Annual Report

Salinity Sampling in Biscayne Bay (2006-2007)

Biscayne National Park
A Report to the United States Army Corps of Engineers
for the Monitoring and Assessment Plan of the Comprehensive Everglades Restoration Plan
for RECOVER Assessment Team Southeast Estuary Subteam

July 27, 2008

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Authors:
Sarah Bellmund, PI
Amy Renshaw
Herve Jobert
Gregory Garis

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1.0 Introduction

1.1 Background

This is the 2007 annual report on salinity in Biscayne Bay, Florida to the Comprehensive Everglades Restoration Plan (CERP) Monitoring and Assessment Plan (MAP) program. This report covers the water year 2006/2007 and provides general statistical analysis and trends for the area covered as well as comparisons to restoration targets and other data sets.

Biscayne Bay is the largest estuary on the southeast coast of Florida, comprising 428 square miles. Average natural depth has historically ranged from one to three meters, however modern average depth ranges from three to four meters (SFWMD, 1995; Harlem, 1979) (Figure 1). Biscayne Bay is generally divided into three sections, North Bay, Central Bay and South Bay, based on hydrodynamic, geographical, and oceanic characteristics (Wang and van de Kreeke, 1984; SFWMD, 1995). North Bay extends from Dumbfoundling Bay at the Broward/Miami-Dade County line south to Rickenbacker Causeway. Central Bay extends from Rickenbacker Causeway south to Black Point. South Bay is the area from Black Point to Manatee Bay and includes Card Sound, and Barnes Sound.

Altered Everglades drainage patterns and intense urban development in the Miami area has contributed to a loss of estuarine conditions and a transition to a marine lagoon. Freshwater flow to Biscayne Bay is controlled by a system of canals. This system causes fluctuations in salinity which have resulted in large-scale ecological degradation in the Bay. One of the goals of CERP is to restore historical flows to the Bay and eliminate pulsed freshwater delivery along the Bay's southwestern shore. The goal of the MAP is to monitor salinity in the area of Biscayne Bay affected by the CERP. This project was identified and directed by the Evaluation Team Southern Estuaries subteam of RECOVER (Restoration Coordination and Verification) and was initiated in FY2004 to overlap with the data collection effort for the Biscayne Bay Coastal Wetlands (BBCW) Project modeling data collection effort. This was seen as a way to use the two projects to collect information more rapidly and cover more area. The sites that were chosen for the BBCW are expanded under the MAP project and are being integrated with sites in North Biscayne Bay that are sampled by Miami-Dade County Department of Environmental Resources Management (DERM). This project's goals are: 1) to collect physical water quality data (primarily salinity) to allow decisions and inferences to be made with respect to changes in freshwater inflow, 2) to distribute this data in the broadest manner, and 3) to provide this information in a manner most useful to researchers.

A primary component of this plan is the BBCW. The main goals of this project is to rehydrate coastal wetlands that are currently drained by the canal system, and redistribute freshwater flow to the Bay from several sources. This restoration project is expected to profoundly alter salinities within the Park, especially in nearshore habitats along the mainland coast (Serafy *et al* 2001). Other components of CERP, including upstream redirection of water, are expected to have equally profound affects on salinity in Biscayne Bay. While the final outcome of the CERP is difficult to forecast, understanding current salinity as well as documenting changes is important to adaptive assessment and to understanding ecological changes resulting from restoration.

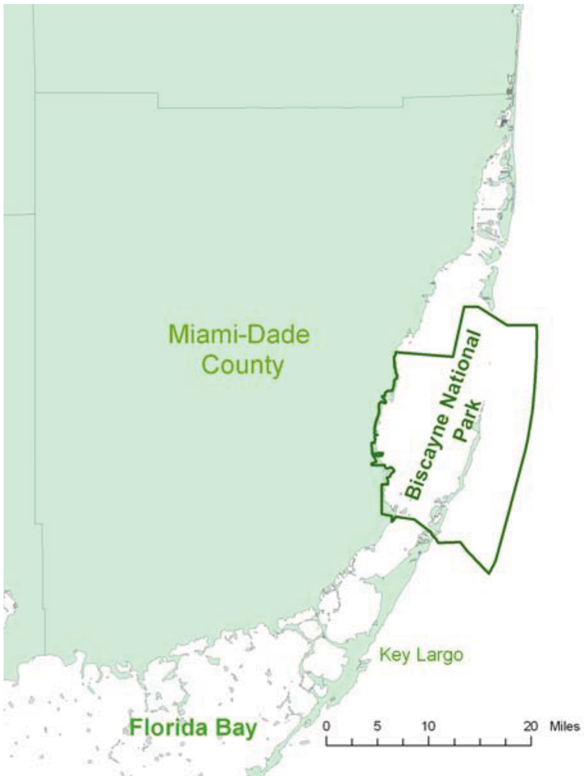


Figure 1.1-1. Location map of Biscayne Bay.

