LOXAHATCHEE RIVER DATASONDE WATER QUALITY MONITORING

TASK 2: FINAL REPORT

ASSESSMENT OF 2007-2008 LOXAHATCHEE RIVER WATER QUALITY

In Partial Fulfillment of Agreement No. 4600001281

For the Period

October 2007 through September 2008

Respectfully Submitted by

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&

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Introduction

Since January 2004, the Loxahatchee River District (LRD) has partnered with the South Florida Water Management District to continuously monitor physical water quality parameters (i.e., temperature, salinity, pH, dissolved oxygen, depth, etc.) within the Loxahatchee River Watershed. This monitoring program has several specific goals, and they include the following: (1) establishing baseline conditions in the Loxahatchee River and Estuary, (2) establishing the relationship between freshwater discharge (i.e., over Lainhart Dam and/or S-46) and salinity dynamics in the estuary and the river, (3) establish a better understanding of the daily salinity variability within the estuary and river, and (4) provide observational data on a nearly continuous basis that can be used to calibrate and validate salinity models. In addition, these data are useful for interpreting changes observed in indictor organisms and communities. For example, results from previous datasonde monitoring were instrumental in understanding why seagrasses exhibited severe impacts by the storms of September 2004 and the resulting freshwater discharge (Ridler et al. 2006). This ongoing monitoring continues to provide valuable information towards achieving each of the goals stated above.

This report presents the data collected from October 2007 through September 2008. Previous reports present data back to April 2004. This report highlights some of the most important and relevant observations and findings that resulted from the datasonde monitoring. An accompanying Microsoft Access Database, containing all data and queries used to provide summary statistics, is available from LRD.

Study Area

The Loxahatchee River Estuary encompasses approximately 400 ha and drains a watershed of approximately 700 km^2 located in northeastern Palm Beach County and southeastern Martin County, Florida, USA. Freshwater discharges into the estuary from the North Fork, the Northwest Fork, and the Southwest Fork of the Loxahatchee River. Flood control efforts since the 1950's substantially altered the hydrology of the basin. Historically (pre-1950), most surface water runoff reaching the estuary originated in the Loxahatchee and Hungryland Sloughs and flowed gradually to the Northwest Fork. In the 1930s the Lainhart Dam, a small fixed-weir dam, was constructed in the Northwest Fork at river mile 14.5 to reduce "over" drainage of upstream reaches of the Northwest Fork during the dry season. In 1958 a major canal (C-18) and flood control structure (S-46) were constructed to divert flows from the Northwest Fork to the Southwest Fork, which increased the intensity and decreased the duration of storm-related discharge to the estuary. Furthermore, in 1947 the Jupiter inlet District began a series of jetty expansions and routine dredging at the Jupiter Inlet, the rivers eastern link to the ocean. The jetty improvements increased saltwater intrusion into the primarily freshwater Northwest Fork. Ongoing restoration efforts seek to increase base flows into the Northwest Fork, while not compromising the ecological integrity of downstream reaches (i.e., estuary) nor impairing valued ecosystem components of the estuary such as oysters and seagrasses (SFWMD 2006).

During this study, we used datasondes, automatic recording, multi-parameter water quality monitoring instruments, to monitor physical water quality conditions at eight sites (Figure 1, Table 1). Water quality monitoring occurred at three stations where the LRD performed seagrass monitoring. These stations were North Bay (NB), Pennock Point (PP), and Station 25. North Bay (NB) and Pennock Point (PP) were located in the central embayment of the Loxahatchee River (Figure 1), while Station #25 is located 8 km north of Jupiter Inlet in the southern Indian River Lagoon. At each of these sampling locations, datasondes monitored temperature, salinity, conductivity, and water depth.

Water quality monitoring also occurred at Station 69 and Kitching Creek in the Wild and Scenic segment of the Northwest Fork of the Loxahatchee River. Station 69 is the most upstream sampling site, located where Indiantown Road crosses the Loxahatchee River (Figure 1). The Kitching Creek (KC) site was in the Loxahatchee River at the confluence of Kitching Creek. Note that two datasondes were deployed at Kitching Creek – one at the surface (0.5 m deep) and one in the middle of the channel approximately 20 cm above the bottom, in waters roughly 3 m deep. At each of these monitoring locations in the Wild and Scenic River, we sampled the following parameters: temperature, pH, DO, salinity, conductivity and water depth. Data collection occurred at a third station (Oyster Reef/OY) within the Northwest Fork, down steam of the Wild and Scenic segment, in the vicinity of high densities of oysters.

