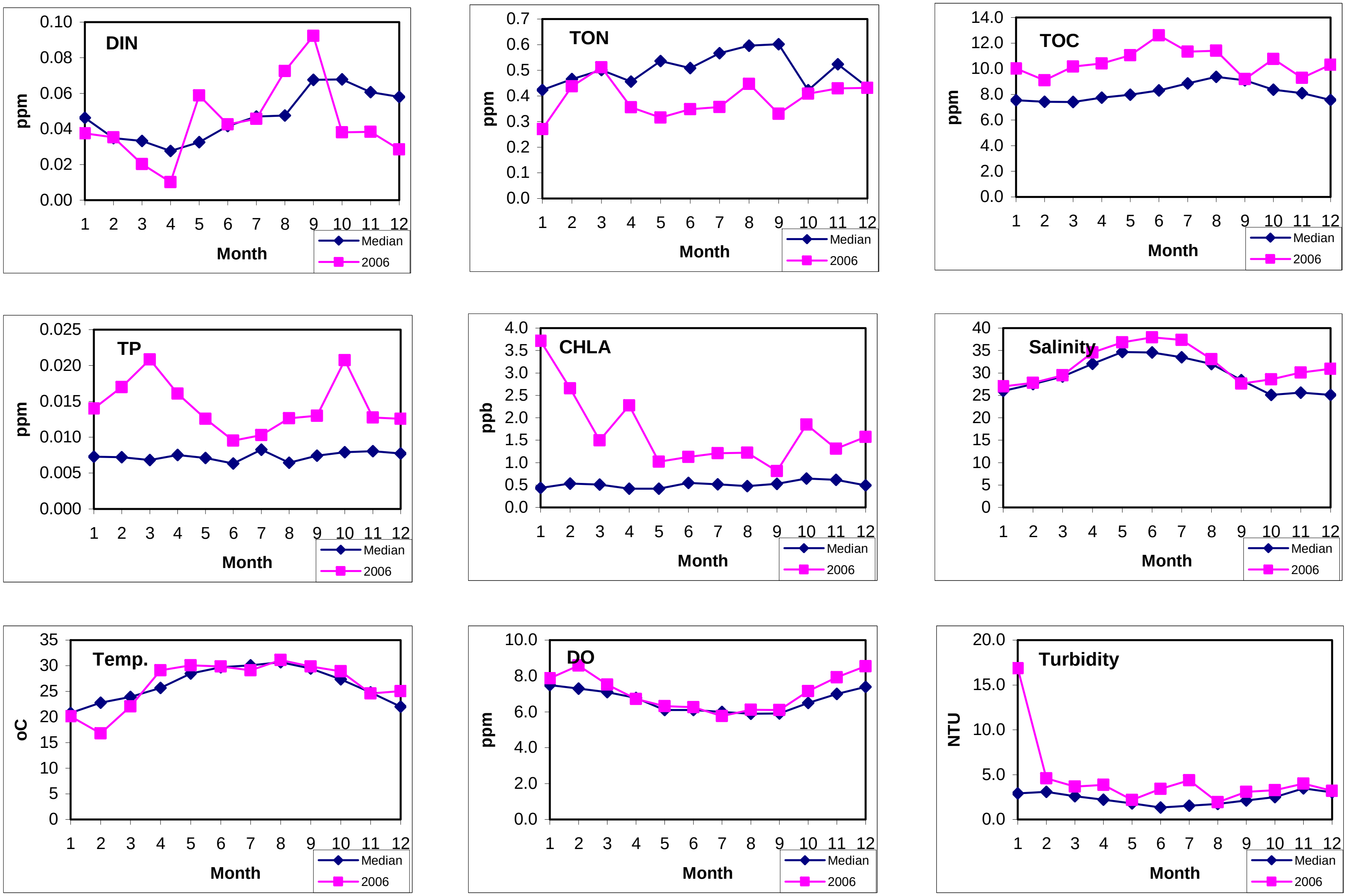


Figure 2.6. Comparison of long-term median with 2006 data.

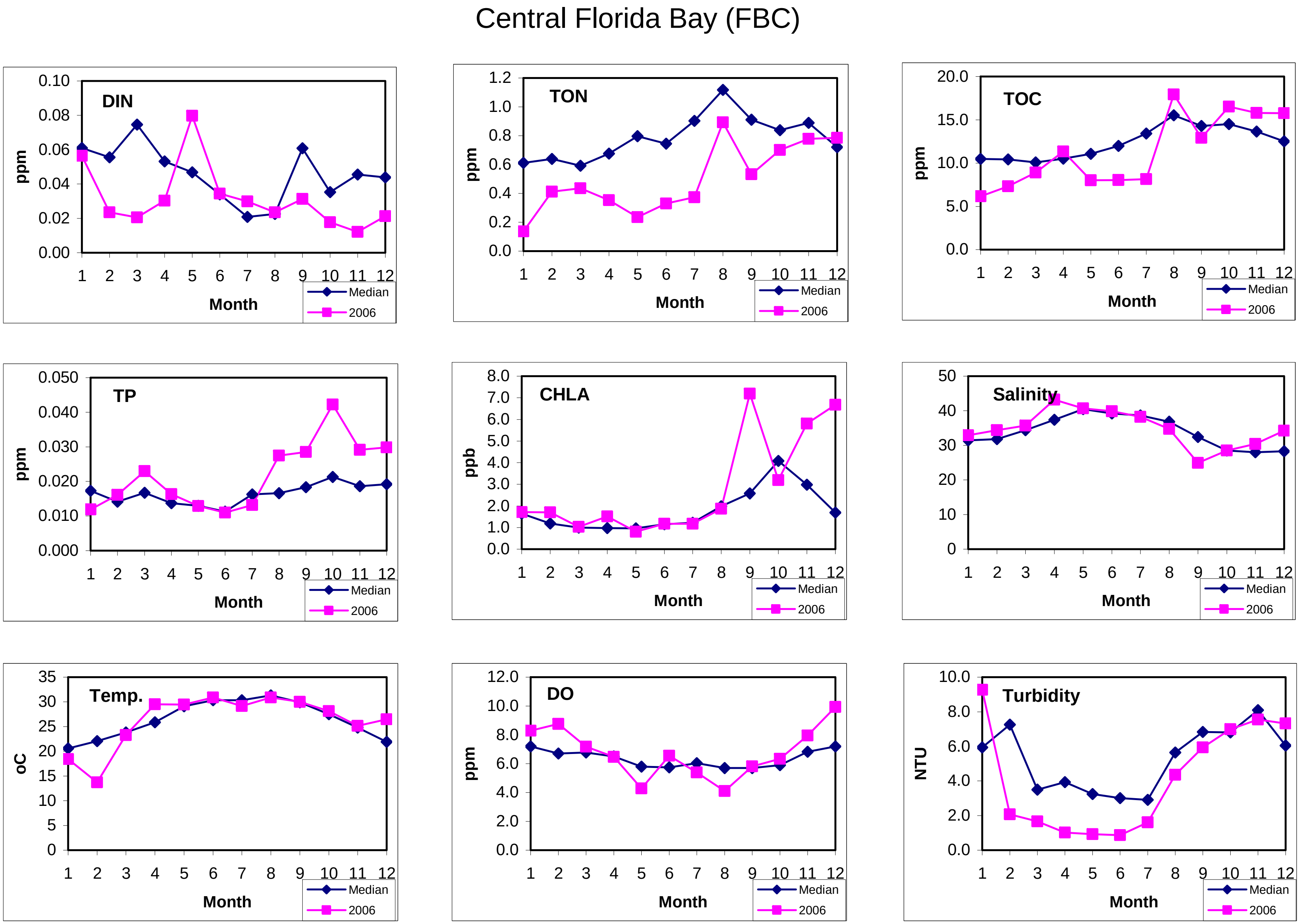

Central Florida Bay (FBC)

Figure 2.7. Comparison of long-term median with 2006 data.

Western Florida Bay (FBW)

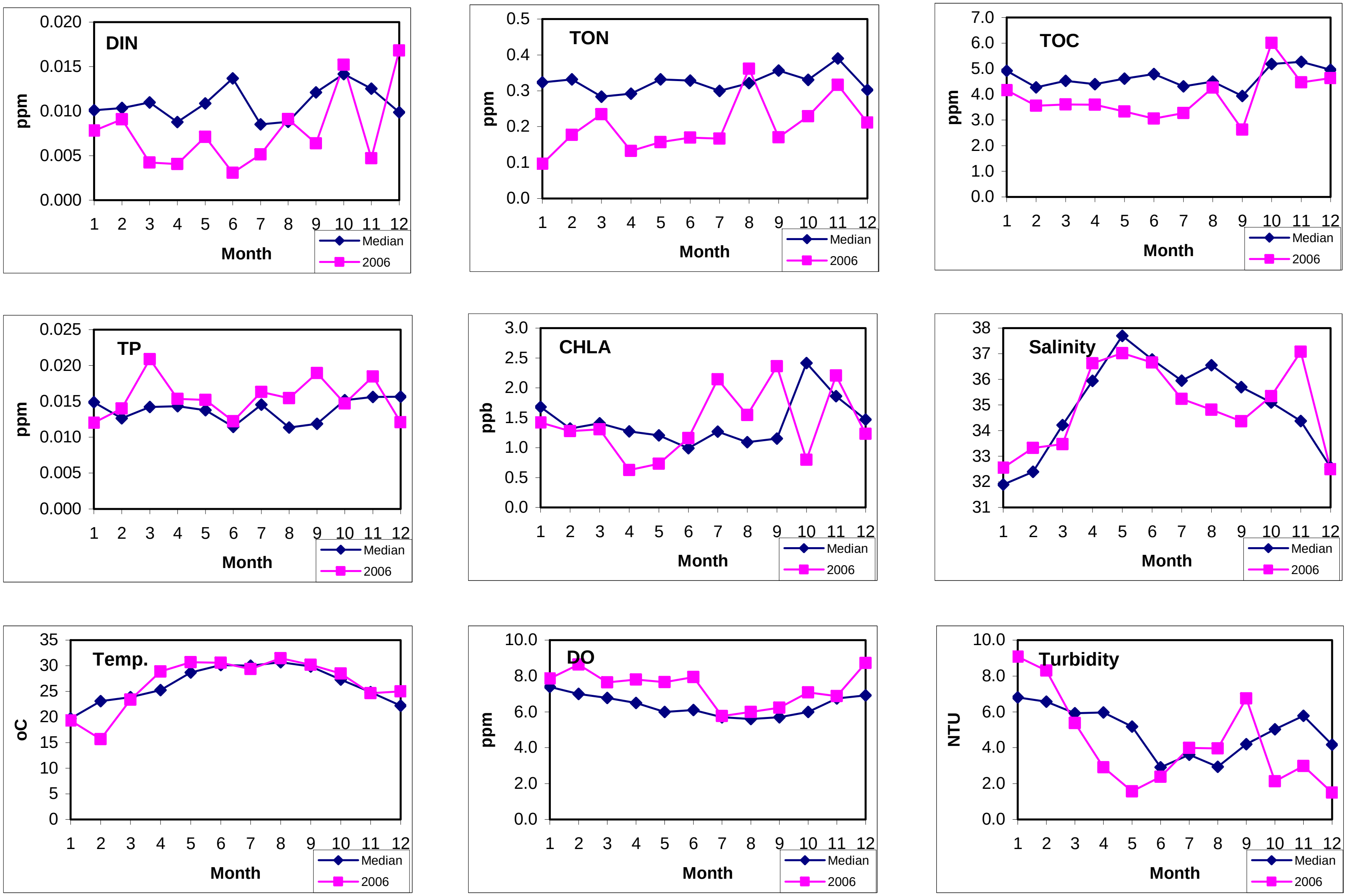


Figure 2.7. Comparison of long-term median with 2006 data.

3. STATE OF WATER QUALITY IN WHITEWATER BAY - TEN THOUSAND ISLANDS COMPLEX

Overall Period of Record

A spatial analysis of data from our monitoring program resulted in the delineation of 6 groups of stations, which have robust similarities in water quality (Fig. 3.1). The first cluster was composed of 13 stations in and around the Shark, Harney, Broad, and Lostmans Rivers and is called the Mangrove River (MR) group. This cluster also included a sampling station just off the Faka Union Canal. The second cluster was made up of the 8 stations enclosed within Whitewater Bay proper (WWB). Twelve stations were sited mostly in and around the coastal islands of TTI-WWB formed the Gulf Island group (GI). The water quality characteristics at the Coot Bay site (COOT) were sufficiently different so as to be a cluster of its own. The next cluster contained the northernmost 2 stations in the Blackwater River estuary (BLK). Finally, the Inland Wilderness Waterway zone (IWW) included 11 stations distributed throughout the inside passage as well as the Chatham River and the station off Everglades City.

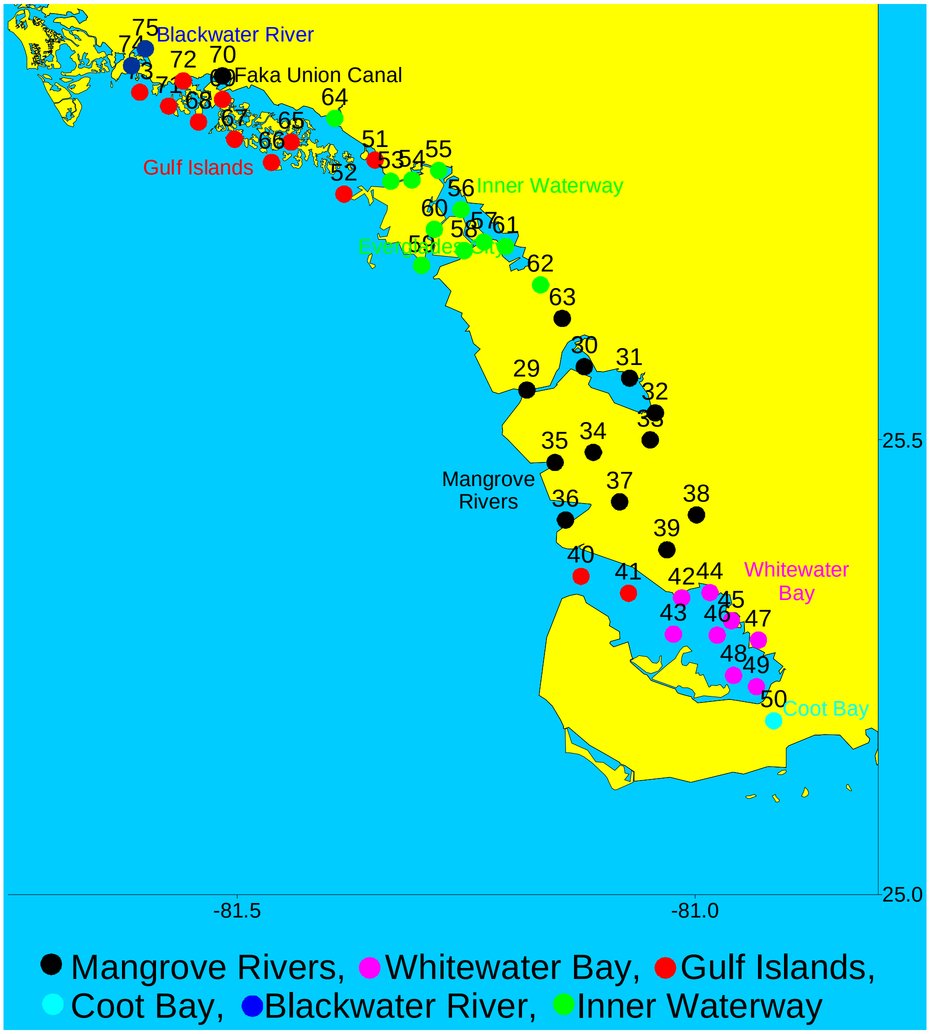


Figure 3.1. Zones of similar water quality in Whitewater Bay-Ten Thousand Islands complex

Marked differences in physical, chemical, and biological characteristics among zones were illustrated by this technique. The general spatial trend is one of highly variable salinity as a result of Shark Slough inputs in the south (Fig. 3.2-3.6). Salinity in the Gulf Islands zone was more consistent due to Gulf of Mexico influence but also is affected by Caloosahatchee River outputs. CHLA concentrations were relatively high in this region compared to Florida Bay and the Shelf. Highest CHLA were observed in the semi-enclosed areas such as Whitewater Bay and the Inner Wilderness Waterway. It is possible that the longer water residence times exhibited in these areas promoted the intensification of algal biomass. TP tended to be lowest in Whitewater Bay and Mangrove Rivers but increased northward along the coast. The spatial distribution of DIN was generally opposite to that of TP. The net effect was the formation of a gradient with strong phosphorus limitation occurring in the southern region which shifted to a more balanced N:P ratio in the northern area around the Blackwater River. The Mangrove Rivers were a significant source of TOC to the Shelf. TOC was highest in the south and declined northward along the coast.

We believe these gradients are the result of coastal geomorphology and watershed characteristics in the region. The width of the mangrove forest is widest in the south (15 km) but grades to only 4 km wide in the northern TTI; this being a function of elevation and sediment type. Whitewater Bay is a semi-enclosed body of water with a relatively long residence time, which receives overland freshwater input from the Everglades marsh. The long water residence time may explain the very low P concentrations (from biological uptake), while the high evaporation rate would tend to concentrate dissolved organic matter (DOM). The Mangrove Rivers are directly connected to the Shark River Slough and therefore have a huge watershed relative to their volume. Freshwater inputs from this source are very low in P while the extensive mangrove forest contributes much DOM. The Inner Waterway is an intermediate zone in all respects; having extensive channelization but low freshwater input. The Gulf Island zone has very low freshwater input due to the poorly drained watershed of the Big Cypress Basin. Instead of mangrove river channels there are many mangrove islands set in low tidal energy environment situated behind the Cape Romano Shoals. Finally there is the Blackwater River cluster with highest TP concentrations. There is considerable agriculture (tomatoes, etc.) in the Blackwater River watershed, which may contribute significant amounts of P to the system via drainage ditches. Further analysis of this relationship is planned.

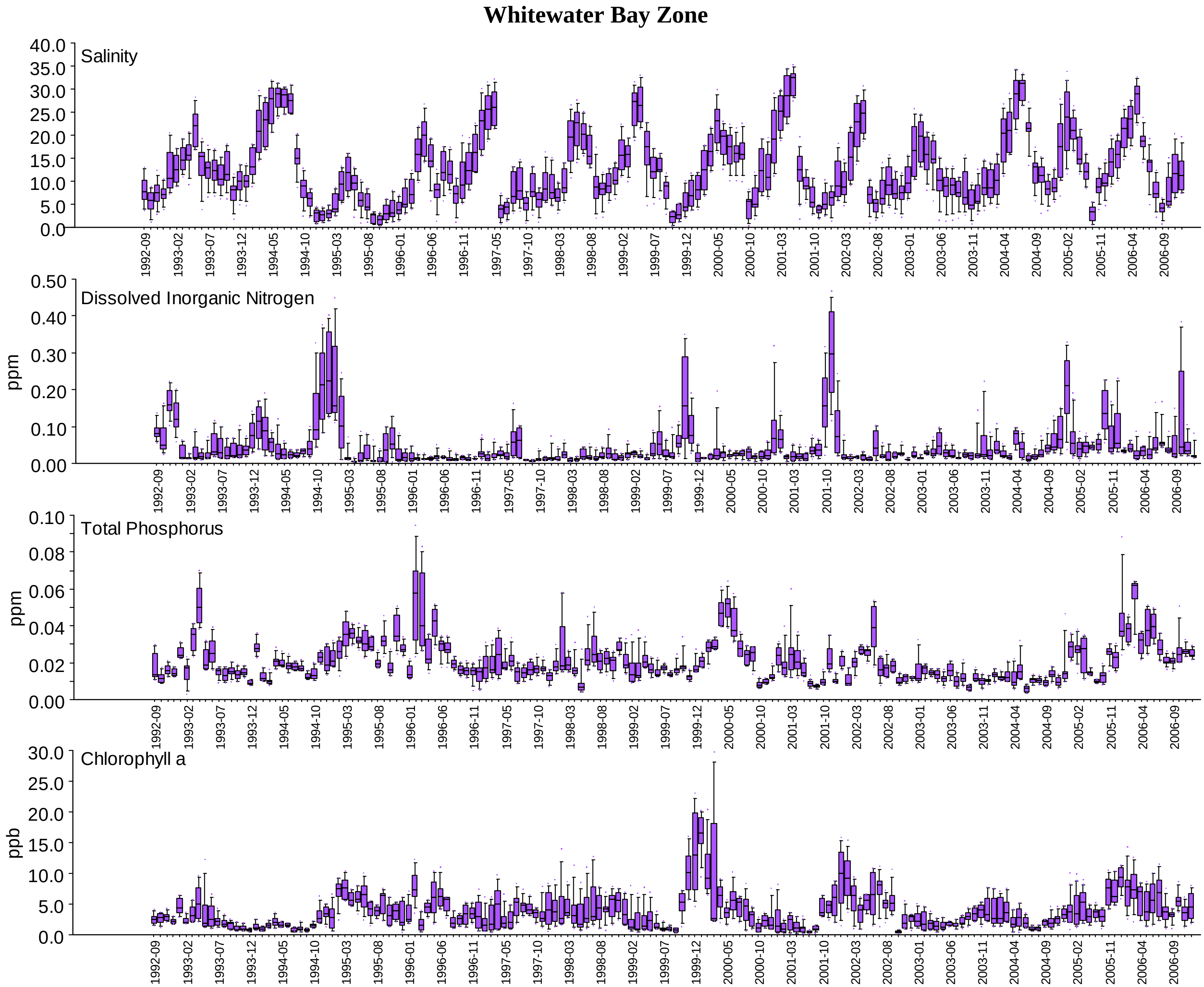


Figure 3.2. Box-and-whisker plots of water quality in WWB-TTI by survey.

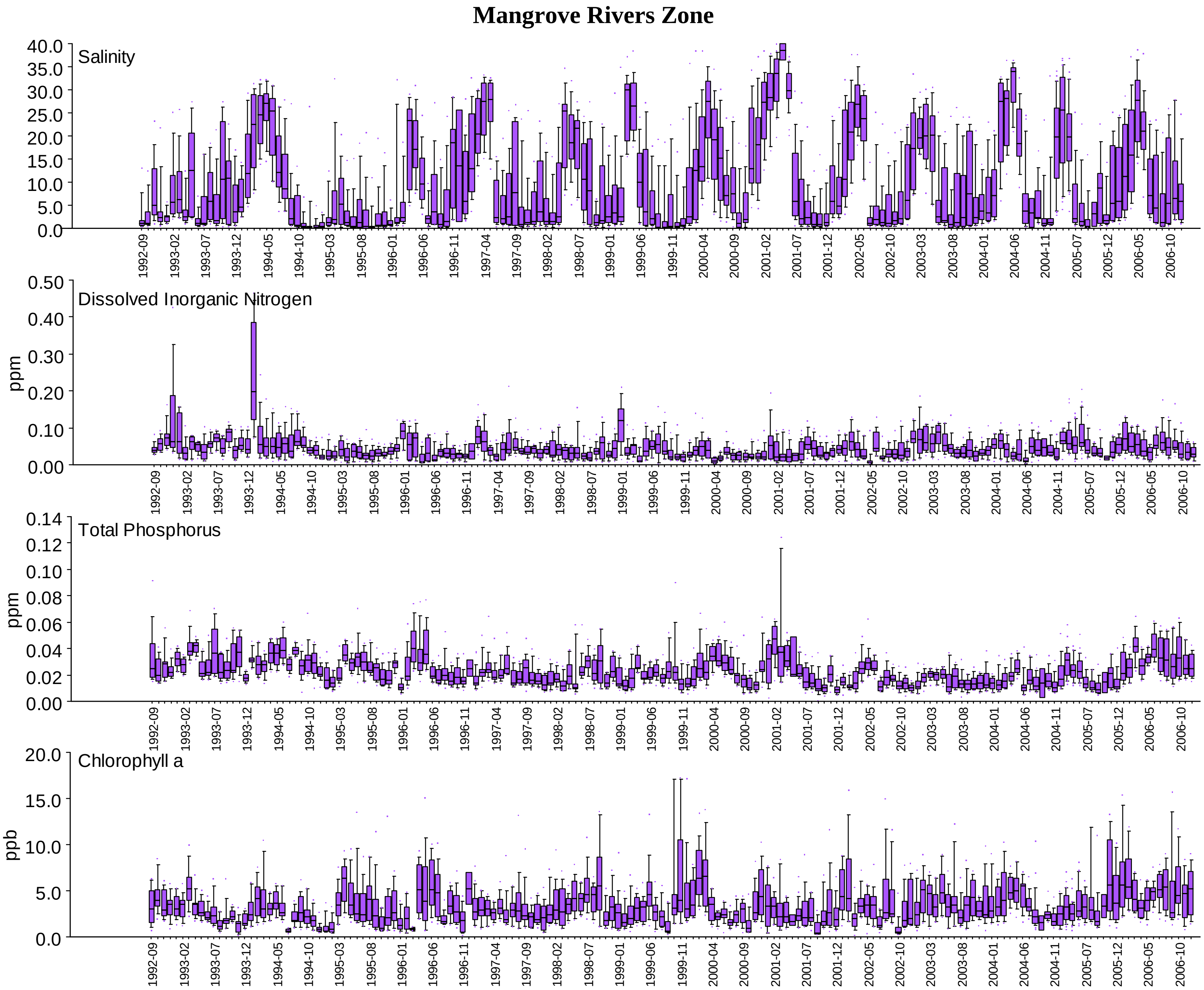


Figure 3.3. Box-and-whisker plots of water quality in WWB-TTI by survey.

Gulf Islands Zone

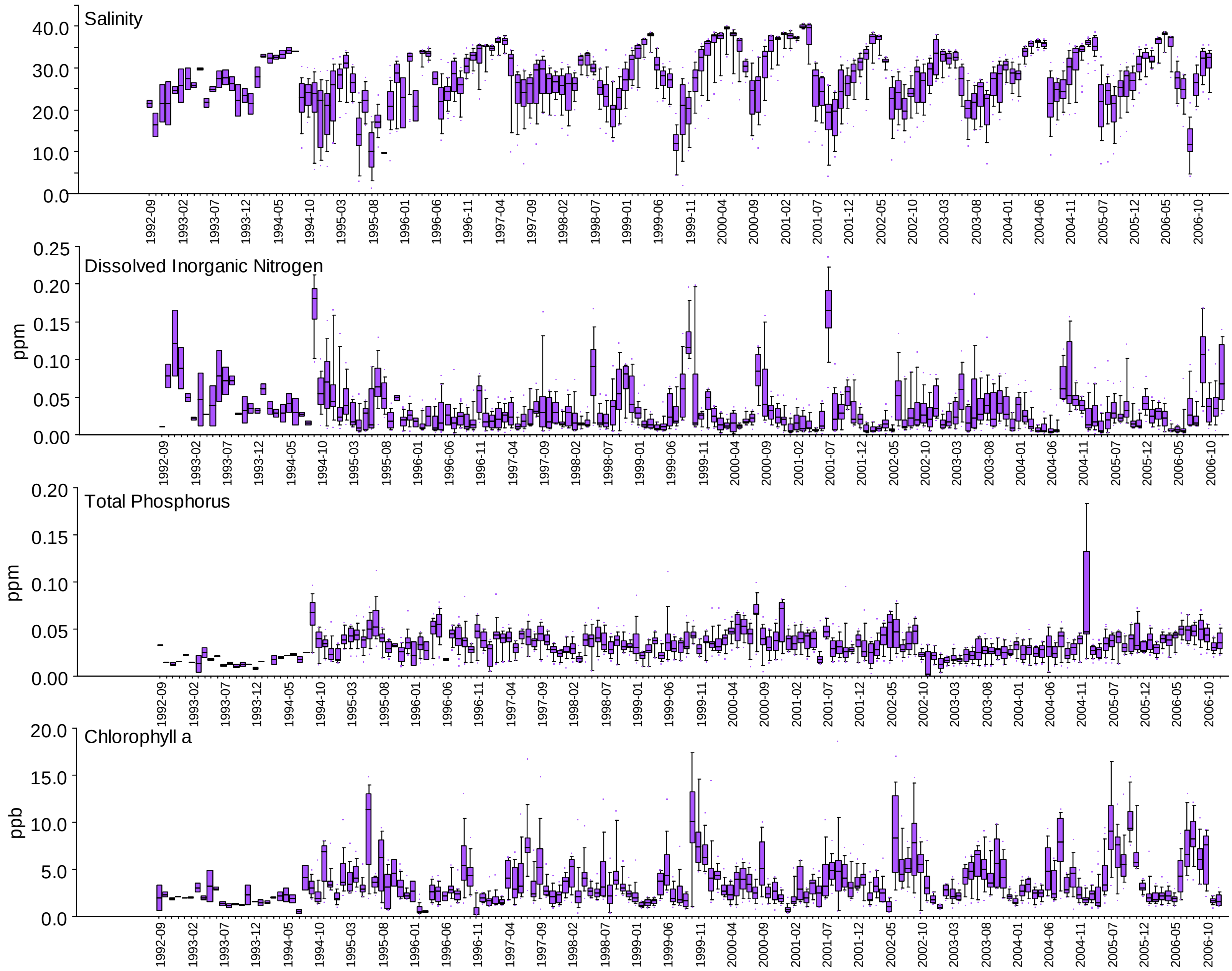


Figure 3.4. Box-and-whisker plots of water quality in WWB-TTI by survey.