The collection of salinity data in Biscayne National Park is currently funded by the CERP-MAP, although portions of this project have been in existence since the early 1990s. Numerous governmental agencies have participated in the development and design of this current project including Miami-Dade County DERM, NOAA, SFWMD, and the USACE. Instruments and sites for salinity analysis were also funded by the SFWMD to gather data regarding salinity changes with respect to the minimum flows and levels requirements of the State of Florida. Data from this longer term project have already been used to develop a two dimensional hydrodynamic model as part of the Biscayne Bay Feasibility Study in the late 1990s and currently to re-calibrate this model to a three dimensional (including depth stratification) hydrodynamic model as part of the CERP BBCW. This work is ongoing, and in FY 2004, the information collected was used to verify a three dimensional model for Biscayne Bay. All data collected is being used to describe current conditions in the bay prior to changes in water flow and in conjunction with biological projects also funded by the MAP. The data is being made readily available by uploading it to the South Florida Natural Resources Center database (Data ForEVER) and submitting it to the South Florida Water Management District for inclusion in their DBHydro database.

2.0 Methods

2.1 Sampling Overview

There are 34 sites where data is collected within central and southern Biscayne Bay (**Table 2.1-1, Figure 2.1-1**) from as far north as the southern side of the Snapper Creek Canal, and extending south to Manatee Bay and Barnes Sound. The sampling sites are set up as a series of east-west transects that radiate outward from canals or other prominent hydrological features. These transects are meant to document a progression of estuarine conditions near shore to marine conditions offshore. There are fourteen sites in the mangrove zone, which is expected to be the first area affected by changes in freshwater delivery to the bay. Twenty sites are located in the central area of the bay. Sites were also chosen as special interest areas, such as Black Point, Turkey Point, Barnes Sound, and Manatee Bay because of their hydrology and proximity to key environmental concerns and changes in water flow. All sites are divided into 7 zones, based on geographic location, which are retrieved tri-weekly.

