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2007 Cumulative Annual Report for the Coastal Water Quality Monitoring Network

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2007 Cumulative Annual Report for the Coastal Water Quality Monitoring Network (Agreement 4600000352)

For the period
January – December 2007

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1. EXECUTIVE SUMMARY

This report summarizes the existing data from the FIU Coastal Water Quality Monitoring Network for calendar year January 1 – December 31, 2007. 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.

Effective Oct. 1, 2007, the SFWMD contract deleted field sampling and lab analyses at 4 sites in Whitewater Bay area #31, 45, 46, and 50; 5 sites in Ten Thousand Islands #51, 60, 62, 68, and 73; 6 sites in Biscayne Bay #103, 109, 113, 116, 126, and 132; and all 49 sites on the SW Florida Shelf. Also effective Oct. 1, 2007 as per SFWMD contract, no samples were analyzed for silicate and field duplicates were reduced to 10% of sites collected.

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.

Climatological Conditions

Climate variability has major effects on the health of South Florida ecosystems because precipitation, temperature, evaporation and wind-driven water flow affect circulation, salinity, water exchange and biogeochemical processes. Furthermore, in a significant proportion water flow from Everglades managed canals partially follow precipitation cycles contributing further to complexity in response from coastal waters. Precipitation on the region has not been uniform over the data collection period of record, neither in space nor in time. 2007 was an average precipitation year from Palm Beach south, but the northern watershed, including Lake Okeechobee itself, experienced an extreme drought. This unusual dry year forced the SFWMD to curtail water supply to South Florida ecosystems, especially affecting those stations influenced by the Loxahatchee. Dryness plus reduced canal flows significantly affected the SW Florida coast during 2007. Precipitation in the Everglades rebounded from the drought of the late 1980's and reached levels equal or greater than the long term average (1949-2007; 141.68 cm yr^{-1}) for 10 of the last 17 years. Total precipitation for 2007 was 150.27 cm y^{r-1} making it equal to the median value year since 1991. Nevertheless, July and August were above their respective medians by about 11 cm.

Florida Bay

The main external influences on water quality in Florida Bay are water exchange with the Gulf of Mexico at the western boundary, atmospheric precipitation, and terrestrial input from Taylor Slough and C-111 panhandle. The two largest impacts cannot be managed by man and even freshwater inputs from land are highly tied to climactic conditions and events.

Eastern Bay: Salinity was higher in the early months due to the drier than normal dry season. This points out the impact that the long water residence time has on Eastern Bay. Temperature, dissolved oxygen (DO), and turbidity were unremarkable. Nitrate (NO_3^-) was higher than normal especially for the summer months. Ammonium (NH_4^+) was higher than the grand median for the first half of the year and then rapidly declined to below average levels during

August. Total Phosphorus (TP) was elevated in Eastern Bay throughout most of the year as a result of the previous hurricane and road construction interaction (Rudnick et al. 2006). Chlorophyll *a* (CHLA) showed an inverse pattern to the dissolved inorganic nitrogen (DIN) pool, being highest in the wet season. Total organic nitrogen (TON) and total organic carbon (TOC) were lower than the grand median being indicative of temporal trend towards lower concentration.

Central Florida Bay: Salinity was higher in the early months due to the drier than normal dry season and was also high in Sep.-Nov. This points out the impact that the long water residence time has on Central Bay. Temperature was unremarkable; DO showed deviations from long term median possibly as a function of CHLA fluctuations. NO_3^- was normal except for large increases in Nov.-Dec. NH_4^+ was significantly below average for the year. TP was slightly lower during the wet season than other years. CHLA was high early in the year but declined to normal levels for the remainder. TOC and TON were higher in the winter-spring and lower than normal for rest of the year. pH in Central Bay was elevated relative to other years but unrelated to salinity. Turbidity was lower for 2007 as well.

Western Florida Bay: Salinity was slightly higher than usual but probably not significantly so. Temperature and DO were unremarkable. NO_3^-, NH_4^+, and TP were normal for Western Bay. Turbidity and CHLA were generally lower than normal.