Some additional monitoring occurred at Station 72 and Station 75 in the Southwest Fork of the Loxahatchee. Station 72, near the main channel of the Southwest Fork of the Loxahatchee, is influenced by freshwater discharges from the C-18 canal through the S-46 structure. Station 75 is in Jones Creek, a tributary to the Southwest Fork. This goal of monitoring Station 75 was to assess the response of the water quality parameters in response environmental enhancement project completed as part of the Loxahatchee River Preservation Initiative. In 2007, the Jupiter Inlet District and their partners dredged portions of the Creek as part of a restoration project to remove accumulated to organic sediments and improve water flow and navigability.

Table 1. Locations of Datasonde water quality monitoring stations in the Loxahatchee River, Jupiter, Florida.

Station	Latitude	Longitude	Location	River Segment
25	27° 00.711”	80° 06.045”	Hobe Sound ICWW	
69	26° 56.239”	80° 10.569”	Indiantown Rd Bridge	Wild & Scenic
KC (surface, bottom)	26° 59.469”	80° 09.302”	Mouth of Kitching Creek, NW Fork	Upper region of Meso-/Oligohaline
OY	26° 58.229”	80° 07.548”	Northwest Fork	Polyhaline
PP	26° 56.888”	80° 06.650”	Pennock Point	Polyhaline
NB	26° 57.055”	80° 05.658”	North Bay, Central Embayment	Marine
72	26° 56.598”	80° 07.311”	Southwest Fork	Polyhaline
75	26° 56.021”	80° 06.788”	Jones Creek, tributary to SW Fork	

Figure 1. Locations of Datasonde water quality monitoring stations, Loxahatchee River, Jupiter, Florida. Photo 2004.

Materials and Methods

At each station, LRD scientists employed a multi-parameter datasonde (either a HydroTech Data Sonde 3 or Data Sonde 4 or a YSI 600 OMS unit) to collect physical water quality parameters. Datasondes were used to monitor temperature, depth, pH, conductivity/salinity and dissolved oxygen in freshwater, while only temperature, depth, and salinity were monitored in marine waters (e.g., NB). Typically, datasondes were placed within 25 cm of the bottom (see Kitching Creek surface site exception above), and observations were recorded every 15 minutes, and 1 hr at Station 69.

Prior to datasonde deployment, we performed an initial calibration following the protocol described in the operating manual. Subsequent to the initial calibration, we programmed the datasonde to begin collecting data at the appropriate start time and with a 15 minute interval between readings. Datasondes were deployed in an upright position, with the probes facing down, to minimize fouling of the probes. On a weekly basis, staff traveled to each of the datasonde sites and performed an in situ QC check by collecting an in situ comparison reading using an appropriately calibrated datasonde. This permitted a comparison between results obtained from the field-deployed datasonde and the hand-held unit. Typically, we deployed datasondes for two weeks then brought the units back to the lab for cleaning, maintenance, and calibration. Following data collection, we perform a final calibration following the protocol described in the operating manual. In order for data to meet LRD's QA/QC acceptance criteria, weekly QC checks and final calibration data must have met the following criteria:

1. Dissolved Oxygen – difference ≤ 0.5 mg/L
2. Specific Conductance – difference ≤ 10%
3. pH – difference ≤ 0.5 pH units
4. Temperature – difference ≤ 0.5 °C

We accepted data meeting the above criteria as valid and rejected the data not meeting these criteria as unreliable and removed from the final (edited) dataset. Instrument failure and losses from vandalism at Station 75 and OY resulted in additional missing data for some of the stations. We discontinued data collection at Station 25 in March 2008 because we have 18 months of data at this site that shows limited variability and we needed instruments to monitor a new site (Station 75).