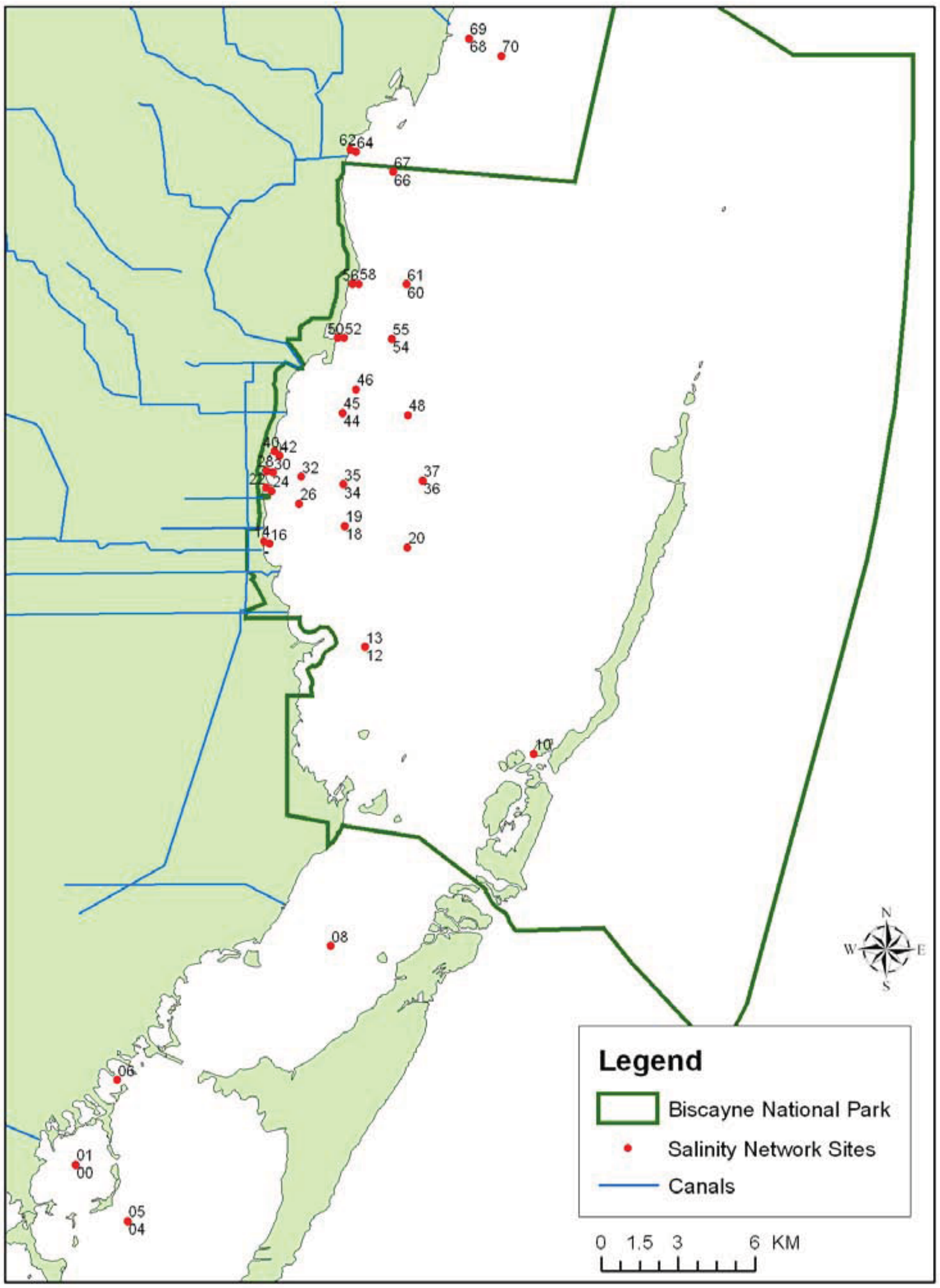


Figure 2.1-1. Map showing all the sites in project.

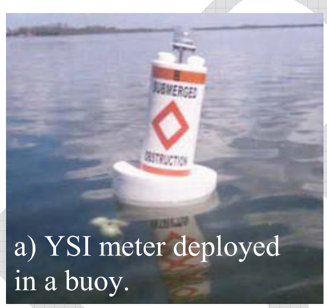
Table 2.1-1. Listing of all sites with GPS coordinates and location relative to the water column.

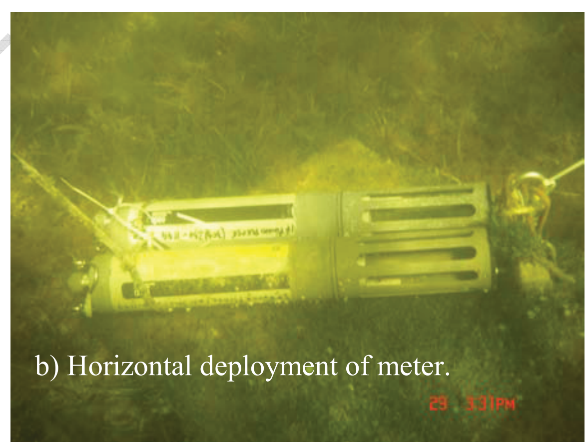
Site ID	Latitude	Longitude	Relative Location
BISC00B	25.25300	-80.41400	Bottom
BISC01S	25.25300	-80.41400	Surface
BISC04B	25.23300	-80.39400	Bottom
BISC05S	25.23300	-80.39400	Surface
BISC06B	25.28300	-80.39800	Bottom
BISC08B	25.33000	-80.31500	Bottom
BISC10B	25.39769	-80.23597	Bottom
BISC12B	25.43600	-80.30100	Bottom
BISC13S	25.43599	-80.30100	Surface
BISC14B	25.47361	-80.34002	Bottom
BISC16B	25.47263	-80.33777	Bottom
BISC18B	25.47877	-80.30886	Bottom
BISC19S	25.47877	-80.30886	Surface
BISC20B	25.47102	-80.28452	Bottom
BISC22B	25.49241	-80.33910	Bottom
BISC24B	25.49133	-80.33693	Bottom
BISC26B	25.48680	-80.32650	Bottom
BISC28B	25.49844	-80.33874	Bottom
BISC30B	25.49800	-80.33627	Bottom
BISC32B	25.49633	-80.32547	Bottom
BISC34B	25.49352	-80.30908	Bottom
BISC35S	25.49352	-80.30908	Surface
BISC36B	25.49472	-80.27836	Bottom
BISC37S	25.49472	-80.27836	Surface
BISC40B	25.50533	-80.33577	Bottom
BISC42B	25.50375	-80.33399	Bottom
BISC44B	25.51886	-80.30936	Bottom
BISC45S	25.51886	-80.30936	Surface
BISC46B	25.52727	-80.30405	Bottom
BISC48B	25.51800	-80.28399	Bottom
BISC50B	25.54547	-80.31119	Bottom
BISC52B	25.54538	-80.30869	Bottom
BISC54B	25.54500	-80.28999	Bottom
BISC55S	25.54500	-80.28999	Surface
BISC56B	25.56444	-80.30530	Bottom
BISC58B	25.56447	-80.30277	Bottom
BISC60B	25.56427	-80.28416	Bottom
BISC61S	25.56427	-80.28416	Surface
BISC62B	25.61225	-80.30583	Bottom
BISC64B	25.61136	-80.30352	Bottom
BISC66B	25.60408	-80.28922	Bottom
BISC67S	25.60408	-80.28922	Surface
BISC68B	25.65127	-80.25958	Bottom
BISC69S	25.65127	-80.25958	Surface
BISC70B	25.64500	-80.24700	Bottom