Whitewater Bay-Ten Thousand Islands Region

The influence of freshwater input from the Everglades Shark Slough is very influential to water quality of this region. Large salinity variations are the norm, being driven by both climactic events and water management practices. Although 2007 was relatively typical rainfall year, 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.

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 2007 was relatively normal rainfall year, salinity patterns were elevated from the grand medians during the early part of the year and were higher than normal during the wet season.

Whitewater Bay: Salinity was elevated relative to long term median. Temperature, DO, and pH were unremarkable with values generally fluctuating around the median. NO_3^-, NH_4^+, and TP concentrations were elevated while TON was reduced. TON 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. CHLA varied seasonally and was more volatile than the median.

Mangrove Rivers: Salinity fluctuated widely due to freshwater inputs from Shark Slough but was slightly higher than usual. Temperature and pH were unremarkable with values generally fluctuating around the median. DO was generally higher than normal as was turbidity. Some peaks in NO_3^-, NH_4^+, and TP were observed. TON was lower than the grand median. CHLA was lower in the dry season but came up to normal levels for the rest of the year.

Inner Waterway: Salinity fluctuated widely due to freshwater inputs from Shark Slough but was higher than usual. Temperature, DO, and pH were unremarkable with values generally fluctuating around the median. NO_3^-, NH_4^+, and TP were all higher than the norm during the wet season. TON was lower than the grand median. CHLA showed a large peak in Jan. and Oct. but was normal for the rest of the year.

Blackwater River: Salinity was elevated relative to long term median and showed a rapid decline in Sep with a quick rebound in Oct. Temperature, DO, turbidity, and pH were unremarkable with values generally fluctuating around the median. Large peaks in NO_3^-, NH_4^+, and TP were observed in Apr. and Oct. TON was lower than the grand median. CHLA was lower in the dry season but varied widely for the rest of the year.

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 (Caccia and Boyer 2005). The largest intra-annual variations in salinity in this area are typically driven by freshwater releases from the canal system. Nutrient loads and concentrations in Biscayne Bay are strongly driven by canal inputs (Caccia and Boyer 2007). Therefore, precipitation patterns have a great impact on the bay both directly and indirectly.

Alongshore Zone: Because 2007 was a "normal" water year, salinity was generally similar to the long term median. Temperature and DO were unremarkable but both turbidity and pH showed large fluctuations, primarily in the dry season. The Oct. drop in salinity coincided with large increases in NO_3^-, NH_4^+, TON, and TP as we have observed in other years. CHLA remained lower than the long term median.

Inshore Zone: Because the Inshore Zone is a continuation of the offshore gradient, trends were very similar to those observed for the Alongshore Zone. Temperature and DO were unremarkable but both turbidity and pH showed large fluctuations, primarily in the dry season. The Oct. drop in salinity coincided with large increases in NO_3^-, NH_4^+, TON, and TP as we have observed in other years. CHLA remained lower than the long term median.

Main Bay: Fluctuations in water quality in the Main Bay were damped by its large volume and short residence time due to oceanic mixing. Salinity, temperature, DO, nutrients, and CHLA were all very similar to the grand median.

South Card Sound: Water quality in Card Sound was characterized by a large peak in Oct.-Nov. of NO_3^-, TON, TP, CHLA and turbidity. We are unsure as to what caused this anomaly as there was no concurrent change in salinity to suggest terrestrial input. 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, but there is no circulation data to support this. Other than that event, water quality was similar to long term median values.

North Bay: The North bay is the most compartmentalized and urbanized area of Biscayne Bay. As such nutrients tend to be higher in this region. Because 2007 was a "normal" water year, salinity was generally similar to the long term median. Temperature and DO were unremarkable but turbidity showed large increase in the fall while pH dropped in early spring. Large variations in NO_3^-, NH_4^+, TON, TP, and CHLA occurred throughout the year, often being temporally unrelated. As such, it is difficult to assign a cause to these fluctuations.

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 area clearly shows the

input of freshwater from Shark River being transported south and east around the Cape. Water overlying the northern 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

Shark Zone: Because 2007 was a "normal" water year, salinity was generally similar to the long term median. Temperature and turbidity were unremarkable but DO, pH, TON, and CHLA were low. NO_3^-, NH_4^+, and TP were similar to other years. CHLA remained lower than the long term median.