Inner Waterway Zone

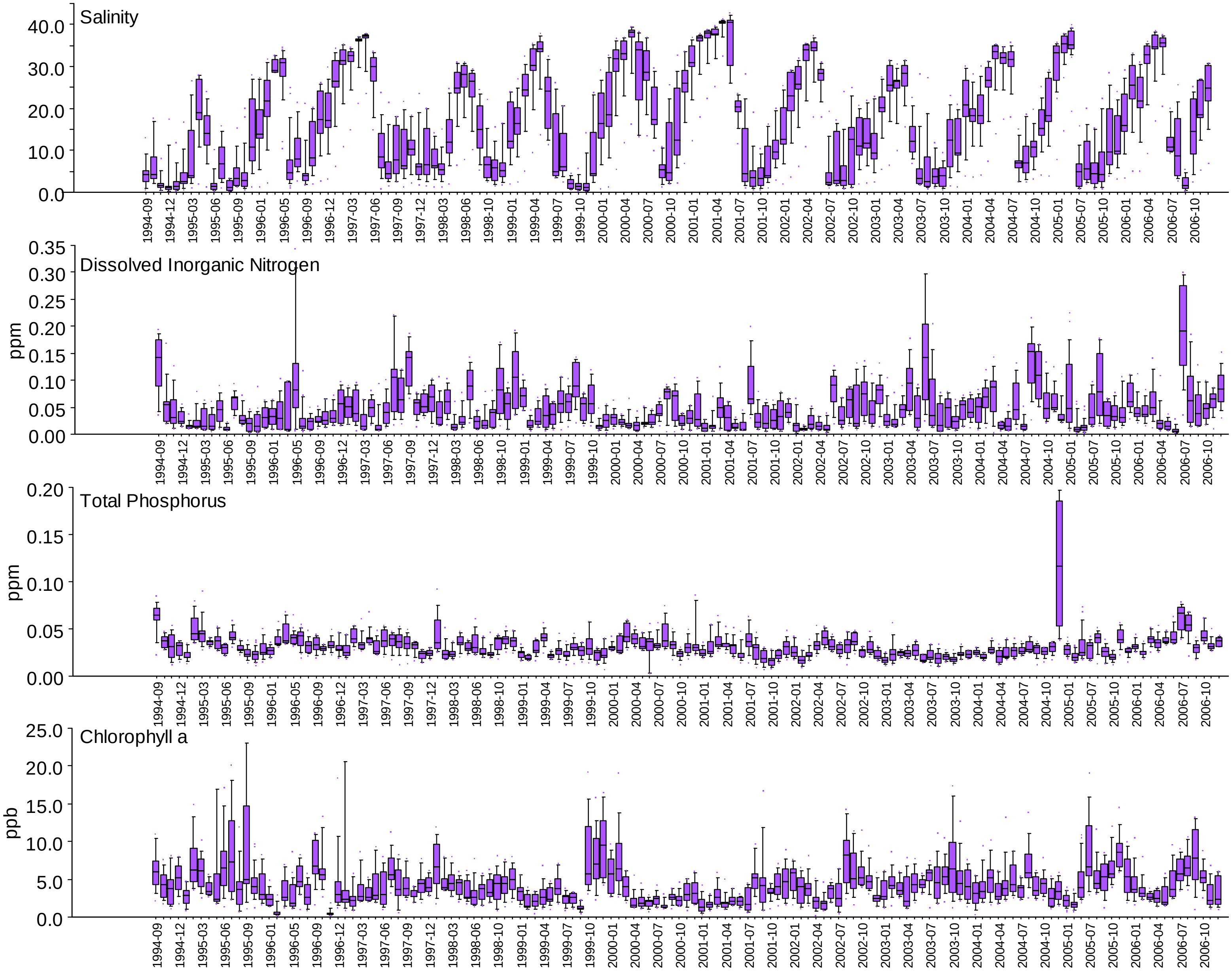


Figure 3.5. Box-and-whisker plots of water quality in WWB-TTI by survey.

Blackwater River Zone

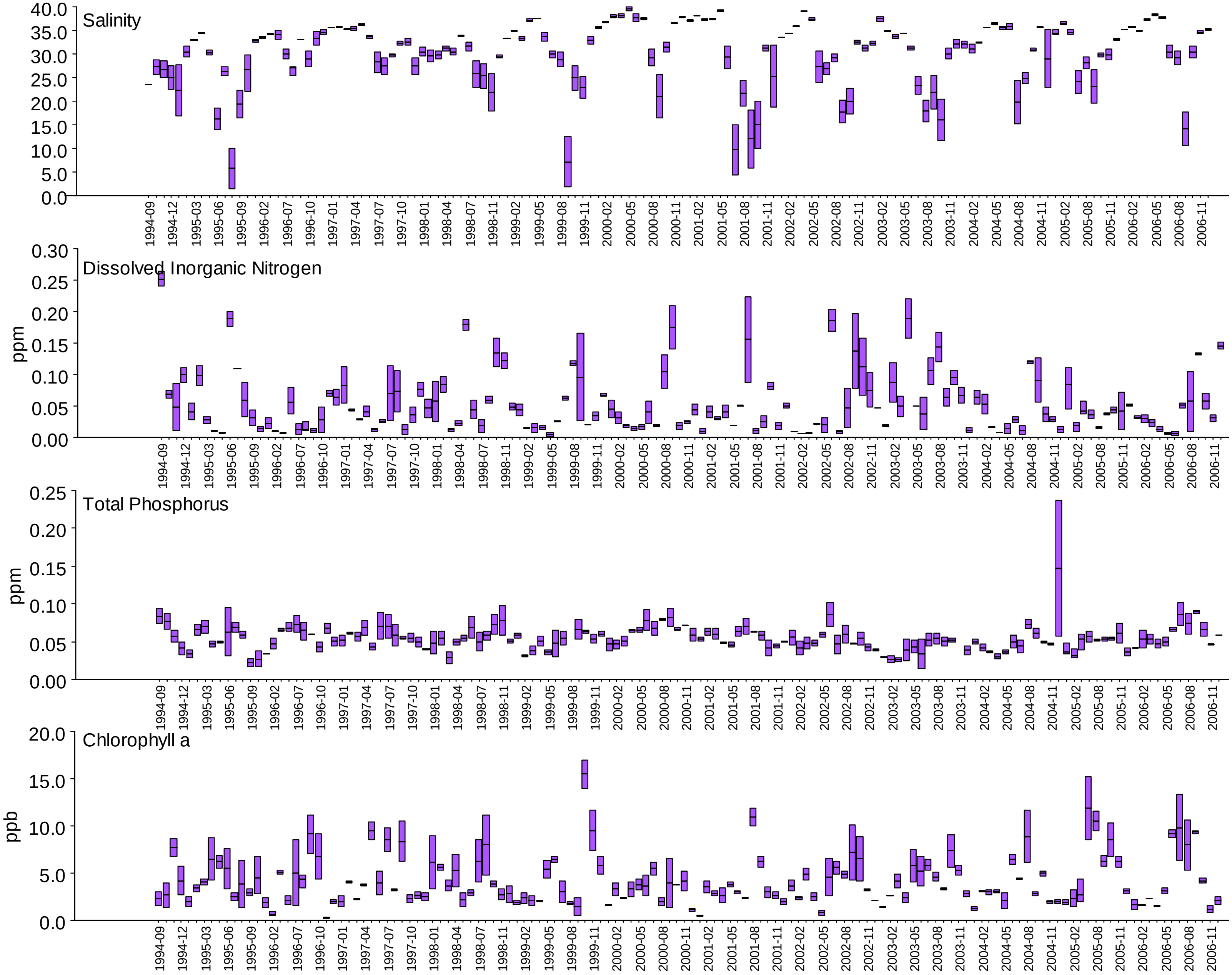


Figure 3.6. Box-and-whisker plots of water quality in WWB-TTI by survey.

2006 Alone

The influence of freshwater input from the Everglades is very significant to this region. Large salinity variations are the norm, being driven by both climactic events and water management practices (Fig. 3.7-3.10). Although 2006 was relatively dry, salinity patterns were generally not different from the grand medians. The exception was Whitewater Bay which exhibited elevated salinities until the onset of the wet season.

DIN concentrations in Whitewater Bay, Mangrove Rivers, and Inner Waterway were elevated relative to the median while those of the other zones were not. Significant spikes in DIN occurred in the Inner Waterway, Gulf Islands, and Blackwater River occurred in the fall season as a result of freshwater loading (see salinity graphs).

TON in all regions was lower than the grand median. This is the result of the system-wide long term decline in TON output from the Everglades. TOC was slightly lower for most areas, but like DIN, increased during large freshwater inputs.

TP was consistently higher than the grand median throughout the year for all regions. We are not sure as to the cause but the effects on CHLA were consistent with P increases after the 2005 hurricane season. For the Gulf Islands, Inner Waterway, and Blackwater River, CHLA was highest during the wet season while in Whitewater Bay and Mangrove Rivers, CHLA was elevated all year.

Annual patterns in temperature and DO were unremarkable with values generally fluctuating around the median for all areas, however some elevated DO was observed in the late fall at many sites.

Data, Graphs, and Figures

All data for the period of record are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/DataDL.htm
Monthly time series graphs for all measured variables for each station are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/WWB.htm
Contour maps showing spatial distributions of all measured variables (quarterly) are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/ContourMaps.htm

Whitewater Bay (WWB)

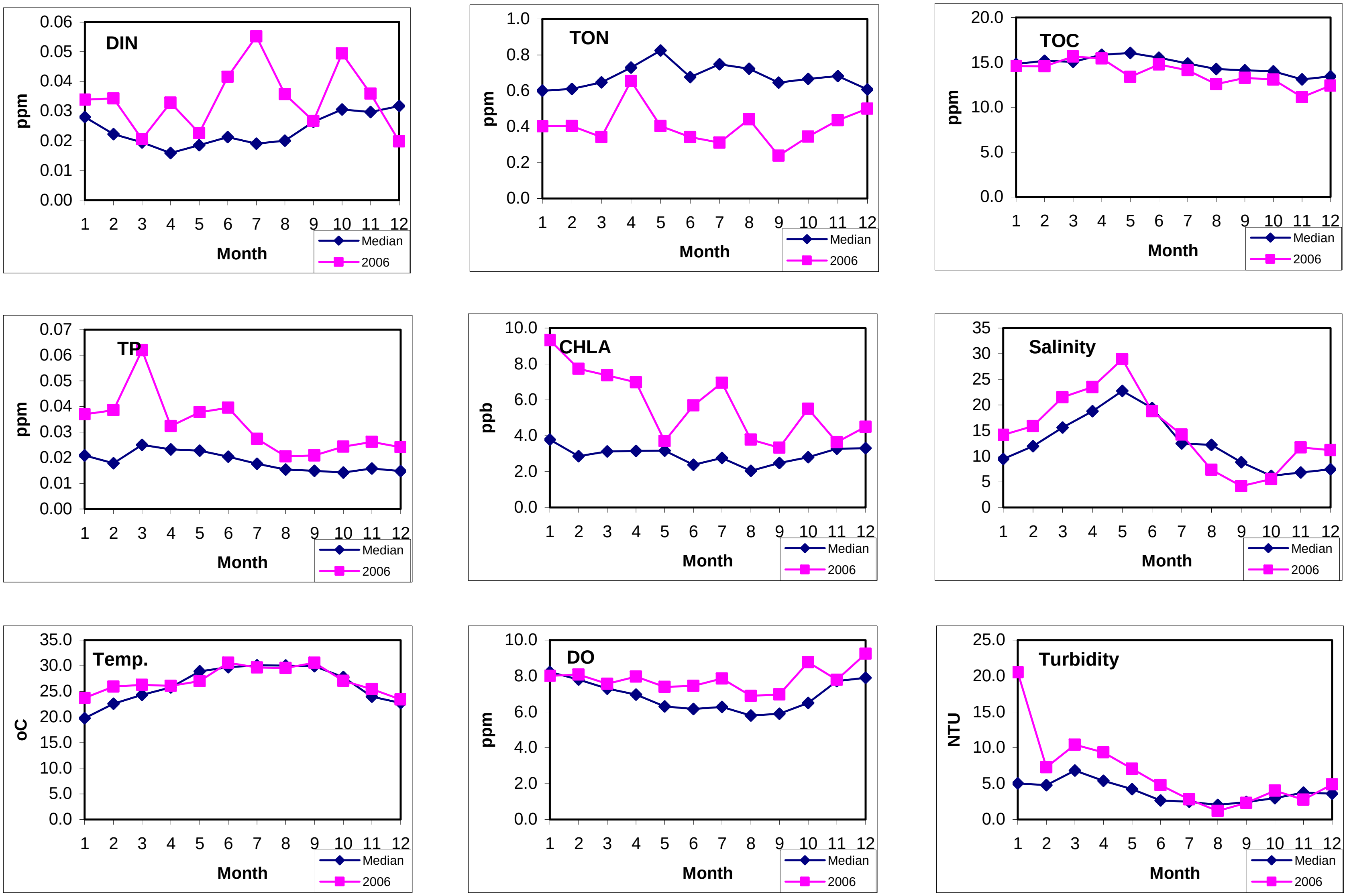


Figure 3.7. Comparison of long-term median with 2006 data.

Mangrove Rivers (MR)

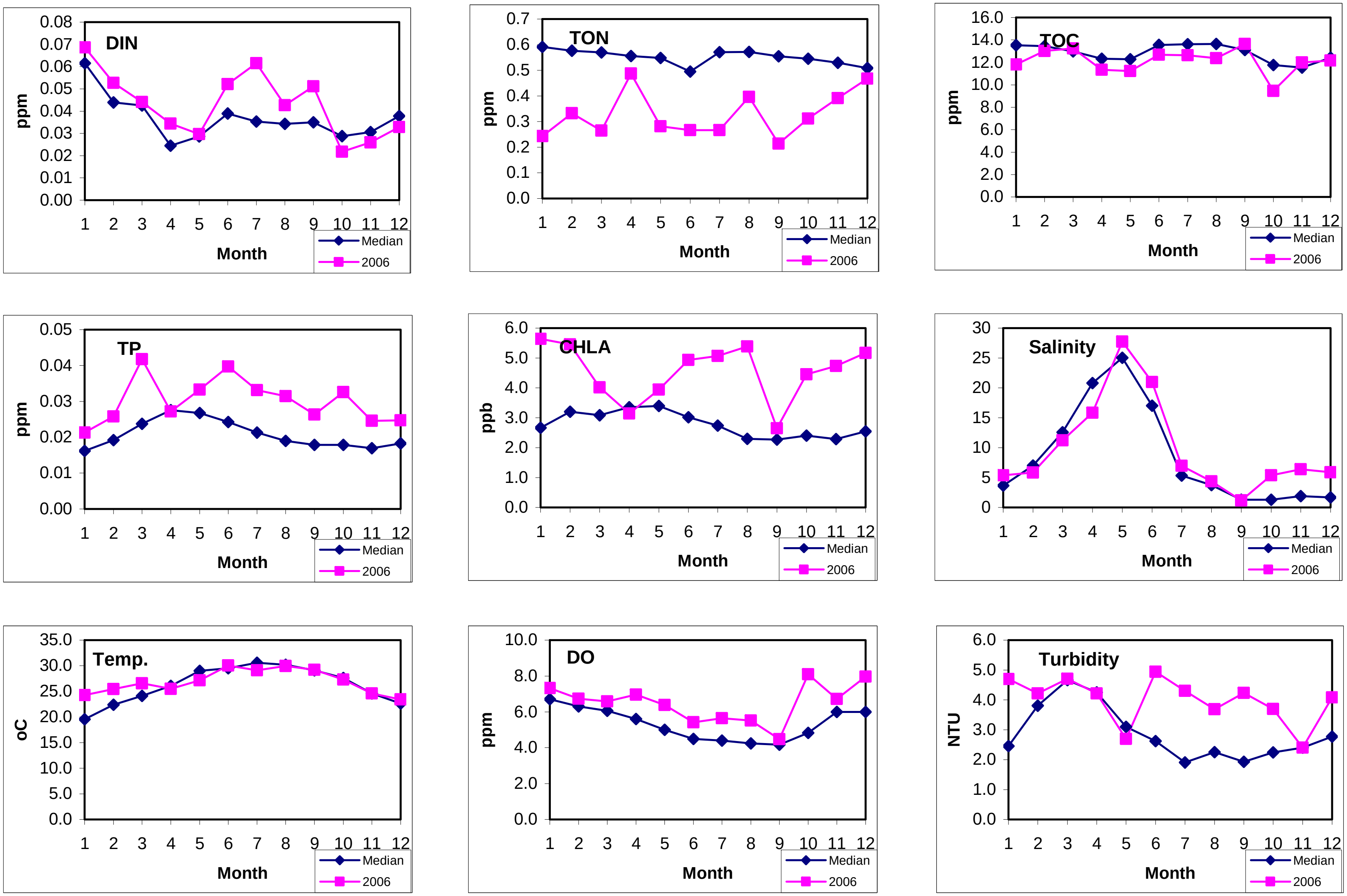


Figure 3.8. Comparison of long-term median with 2006 data.

Gulf Islands (GI)

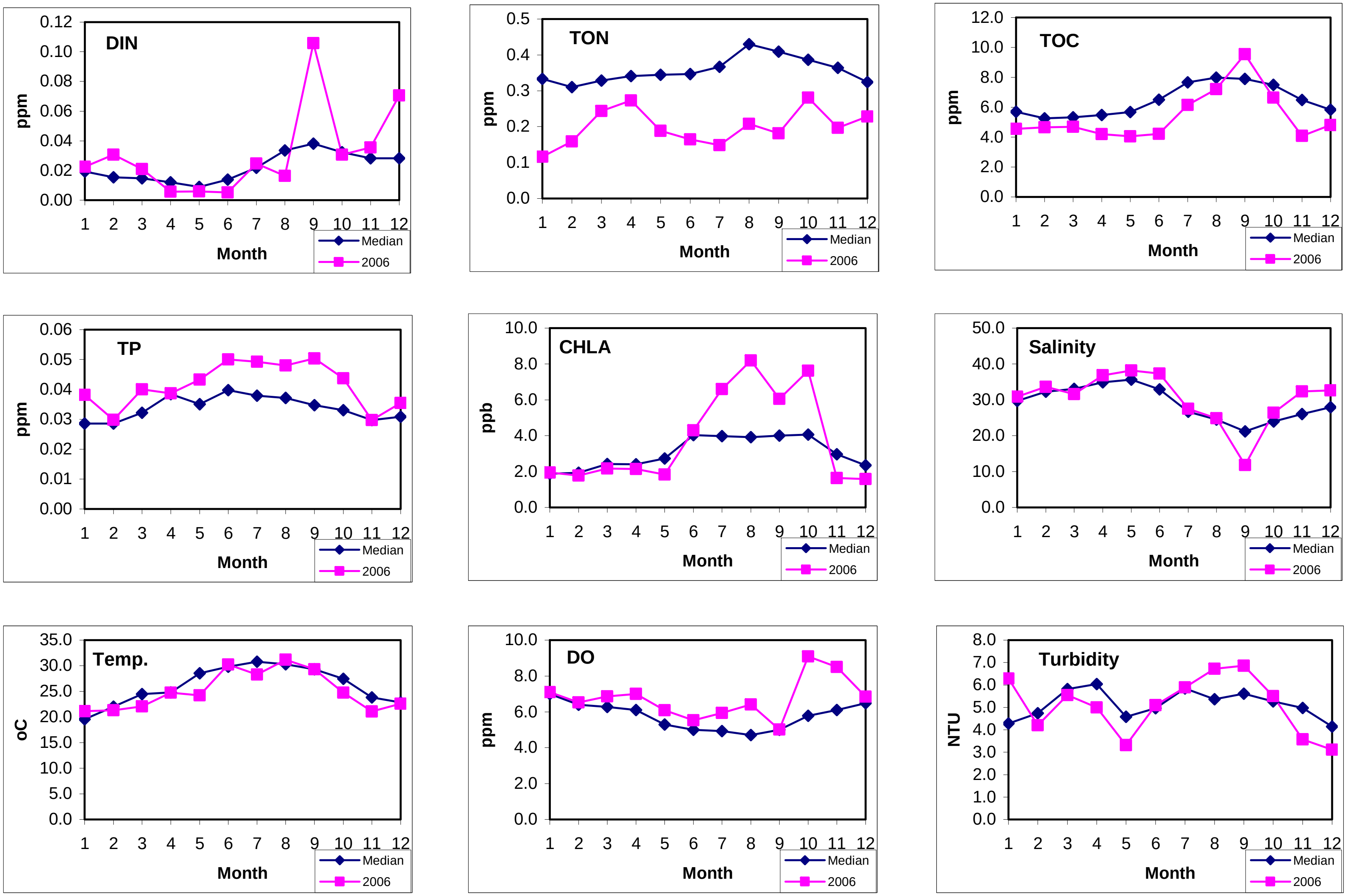


Figure 3.8. Comparison of long-term median with 2006 data.

Inner Waterway (IWW)

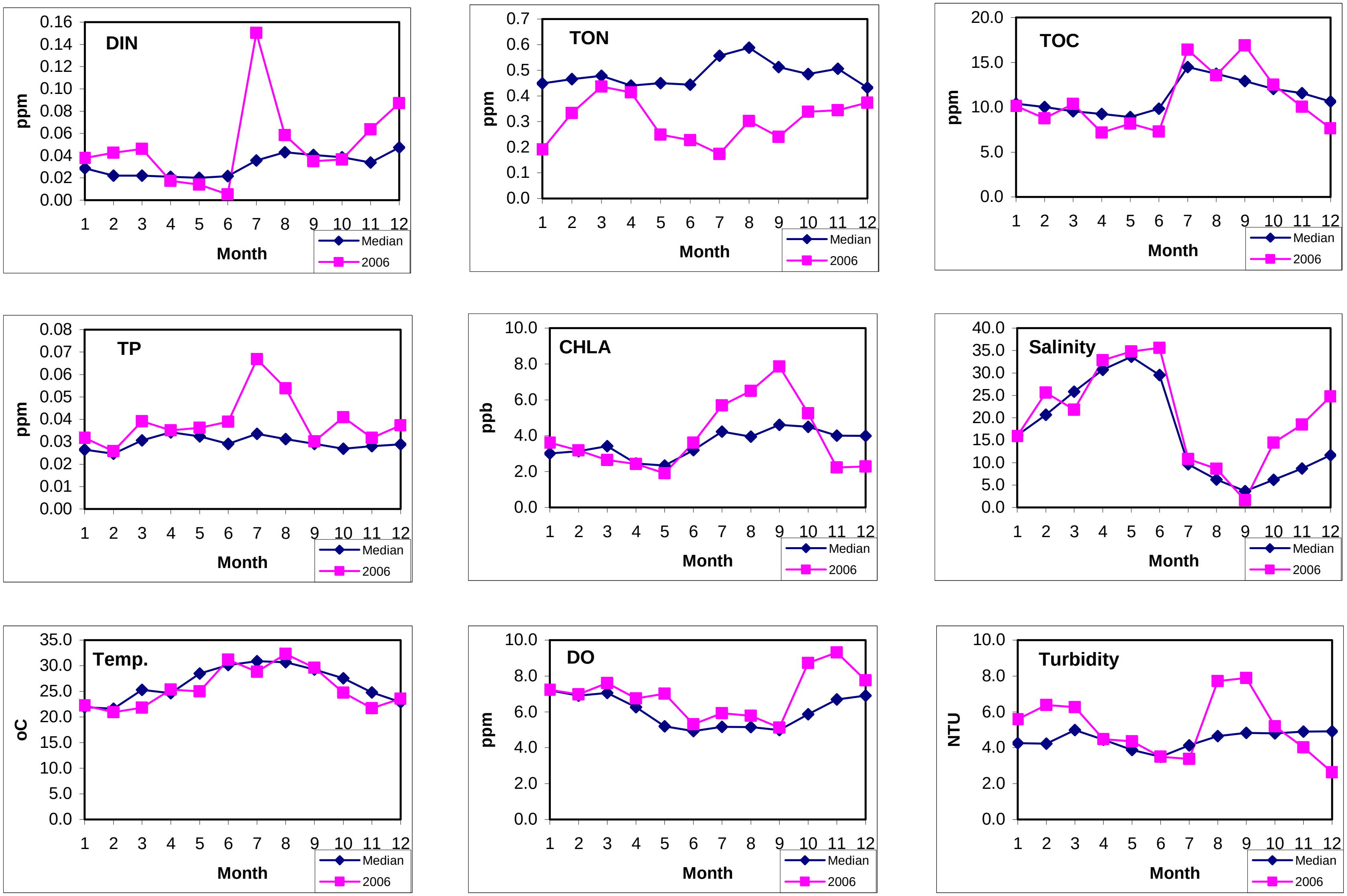


Figure 3.9. Comparison of long-term median with 2006 data.

Blackwater River (BLK)

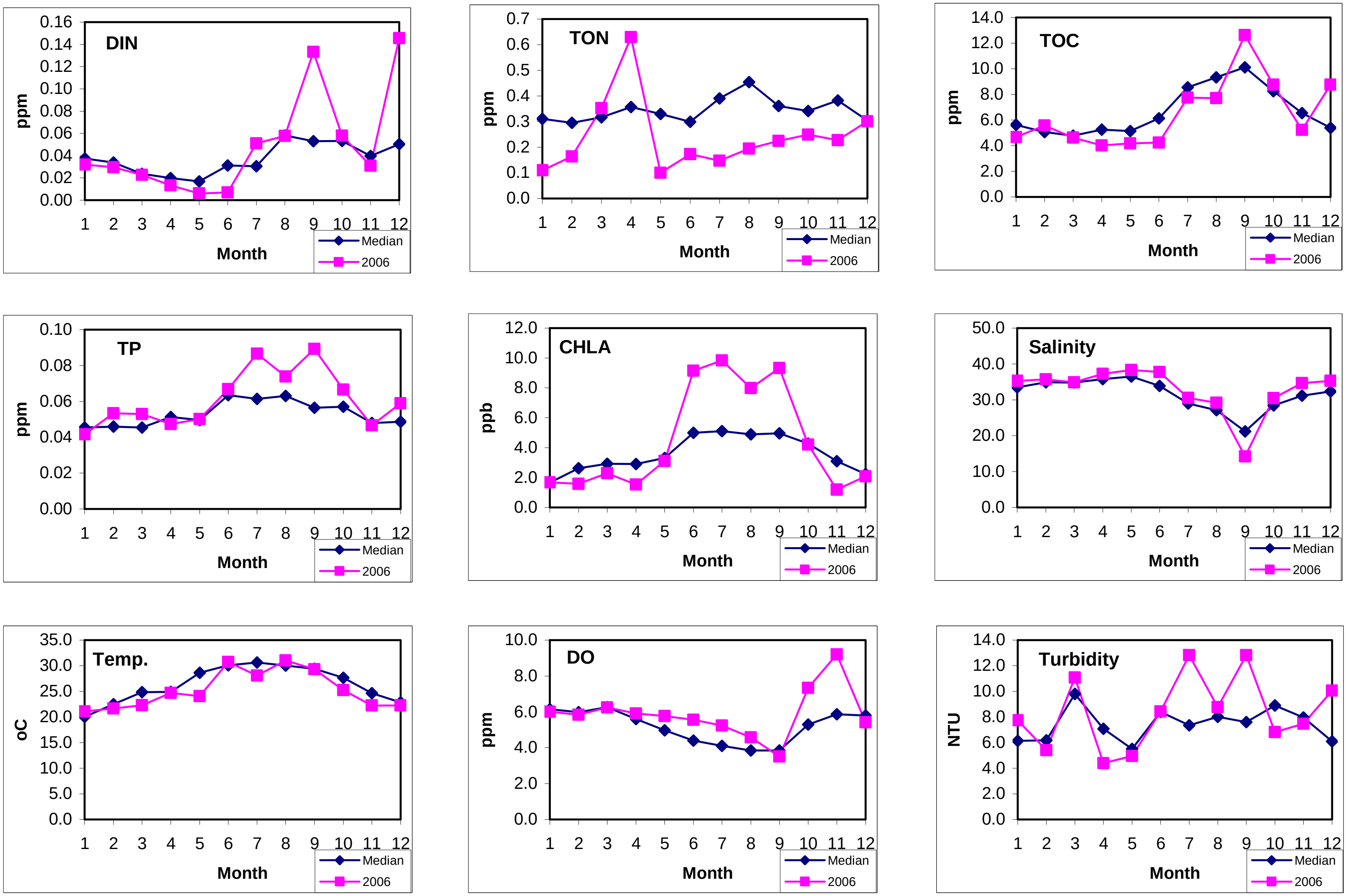


Figure 3.10. Comparison of long-term median with 2006 data.