Results

Results from the datasonde monitoring project clearly show the daily and seasonal variability of the various monitored parameters (e.g., salinity, dissolved oxygen) within and among the monitored locations. Table 2 presents the summary statistics for each water quality parameter at each station. Appendix A presents plots of the daily average, minimum and maximum values for each parameter and station over time.

Table 2. Summary statistics for water quality parameters measured by Datasonde between October 1, 2007 and September 30, 2008, Loxahatchee River, Florida.

		Temperature °C			Salinity (ppt)			Conductivity (µmho/cm)			pH			Dissolved Oxygen (mg/L)		
Station	N	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max
25	11,214	23.5	17.3	30.5	31.0	23.1	38.1	47,249	23,338	57,257						
69	8,289	25.9	17.0	32.6	0.3	0.1	0.4	505	298	792	7.3	6.9	7.9	4.2	0.8	8.1
72	15,066	28.7	20.2	33.7	23.5	0.2	35.5	36,798	479	53,932						
75	5,022	29.7	25.7	33.6	14.8	0.3	30.1	24,221	577	46,600						
Kitching Creek Surface	24,369	25.3	17.1	31.7	0.4	0.0	12.2	781	48	20,479	7.1	5.6	7.8	3.4	0.6	8.0
Kitching Creek Bottom	31,997	25.2	16.7	31.0	1.8	0.0	17.0	3,042	77	27,712	7.2	6.3	7.7	3.6	0.0	7.6
NB	30,814	26.1	16.2	32.9	32.2	5.2	37.7	49,380	9,340	63,356						
OY	24,075	24.5	16.0	31.8	17.4	0.1	35.5	27,912	250	53,644						
PP	27,888	25.8	14.6	32.5	29.7	0.5	39.5	45,513	1,089	59,192						

Salinity data from the datasonde monitoring project have been used to understand how freshwater discharged into the Loxahatchee River Estuary (e.g., over Lainhart Dam and/or S-46) influence the daily salinity regime in the estuary and at the monitored seagrass beds. It is both intuitive and immediately apparent that as freshwater flows (i.e., discharge into the system) increase, salinity values decrease. Nonetheless, datasonde data clearly describes the effect of discharge on minimum daily salinity, mean daily salinity, and maximum daily salinity values. Simple correlation analysis shows strong relationships (ρ_{xy}>= 0.7) between the station flows and daily average and minimum salinities, summarized in Table 3.

Table 3. Summary of correlation analysis evaluating the relationships between daily mean station flows and daily average and minimum salinities (or conductivity for Station 69).

Station Flow	Strong Correlation to Stations & Parameters (ρ_{xy} >=0.7)
S-46	Sta 72 Daily Min; Sta 75 Daily Ave; North Bay Daily Ave; North Bay Daily Min
Lainhart	Sta 69 Daily Ave; Sta 69 Daily Min; Sta 75 Daily Ave; OY Daily Min
S-46 + Lainhart	Sta 72 Daily Ave; Sta 72 Daily Min; Sta 75 Daily Ave; North Bay daily Ave; North Bay Daily Min; Pennock Point Daily Min

From a river restoration perspective, we are interested in high conductivity or salinity values throughout the regions of the river that were historically fresh. Equally important is the influence of low salinities in the downstream reaches and central embayment of the river that result from freshwater discharges because of the potential for detrimental effects on the natural resources. Figures 2 through 4 provide a cursory assessment of these relationships, grouped by flow measurements at Lainhart Dam, the S-46 structure, and the combination of Lainhart and S-46. In Figure 2, conductivity showed a strong, negative relationship between flow and daily maximum conductivity at Station 69, with a similar relationship with salinity at the Oyster Reef and North Bay sites. While unlikely influenced by saline water coming from downstream, the findings at Station 69 clearly shows the influence of the rainwater during high river flows during storm events. Further downstream, the Oyster Reef and North Bay sites show a respectable relationship between daily minimum salinities and flows over Lainhart Dam. Similar relationships are evident for flows at the S-46 structure and the downstream monitoring stations including station 72 in the Southwest Fork, Pennock Point, and North Bay, as presented in Figure 3. The combined flow values for Lainhart and S-46 show a clear influence on salinity at Pennock Point and North Bay. Depending on duration, these fluxes of freshwater into these regions may have deleterious effects on the area's natural resources.