2.2 Location and Deployment

Eleven of the 34 sites within the bay are recording data approximately 0.25 m below water surface via meters placed within a surface buoy (**Figure 2.2-1 a**) using YSI Environmental 6600 Series instruments. These buoys are were specifically designed for this application and are made by modifying a normal can buoy using two tubes of PVC pipe approximately four inches in diameter running the height of the buoy. This configuration allows for the simultaneous deployment of two meters making overlapping readings used in QA/QC analysis of the data. The tops of these PVC pipes are fitted with PVC caps which are drilled and set with eyebolts from which small link stainless steel chain is hung. From the chain, using a snap shackle for ease, the 6600 meters are attached.

Surface sites also have instruments deployed on the bottom, but at other locations through the bay where there are no surface meters. Most sites, including the sites with surface buoys, have bottom meters deployed horizontally (**Figure 2.2-1 b**). Only sites 08, 10, 20, and 70 are deployed vertically (**Figure 2.2-1 c**), to simplify deployment. At those sites where there is horizontal deployment, the meter is locked onto a concrete paver fitted with two eyebolts. At one end, the smaller eyebolt has two UV-black cable ties. The meter is inserted through one cable tie of the eyebolt to hold the meter in the correct position. The other eye bolt at the far end of the paver is used to lock the instrument down with a brass padlock. During horizontal deployment, it is essential the sensor be facing sideways to prevent flow through the opening to the sensor from being blocked by biofouling organisms. At vertical deployment sites the U-bolt of the meter cage is attached to an eye-pin cemented into the bay floor using a brass padlock. In case of possible lock failure, a heavy-duty cable tie is fitted between the U-bolt and eye-pin for extra support.


a) YSI meter deployed in a buoy.


b) Horizontal deployment of meter.


c) Vertical deployment of meter.

Figure 2.2-1: Deployment of YSI meter.

A portable weather instrument is used to denote deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site. Time is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado. All data is maintained in Eastern Standard Time. Once all meters have been deployed within the zone, there is a waiting period of a minimum of one-hour before retrieving the old meter. The waiting period allows a minimum of four-consecutive overlap readings. The meters to be retrieved are then collected, with all relevant environmental data collected as well.

2.3 Calibration and Data Collection

The YSI 6600 and/or 6000 data sondes are calibrated and cleaned after each retrieval. During calibration, the temperature and specific conductivity of the seawater standard is used to calibrate the instrument are recorded. Once calibrated, the instrument is set up in unattended mode with the file name corresponding to site number, instrument number, and date of deployment. Specific calibration procedures are described below.

Temperature. The temperature probe is checked on a monthly basis using the laboratory traceable Celsius thermometer. A temperature reading must be within +/- 0.15 degrees Celsius to be acceptable. If the probe does not meet these requirements, it will be checked in a controlled temperature bath. If required accuracy is not attained, the associated data will be flagged and the unit will then be sent to the manufacturer for service.