4. STATE OF WATER QUALITY IN BISCAYNE BAY

<u>Overall Period of Record</u>

A spatial analysis of data from our monitoring program resulted in the delineation of 6 groups of stations, which have robust similarities in water quality (Fig. 4.1). The first cluster was composed of 2 stations closest to the shore in the south Bay and was called the Alongshore group (AS). These are stations most influenced by the Goulds, Military and Mowry Canals. The second cluster was made up of the 5 stations farther from the coast called Inshore (IS). Thirteen stations situated mostly in the bay proper were called the main Bay (MAIN) group. The next cluster contained 3 stations situated in areas of great tidal exchange (ocean channel, not shown). Two stations in Card Sound grouped together SCARD. Finally, the Turkey Point station comprised its own cluster (not shown).

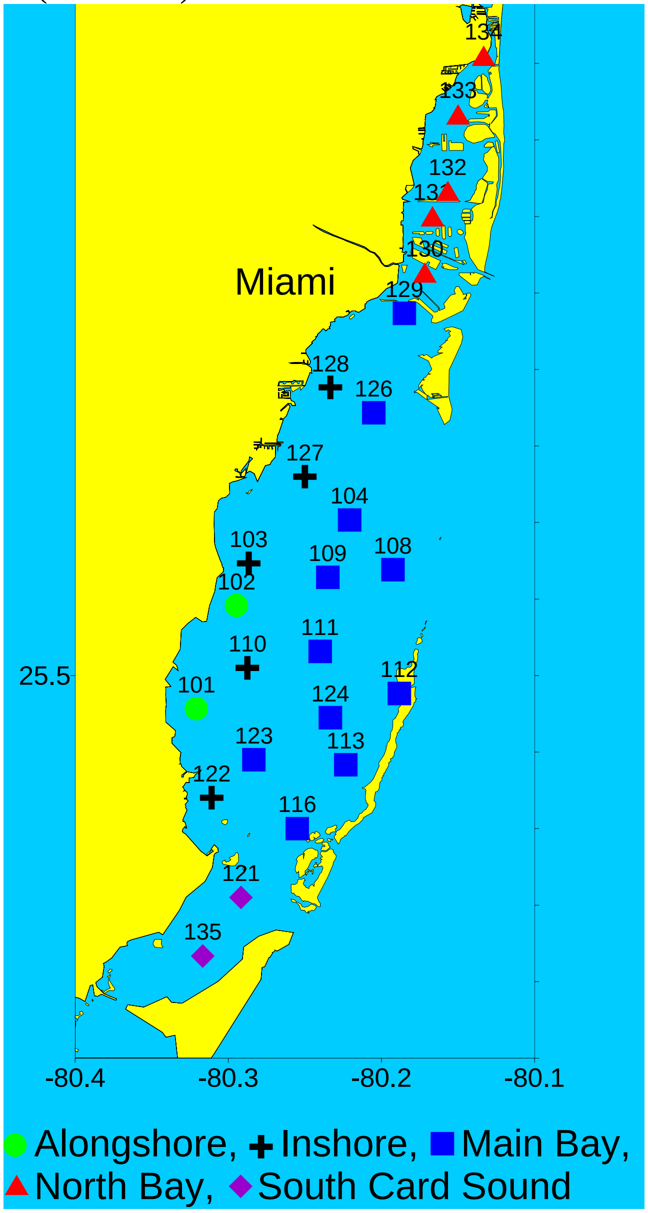


Figure 4.1. Zones of similar water quality in Biscayne Bay.

As mentioned previously, 10 stations were selected for their status as being either redundant (as in some of the Main Bay stations) or as outliers (Turkey Point and the ocean channel sites) and redistributed throughout the Bay to provide us with more complete coverage. For purposes of this report, the stations added to the area north of the Rickenbacker Causeway are defined, a priori, as a distinct cluster, North Bay (NBAY).

There was a gradient of increasing salinity with distance from the west coast of the Bay (AS <IS <MAIN clusters Fig. 4.2-4.6). Opposite to the salinity gradient, highest concentrations of CHLA, DIN, and TP were observed near the coast. These type of gradients are indicative of anthropogenic inputs. NBAY showed DIN levels comparable to the high concentrations seen AS but had a higher median salinity. In addition, NBAY had the highest median TP concentration of any zone. SCARD had relatively high DIN concentrations relative to the other nutrients. Some of this may be attributed to the long water residence time of this basin as evidence by near ocean salinities. TOC concentrations were highest in AS > IS > MAIN, denoting a freshwater source (not shown).

Alongshore Zone

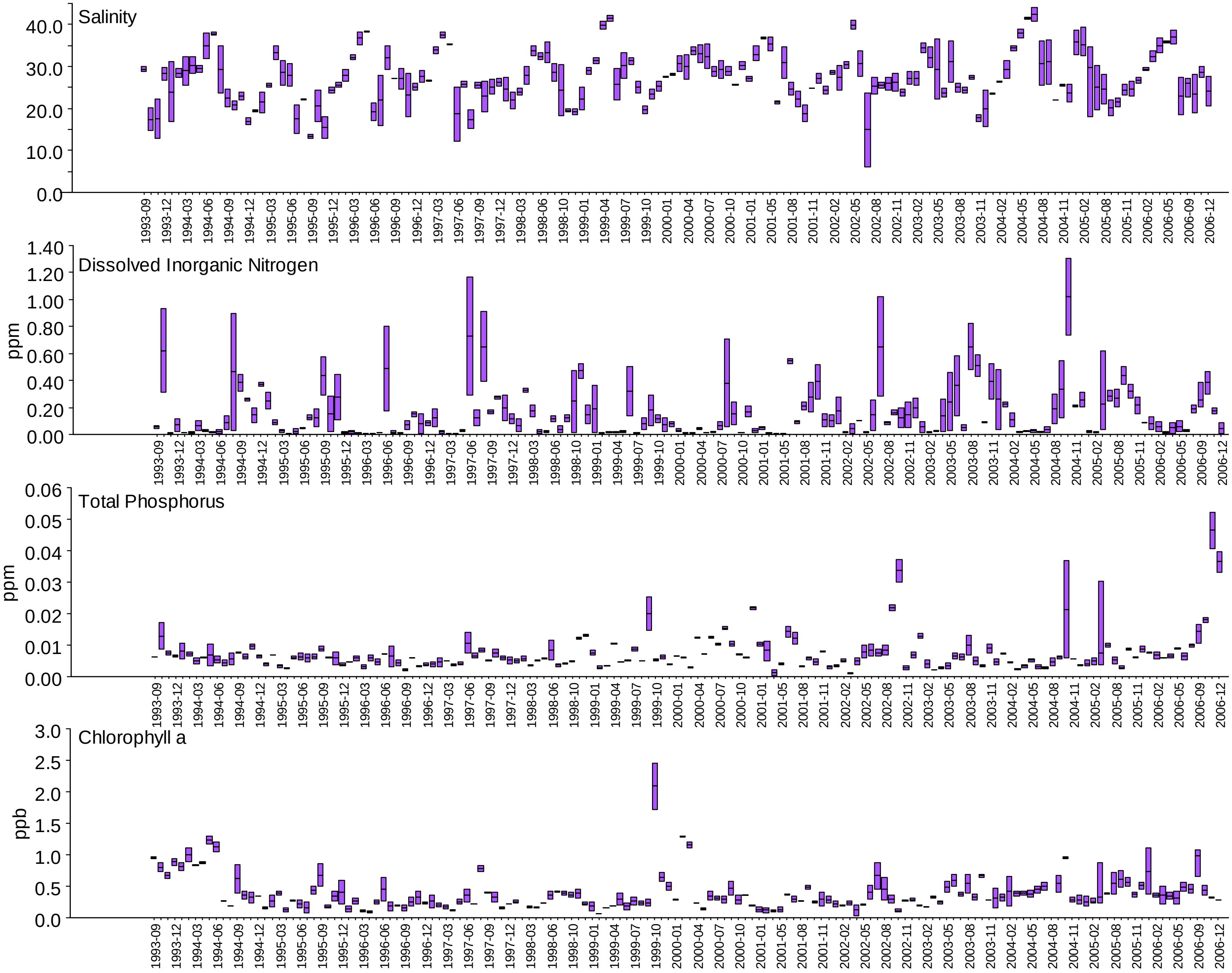


Figure 4.2. Box-and-whisker plots of water quality in Biscayne Bay by survey.

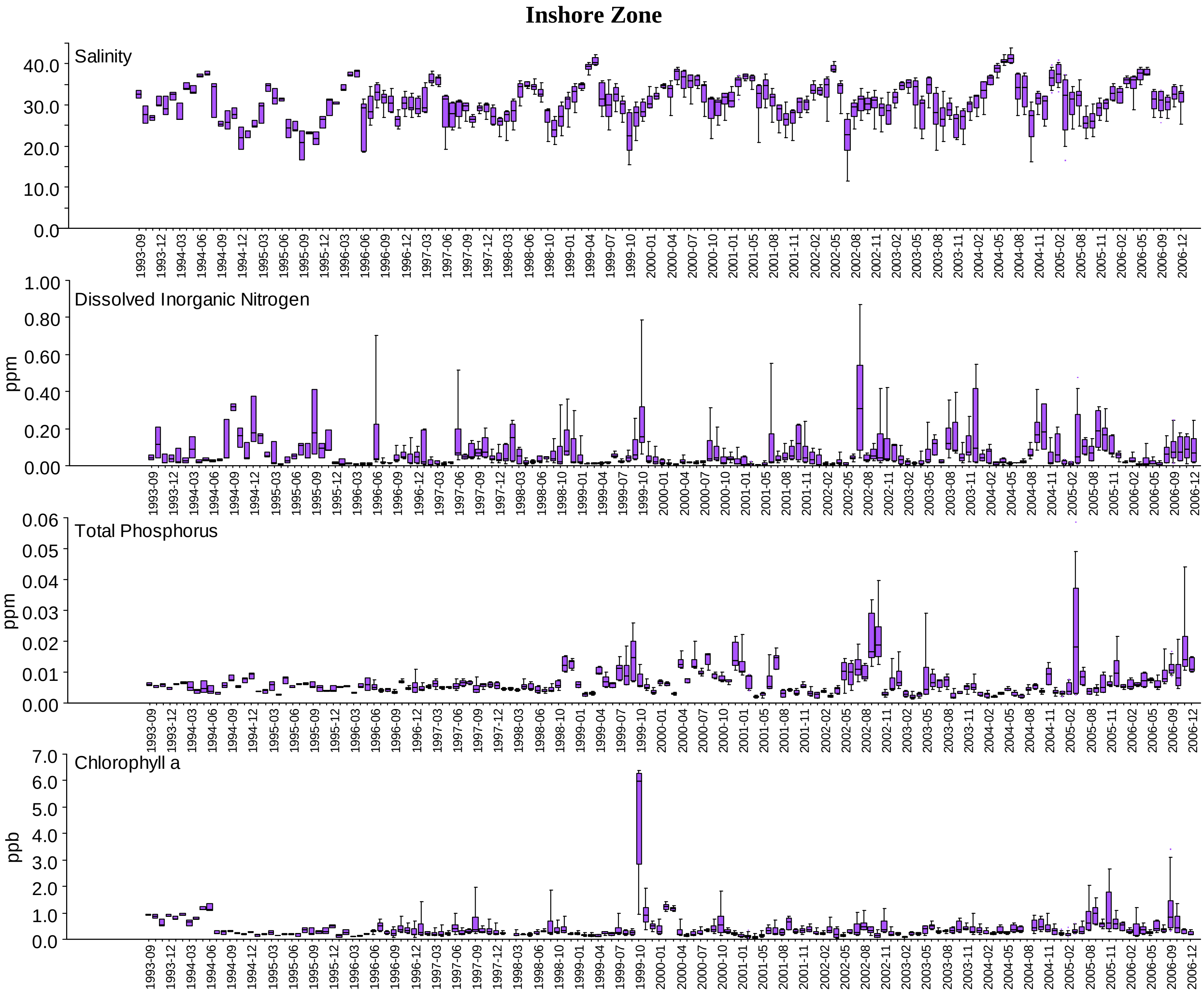


Figure 4.3. Box-and-whisker plots of water quality in Biscayne Bay by survey.

Main Bay Zone

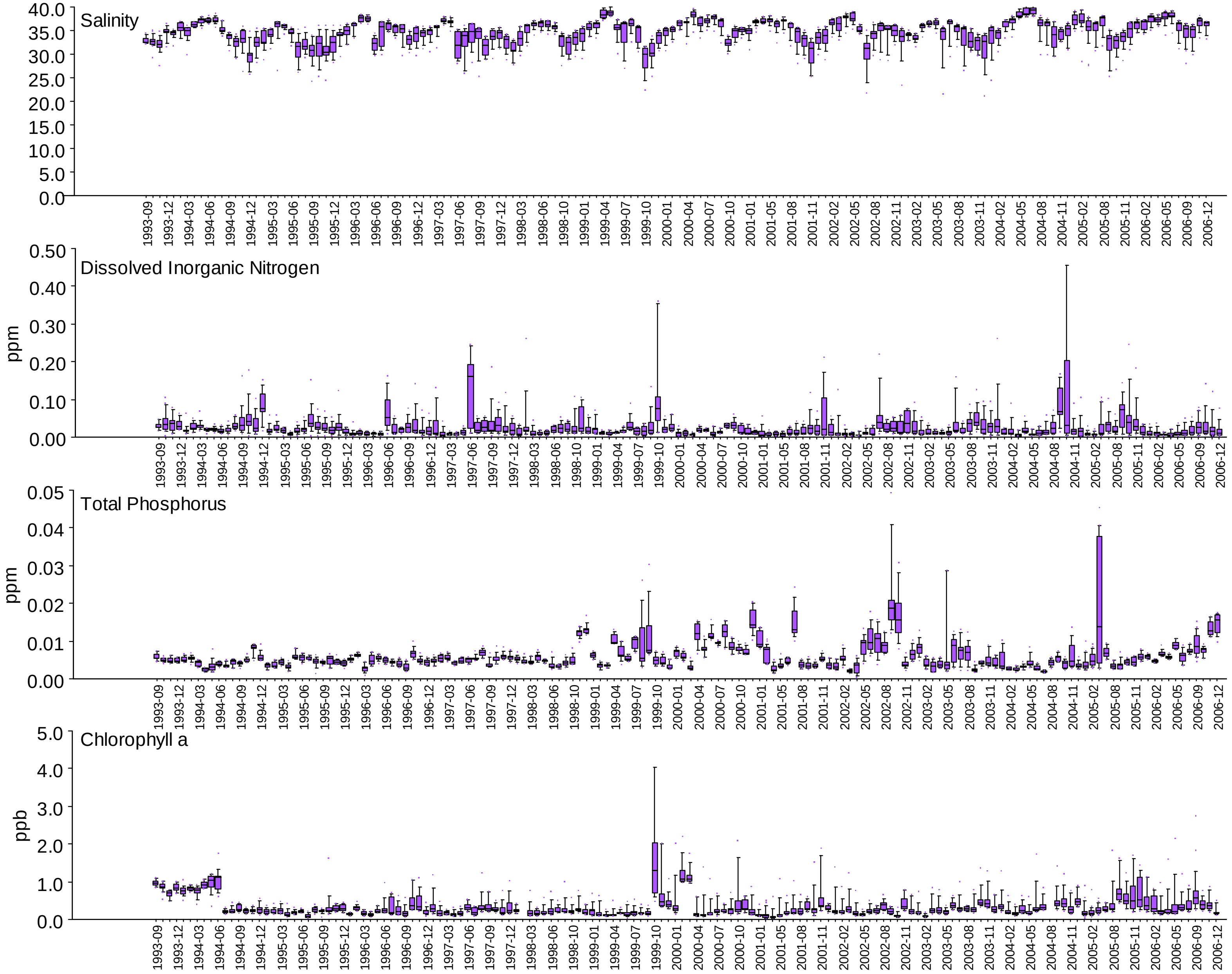


Figure 4.4. Box-and-whisker plots of water quality in Biscayne Bay by survey.

South Card Sound Zone

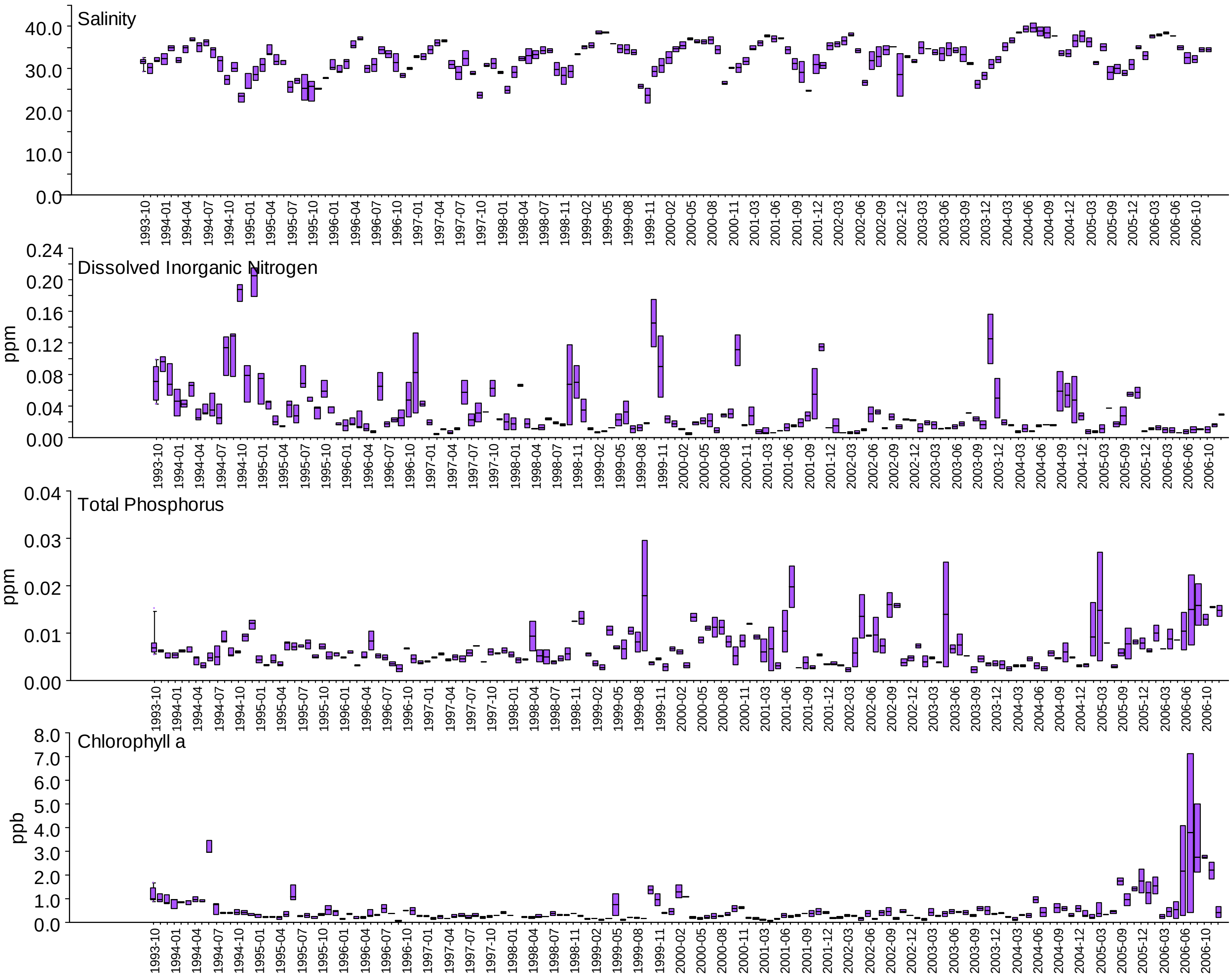


Figure 4.5. Box-and-whisker plots of water quality in Biscayne Bay by survey.

North Bay Zone

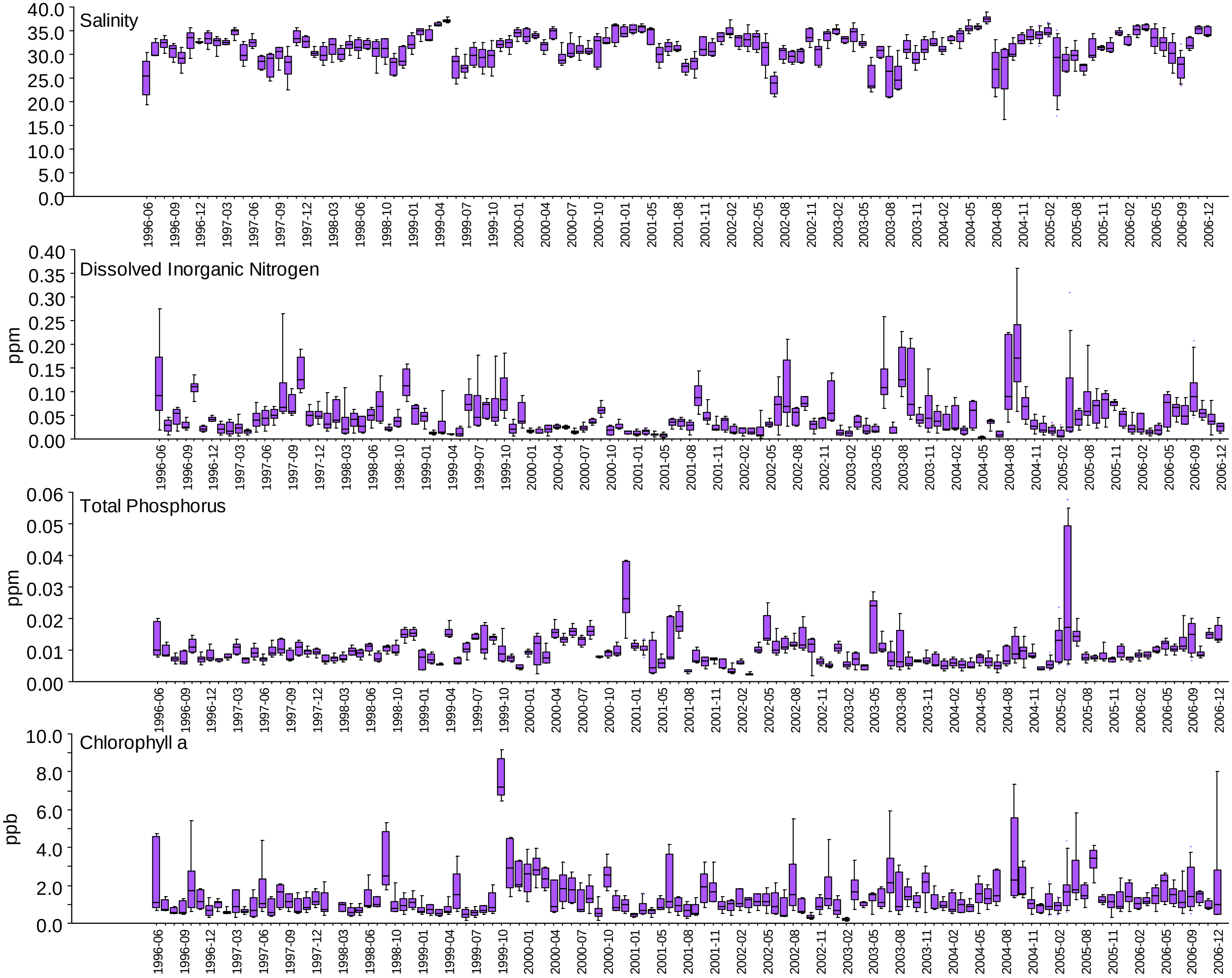


Figure 4.6. Box-and-whisker plots of water quality in Biscayne Bay by survey.

2006 Alone

Salinity in Biscayne Bay is strongly modulated by its large tidal exchange with the ocean. Nevertheless, canal inputs do have a significant impact on the ecosystem, as evidenced by the reduced nearshore salinity patterns (Fig. 4.7-4.11). As 2006 was relatively dry, some areas of Biscayne Bay experience hypersalinity prior to the onset of the wet season. Unlike other zones, the Main Bay experienced hypersalinity above usual levels for almost the whole year. The largest intra-annual variations in salinity in this area are typically driven by freshwater releases from the canal system. Interestingly, salinity at the Inshore and Alongshore regions were not different than long term median.

DIN loads and concentrations in Biscayne Bay are driven by canal inputs (Caccia and Boyer in press). Drops in salinity in the Alongshore and Inshore regions coincided with increases in DIN. Fluctuations in DIN concentrations in the Main Bay were damped by its large volume. DIN in the Main Bay and South Card Sound were lower than the grand median.

Overall TP concentrations were higher than normal throughout the bay and also showed a strong increasing trend for 2006, especially for the last two months of the year. We have no explanation for this trend but will have to wait for further data to see if it continues.

CHLA in the Alongshore, Inshore, and Main Bay were slightly elevated relative to the grand median. They also exhibited a spike during the August sampling which corresponded with a depression in DO at the same time. CHLA in South Card Sound was much higher than normal, especially during the wet season. One of the reasons for this may have been the advection of the Florida Bay bloom organisms to this part of Biscayne Bay by wind forcing.

Otherwise, annual patterns in temperature and DO were unremarkable with values generally fluctuating around the median for all areas. Turbidity was highly variable during 2006, much more so than the grand median.

Data, Graphs, and Figures

All data for the period of record are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/DataDL.htm

Monthly time series graphs for all measured variables for each station are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/BB.htm

Contour maps showing spatial distributions of all measured variables (quarterly) are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/ContourMaps.htm

Alongshore (AS)

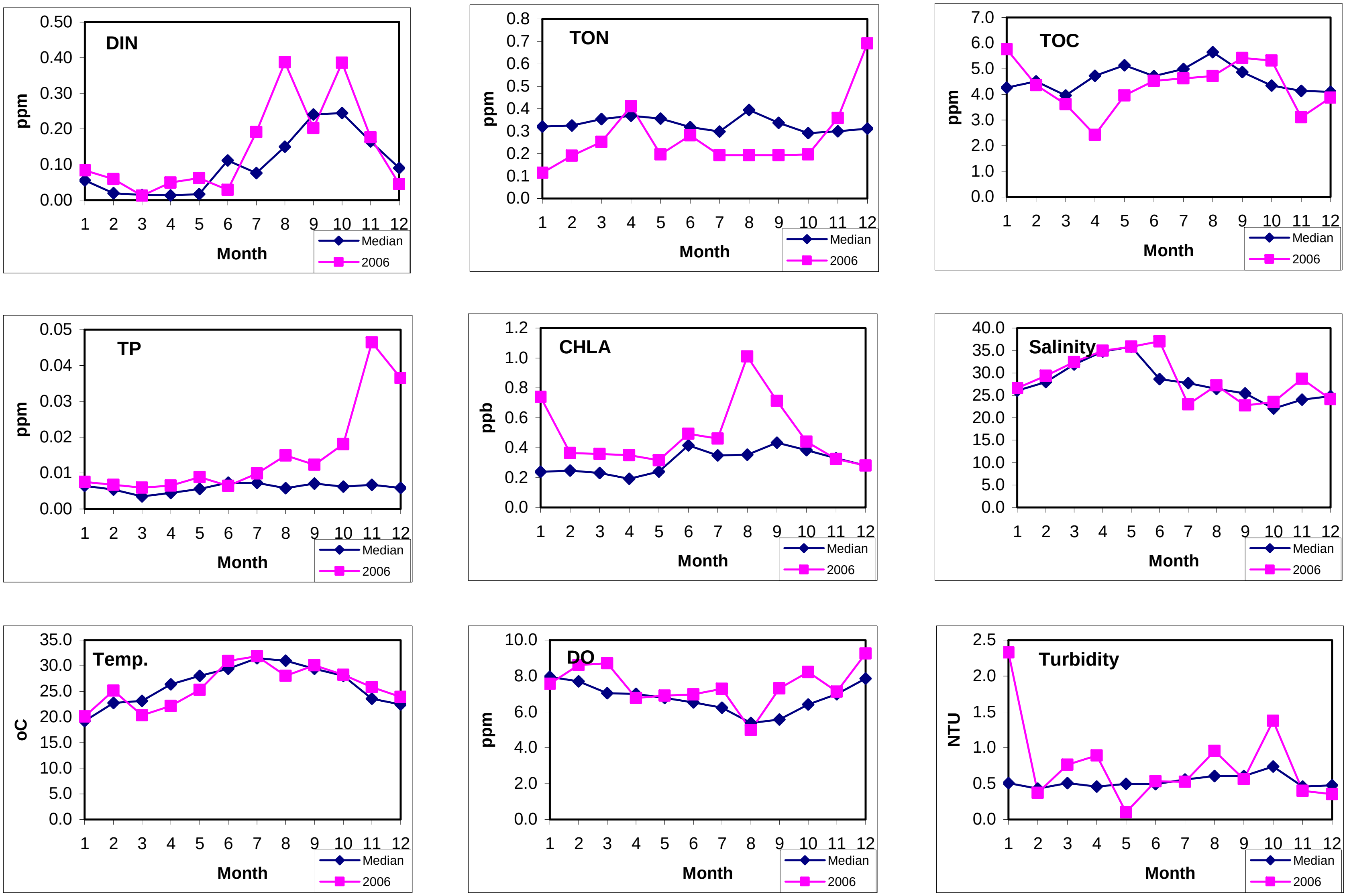


Figure 4.7. Comparison of long-term median with 2006 data.