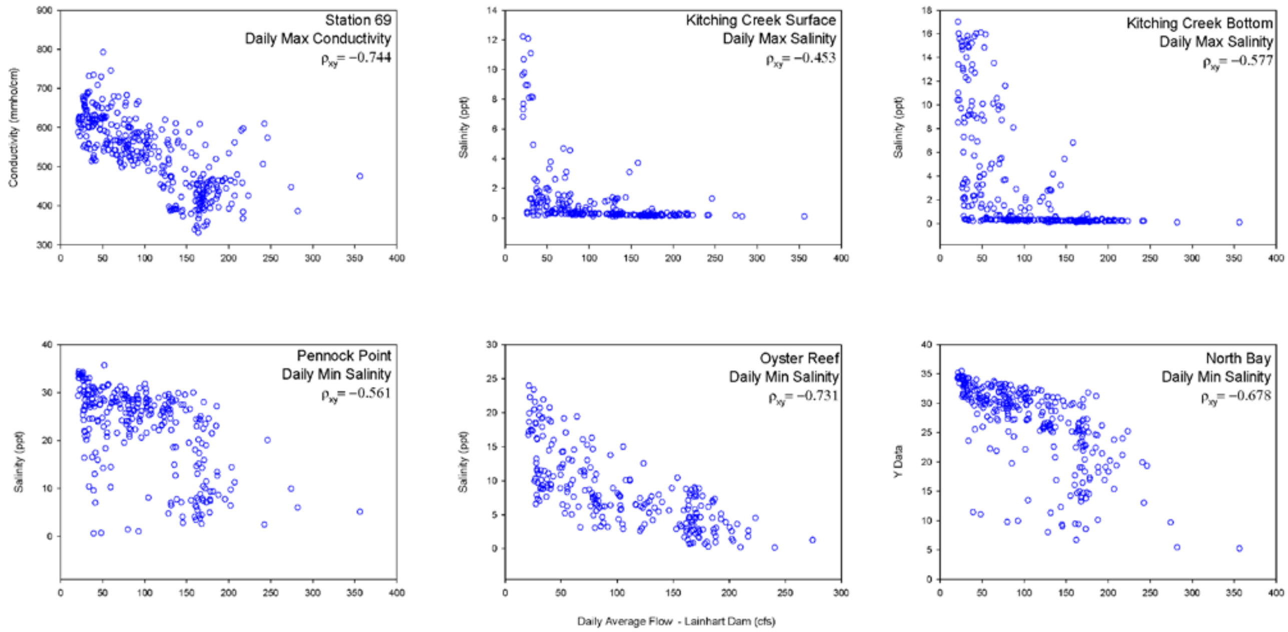

Figure 2. Plots showing the relationship of salinity/conductivity with water flow at Lainhart Dam, Loxahatchee River, Florida.

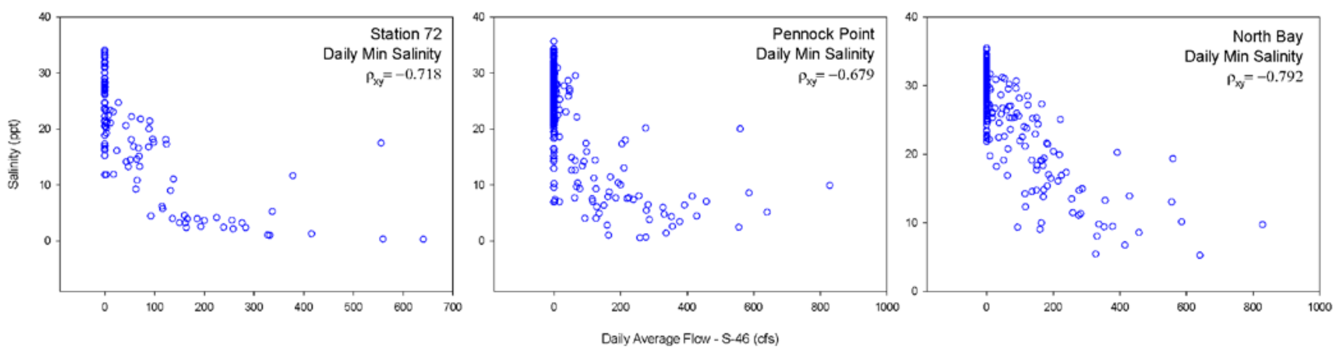

Figure 3. Plots showing the relationship of salinity with water flow at S-46 Structure, Loxahatchee River, Florida.