Conductivity. The conductivity probe is calibrated by immersing the sonde probe in a seawater standard. The unit is considered calibrated if the sonde reads within +/- 0.5% of the true value of the standard. If the reading does not meet parameters, the probe will be replaced. Conductivity is calibrated using one point. Older technology required two points, because the probes were not linear from zero. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration. However, a zero check is done with deionized water to ensure accurate calibration and is noted on the Calibration Sheet. In the event the zero check does not read zero, the meter is recalibrated

Depth. Depth is determined using a pressure sensor. Barometric pressure, taken from a Princo Nova mercury barometer is entered into the EcoWatch sonde interface program and the depth is calibrated to 0 meters. Atmospheric pressure offset is noted to ensure the meters are responding throughout the expected measurement range.

Weather Data. A portable weather instrument is used to denote deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site. Time is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado. All data is maintained in Eastern Standard Time. Once all meters have been deployed within the zone, there is a waiting period of a minimum of one-hour before retrieving the old meter. The waiting period allows a minimum of four-consecutive overlap readings. The meters to be retrieved are then collected, with all relevant environmental data collected as well.

2.4 Data downloading and Post Calibration

The retrieved meters are brought back to the lab for uploading of data and post calibration. The sensor is placed in the same standard seawater used to calibrate the instrument. Temperature, specific conductivity, depth, and battery levels are recorded onto the calibration sheet, which is later entered into the computer and associated with that particular filename and site. Cell constants are also reviewed and noted on the calibration sheet to ensure there was no instrument sensor variation between calibrations. Post calibration is done twice: once prior to the meter being cleaned of biofouling and then once the meter has been cleaned. The meter is then recalibrated and if necessary, set up to record for the next set of sites. For additional details on calibration and post-calibration procedures, see Appendix III: Quality Assurance/Quality Control Plan.

Using YSI Endeco-EcoWatch software, the data is uploaded to the computer. Data from the sonde is exported to a Microsoft Excel spreadsheet. These data are entered into the South Florida Natural Resource Center's Database Data ForEVER (Appendix IV: Data Processing).

The weather data collected at deployment sites is entered into a database along with information about the calibration of each instrument used at every site. This facilitates QA/QC for an individual data sonde's repetitive malfunction due to site-specific or weather-related conditions.

The MAP's QA/QC consists of analytical data review and selection of a data output format to benefit other data users. Once the data file is uploaded to the South Florida Natural Resource Center's Database (ForEVER), it is reviewed for outliers and instrument malfunctions. In the event that there are single outlier data points in which one salinity data point suddenly decreases that are over +/- 5% around a linear regression of the data (to find outliers where the salinity increases are anomalies), canal discharge and rainfall measurements are checked to determine whether they would be cause for the sudden change in salinity value. If a large rainfall or canal discharge was recorded a few days prior to the outlying data point, the data point will be retained. Otherwise the point is deleted. When data points from surface sites which fall below the depth of zero, it is assumed that the meter came out of water during those readings so these data are disregarded.

Once the data file is QA/QC'd, null values are entered into empty time slots, and the data is run through Estimated Linear Interpolation. It is assumed that a newly deployed meter is reading correctly and that drift could have occurred in meters that are retrieved later. Using SigmaPlot, the data are plotted to see whether the overlap in readings corresponds to the same pattern of increase/decrease in salinity. If the readings from the previous file match or follow the same pattern as the meter file that follows, the database uses the first reading of the deployed meter file to interpolate the drift that occurred between the first reading of the retrieved meter file and the last reading of the retrieved meter file. If the final reading of the previous retrieved meter file and the first reading of the deployed meter file do not match or follow the same pattern, the first (dirty) post-calibration reading is used to determine the linear interpolation. After 'Estimation Linear Interpolation' is completed, the data is validated. Data Validation performs two vital roles. In addition to making the data available to the public and transfer to DBHydro, salinity is calculated from the new interpolated conductivity values.

3.0 Data Analysis and Results

3.1 Annual Results

3.11 Salinity November 2006 - October 2007

The average salinity in Biscayne National Park between November 2006 and October 2007 was 26.8 psu **(Table 3.11-1).** The lowest average monthly salinity for the time period was 9.5 psu (Site 14) and the highest average monthly salinity was 37.3 psu (Site 48). **(Table 3.11-1).** Lowest salinities were found at the inshore sites located between C-1 and C-103 canals. Sites with the highest salinities were located furthest offshore, approaching seawater levels. Site 10, located near Adams Key, exhibited the highest overall salinity during this period (35.2 psu, $\sigma = 1.77$), most likely due to its proximity to oceanic waters.