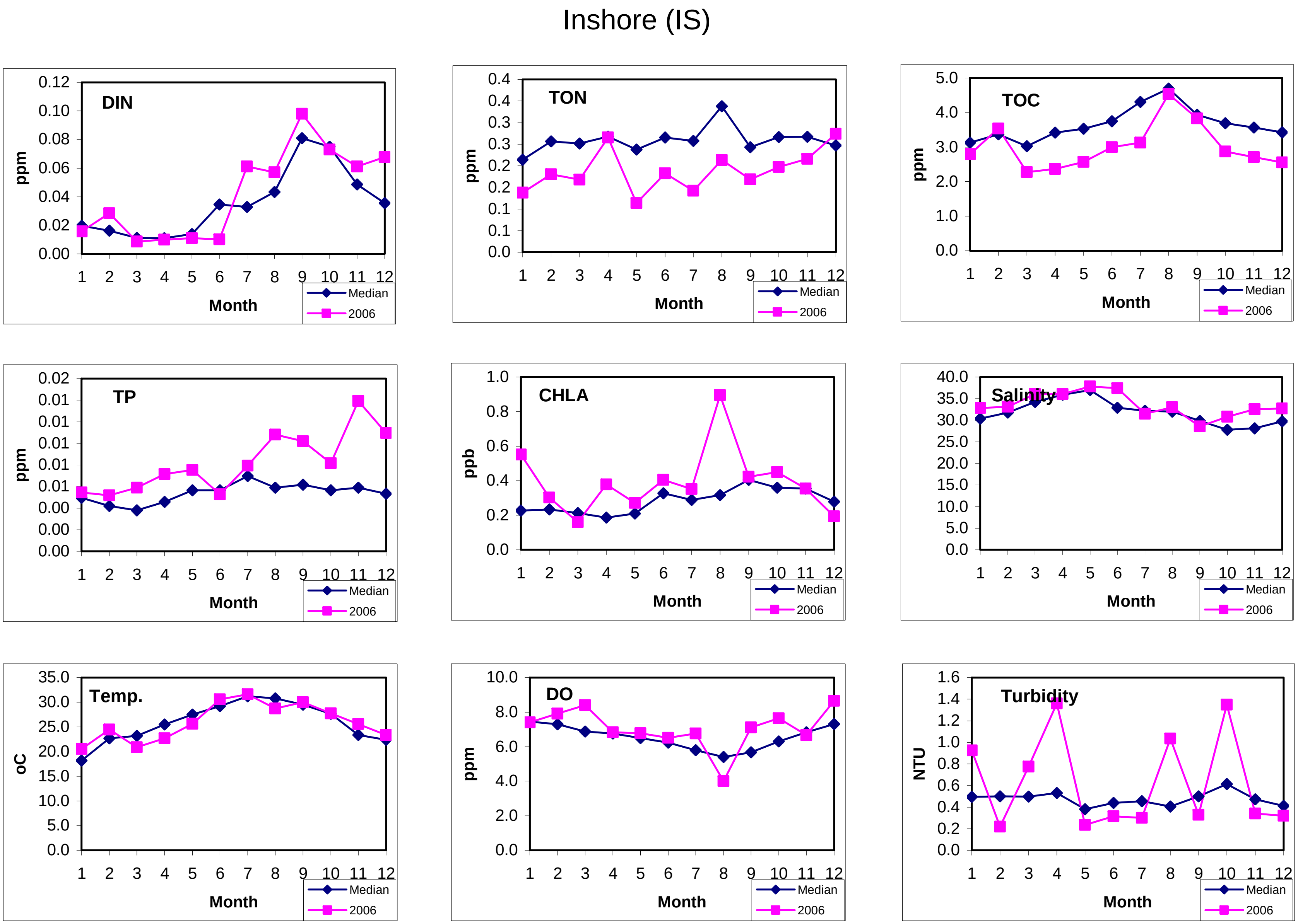


Figure 4.8. Comparison of long-term median with 2006 data.

Main Bay (MAIN)

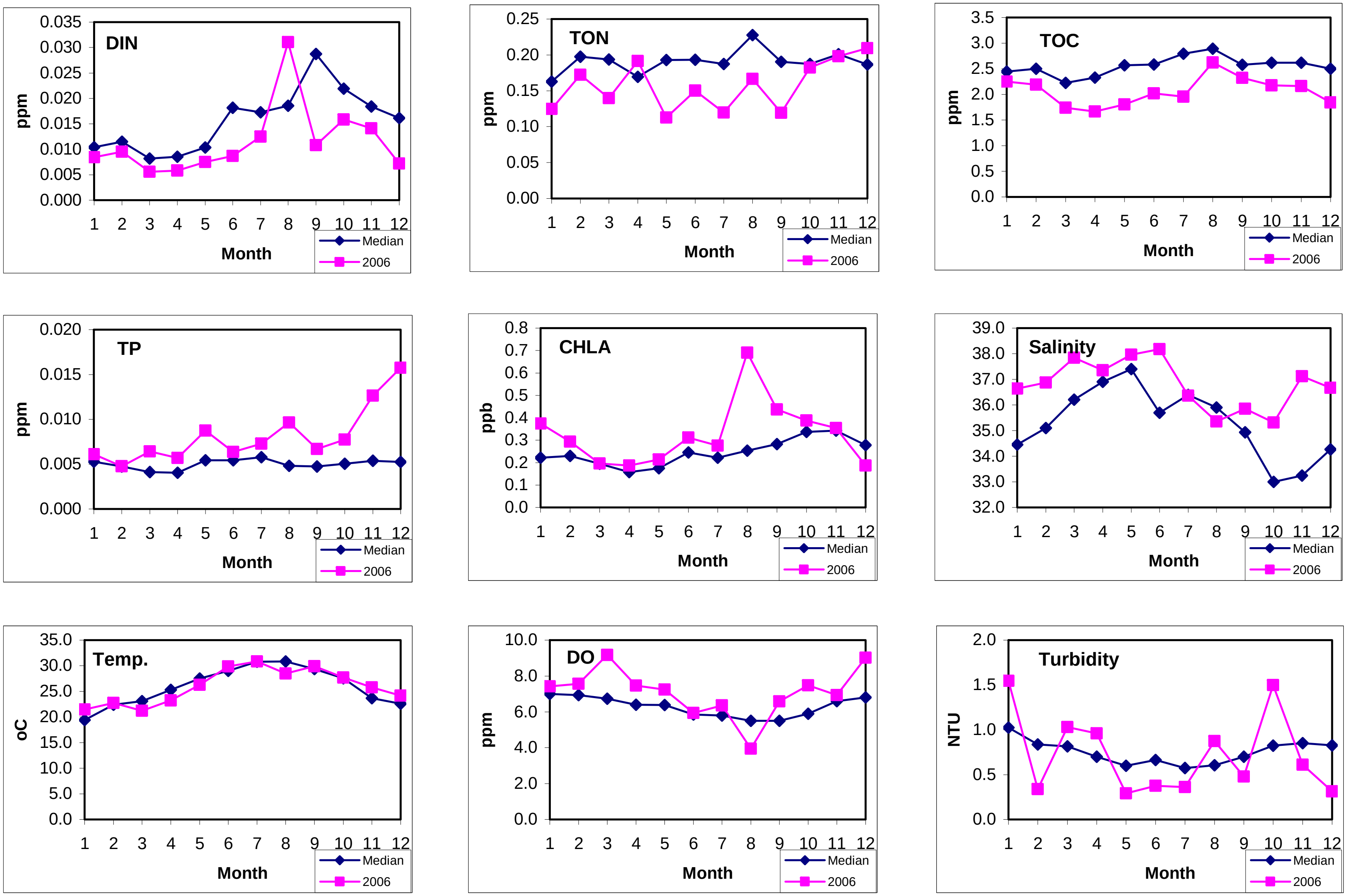


Figure 4.9. Comparison of long-term median with 2006 data.

South Card Sound (SCARD)

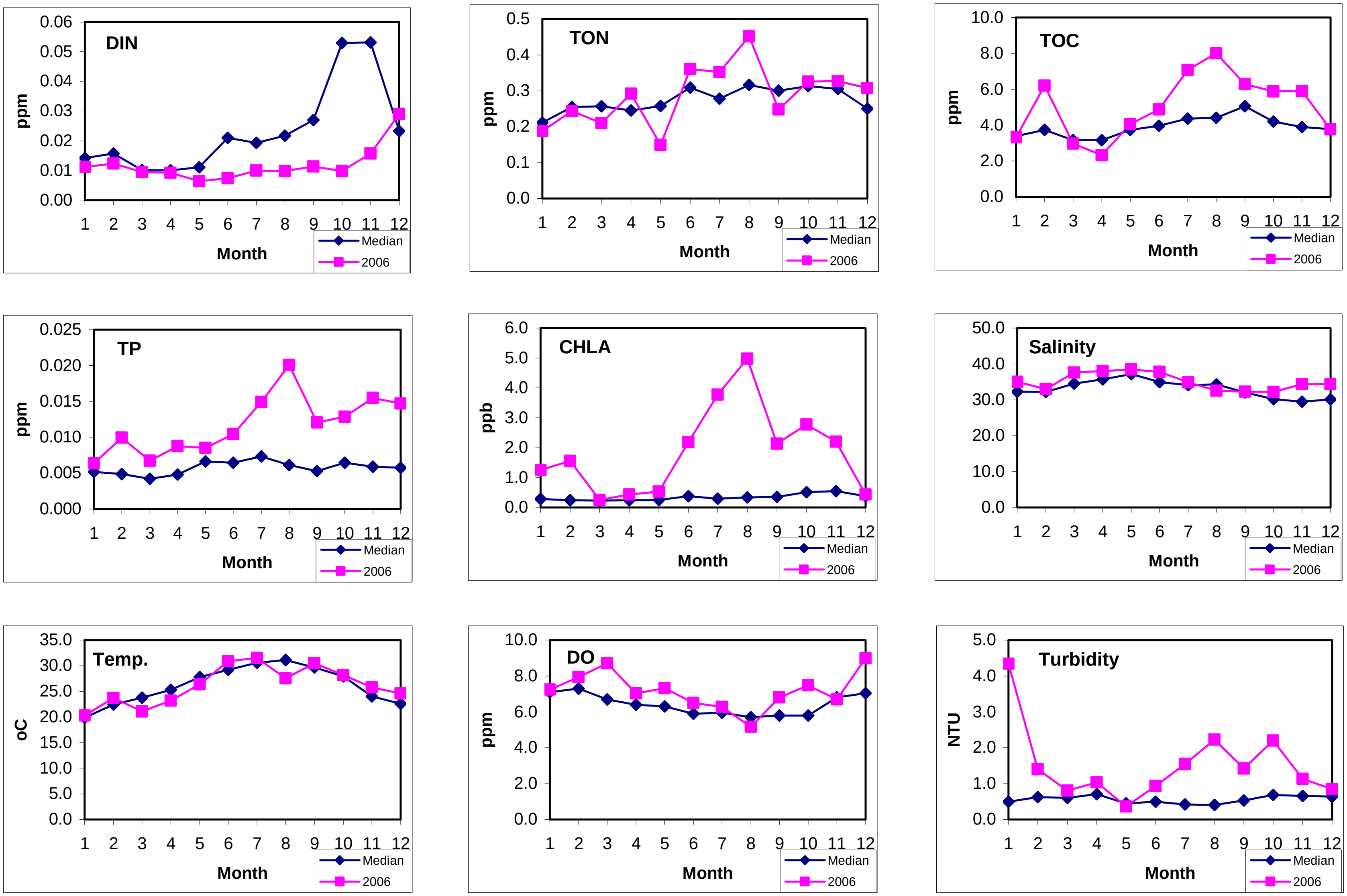


Figure 4.10. Comparison of long-term median with 2006 data.

North Bay (NBAY)

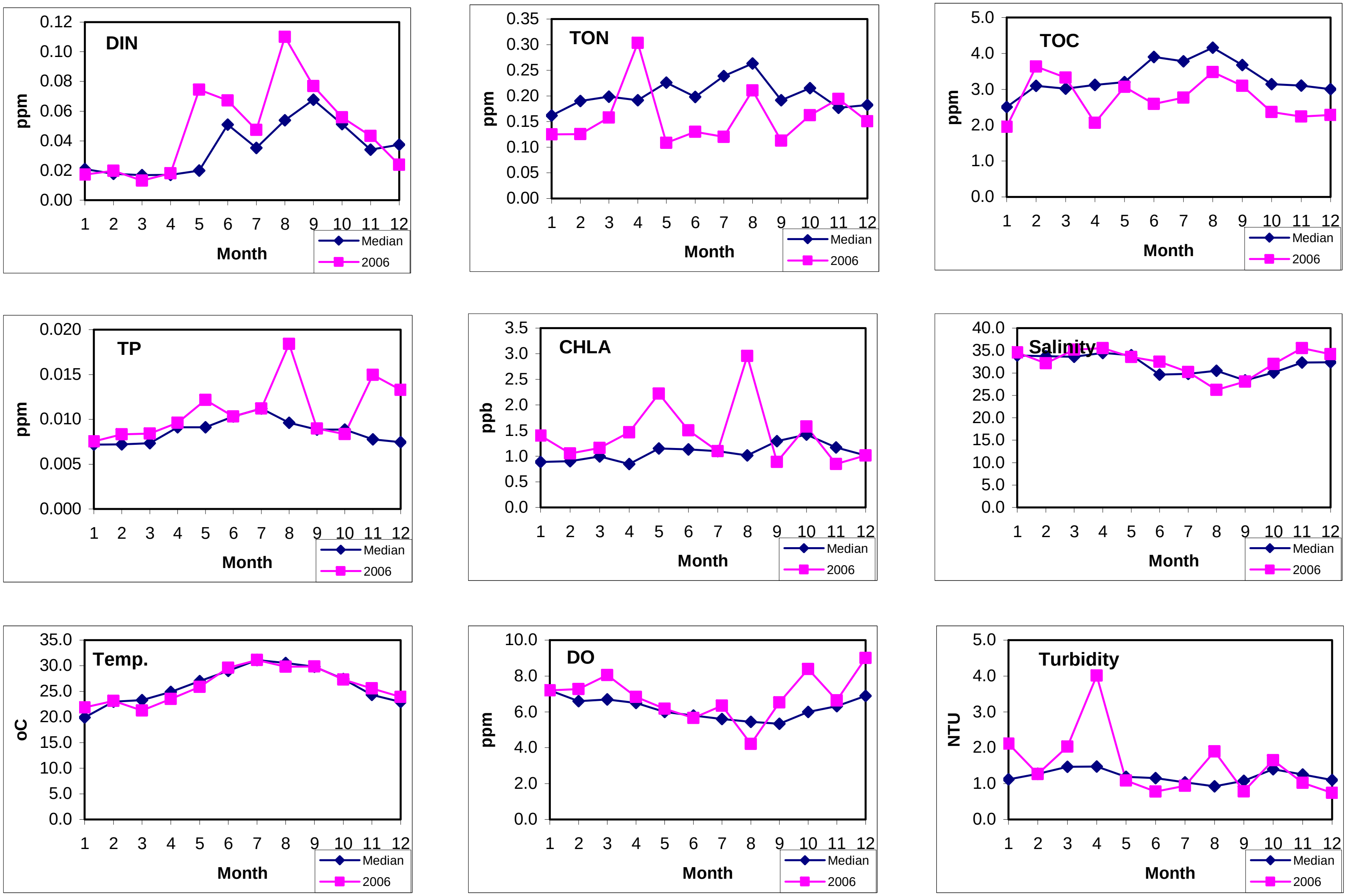


Figure 4.11. Comparison of long-term median with 2006 data.

5. STATE OF WATER QUALITY ON THE SOUTHWEST FLORIDA SHELF

Overall Period of Record

A spatial analysis of data from our monitoring program resulted in the delineation of 3 groups of stations, which have robust similarities in water quality (Fig. 5.1). The first cluster was composed of only 2 stations, which were closest to the shore off Cape Sable; they were called the SHARK group after the Shark River, the main source of freshwater to the region. The second cluster was made up of the 7 more northerly stations nearest the coast and called SHOAL. The remaining stations were called the SHELF group.

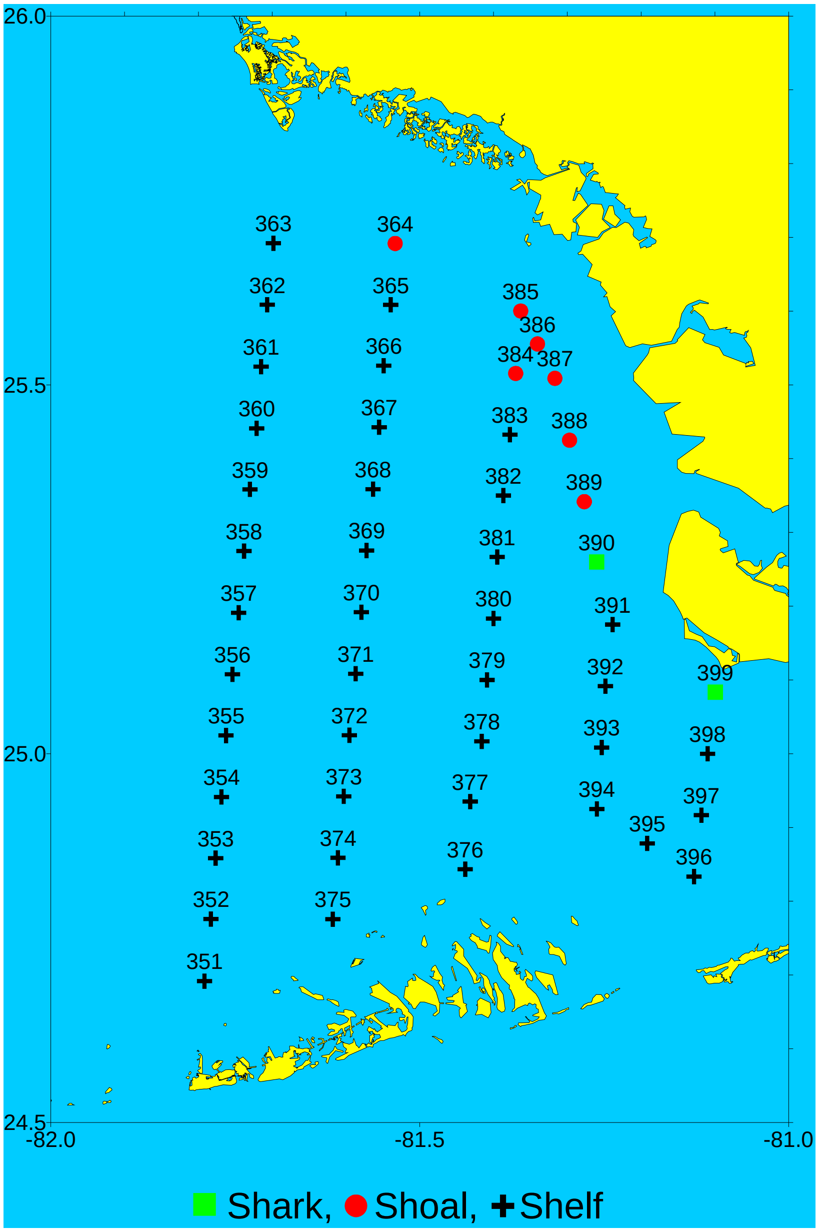


Figure 5.1. Zones of similar water quality on the SW Shelf.

Salinity was lowest in the SHARK zone as a result of the Shark River, Everglades influence (Fig. 5.2-5.4). There is a decreasing concentration gradient of SHARK > SHOAL > SHELF for CHLA, TP, and TOC. It is clear that the SHARK stations have higher DIN concentrations while the SHOAL and SHELF stations were similar.

Although these analyses are preliminary (only 46 sampling events) it is possible to speculate that the clusters are formed as a function of hydrology and circulation patterns. We believe that the SHARK stations clearly show the input of freshwater from Shark River being transported south and east around the Cape. Water overlying the SHOAL stations probably originates somewhere in or north of the Ten Thousand Islands. Our level of resolution is very low due to the limited numbers of sampling events and by the relatively large spatial gap between coastal and Shelf sampling sites.

A better understanding of local circulation patterns in addition to increased density and frequency of sampling in the nearshore region may help define the coupling between freshwater inflow and Shelf water quality. This is a preliminary analysis and will be repeated after a few more years of data have been collected.