Shelf Zone: Because the Shelf Zone is a continuation of the offshore gradient, trends were very similar to those observed for the Shark Zone. Fluctuations in water quality on the Shelf were damped by its large volume mixing with the Gulf of Mexico. Only DO, turbidity, pH, and CHLA deviated from the median being lower than usual.

Shoal Zone: The Shoal area nearest the Ten Thousand Islands also showed similarities to the other SW Shelf sites with DO, turbidity, and pH being lower than usual. However, CHLA levels were more representative of long term median.

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 and water quality in this area are driven by freshwater releases from the Caloosahatchee River at Franklin Lock (S-79 water control structure) and associated pathways. This is 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. Releases were minimal this year due to the drought in central Florida.

Marco Island: Salinities remained high all year reflecting the drought conditions in the watershed. Variations in temperature, DO pH, and TON were unremarkable as compared to long term median. TOC was lower than average due to low freshwater inputs. NO_3^- and NH_4^+ were highly variable and did not seem to be driven by freshwater inputs. TP was higher than average in the dry season and lower in the wet season. CHLA was lower than usual but peaked in the fall.

Rookery Bay: Salinities remained high all year reflecting the drought conditions in the watershed. Temperature, DO, pH, TON, and TP were unremarkable as compared to long term median. None of the measured variables help explain why pH dropped to 7.4 in May. TOC was lower than average due to low freshwater inputs but mirrored the annual pattern. NO_3^-, NH_4^+, and turbidity were highly variable and did not seem to be driven by freshwater inputs. CHLA was generally lower than usual.

Naples Bay: Salinity was marginally higher in the fall but was not different for the bulk of the year. Temperature, TON, and TP were unremarkable as compared to long term median. pH was higher than normal and also highly variable. DO was slightly higher than usual while NO_3^- and CHLA were down. Turbidity, pH, and NH_4^+ were highly variable but did not seem to be driven by freshwater inputs. CHLA was generally lower than usual.

San Carlos Bay: This is the region most affected by Lake Okeechobee water releases through the Caloosahatchee River (S-79). The drought of 2007 was reflected in the high salinities throughout the region. We did not observe the usual 10-15 psu drop during the wet season nor the concomitant increase in NO_3^-. Temperature, DO, and TON were unremarkable as compared to long term median. Turbidity, NO_3^-, TP, TOC, and CHLA were generally lower than usual, especially during the wet season. $NH_4^+$was highly variable and did not seem to be driven by freshwater inputs.

Estero Bay: Salinity was relatively invariant during 2007 and did not show the usual decline during the wet season. Temperature, TON, TP, and TOC were unremarkable as compared to long term median. DO was slightly elevated while pH was higher than normal in the spring-summer. Turbidity, NO_3^-, TOC, and CHLA were generally lower than usual, especially during the wet season. Peaks in CHLA sometimes corresponded with peaks in TP and NH_4^+. TP was higher in the first 8 months and then declined to below the average. NH_4^+ was highly variable and did not seem to be driven by freshwater inputs.

Pine Island Sound: Salinity was relatively invariant during 2007 and did not show the usual decline during the wet season. Temperature, NO_3^-, TON, and TP were unremarkable as compared to long term median. DO was elevated for the first 2 months then declined to usual levels. pH was generally lower than normal but peaked in May for no obvious reason. Turbidity was higher during the summer but quickly dropped to very low levels in Sept.-Dec. NH_4^+ was highly variable and did not seem to be driven by freshwater inputs. TOC and CHLA were generally lower than usual, especially during the wet season. Peaks in CHLA sometimes corresponded with peaks in TP and NH_4^+.

Cocohatchee River: Like the Caloosahatchee, the Cocohatchee River at Wiggins Pass was under low flow conditions due to the drought. Salinity dipped only slightly during the wet season in contrast to the large declines usually observed. We did not observe the usual 20-25 psu drop during the wet season or the concomitant increase in NO_3^-, NH_4^+ and TOC. Most all water quality variables were lower than the long term median with the exception of pH and DO which were higher.

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