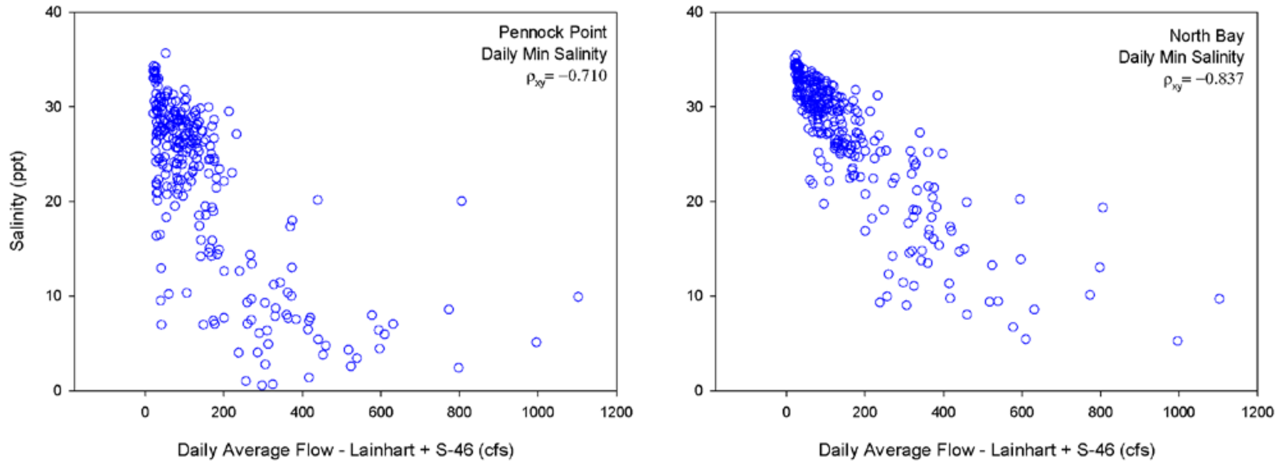

Figure 4. Plots showing the relationship of salinity with combined water flow values at Lainhart Dam and S-46 Structure, Loxahatchee River, Florida.

Discussion

The goals of the datasonde monitoring project were to: (1) establish baseline conditions in the Loxahatchee River and Estuary, (2) establish the relationship between freshwater discharge and salinity dynamics in the estuary and the river, (3) establish a better understanding of the daily salinity variability within the estuary and river, and (4) provide observational data on a nearly continuous basis that can be used to calibrate and validate salinity models. The Figures contained above and in Appendix A help to accomplish goal 1. That is, we are gaining a solid understanding of the pre-CERP physical water quality conditions in the Loxahatchee River and Estuary. These data also help to document the relationships between freshwater discharge and salinity conditions in the Loxahatchee River and Estuary (goals 2 and 3). We look forward to continuing our collaborative relationship with SFWMD staff to provide the data necessary to further calibrate and validate salinity models (goal 4).

In conclusion, the datasonde project has resulted in the compilation of an amazing amount of data that has a very direct relevance to ongoing research, monitoring, and restoration in the Loxahatchee River and Estuary. However, our work is not done. More work needs to be accomplished, and more specifically, more datasonde data needs to be collected to understand the wide variety of scenarios that occur within the river system. We look forward to continuing this cost-effective collaboration.

Literature Cited

Ridler, M. S., R. C. Dent and D. A. Arrington. 2006. Effects of two hurricanes on Syringodium filiforme, manatee grass, within the Loxahatchee River Estuary, Southeast Florida. Estuaries and Coasts 29: In Press.

South Florida Water Management District. 2006. Restoration Plan for the Northwest Fork of the Loxahatchee River. South Florida Water Management District, Watershed Management Department, Coastal Ecosystems Division. West Palm Beach, Florida.

Appendix A

Plots of Daily Average, Minimum, and Maximum Water Quality Parameters