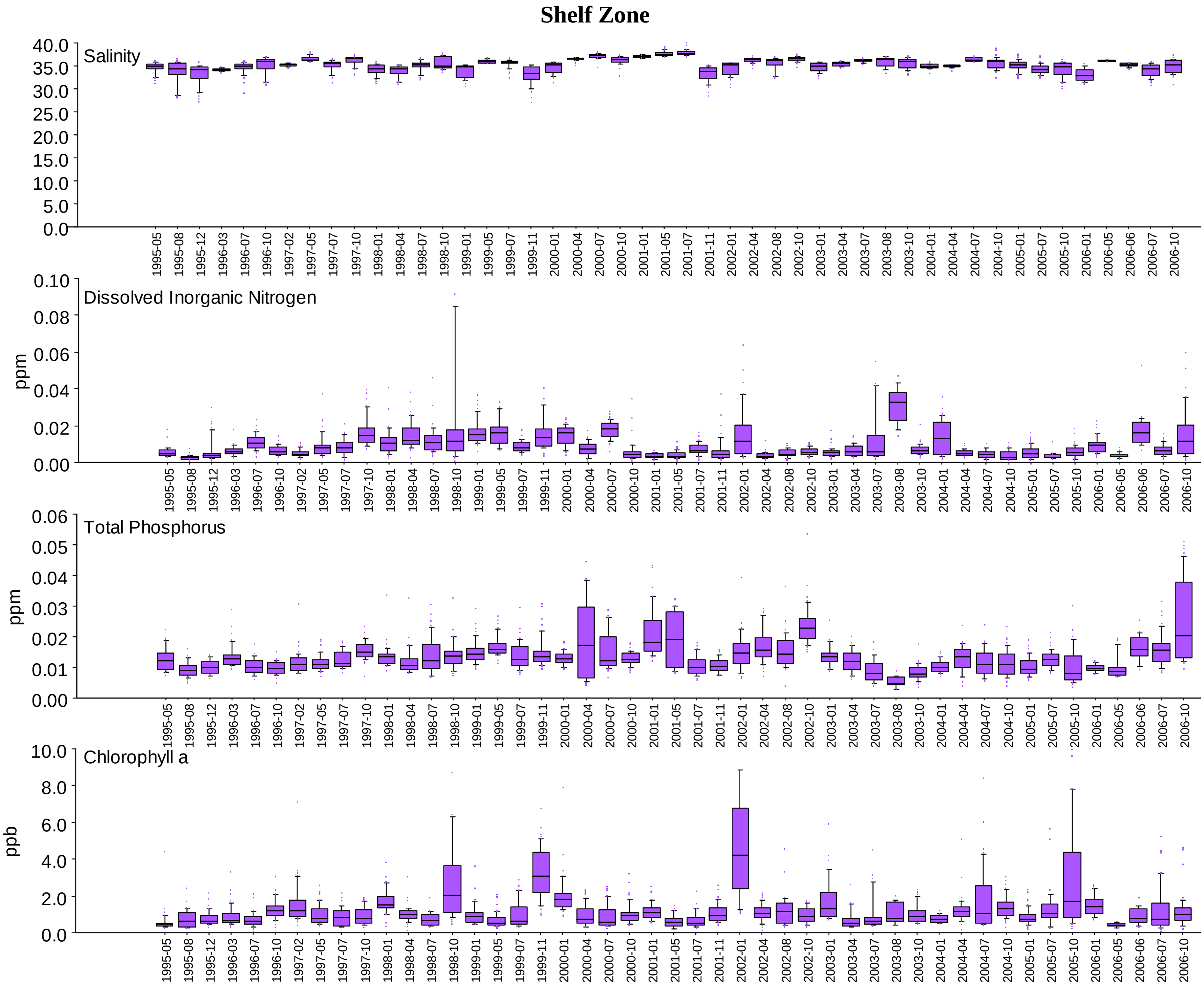


Figure 5.2. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

Shark Zone

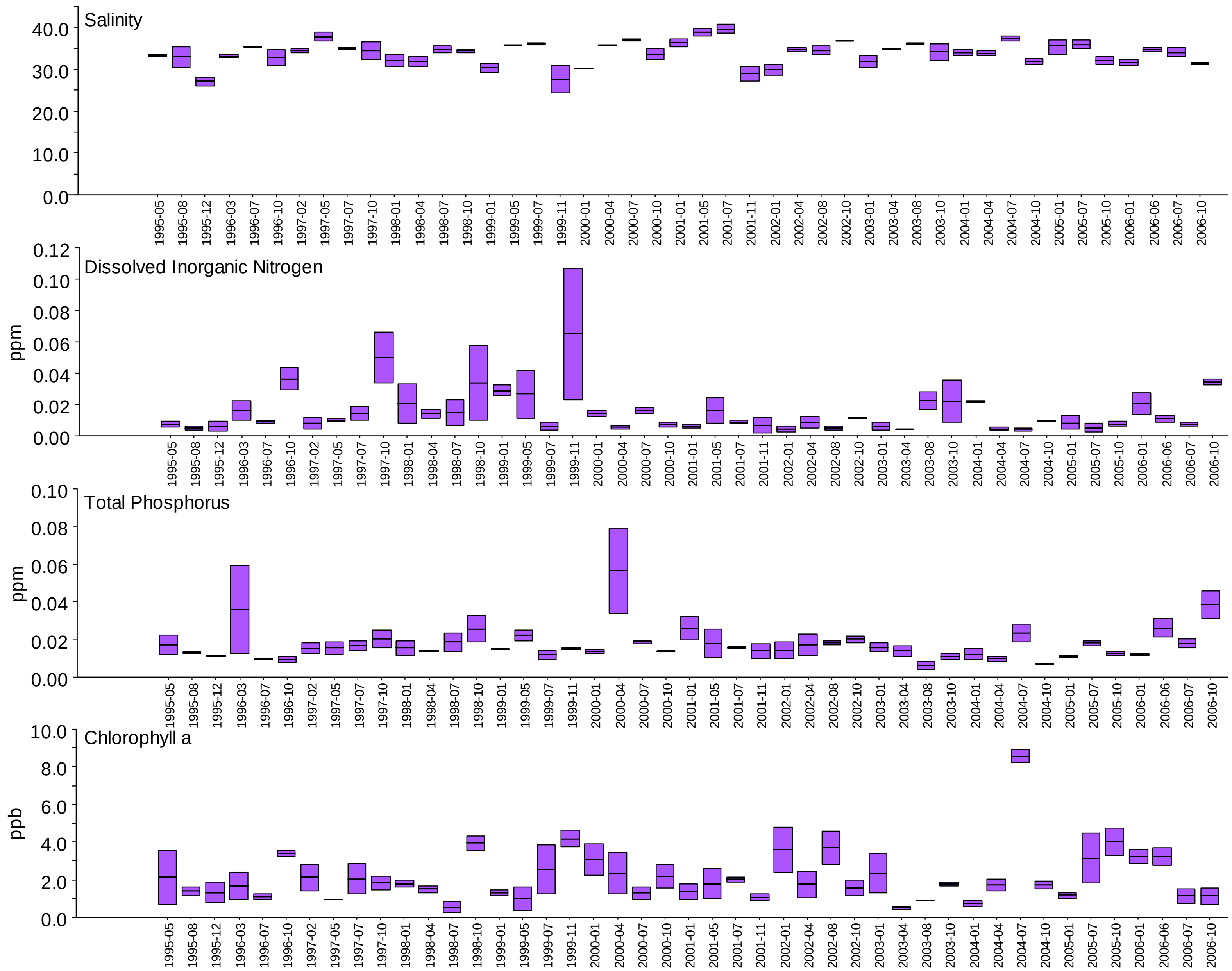


Figure 5.3. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

Shoal Zone

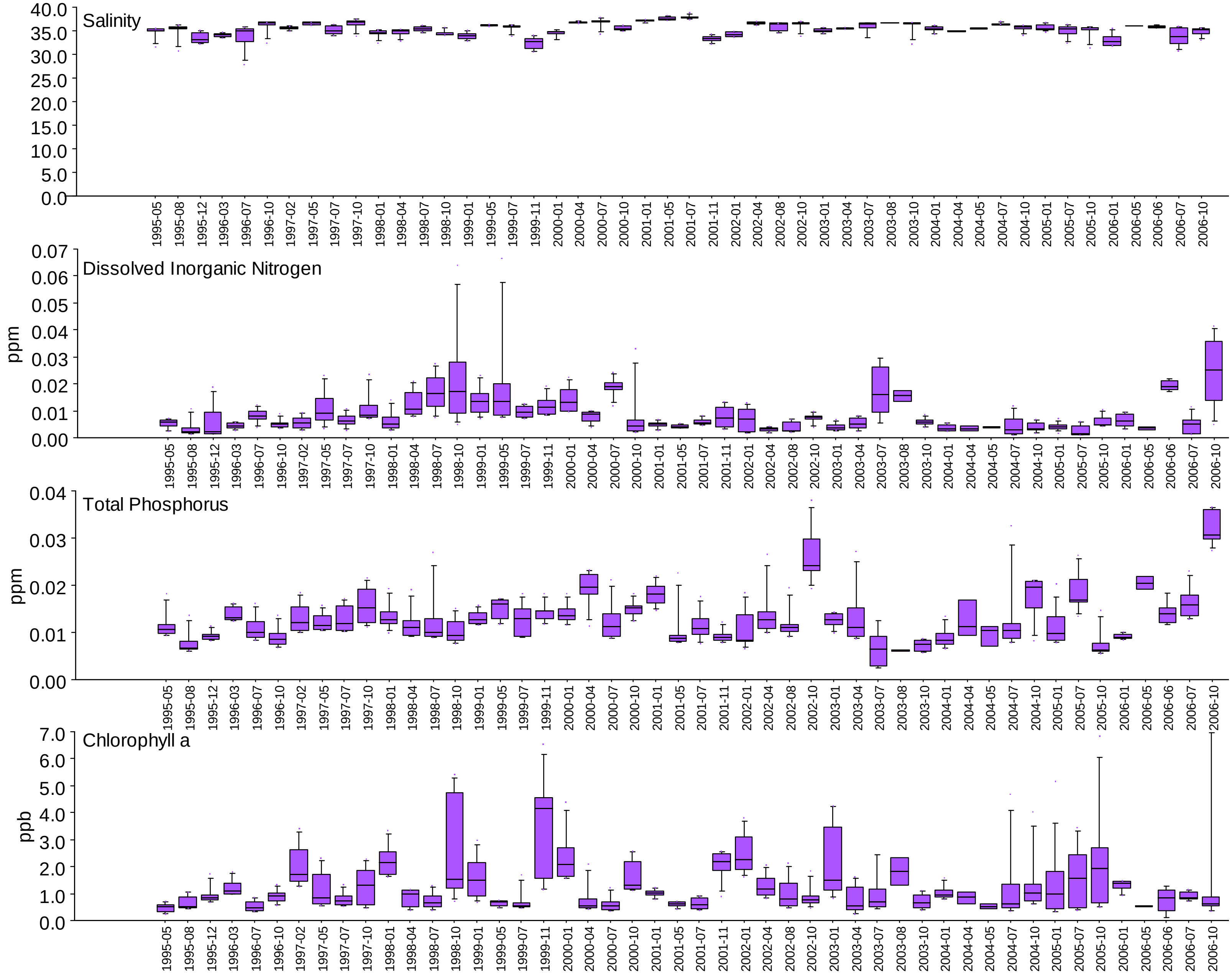


Figure 5.4. Box-and-whisker plots of water quality in SW Florida Shelf by survey.

2006 Alone

Since this component of the monitoring program began in 1995 and is only sampled quarterly, there is not as much trend data to analyze as for other components. Although these analyses are preliminary it is possible to speculate that the clusters are formed as a function of hydrology and circulation patterns. We believe that the most inshore cluster (SHARK) clearly shows the input of freshwater from Shark River being transported south and east around the Cape. Water overlying the shoal stations probably originates somewhere in or north of the Ten Thousand Islands. Our level of resolution is very low due to the limited numbers of sampling events and by the relatively large spatial gap between coastal and Shelf sampling sites. A better understanding of local circulation patterns in addition to increased density and frequency of sampling in the nearshore region may help define the coupling between freshwater inflow and Shelf water quality

Overall, 2006 was relatively unremarkable except for a few outliers (Fig. 5.5-5.7). TON was lower than normal for most of the year, CHLA was elevated in the Shark zone, and DO was lower for most areas prior to the wet season.

Data, Graphs, and Figures

All data for the period of record are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/DataDL.htm
Monthly time series graphs for all measured variables for each station are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/Shelf.htm
Contour maps showing spatial distributions of all measured variables (quarterly) are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/ContourMaps.htm

Shark (SHARK)

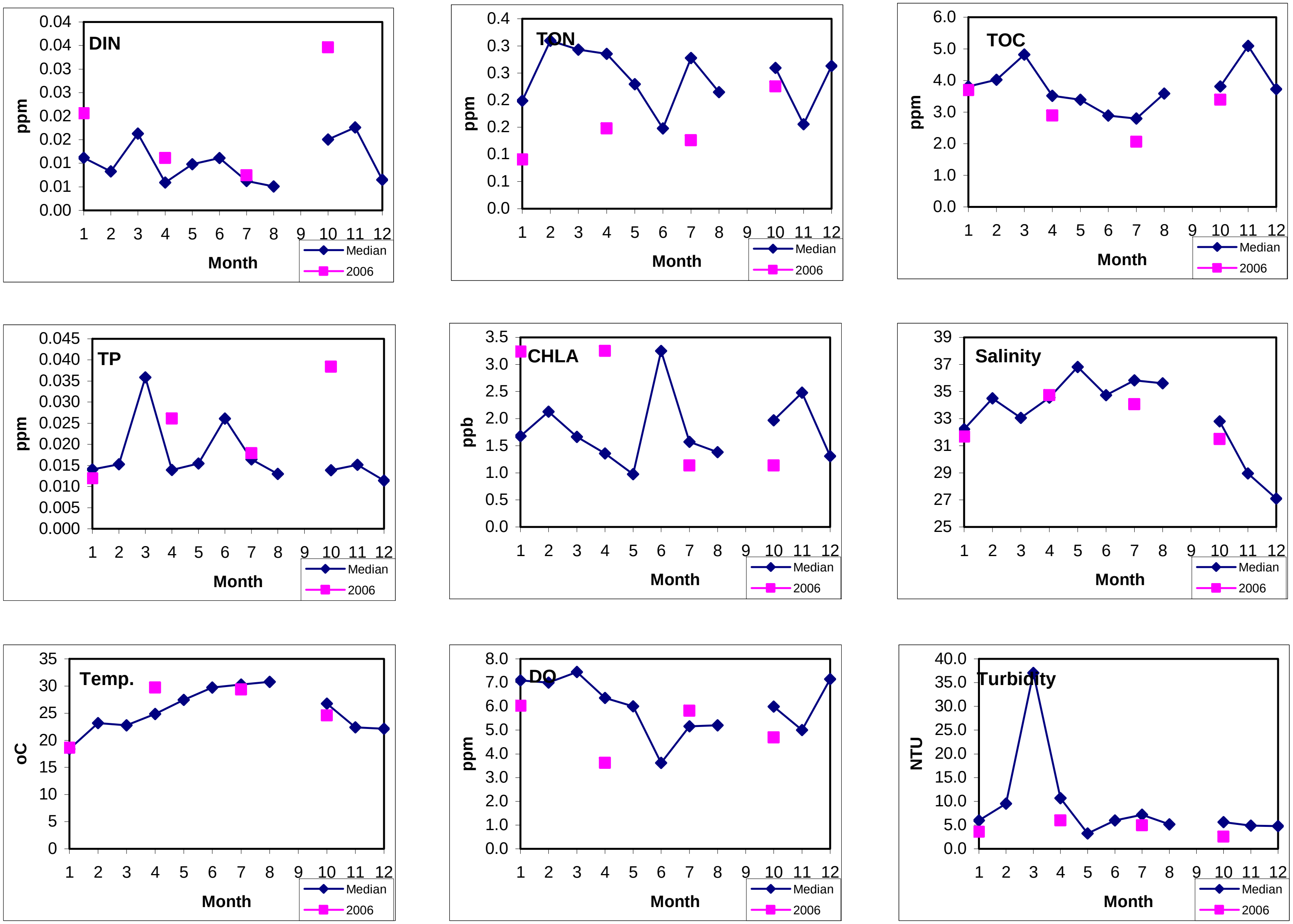


Figure 5.5. Comparison of long-term median with 2006 data.

Shelf (SHELF)

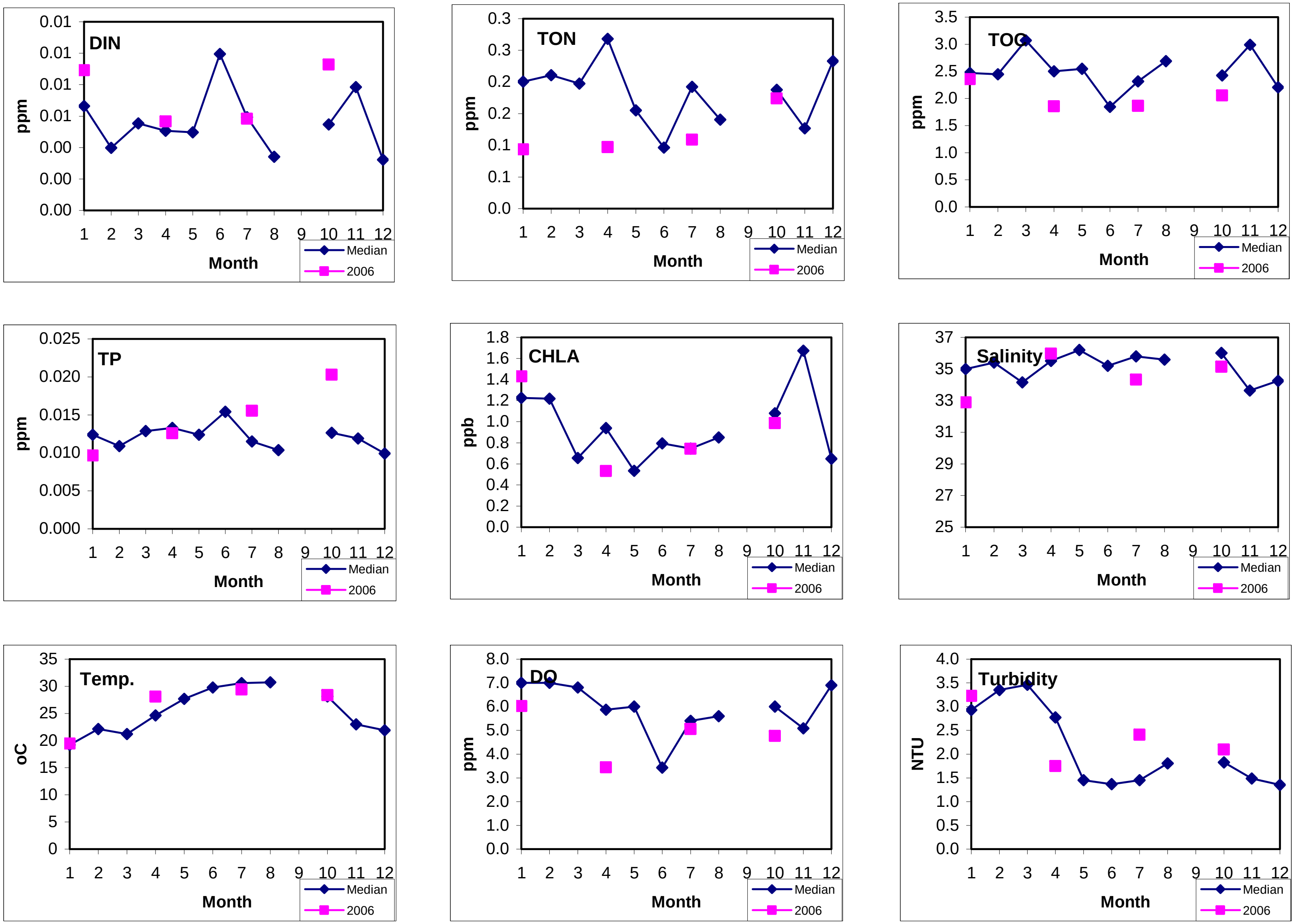


Figure 5.6. Comparison of long-term median with 2006 data.

Shoal (SHOAL)

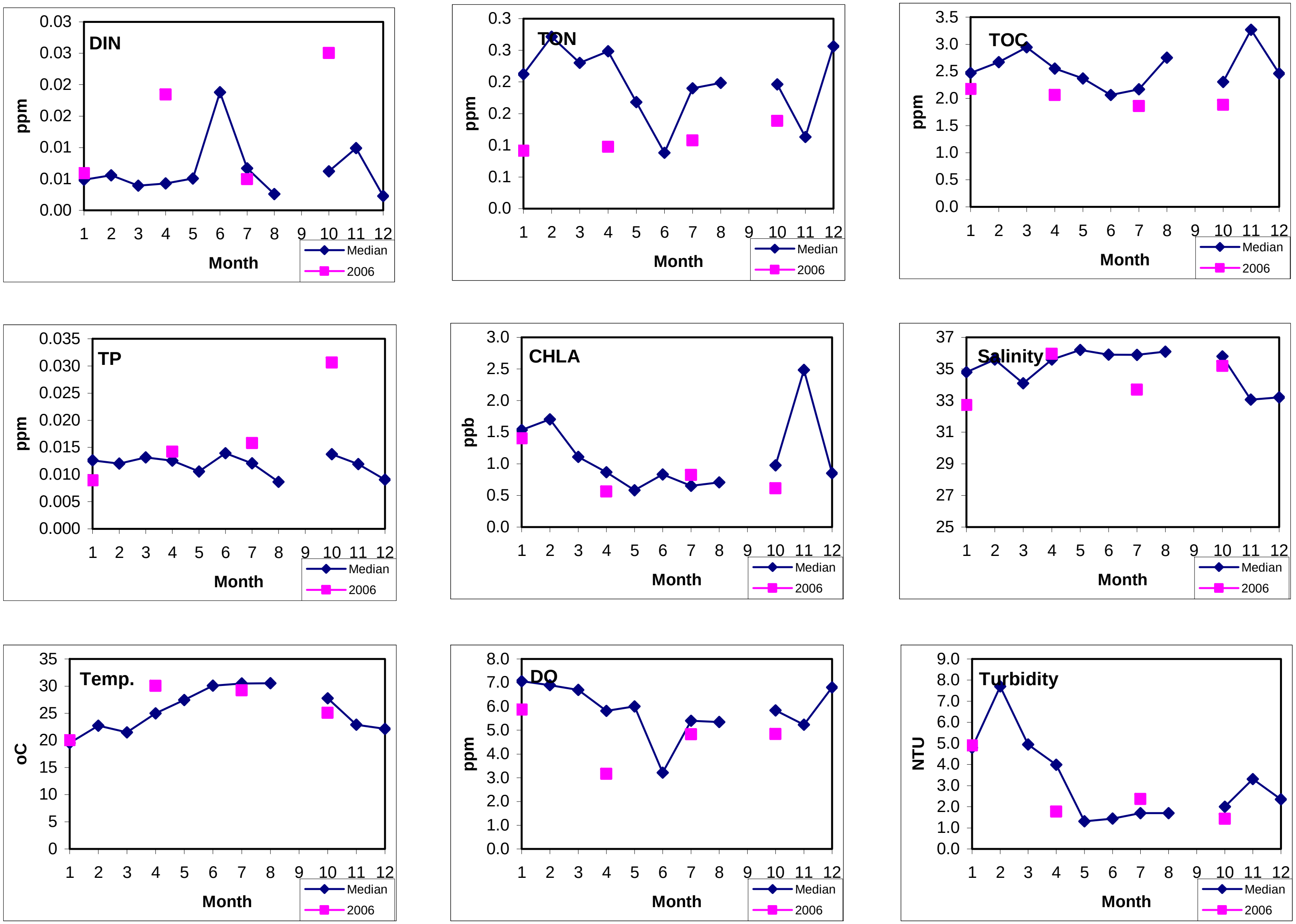


Figure 5.7. Comparison of long-term median with 2006 data.

6. STATE OF WATER QUALITY IN THE CAPE ROMANO - PINE ISLAND SOUND AREA

Overall Period of Record

Sampling in this area began Jan. 1999, therefore we now have five years of data available for analysis. However, until we perform a full spatial analysis, we will use generally accepted geomorphological characteristics to group the stations (Fig. 6.1). These groupings are the Cocohatchee River at Wiggins Pass (COCO), Estero Bay (EST), Cape Romano-Marco Island (MARC), Naples Bay (NPL), Pine Island Sound (PIS), Rookery Bay (RB), and San Carlos Bay (SCB). SCB is located at the mouth of the Caloosahatchee River, a major managed outlet for freshwater from Lake Okeechobee.

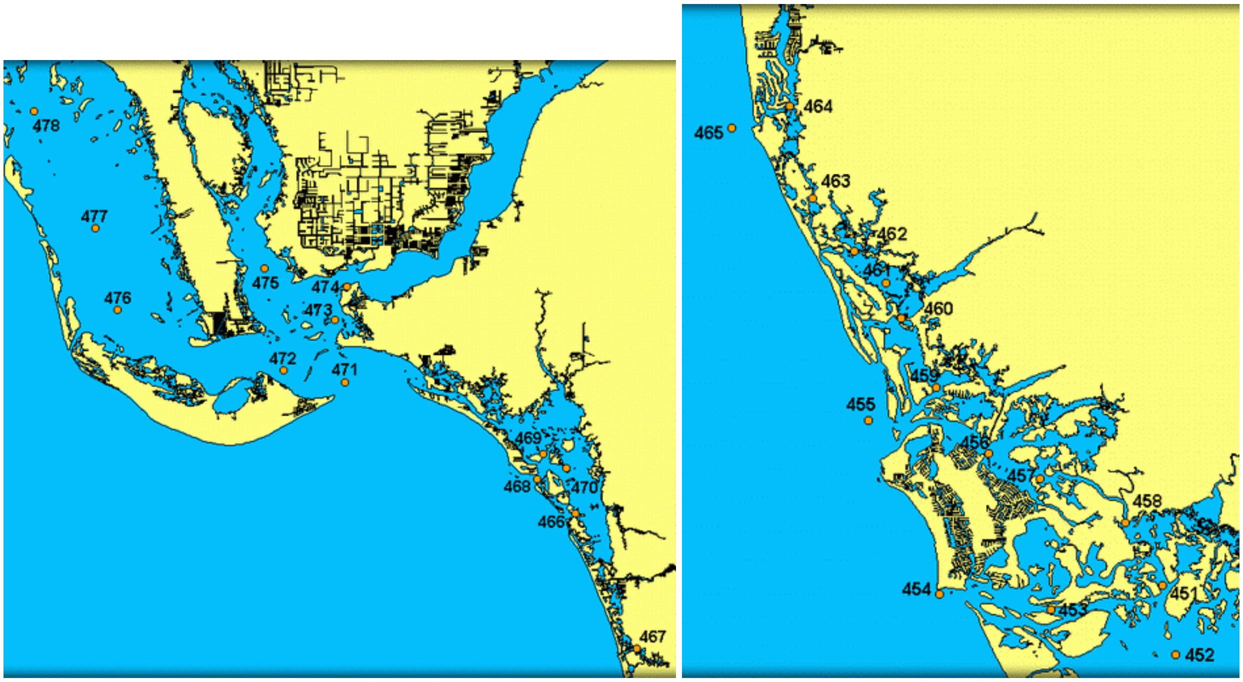


Figure 6.1. Map of station locations in Cape Romano-Pine Island Sound area.

All zones experienced low salinity during the beginning of the wet season with the opening of the Caloosahatchee structure (Fig. 6.2-6.7). CHLA is elevated in this area but not excessive when compared to the overall Ten Thousand Islands. SCB is most directly affected by the releases also had highest concentrations of TP, DIN, and TOC. Estero Bay also exhibited lower salinities than the other areas as a result of freshwater input from the Estero and Imperial Rivers as well as Hendry Creek. EST is relatively enclosed, has a long water residence time, and is bordered on the north by the city of Ft. Meyers. These facts may account for the elevated CHLA, DIN and TP.

Overall, this area has significantly higher concentrations of CHLA, TP, and DIN than the bulk of the Ten Thousand Islands stations. Much of this is due to geological changes from carbonates to silicates, which facilitates transport of phosphorus, and to major land use changes from the Big Cypress National Preserve to suburban and agricultural.

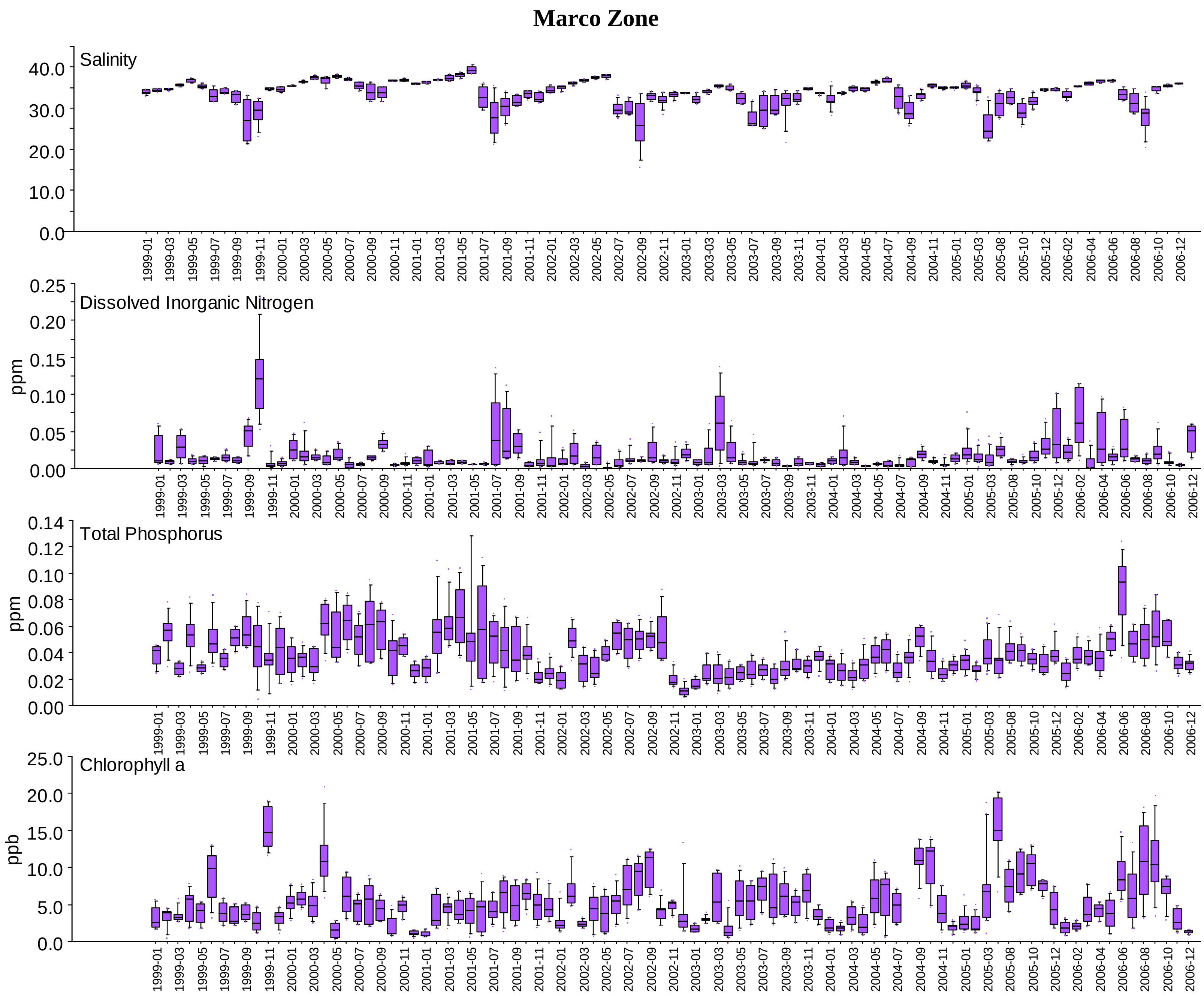


Figure 6.2. Box-and-whisker plots of water quality in RB-PIS by survey.

Rookery Bay Zone

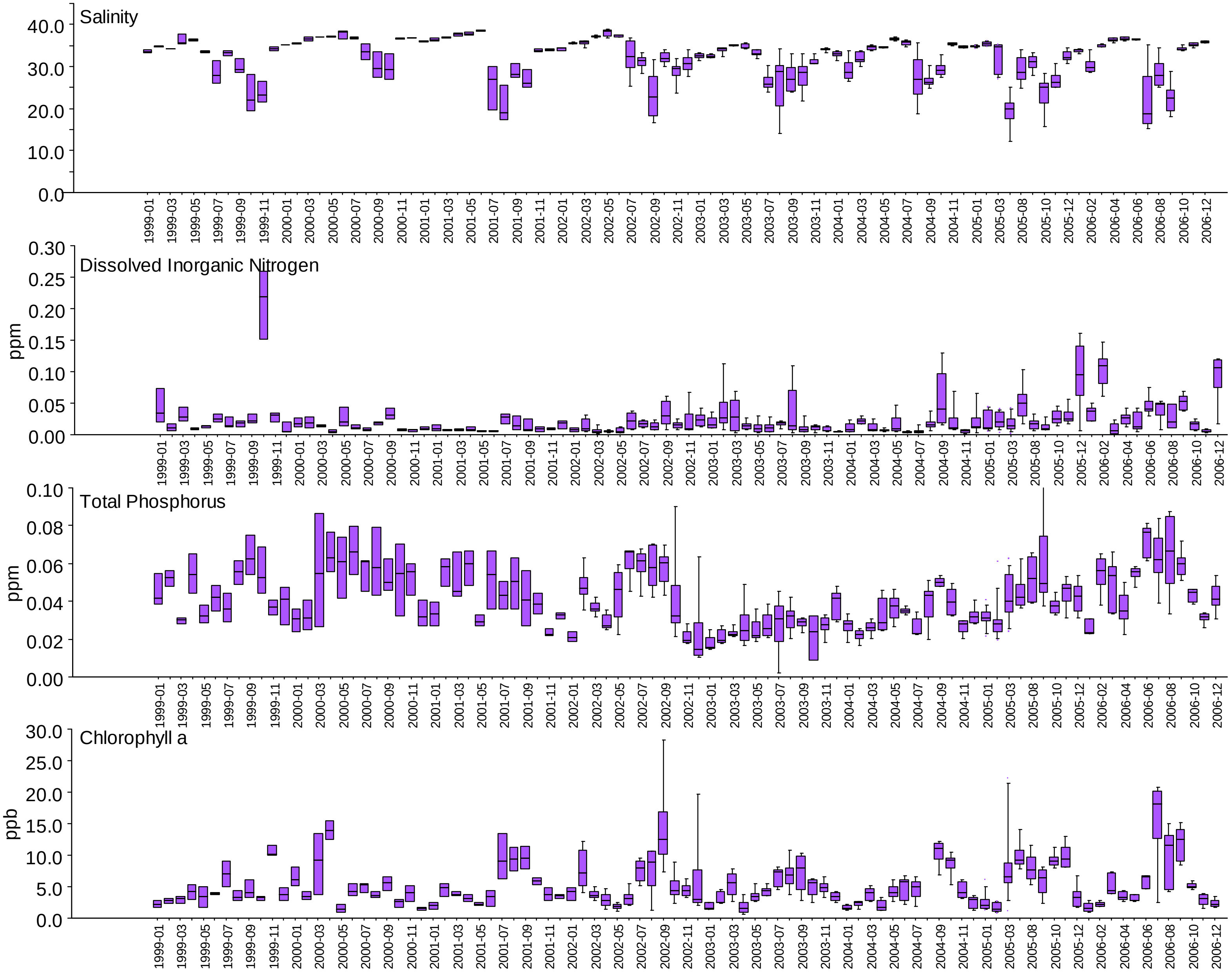


Figure 6.3. Box-and-whisker plots of water quality in RB-PIS by survey.

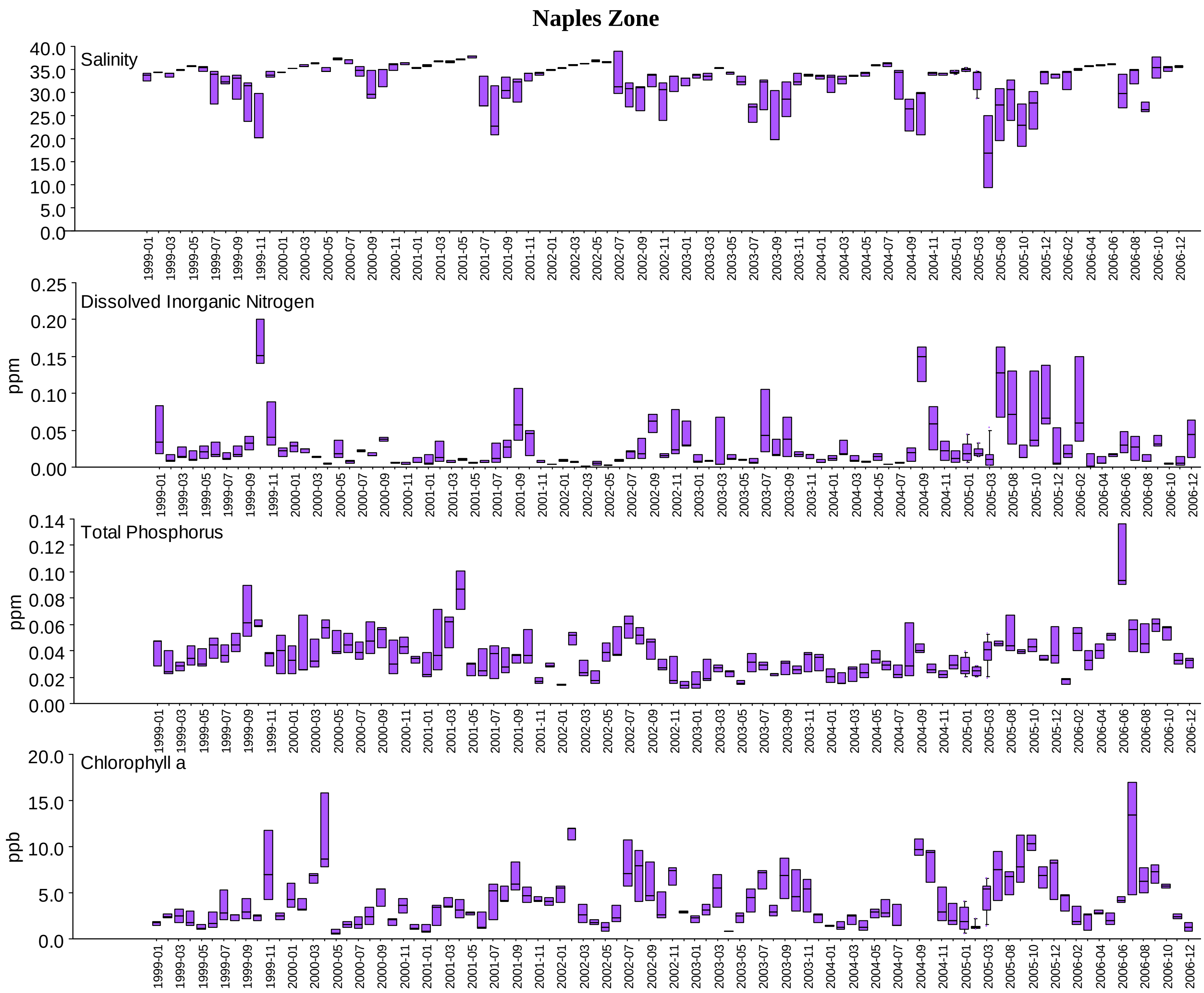


Figure 6.4. Box-and-whisker plots of water quality in RB-PIS by survey.

San Carlos Bay Zone

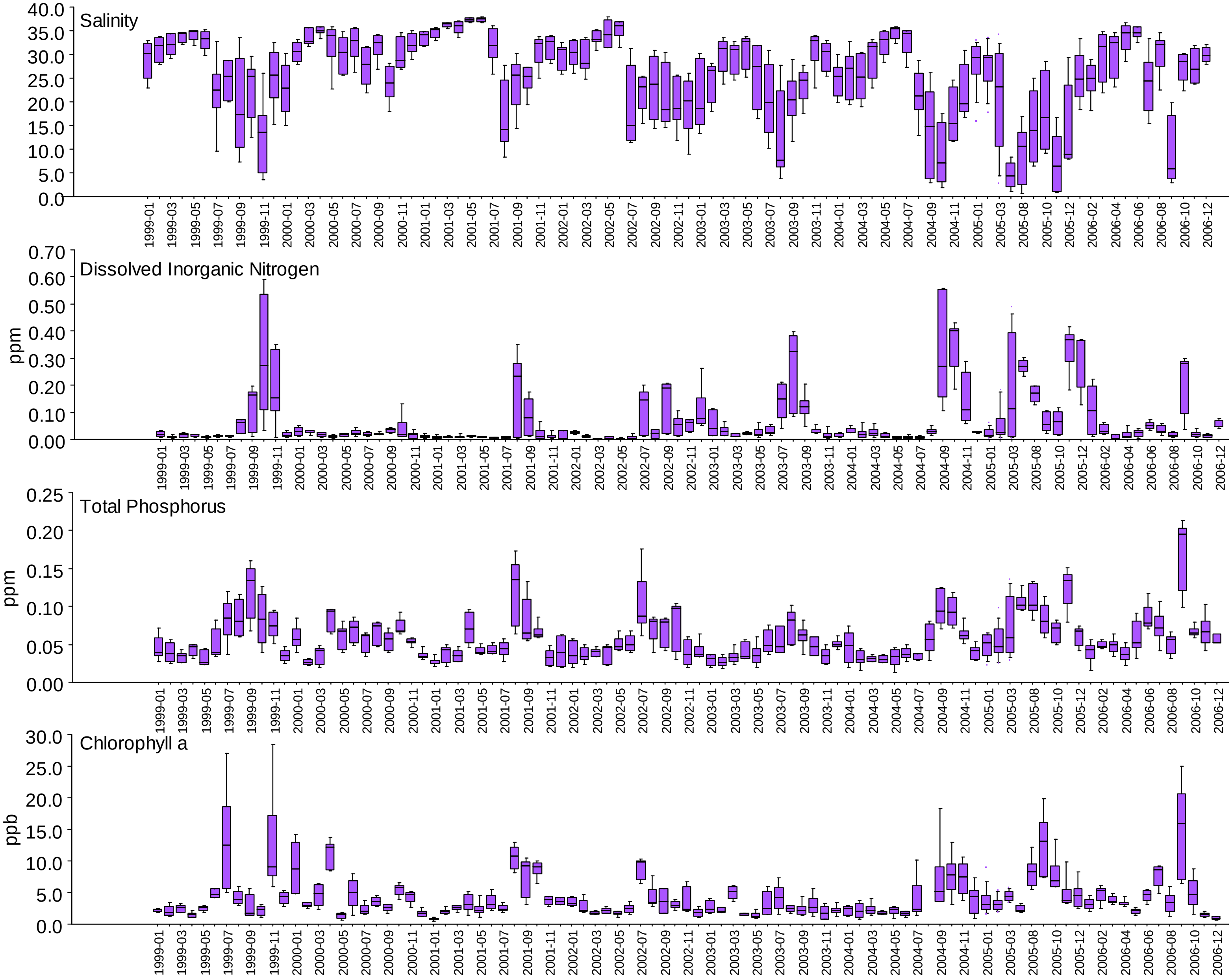


Figure 6.5. Box-and-whisker plots of water quality in RB-PIS by survey.

Estero Bay Zone

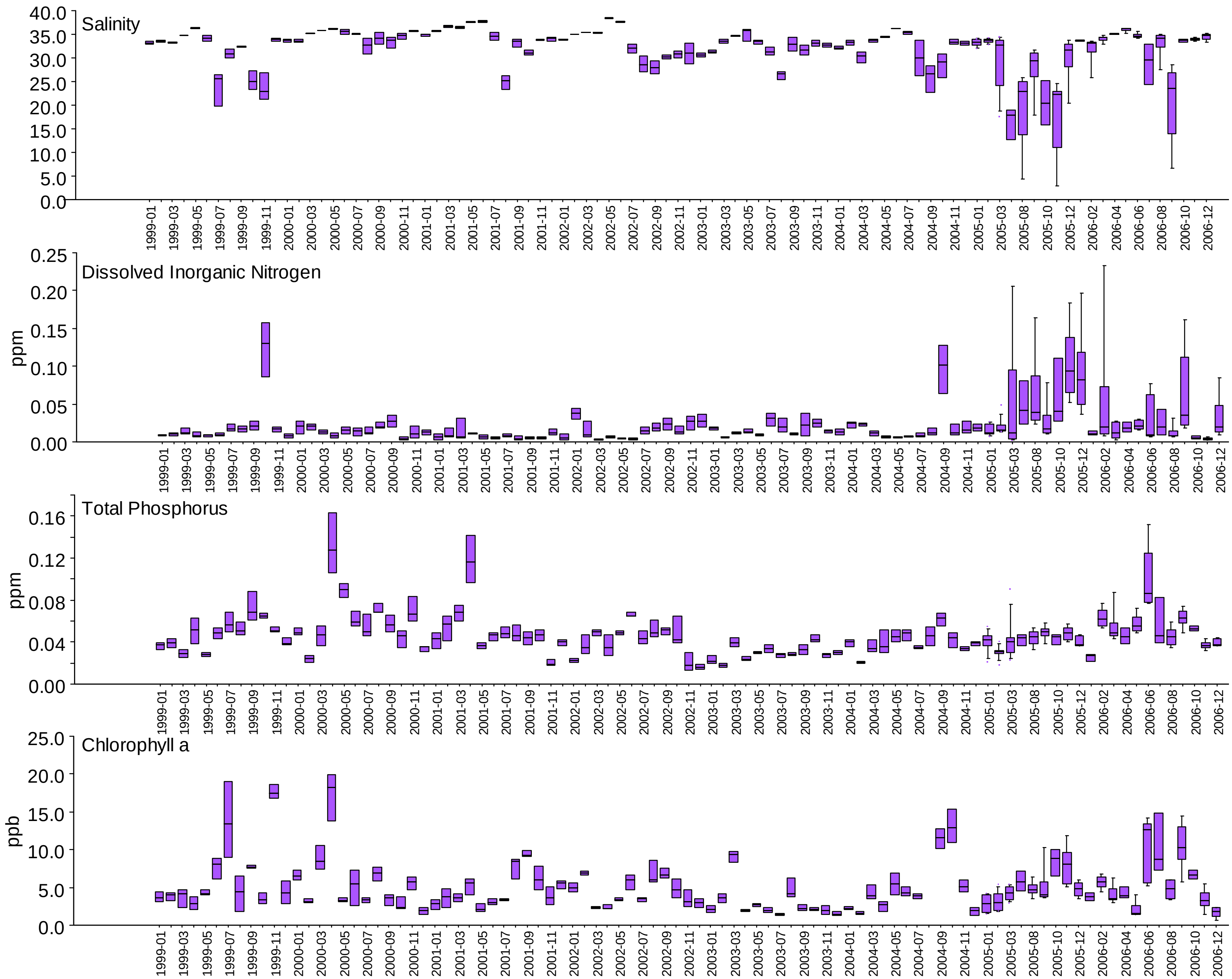


Figure 6.6. Box-and-whisker plots of water quality in RB-PIS by survey.

Pine Island Sound Zone

Figure 6.7. Box-and-whisker plots of water quality in RB-PIS by survey.

2006 Alone

Overall, this part of coastal Florida has significantly higher concentrations of CHLA, TP, and DIN than the rest of the Ten Thousand Islands stations. Much of this is due to geological changes from carbonate rocks to silicates, which facilitates transport of phosphorus, and to major land use changes from the Big Cypress National Preserve to suburban and agricultural.

The largest intra-annual variations in salinity in this area are driven by freshwater releases from the Caloosahatchee River and associated pathways (Fig. 6.8-6.14). This was due to the need to lower the water table inland because of potential flooding from hurricanes and to lower the Lake Okeechobee because of structural problems with the Hover Dike.

Freshwater releases begin in June-July and cause rapid declines in salinity across the region, especially in San Carlos Bay, Rookery Bay, and the Cocohatchee River at Wiggins Pass. A large release occurred in Sept., the effect of which is clearly see in the graphs as an increase in DIN and TOC. The large freshwater inputs typically result in high DIN loads and concentrations. These large and rapid increases in N loading (and P in San Carlos Bay and Cocohatchee River) may cause large phytoplankton blooms (CHLA) across the region.

TON in most areas was below the annual median while TOC was more consistent with historical values. TP in Marco Island, Estero Bay, Naples Bay, and Pine Island Sound spiked in June (with DIN) at the onset of the wet season. DO in most areas was elevated relative to the long term median, especially in the Cocohatchee River where is was double normal values.

Data, Graphs, and Figures

All data for the period of record are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/DataDL.htm
Monthly time series graphs for all measured variables for each station are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/RB.htm
Contour maps showing spatial distributions of all measured variables (quarterly) are available at:
http://serc.fiu.edu/wqmnetwork/SFWMD-CD/ContourMaps.htm

Marco Island (MARC)

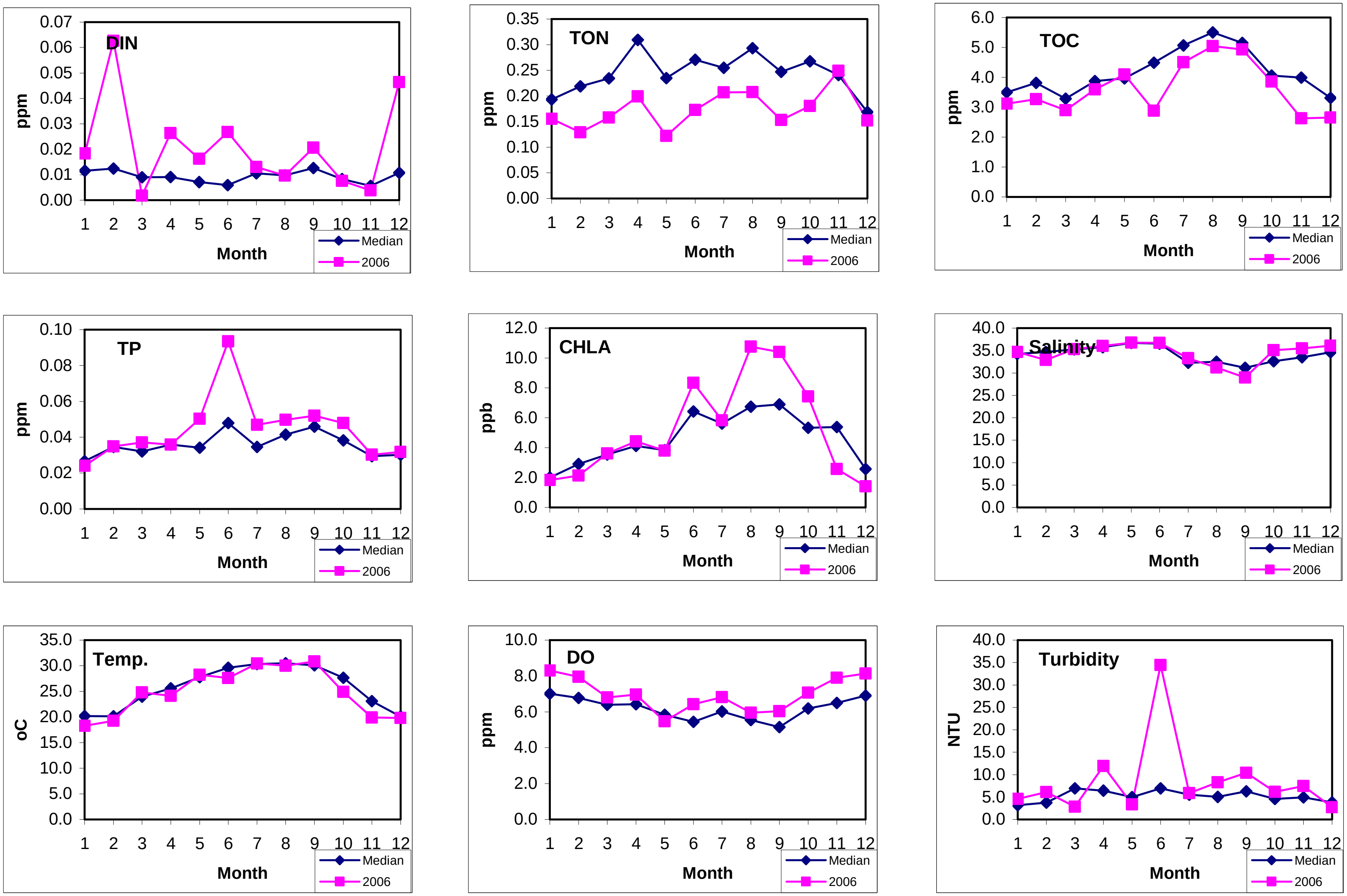
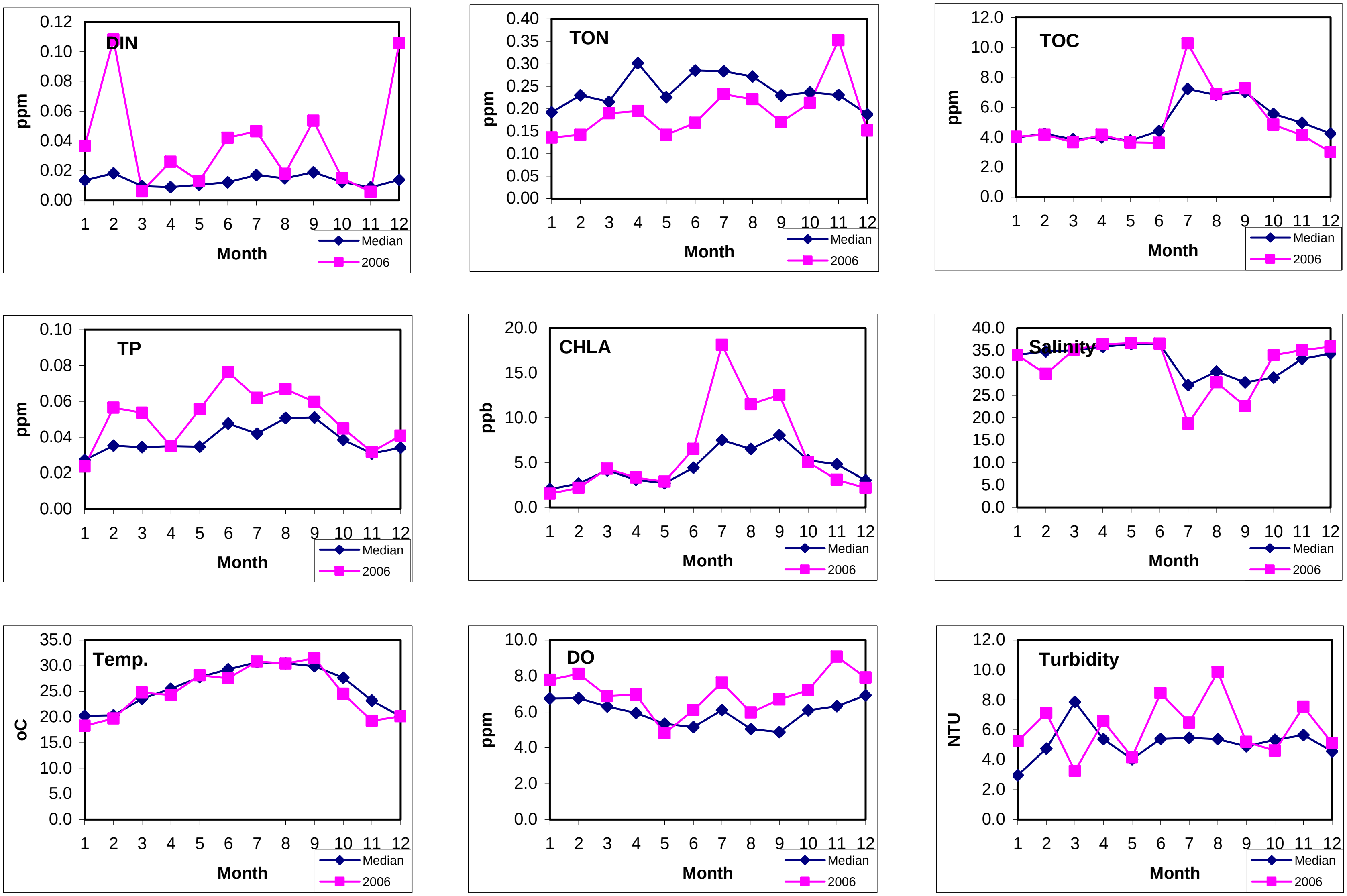


Figure 6.8. Comparison of long-term median with 2006 data.



Rookery Bay (RB)

Figure 6.9. Comparison of long-term median with 2006 data.

Naples Bay (NPL)

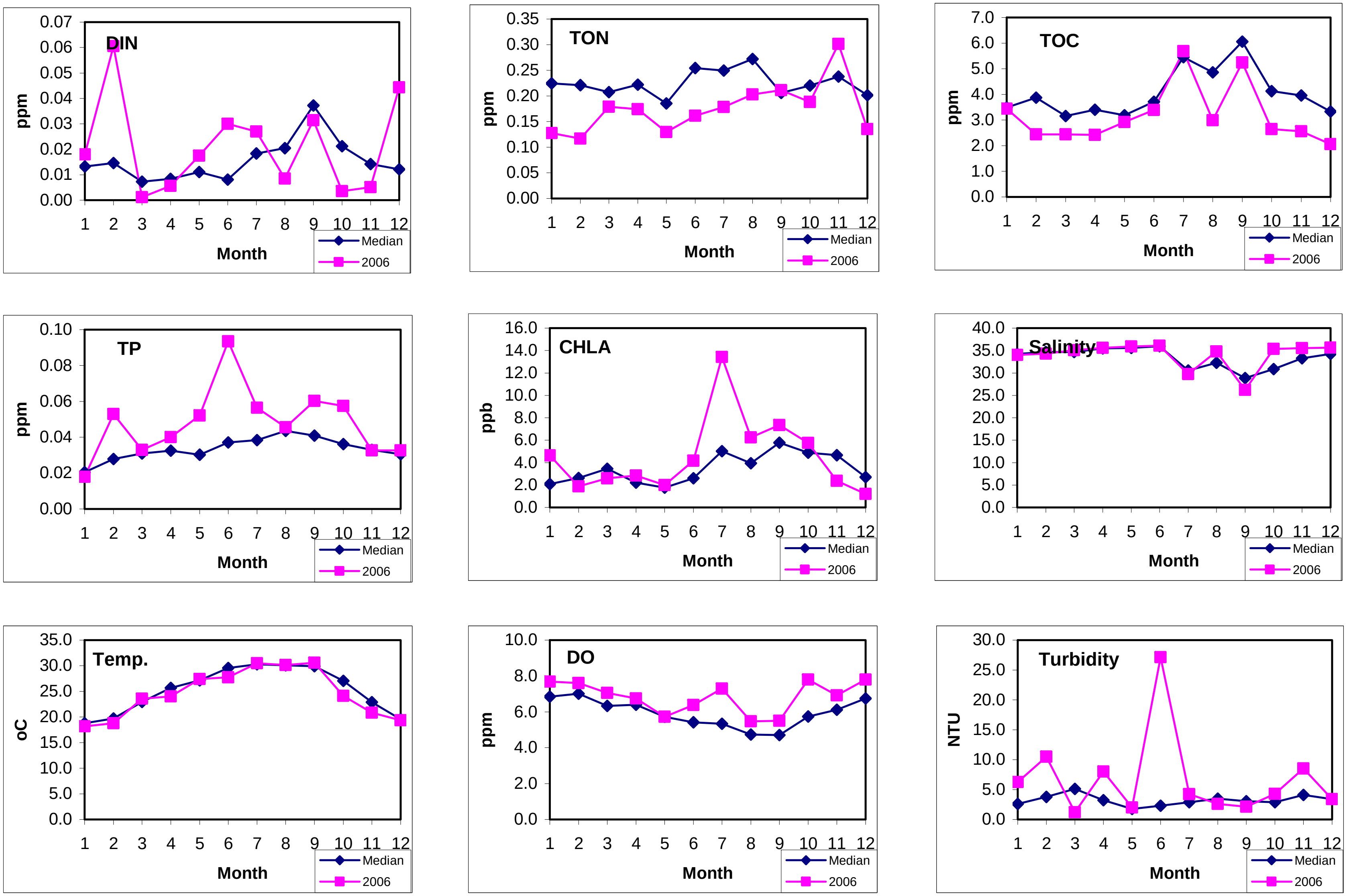


Figure 6.10. Comparison of long-term median with 2006 data.

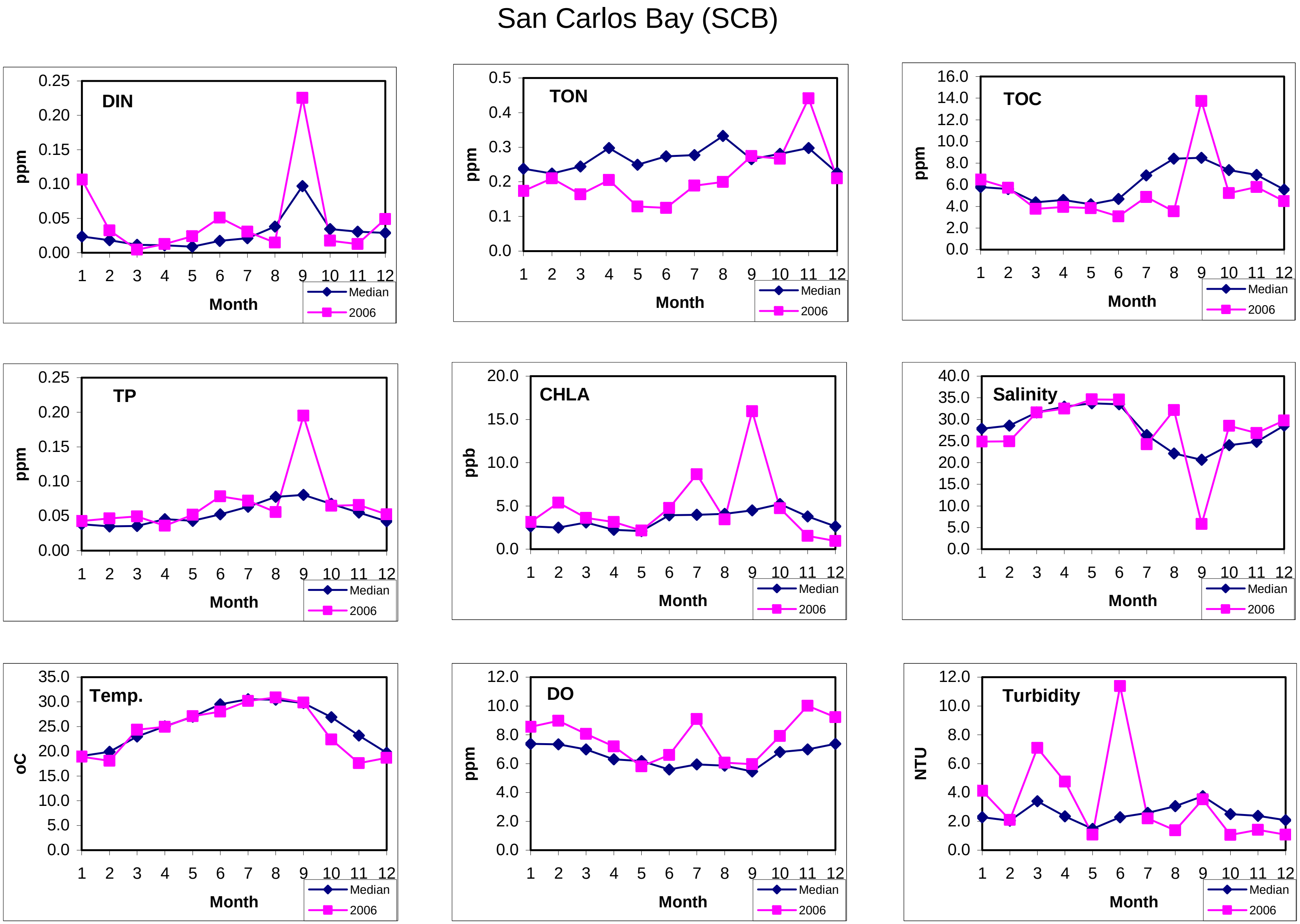


Figure 6.11. Comparison of long-term median with 2006 data.

Estero Bay (EST)

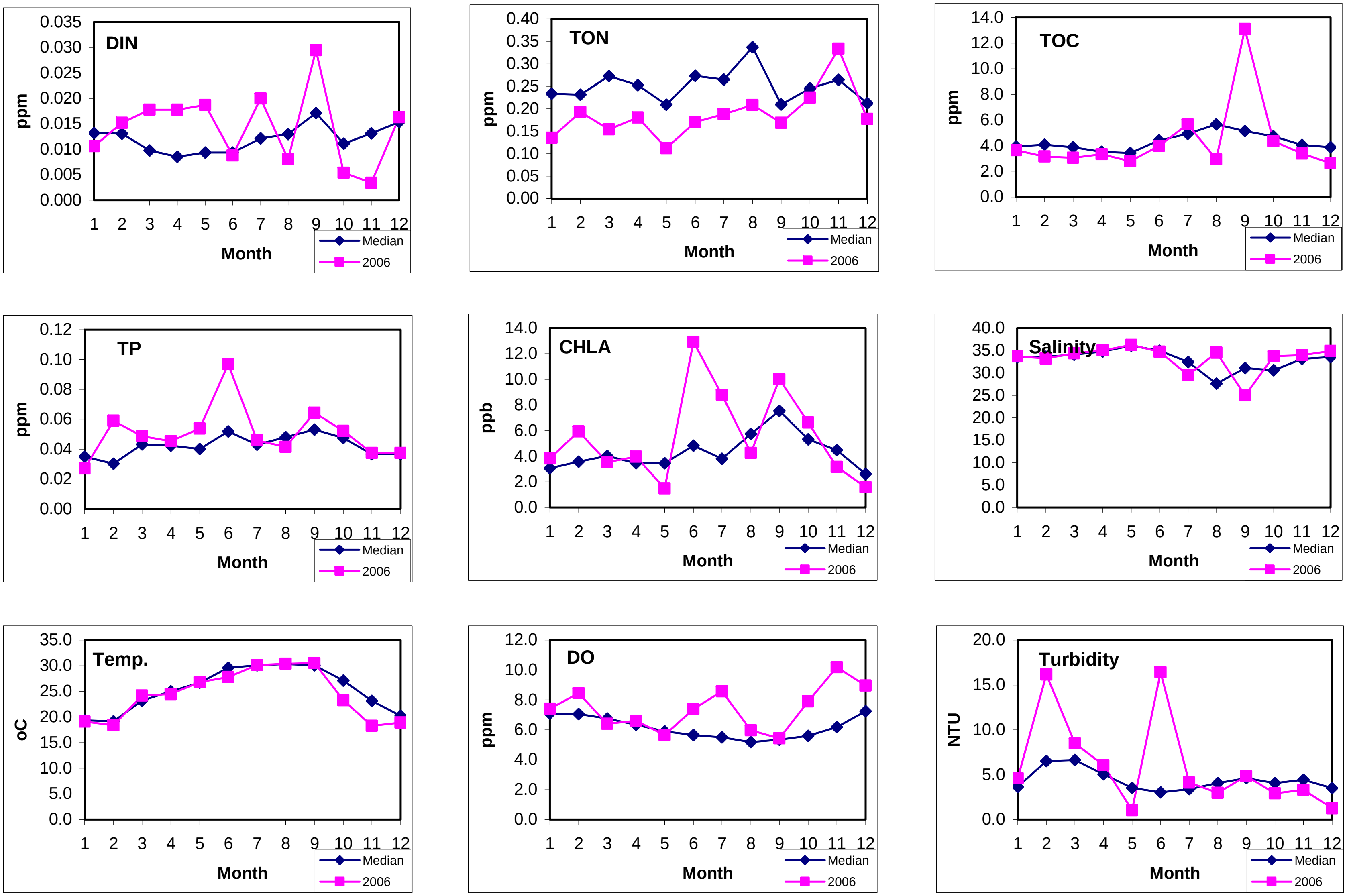


Figure 6.12. Comparison of long-term median with 2006 data.

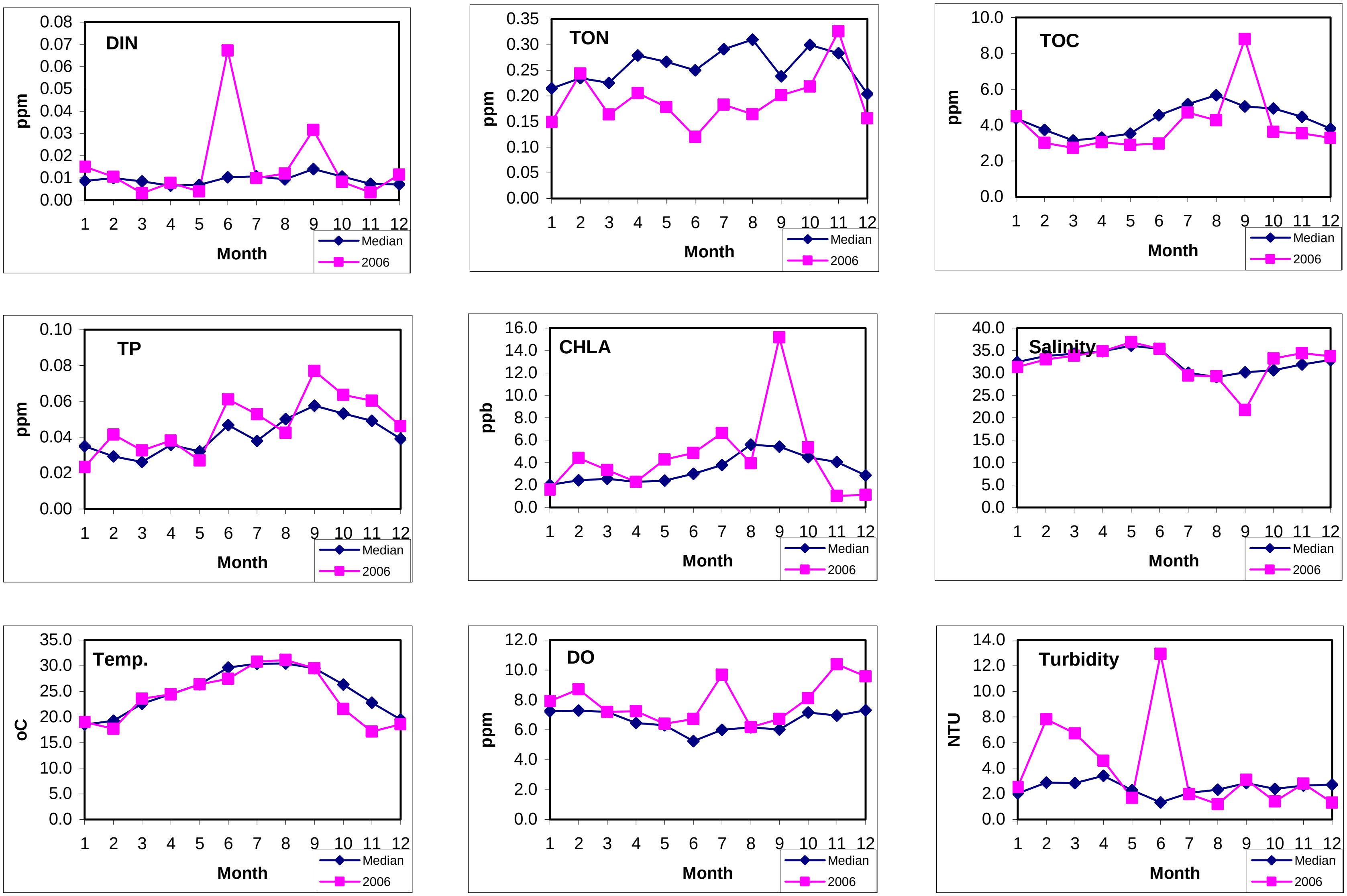
 Pine Island Sound (PIS)

Figure 6.13. Comparison of long-term median with 2006 data.

Cocohatchee River (COCO)

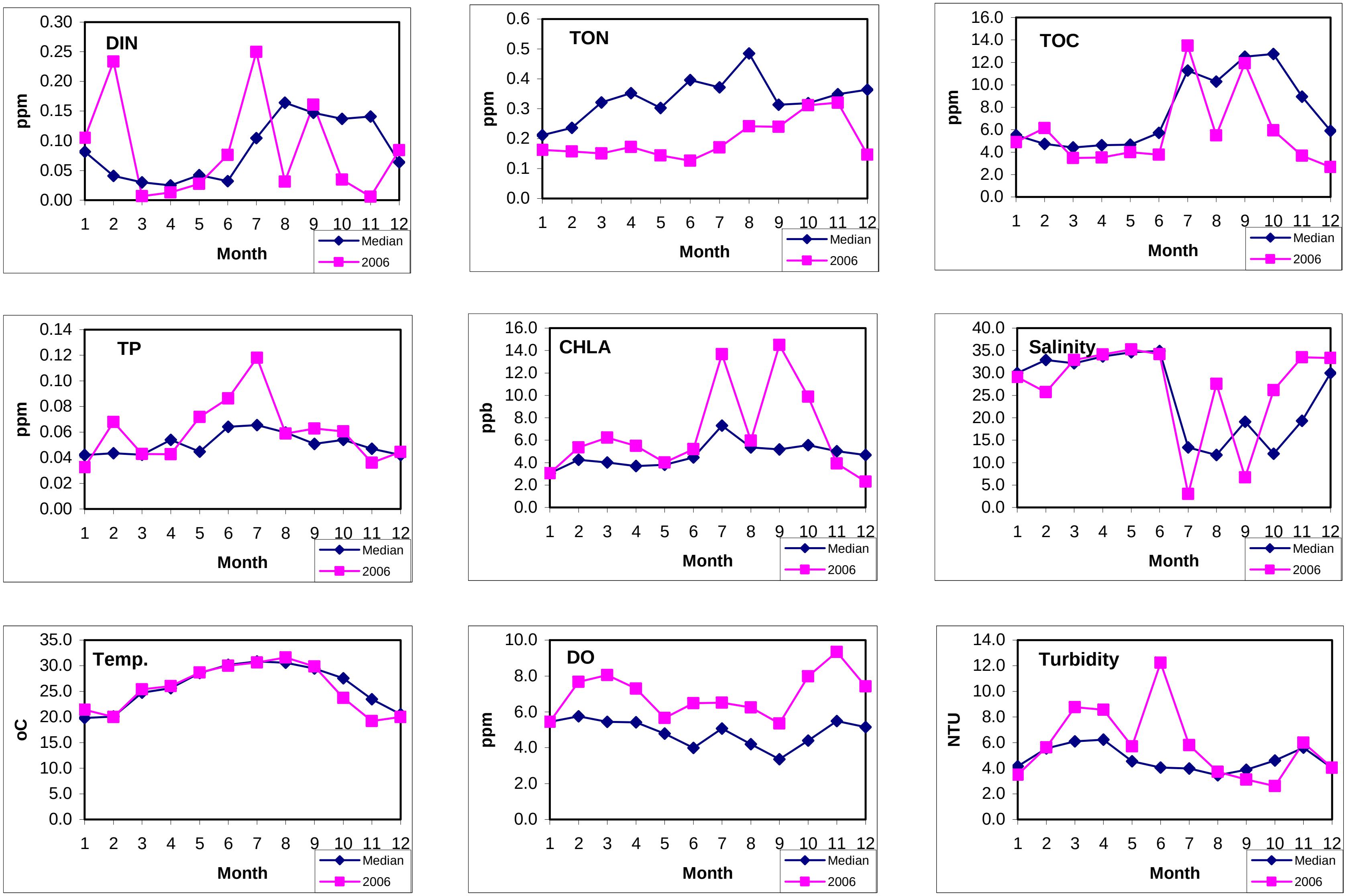


Figure 6.14. Comparison of long-term median with 2006 data.

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10.TABLES

Table 9.1. List of fixed station location and sampling period of record.

Station Name	Number	Area	Latitude	Longitude	Period of Record	Surveys
Card Sound Bridge	1	FB	25 16.413	-80 22.475	Mar 91 - Dec 06	1-190
Middle Key	2	FB	25 17.102	-80 23.702	Mar 91 - Dec 06	1-190
Manatee Bay	3	FB	25 15.062	-80 24.910	Mar 91 - Dec 06	1-190
Barnes Sound	4	FB	25 13.304	-80 23.299	Mar 91 - Dec 06	1-190
Blackwater Sound	5	FB	25 10.443	-80 25.385	Mar 91 - Dec 06	1-190
Little Blackwater Sound	6	FB	25 12.401	-80 26.424	Mar 91 - Dec 06	1-190
Highway Creek	7	FB	25 15.216	-80 26.649	Mar 91 - Dec 06	1-190
Long Sound	8	FB	25 13.642	-80 27.700	Mar 91 - Dec 06	1-190
Duck Key	9	FB	25 10.624	-80 29.494	Mar 91 - Dec 06	1-190
Joe Bay	10	FB	25 13.468	-80 32.195	Mar 91 - Dec 06	1-190
Little Madeira Bay	11	FB	25 10.510	-80 37.615	Mar 91 - Dec 06	1-190
Terrapin Bay	12	FB	25 08.422	-80 42.967	Mar 91 - Dec 06	1-190
Whipray Basin	13	FB	25 05.485	-80 45.287	Mar 91 - Dec 06	1-190
Garfield Bight	14	FB	25 09.029	-80 48.553	Apr 91 - Dec 06	2-190
Rankin Lake	15	FB	25 07.283	-80 48.173	Mar 91 - Dec 06	1-190
Murray Key	16	FB	25 07.096	-80 56.379	Mar 91 - Dec 06	1-190
Johnson Key Basin	17	FB	25 02.548	-80 54.889	Mar 91 - Dec 06	1-190
Rabbit Key Basin	18	FB	25 00.145	-80 54.006	Mar 91 - Dec 06	1-190
Twin Key Basin	19	FB	24 58.660	-80 45.211	Apr 91 - Dec 06	2-190
Peterson Keys	20	FB	24 55.770	-80 45.028	Mar 91 - Dec 06	1-190
Porpoise Lake	21	FB	25 00.396	-80 40.876	Mar 91 - Dec 06	1-190
Captain Key	22	FB	25 02.405	-80 36.843	Apr 91 - Dec 06	2-190
Park Key	23	FB	25 07.078	-80 35.983	Apr 91 - Dec 06	2-190
Butternut Key	24	FB	25 06.105	-80 31.884	Mar 91 - Dec 06	1-190
East Cape	25	FB	25 05.022	-81 04.835	July 92 - Dec 06	17-190
Oxfoot Bank	26	FB	24 58.844	-81 00.098	July 92 - Dec 06	17-190
Sprigger Bank	27	FB	24 55.116	-80 56.092	July 92 - Dec 06	17-190
Old Dan Bank	28	FB	24 52.032	-80 48.429	July 92 - Dec 06	17-190
First Bay	29	WWB	25 33.272	-81 11.020	Sept 92 - Dec 06	19-190
Third Bay	30	WWB	25 34.810	-81 07.256	Sept 92 - Dec 06	19-190
Big Lostmans Bay	31	WWB	25 34.055	-81 04.288	Sept 92 - Dec 06	19-190
Cabbage Island	32	WWB	25 31.764	-81 02.603	Sept 92 - Dec 06	19-190
Broad River Bay	33	WWB	25 29.984	-81 02.939	Sept 92 - Dec 06	19-190
Middle Broad River	34	WWB	25 29.163	-81 06.669	Sept 92 - Dec 06	19-190
Broad River Mouth	35	WWB	25 28.501	-81 09.176	Sept 92 - Dec 06	19-190
Harney River Mouth	36	WWB	25 24.701	-81 08.487	Sept 92 - Dec 06	19-190
Harney Rivers Junction	37	WWB	25 25.901	-81 04.943	Sept 92 - Dec 06	19-190
Tarpon Bay	38	WWB	25 25.037	-80 59.906	Sept 92 - Dec 06	19-190
Gunboat Island	39	WWB	25 22.735	-81 01.844	Sept 92 - Dec 06	19-190
Ponce de Leon Bay	40	WWB	25 20.983	-81 07.474	Sept 92 - Dec 06	19-190
Oyster Bay	41	WWB	25 19.869	-81 04.360	Sept 92 - Dec 06	19-190
North Marker 36	42	WWB	25 19.560	-81 00.873	Sept 92 - Dec 06	19-190
West Marker 34	43	WWB	25 17.168	-81 01.419	Sept 92 - Dec 06	19-190
Watson River Chickee	44	WWB	25 19.912	-80 59.022	Sept 92 - Dec 06	19-190
North River Mouth	45	WWB	25 18.054	-80 57.620	Sept 92 - Dec 06	19-190
Midway Keys	46	WWB	25 17.102	-80 58.548	Sept 92 - Dec 06	19-190

Station Name	Number	Area	Latitude	Longitude	Period of Record	Surveys
Roberts River Mouth	47	WWB	25 16.779	-80 55.846	Sept 92 - Dec 06	19-190
West Marker 18	48	WWB	25 14.448	-80 57.476	Sept 92 - Dec 06	19-190
Southeast Marker 12	49	WWB	25 13.704	-80 55.980	Sept 92 - Dec 06	19-190
Coot Bay	50	WWB	25 11.452	-80 54.848	Sept 92 - Dec 06	19-190
Chokoloskee	51	TTI	25 48.450	-81 20.970	Sept 94 - Dec 06	43-190
Rabbit Key Pass	52	TTI	25 46.200	-81 23.000	Sept 94 - Dec 06	43-190
Lopez Bay	53	TTI	25 47.050	-81 19.930	Sept 94 - Dec 06	43-190
Lopez River	54	TTI	25 47.130	-81 18.550	Sept 94 - Dec 06	43-190
Sunday Bay	55	TTI	25 47.760	-81 16.800	Sept 94 - Dec 06	43-190
Huston Bay	56	TTI	25 45.180	-81 15.330	Sept 94 - Dec 06	43-190
Upper Chatham River	57	TTI	25 43.050	-81 13.830	Sept 94 - Dec 06	43-190
Watson Place	58	TTI	25 42.470	-81 15.130	Sept 94 - Dec 06	43-190
Gun Rock Point	59	TTI	25 41.500	-81 17.920	Sept 94 - Dec 06	43-190
Huston River	60	TTI	25 43.880	-81 17.080	Sept 94 - Dec 06	43-190
Chevalier Bay	61	TTI	25 42.750	-81 12.420	Sept 94 - Dec 06	43-190
Alligator Bay	62	TTI	25 40.210	-81 10.120	Sept 94 - Dec 06	43-190
Lostmans Five Bay	63	TTI	25 38.000	-81 08.700	Sept 94 - Dec 06	43-190
Barron River	64	TTI	25 51.196	-81 23.602	Sept 94 - Dec 06	43-190
Indian Key Pass	65	TTI	25 49.631	-81 26.465	Sept 94 - Dec 06	43-190
Indian Key	66	TTI	25 48.290	-81 27.750	Sept 94 - Dec 06	43-190
West Pass	67	TTI	25 49.820	-81 30.170	Sept 94 - Dec 06	43-190
Panther Key	68	TTI	25 50.960	-81 32.530	Sept 94 - Dec 06	43-190
Faka Union Pass	69	TTI	25 52.450	-81 30.960	Sept 94 - Dec 06	43-190
Faka Union Bay	70	TTI	25 54.000	-81 30.960	Sept 94 - Dec 06	43-190
White Horse Key	71	TTI	25 52.007	-81 34.489	Sept 94 - Dec 06	43-190
Dismal Key	72	TTI	25 53.668	-81 33.532	Sept 94 - Dec 06	43-190
Long Rock	73	TTI	25 52.920	-81 36.380	Sept 94 - Dec 06	43-190
Shell Key	74	TTI	25 54.670	-81 36.920	Sept 94 - Dec 06	43-190
Blackwater River	75	TTI	25 55.788	-81 36.019	Sept 94 - Dec 06	43-190
Convoy Point	101	BB	25 28.700	-80 19.250	Sept 93 - Dec 06	31-190
Black Point	102	BB	25 32.750	-80 17.680	Sept 93 - Dec 06	31-190
Near Black Ledge	103	BB	25 34.400	-80 17.200	Sept 93 - Dec 06	31-190
BNP Marker C	104	BB	25 36.100	-80 13.250	Sept 93 - Dec 06	31-190
Biscayne Channel	105	BB	25 39.252	-80 11.202	Sept 93 - May 96	31-63
White Marker	106	BB	25 38.052	-80 07.800	Sept 93 - May 96	31-63
Fowey Rocks	107	BB	25 35.400	-80 06.000	Sept 93 - May 96	31-63
Marker G-1B	108	BB	25 34.150	-80 11.550	Sept 93 - Dec 06	31-190
North Midbay	109	BB	25 33.850	-80 14.100	Sept 93 - Dec 06	31-190
Fender Point	110	BB	25 30.300	-80 17.250	Sept 93 - Dec 06	31-190
Featherbed Bank	111	BB	25 30.950	-80 14.400	Sept 93 - Dec 06	31-190
Sands Cut	112	BB	25 29.300	-80 11.300	Sept 93 - Dec 06	31-190
Elliott Key	113	BB	25 26.500	-80 13.400	Sept 93 - Dec 06	31-190
Caesar Creek	114	BB	25 23.100	-80 11.502	Sept 93 - May 96	31-63
Adams Key	115	BB	25 24.252	-80 14.448	Sept 93 - May 96	31-63
Rubicon Keys	116	BB	25 24.000	-80 15.300	Sept 93 - Dec 06	31-190
Totten Key	117	BB	25 23.100	-80 15.900	Sept 93 - May 96	31-63
Broad Creek	118	BB	25 20.898	-80 15.300	Sept 93 - May 96	31-63
Pumpkin Key	119	BB	25 19.098	-80 18.198	Sept 93 - May 96	31-63
Card Bank, G-17	120	BB	25 18.852	-80 20.598	Sept 93 - May 96	31-63
North Card Sound	121	BB	25 21.300	-80 17.500	Sept 93 - Dec 06	31-190

Station Name	Number	Area	Latitude	Longitude	Period of Record	Surveys
West Arsenicker	122	BB	25 25.210	-80 18.650	Sept 93 - Dec 06	31-190
Pelican Bank	123	BB	25 26.700	-80 17.000	Sept 93 - Dec 06	31-190
South Midbay	124	BB	25 28.350	-80 14.000	Sept 93 - Dec 06	31-190
Turkey Point	125	BB	25 28.200	-80 16.998	Sept 93 - May 96	31-63
BNP Marker B	126	BB	25 40.300	-80 12.300	Jun 96 - Dec 06	64-190
Shoal Point	127	BB	25 37.800	-80 15.000	Jun 96 - Dec 06	64-190
Matheson Beach	128	BB	25 41.300	-80 14.000	Jun 96 - Dec 06	64-190
Marker G-71	129	BB	25 44.200	-80 11.100	Jun 96 - Dec 06	64-190
South Dodge Island	130	BB	25 45.800	-80 10.300	Jun 96 - Dec 06	64-190
North Venetian Basin	131	BB	25 48.000	-80 10.000	Jun 96 - Dec 06	64-190
North I-195 Basin	132	BB	25 49.000	-80 10.000	Jun 96 - Dec 06	64-190
North Normandy Isle	133	BB	25 52.000	-80 09.000	Jun 96 - Dec 06	64-190
Oleta River Park	134	BB	25 54.300	-80 08.000	Jun 96 - Dec 06	64-190
South Card Sound	135	BB	25 19.000	-80 19.000	Jun 96 - Dec 06	64-190
Off Lower Harbor Keys	351	SHELF	24 41.500	-81 47.500	May 95 - Dec 06	1-46
	352	SHELF	24 46.550	-81 46.980	May 95 - Dec 06	1-46
	353	SHELF	24 51.500	-81 46.600	May 95 - Dec 06	1-46
	354	SHELF	24 56.480	-81 46.120	May 95 - Dec 06	1-46
	355	SHELF	25 01.480	-81 45.750	May 95 - Dec 06	1-46
	356	SHELF	25 06.460	-81 45.230	May 95 - Dec 06	1-46
	357	SHELF	25 11.470	-81 44.720	May 95 - Dec 06	1-46
	358	SHELF	25 16.480	-81 44.290	May 95 - Dec 06	1-46
	359	SHELF	25 21.500	-81 43.800	May 95 - Dec 06	1-46
	360	SHELF	25 26.470	-81 43.260	May 95 - Dec 06	1-46
	361	SHELF	25 31.480	-81 42.900	May 95 - Dec 06	1-46
	362	SHELF	25 36.520	-81 42.400	May 95 - Dec 06	1-46
Off Cape Romano	363	SHELF	25 41.520	-81 41.900	May 95 - Dec 06	1-46
	364	SHELF	25 41.500	-81 32.000	May 95 - Dec 06	1-46
	365	SHELF	25 36.510	-81 32.360	May 95 - Dec 06	1-46
	366	SHELF	25 31.560	-81 32.930	May 95 - Dec 06	1-46
	367	SHELF	25 26.550	-81 33.300	May 95 - Dec 06	1-46
	368	SHELF	25 21.510	-81 33.800	May 95 - Dec 06	1-46
	369	SHELF	25 16.530	-81 34.320	May 95 - Dec 06	1-46
	370	SHELF	25 11.510	-81 34.750	May 95 - Dec 06	1-46
	371	SHELF	25 06.500	-81 35.210	May 95 - Dec 06	1-46
	372	SHELF	25 01.500	-81 35.720	May 95 - Dec 06	1-46
	373	SHELF	24 56.530	-81 36.180	May 95 - Dec 06	1-46
	374	SHELF	24 51.530	-81 36.650	May 95 - Dec 06	1-46
Off Johnson Key	375	SHELF	24 46.540	-81 37.070	May 95 - Dec 06	1-46
Harbor Key Bank	376	SHELF	24 50.600	-81 26.300	May 95 - Dec 06	1-46
	377	SHELF	24 56.100	-81 25.900	May 95 - Dec 06	1-46
	378	SHELF	25 01.000	-81 24.950	May 95 - Dec 06	1-46
	379	SHELF	25 06.000	-81 24.530	May 95 - Dec 06	1-46
	380	SHELF	25 11.000	-81 24.000	May 95 - Dec 06	1-46
	381	SHELF	25 16.000	-81 23.700	May 95 - Dec 06	1-46
	382	SHELF	25 21.000	-81 23.200	May 95 - Dec 06	1-46
	383	SHELF	25 25.950	-81 22.670	May 95 - Dec 06	1-46
	384	SHELF	25 30.930	-81 22.200	May 95 - Dec 06	1-46
	385	SHELF	25 36.010	-81 21.790	May 95 - Dec 06	1-46

Station Name	Number	Area	Latitude	Longitude	Period of Record	Surveys
	386	SHELF	25 33.330	-81 20.430	May 95 - Dec 06	1-46
	387	SHELF	25 30.530	-81 19.010	May 95 - Dec 06	1-46
	388	SHELF	25 25.500	-81 17.820	May 95 - Dec 06	1-46
	389	SHELF	25 20.500	-81 16.620	May 95 - Dec 06	1-46
	390	SHELF	25 15.600	-81 15.610	May 95 - Dec 06	1-46
	391	SHELF	25 10.500	-81 14.320	May 95 - Dec 06	1-46
	392	SHELF	25 05.500	-81 14.900	May 95 - Dec 06	1-46
	393	SHELF	25 00.500	-81 15.200	May 95 - Dec 06	1-46
	394	SHELF	24 55.500	-81 15.600	May 95 - Dec 06	1-46
Off Bluefish Bank	395	SHELF	24 52.700	-81 11.500	May 95 - Dec 06	1-46
Off Bullard Bank	396	SHELF	24 50.000	-81 07.700	May 95 - Dec 06	1-46
	397	SHELF	24 55.000	-81 07.100	May 95 - Dec 06	1-46
	398	SHELF	25 00.000	-81 06.600	May 95 - Dec 06	1-46
Off East Cape	399	SHELF	25 05.000	-81 05.960	May 95 - Dec 06	1-46
Coon Key Pass, G3	451	ROOK	25 54.626	-81 38.309	Jan 99 - Dec 06	97-190
Coon Key Light	452	ROOK	25 52.918	-81 37.954	Jan 99 - Dec 06	97-190
Fred Key, G5	453	ROOK	25 53.978	-81 41.027	Jan 99 - Dec 06	97-190
Caxambas Pass, R4	454	ROOK	25 54.360	-81 43.733	Jan 99 - Dec 06	97-190
Capri Pass, R2A	455	ROOK	25 59.285	-81 43.740	Jan 99 - Dec 06	97-190
Rt. 951 Bridge, R26	456	ROOK	25 57.737	-81 42.524	Jan 99 - Dec 06	97-190
Big Marco River, R24	457	ROOK	25 57.122	-81 41.243	Jan 99 - Dec 06	97-190
Goodland Bridge, G15	458	ROOK	25 56.080	-81 39.204	Jan 99 - Dec 06	97-190
Johnson Bay	459	ROOK	25 59.291	-81 43.748	Jan 99 - Dec 06	97-190
Hall Bay	460	ROOK	26 00.941	-81 44.566	Jan 99 - Dec 06	97-190
Rookery Bay	461	ROOK	26 01.755	-81 44.888	Jan 99 - Dec 06	97-190
First National	462	ROOK	26 02.441	-81 45.955	Jan 99 - Dec 06	97-190
Kewaydin Channel, G55	463	ROOK	26 03.611	-81 46.713	Jan 99 - Dec 06	97-190
Dollar Bay, G73	464	ROOK	26 06.000	-81 47.213	Jan 99 - Dec 06	97-190
Outer Gordon Pass, G1	465	ROOK	26 05.480	-81 48.686	Jan 99 - Dec 06	97-190
New Pass	466	ROOK	26 22.692	-81 51.508	Jan 99 - Dec 06	97-190
Wiggins Pass Bridge	467	ROOK	26 17.441	-81 49.105	Jan 99 - Dec 06	97-190
Big Carlos Pass Bridge	468	ROOK	26 24.146	-81 52.850	Jan 99 - Dec 06	97-190
Coon Key, R2A	469	ROOK	26 25.422	-81 52.400	Jan 99 - Dec 06	97-190
Central Estero Bay, R2	470	ROOK	26 24.459	-81 51.885	Jan 99 - Dec 06	97-190
Point Ybel, R8	471	ROOK	26 27.492	-82 00.444	Jan 99 - Dec 06	97-190
San Carlos Bay, R4	472	ROOK	26 28.013	-82 02.723	Jan 99 - Dec 06	97-190
Kitchel Key, G13	473	ROOK	26 30.070	-82 00.789	Jan 99 - Dec 06	97-190
Shell Point	474	ROOK	26 31.368	-82 00.417	Jan 99 - Dec 06	97-190
Reckems Point	475	ROOK	26 32.108	-82 03.548	Jan 99 - Dec 06	97-190
Sanibel	476	ROOK	26 30.472	-82 09.113	Jan 99 - Dec 06	97-190
Pine Island Sound	477	ROOK	26 33.702	-82 09.934	Jan 99 - Dec 06	97-190
Cayo Costa	478	ROOK	26 38.150	-82 12.517	Jan 99 - Dec 06	97-190
Fakahatchee Bay	479	ROOK	26 01.542	-81 43.992	Jan 01 - Dec 06	131-190

Table 9.2. Statistical summary of Florida Bay water quality variables by zone.

Variable	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity (μM hr^{-1})	FBC	1.14	0.01	6.90	755
	FBE	0.35	0.01	6.11	3369
	FBW	0.16	0.01	4.93	1095
Chlorophyll *a* (μg l^{-1})	FBC	1.55	0.11	35.61	782
	FBE	0.51	0.00	11.35	3495
	FBW	1.34	0.10	22.08	1146
Surface Dissolved Oxygen (mg l^{-1})	FBC	6.4	2.4	12.3	785
	FBE	6.6	0.4	15.2	3499
	FBW	6.3	3.0	11.5	1159
Bottom Dissolved Oxygen (mg l^{-1})	FBC	6.3	0.4	12.2	754
	FBE	6.6	1.4	15.0	3384
	FBW	6.3	3.0	11.1	1086
Ammonium (ppm)	FBC	0.035	0.000	1.681	774
	FBE	0.036	0.000	1.149	3487
	FBW	0.008	0.000	0.342	1140
Nitrite (ppm)	FBC	0.002	0.000	0.111	779
	FBE	0.002	0.000	0.041	3489
	FBW	0.001	0.000	0.025	1140
Nitrate (ppm)	FBC	0.003	0.000	0.080	777
	FBE	0.008	0.000	0.154	3479
	FBW	0.002	0.000	0.101	1135
pH	FBC	8.255	7.394	8.850	224
	FBE	8.135	7.535	9.115	1008
	FBW	8.168	7.780	8.775	336
Surface Salinity	FBC	34.00	8.70	63.00	794
	FBE	29.30	0.10	54.30	3535
	FBW	35.10	16.50	52.00	1173
Bottom Salinity	FBC	33.60	11.90	63.00	750
	FBE	29.20	0.10	54.30	3347
	FBW	34.98	16.60	51.00	1086
Silicate (ppm)	FBC	0.835	0.000	5.731	180
	FBE	0.275	0.000	4.604	810
	FBW	0.476	0.000	5.089	270
Soluble Reactive Phosphorus (ppm)	FBC	0.001	0.000	0.026	777
	FBE	0.001	0.000	0.020	3469
	FBW	0.001	0.000	0.058	1133
Surface Temperature (^{o}C)	FBC	26.6	13.0	36.7	790
	FBE	26.6	14.2	34.5	3516
	FBW	26.5	14.1	36.0	1167
Bottom Temperature (^{o}C)	FBC	26.5	13.2	35.3	758
	FBE	26.5	14.2	34.6	3394
	FBW	26.3	13.9	34.7	1092
Total Nitrogen (ppm)	FBC	0.906	0.117	4.408	779
	FBE	0.568	0.060	3.142	3488
	FBW	0.341	0.067	1.691	1141

Variable	Zone	Median	Min.	Max.	*n*
Total Organic Carbon (ppm)	FBC	12.176	3.585	42.872	774
	FBE	8.188	0.000	58.043	3477
	FBW	4.653	1.199	27.370	1134
Total Organic Nitrogen (ppm)	FBC	0.756	0.106	4.355	772
	FBE	0.501	0.000	3.098	3475
	FBW	0.322	0.046	1.680	1134
Total Phosphorus (ppm)	FBC	0.016	0.002	0.131	778
	FBE	0.007	0.001	0.099	3489
	FBW	0.014	0.000	0.232	1142
Turbidity (NTU)	FBC	5.45	0.12	134.85	763
	FBE	2.20	0.00	172.95	3417
	FBW	4.66	0.07	178.55	1097

Table 9.3. Statistical summary of Whitewater Bay-Ten Thousand Islands water quality variables by zone.

Variable	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity (μM hr^{-1})	BLK	0.04	0.02	0.28	285
	GI	0.05		3.23	1764
	IWW	0.10	0.00	8.31	1570
	MR	0.22	0.00	3.70	2111
	WWB	1.26	0.00	5.96	1334
Chlorophyll *a* (μg l^{-1})	BLK	3.23	0.25	17.02	294
	GI	2.85	0.12	23.78	1810
	IWW	3.55	0.19	45.11	1614
	MR	2.76	0.15	28.76	2163
	WWB	2.92	0.11	29.78	1359
Surface Dissolved Oxygen (mg l^{-1})	BLK	5.3	0.3	10.3	294
	GI	5.8	1.4	12.1	1808
	IWW	6.0	1.8	11.8	1614
	MR	5.2	0.4	13.9	2152
	WWB	6.9	2.2	24.4	1352
Bottom Dissolved Oxygen (mg l^{-1})	BLK	5.1	0.1	9.8	294
	GI	5.7	0.2	11.8	1808
	IWW	5.9	1.1	11.9	1614
	MR	5.1	0.4	12.3	2151
	WWB	6.9	0.4	24.4	1352
Ammonium (ppm)	BLK	0.021	0.001	0.195	294
	GI	0.011	0.000	0.183	1810
	IWW	0.017	0.000	0.314	1614
	MR	0.018	0.000	0.402	2163
	WWB	0.014	0.000	0.408	1360
Nitrite (ppm)	BLK	0.003	0.000	0.017	294
	GI	0.002	0.000	0.033	1810
	IWW	0.002	0.000	0.036	1614
	MR	0.002	0.000	0.024	2163
	WWB	0.002	0.000	0.086	1360
Nitrate (ppm)	BLK	0.009	0.000	0.080	294
	GI	0.008	0.000	0.135	1810
	IWW	0.010	0.000	0.133	1614
	MR	0.015	0.000	0.142	2163
	WWB	0.006	0.000	0.268	1360
pH	BLK	7.793	7.170	8.530	112
	GI	7.880	6.920	8.765	670
	IWW	7.820	7.240	8.825	616
	MR	7.705	6.970	8.595	717
	WWB	8.180	7.510	8.810	440
Surface Salinity	BLK	32.0	1.4	39.9	294
	GI	28.9	1.3	40.7	1810
	IWW	15.7	0.1	42.8	1614
	MR	6.2	0.0	40.5	2160
	WWB	11.5	0.3	35.4	1360

Variable	Zone	Median	Min.	Max.	*n*
Bottom Salinity	BLK	32.4	1.4	39.9	294
	GI	29.5	1.0	40.7	1808
	IWW	17.6	0.2	53.6	1614
	MR	7.3	0.0	40.5	2148
	WWB	11.8	0.3	34.9	1352
Silicate (ppm)	BLK	1.733	0.000	4.493	84
	GI	1.491	0.000	4.705	505
	IWW	1.744	0.000	4.688	461
	MR	2.081	0.000	6.400	568
	WWB	1.422	0.002	4.880	352
Soluble Reactive Phosphorus (ppm)	BLK	0.017	0.002	0.066	294
	GI	0.006	0.000	0.044	1805
	IWW	0.003	0.000	0.033	1614
	MR	0.002	0.000	0.034	2160
	WWB	0.002	0.000	0.026	1357
Surface Temperature (^{o}C)	BLK	27.0	15.9	38.4	294
	GI	26.7	13.7	37.2	1808
	IWW	27.0	15.1	37.5	1614
	MR	26.7	13.6	34.4	2152
	WWB	26.7	12.3	34.4	1352
Bottom Temperature (^{o}C)	BLK	26.9	15.9	35.9	294
	GI	26.6	14.1	37.2	1808
	IWW	27.0	15.2	33.3	1614
	MR	26.5	13.6	33.3	2151
	WWB	26.6	11.8	33.5	1352
Total Nitrogen (ppm)	BLK	0.395	0.066	1.380	293
	GI	0.384	0.059	1.955	1808
	IWW	0.519	0.048	2.031	1614
	MR	0.596	0.038	3.046	2163
	WWB	0.714	0.057	2.588	1360
Total Organic Carbon (ppm)	BLK	6.316	2.897	21.385	293
	GI	6.465	1.482	27.170	1801
	IWW	10.929	2.112	23.348	1608
	MR	12.743	0.458	64.008	2162
	WWB	14.586	0.300	39.373	1358
Total Organic Nitrogen (ppm)	BLK	0.344	0.044	1.313	293
	GI	0.353	0.055	1.896	1808
	IWW	0.476	0.021	2.011	1614
	MR	0.555	0.021	2.989	2163
	WWB	0.675	0.000	2.535	1360
Total Phosphorus (ppm)	BLK	0.053	0.014	0.237	287
	GI	0.033	0.001	0.204	1802
	IWW	0.029	0.002	0.207	1612
	MR	0.021	0.001	0.125	2161
	WWB	0.018	0.003	0.094	1360
Turbidity (NTU)	BLK	7.30	0.49	40.50	293
	GI	5.05	0.09	68.00	1809
	IWW	4.41	0.06	66.60	1614
	MR	2.80	0.09	58.65	2163
	WWB	3.48	0.21	107.81	1360

Table 9.4. Statistical summary of Biscayne Bay water quality variables by zone.

Variable	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity (μM hr^{-1})	AS	0.327	0.091	3.209	312
	IS	0.193	0.013	3.378	713
	MAIN	0.111	0.008	2.720	1781
	NBAY	0.117	0.008	1.475	613
	SCARD	0.142	0.022	2.949	345
Chlorophyll *a* (μg l^{-1})	AS	0.30	0.03	2.46	314
	IS	0.28	0.02	6.37	719
	MAIN	0.24	0.00	5.89	1792
	NBAY	1.06	0.12	9.18	620
	SCARD	0.32	0.06	7.21	347
Surface Dissolved Oxygen (mg l^{-1})	AS	6.9	3.1	11.6	316
	IS	6.6	3.5	11.5	728
	MAIN	6.3	2.8	10.2	1813
	NBAY	6.2	3.0	10.2	630
	SCARD	6.4	4.0	9.1	351
Bottom Dissolved Oxygen (mg l^{-1})	AS	7.1	3.0	12.9	316
	IS	6.7	2.6	11.8	728
	MAIN	6.4	2.8	10.6	1813
	NBAY	6.2	3.2	10.4	630
	SCARD	6.5	3.3	9.5	351
Ammonium (ppm)	AS	0.018	0.001	0.228	318
	IS	0.013	0.000	0.148	729
	MAIN	0.009	0.000	0.120	1815
	NBAY	0.014	0.000	0.220	630
	SCARD	0.011	0.000	0.121	351
Nitrite (ppm)	AS	0.004	0.000	0.048	318
	IS	0.002	0.000	0.043	729
	MAIN	0.001	0.000	0.019	1815
	NBAY	0.002	0.000	0.068	630
	SCARD	0.002	0.000	0.019	351
Nitrate (ppm)	AS	0.046	0.000	1.173	318
	IS	0.012	0.000	0.732	728
	MAIN	0.004	0.000	0.633	1815
	NBAY	0.016	0.000	0.174	630
	SCARD	0.006	0.000	0.129	351
pH	AS	8.157	7.180	8.800	112
	IS	8.120	7.280	8.820	280
	MAIN	8.115	7.095	8.900	614
	NBAY	8.050	7.225	8.815	280
	SCARD	8.090	7.125	8.825	112
Surface Salinity	AS	27.1	6.2	44.1	318
	IS	31.4	11.5	43.8	729
	MAIN	35.3	21.2	41.4	1814
	NBAY	32.1	16.2	38.9	630
	SCARD	33.1	21.0	40.8	351

Variable	Zone	Median	Min.	Max.	*n*
Bottom Salinity	AS	28.0	7.2	44.1	318
	IS	32.0	11.5	43.9	729
	MAIN	35.5	24.2	41.5	1813
	NBAY	33.4	24.7	39.0	630
	SCARD	33.5	20.9	40.9	351
Silicate (ppm)	AS	0.181	0.000	1.972	84
	IS	0.074	0.000	1.268	210
	MAIN	0.025	0.000	0.720	462
	NBAY	0.194	0.001	1.287	210
	SCARD	0.031	0.000	1.552	84
Soluble Reactive Phosphorus (ppm)	AS	0.001	0.000	0.010	317
	IS	0.001	0.000	0.009	725
	MAIN	0.001	0.000	0.009	1808
	NBAY	0.001	0.000	0.021	626
	SCARD	0.001	0.000	0.008	349
Surface Temperature (°C)	AS	26.7	10.2	33.0	318
	IS	26.3	14.2	33.3	729
	MAIN	26.3	13.5	32.8	1814
	NBAY	26.0	14.3	32.5	630
	SCARD	26.3	15.9	33.0	351
Bottom Temperature (°C)	AS	26.7	10.3	33.2	318
	IS	26.3	14.2	33.4	729
	MAIN	26.3	13.5	32.7	1814
	NBAY	25.8	14.5	32.9	630
	SCARD	26.6	15.8	33.8	351
Total Nitrogen (ppm)	AS	0.445	0.101	1.560	318
	IS	0.313	0.031	1.026	726
	MAIN	0.215	0.000	1.313	1815
	NBAY	0.248	0.047	1.011	626
	SCARD	0.301	0.055	1.325	350
Total Organic Carbon (ppm)	AS	4.477	1.379	9.330	318
	IS	3.590	1.463	9.415	728
	MAIN	2.542	0.326	11.982	1815
	NBAY	3.261	1.128	10.690	629
	SCARD	3.801	1.684	11.050	350
Total Organic Nitrogen (ppm)	AS	0.325	0.000	1.010	318
	IS	0.261	0.014	0.877	726
	MAIN	0.192	0.000	1.288	1815
	NBAY	0.201	0.032	0.983	626
	SCARD	0.273	0.030	1.229	350
Total Phosphorus (ppm)	AS	0.006	0.000	0.052	318
	IS	0.005	0.001	0.059	727
	MAIN	0.005	0.000	0.049	1815
	NBAY	0.009	0.002	0.058	629
	SCARD	0.006	0.002	0.030	351
Turbidity (NTU)	AS	0.50	0.05	11.53	318
	IS	0.47	0.00	5.09	728
	MAIN	0.75	0.00	19.00	1813
	NBAY	1.18	0.01	22.35	630
	SCARD	0.55	0.00	5.17	351

Table 9.5. Statistical summary of Southwest Florida Shelf water quality variables by zone.

Variable	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity (μM hr^{-1})	SHARK	0.055	0.016	2.485	85
	SHELF	0.043	0.004	12.017	1677
	SHOAL	0.047	0.006	7.627	296
Chlorophyll *a* (μg l^{-1})	SHARK	1.608	0.254	8.910	92
	SHELF	0.913	0.000	13.791	1825
	SHOAL	0.922	0.120	8.448	320
Surface Dissolved Oxygen (mg l^{-1})	SHARK	6.1	2.4	8.6	91
	SHELF	6.0	1.0	12.6	1803
	SHOAL	6.0	0.9	12.8	318
Bottom Dissolved Oxygen (mg l^{-1})	SHARK	5.4	2.8	8.6	62
	SHELF	5.8	1.7	29.9	1235
	SHOAL	5.8	2.6	9.7	219
Ammonium (ppm)	SHARK	0.006	0.001	0.049	92
	SHELF	0.004	0.000	0.129	1825
	SHOAL	0.004	0.000	0.064	320
Nitrite (ppm)	SHARK	0.001	0.000	0.006	92
	SHELF	0.000	0.000	0.008	1825
	SHOAL	0.000	0.000	0.005	320
Nitrate (ppm)	SHARK	0.002	0.000	0.072	92
	SHELF	0.001	0.000	0.078	1825
	SHOAL	0.001	0.000	0.022	320
pH	SHARK	7.918	7.565	8.265	30
	SHELF	7.895	7.395	8.780	584
	SHOAL	7.905	7.595	8.885	103
Surface Salinity	SHARK	34.6	24.4	40.7	91
	SHELF	35.4	27.0	40.1	1809
	SHOAL	35.5	27.9	38.8	318
Bottom Salinity	SHARK	34.6	26.0	40.7	62
	SHELF	35.7	24.4	40.1	1241
	SHOAL	35.7	31.0	39.2	219
Silicate (ppm)	SHARK	0.424	0.000	1.756	85
	SHELF	0.063	0.000	2.238	1738
	SHOAL	0.041	0.000	1.698	305
Soluble Reactive Phosphorus (ppm)	SHARK	0.001	0.000	0.006	92
	SHELF	0.001	0.000	0.014	1825
	SHOAL	0.001	0.000	0.008	320
Surface Temperature (^{o}C)	SHARK	26.4	14.8	32.1	91
	SHELF	26.7	14.7	32.7	1809
	SHOAL	26.8	15.2	32.3	318
Bottom Temperature (^{o}C)	SHARK	26.3	14.8	31.4	62
	SHELF	26.5	14.7	31.9	1241
	SHOAL	26.2	15.2	32.0	219
Total Nitrogen (ppm)	SHARK	0.262	0.068	0.967	91
	SHELF	0.200	0.027	1.028	1817
	SHOAL	0.207	0.023	1.043	320

Variable	Zone	Median	Min.	Max.	*n*
Total Organic Carbon (ppm)	SHARK	3.553	1.722	5.812	91
	SHELF	2.482	1.009	16.708	1822
	SHOAL	2.441	1.055	5.864	320
Total Organic Nitrogen (ppm)	SHARK	0.247	0.059	0.957	91
	SHELF	0.191	0.023	1.021	1817
	SHOAL	0.198	0.020	1.040	320
Total Phosphorus (ppm)	SHARK	0.015	0.004	0.079	92
	SHELF	0.012	0.000	0.190	1825
	SHOAL	0.012	0.003	0.038	320
Turbidity (NTU)	SHARK	5.99	0.62	66.25	88
	SHELF	2.02	0.00	45.05	1745
	SHOAL	2.64	0.19	20.70	305

Table 9.6. Statistical summary of Cape Romano-Pine Island Sound water quality variables by zone.

Variable	Zone	Median	Min.	Max.	*n*
Alkaline Phosphatase Activity (μM hr^{-1})	COCO	0.05	0.02	0.30	77
	EST	0.05	0.01	0.22	386
	MARC	0.04	0.01	0.29	743
	NPL	0.05	0.02	0.31	279
	PIS	0.05	0.01	0.17	279
	RB	0.05	0.01	0.44	428
	SCB	0.05	0.01	0.19	465
Chlorophyll *a* (μg l^{-1})	COCO	4.34	0.63	18.27	78
	EST	3.95	0.41	24.68	395
	MARC	4.37	0.38	20.85	757
	NPL	2.99	0.33	18.22	285
	PIS	3.34	0.49	28.63	285
	RB	4.00	0.67	28.30	438
	SCB	3.05	0.53	28.47	475
Surface Dissolved Oxygen (mg l^{-1})	COCO	5.5	1.8	7.3	20
	EST	6.1	2.0	9.9	400
	MARC	6.0	2.8	14.8	765
	NPL	5.8	2.1	11.7	288
	PIS	6.4	1.0	9.8	288
	RB	5.8	1.3	12.9	431
	SCB	6.4	3.0	10.8	480
Bottom Dissolved Oxygen (mg l^{-1})	COCO	4.9	2.6	8.0	79
	EST	6.3	2.8	10.5	400
	MARC	6.2	2.8	13.2	765
	NPL	5.9	2.3	11.5	288
	PIS	6.8	3.9	10.6	288
	RB	6.0	2.7	10.0	443
	SCB	6.6	3.1	11.1	480
Ammonium (ppm)	COCO	0.046	0.001	0.217	77
	EST	0.008	0.000	0.141	400
	MARC	0.006	0.000	0.194	764
	NPL	0.008	0.000	0.170	288
	PIS	0.005	0.000	0.173	288
	RB	0.008	0.000	0.239	442
	SCB	0.010	0.000	0.184	477
Nitrite (ppm)	COCO	0.002	0.000	0.017	78
	EST	0.001	0.000	0.014	400
	MARC	0.001	0.000	0.010	765
	NPL	0.001	0.000	0.009	288
	PIS	0.001	0.000	0.023	288
	RB	0.001	0.000	0.009	443
	SCB	0.001	0.000	0.047	480

Variable	Zone	Median	Min.	Max.	*n*
Nitrate (ppm)	COCO	0.013	0.000	0.137	78
	EST	0.003	0.000	0.126	400
	MARC	0.002	0.000	0.052	765
	NPL	0.003	0.000	0.103	288
	PIS	0.003	0.000	0.087	288
	RB	0.003	0.000	0.056	443
	SCB	0.009	0.000	0.424	480
pH	COCO	7.745	5.200	8.390	53
	EST	7.990	5.300	8.525	292
	MARC	7.982	5.150	8.560	550
	NPL	7.920	5.180	8.475	207
	PIS	8.100	5.250	8.715	207
	RB	7.870	5.180	8.565	335
	SCB	8.025	5.260	8.550	345
Surface Salinity	COCO	33.1	3.5	38.3	20
	EST	33.7	5.5	38.3	400
	MARC	34.5	21.2	40.7	765
	NPL	34.5	8.7	41.5	288
	PIS	33.7	18.3	38.6	288
	RB	34.3	14.2	40.5	430
	SCB	30.3	1.3	37.9	480
Bottom Salinity	COCO	29.6	0.0	37.1	79
	EST	33.5	2.8	38.5	400
	MARC	34.5	15.5	40.6	765
	NPL	34.3	6.8	41.4	288
	PIS	33.1	17.0	38.5	288
	RB	34.2	12.2	39.9	442
	SCB	28.4	0.6	38.0	480
Silicate (ppm)	COCO	0.825	0.166	2.940	31
	EST	0.646	0.033	2.476	128
	MARC	0.645	0.003	3.488	253
	NPL	0.546	0.006	2.466	96
	PIS	0.374	0.000	1.612	96
	RB	0.717	0.014	2.436	147
	SCB	0.821	0.045	4.175	160
Soluble Reactive Phosphorus (ppm)	COCO	0.012	0.000	0.068	78
	EST	0.006	0.000	0.060	400
	MARC	0.004	0.000	0.035	765
	NPL	0.005	0.000	0.034	288
	PIS	0.005	0.000	0.153	288
	RB	0.005	0.000	0.031	443
	SCB	0.014	0.000	0.165	477
Surface Temperature (^{o}C)	COCO	28.7	19.8	32.7	20
	EST	25.4	15.7	32.0	400
	MARC	25.8	12.7	32.5	765
	NPL	25.8	15.4	32.0	288
	PIS	24.9	14.3	33.0	288
	RB	26.2	15.1	33.5	431
	SCB	25.1	14.9	34.5	480

Variable	Zone	Median	Min.	Max.	*n*
Bottom Temperature (^{o}C)	COCO	26.1	17.7	32.8	79
	EST	25.6	15.7	32.2	400
	MARC	25.9	14.8	38.0	765
	NPL	25.8	15.8	32.1	288
	PIS	25.1	14.2	32.0	288
	RB	26.3	15.1	33.6	443
	SCB	25.3	15.0	33.1	480
Total Nitrogen (ppm)	COCO	0.428	0.186	1.108	79
	EST	0.273	0.092	0.982	400
	MARC	0.255	0.055	0.951	765
	NPL	0.255	0.066	0.736	288
	PIS	0.276	0.019	1.250	288
	RB	0.268	0.029	1.056	443
	SCB	0.308	0.030	1.849	479
Total Organic Carbon (ppm)	COCO	5.939	2.458	16.598	79
	EST	4.303	2.087	17.602	399
	MARC	3.987	1.443	15.172	765
	NPL	3.714	1.748	13.520	288
	PIS	4.240	1.808	13.733	288
	RB	4.498	1.495	16.720	443
	SCB	5.805	1.700	19.688	480
Total Organic Nitrogen (ppm)	COCO	0.325	0.053	1.052	77
	EST	0.250	0.033	0.769	400
	MARC	0.241	0.048	0.908	764
	NPL	0.228	0.028	0.713	288
	PIS	0.246	0.017	1.229	288
	RB	0.245	0.013	1.034	442
	SCB	0.266	0.024	1.417	476
Total Phosphorus (ppm)	COCO	0.049	0.018	0.118	79
	EST	0.043	0.012	0.186	400
	MARC	0.035	0.000	0.160	763
	NPL	0.033	0.011	0.150	287
	PIS	0.039	0.014	0.215	285
	RB	0.038	0.002	0.102	441
	SCB	0.050	0.012	0.213	475
Turbidity (NTU)	COCO	4.46	0.35	18.08	79
	EST	4.07	0.13	63.90	400
	MARC	5.02	0.39	60.30	765
	NPL	3.01	0.25	38.65	288
	PIS	2.40	0.07	20.65	288
	RB	5.01	0.61	35.25	443
	SCB	2.53	0.06	55.35	480