3.12 Salinity in 2006-2007

Average salinity in Biscayne National Park between November 2006 and October 2007 was 27.6 psu **(Table 3.2-1).** There is large variation within and between sites: 35.7 psu (Site 10 and 15.4 psu (Site 40). As expected, salinities recorded at nearshore sites were lowest, and sites furthest offshore maintained salinities near that of seawater. Overall, the lowest salinities occurred in the nearshore sites between Mowry Canal and Princeton Canal. At these sites, average salinity was less than 20 psu all year. Slightly higher salinities were noted at the nearshore areas north of Black Point.

A trend of increasing salinity was observed from east to west into the more ocean-influenced area of the Bay. Salinities greater than 30 psu are observed throughout the year at several of the Bay sites.Adams Key (Site 10), which is directly influenced by the ocean, is the only sampling site with marine salinity throughout the water year.

Table 3.11-1: Monthly average salinity for all sites in the Salinity Monitoring Network, including summary statistics by month and site

Site	11/06	12/06	1/07	2/07	3/07	4/07	5/07	6/07	7/07	8/07	9/07	10/07	11/07	12/07
0	28.43	28.78	29.4	30.2	32.1	33.7	36.3	32.8	28.0	26.9	26.5	21.1	24.1	24.1
4	30.02	30.45	30.5	32.0	36.0	35.3	36.2	35.3	31.2	32.0	29.9	25.2	25.2	23.7
6	null	null	null	31.6	33.9	34.8	35.6	31.3	26.8	26.4	28.7	22.9	23.6	24.9
8	32.7	32.94	34.0	34.9	36.2	36.9	36.5	34.5	null	null	null	null	null	null
10	35.41	35.61	35.9	35.7	36.1	36.5	36.9	35.4	36.0	36.7	35.5	32.6	32.1	32.6
12	29.62	30.87	33.1	33.4	33.9	34.9	36.0	34.0	31.2	33.1	34.2	26.7	27.7	32.0
14	20.04	15.7	19.7	25.7	27.6	28.3	25.4	19.9	18.4	20.3	21.0	9.5	15.8	18.0
16	22.08	18.41	23.2	27.4	29.5	30.4	27.9	24.5	22.8	24.5	25.4	12.0	17.4	22.0
18	28.72	29.16	31.1	31.9	33.9	34.2	35.1	31.7	29.5	31.3	32.4	26.7	28.4	29.2
20	32.26	32.19	33.4	34.7	35.8	36.5	37.0	34.6	31.9	33.7	35.0	30.1	31.9	31.7
22	20.41	17.94	19.4	23.8	26.8	27.2	28.1	21.4	17.3	21.4	21.8	11.0	17.0	19.0
24	21.26	18.41	20.5	25.2	28.3	28.9	29.4	22.9	18.6	21.3	23.1	12.1	17.9	20.2
26	24.66	24.59	25.6	27.8	31.6	31.6	33.5	27.2	23.6	27.2	28.0	18.8	23.0	25.4
28	20.48	18.76	18.9	23.6	27.6	27.4	27.0	20.9	17.4	21.0	21.6	10.7	16.6	18.9
30	20.45	18.8	19.6	24.2	28.2	28.0	28.8	21.6	18.4	21.8	22.5	11.5	17.0	19.4
32	24.5	24.35	24.7	27.3	31.3	31.3	33.6	26.5	23.0	26.2	27.1	17.6	22.6	24.3
34	27.99	29.43	30.4	31.3	34.0	34.0	36.6	30.6	27.4	30.8	32.1	25.5	27.8	27.9
36	null	33.67	34.1	35.0	36.5	36.9	37.1	34.2	31.6	33.6	34.1	30.0	32.1	31.9
40	19.33	17.62	18.3	22.8	27.5	27.3	26.7	19.4	15.4	20.1	20.9	10.2	15.0	18.4
42	19.38	17.57	18.3	22.6	27.5	29.5	27.5	20.1	15.9	20.4	21.3	10.0	15.9	18.6
44	25.92	27.14	25.9	28.6	32.7	32.4	33.7	26.1	22.4	26.7	27.9	20.9	24.7	25.2
46	26.39	28.62	27.2	28.6	32.6	32.2	33.9	26.2	21.7	26.4	28.1	21.6	24.1	24.4
48	32.08	32.48	33.1	35.3	36.2	36.4	37.3	32.5	29.5	32.9	34.8	29.0	29.9	29.2
50	23.41	25.04	25.2	28.1	30.2	35.3	null	21.3	14.9	21.9	23.7	15.2	19.1	21.0
52	23.51	24.92	24.9	28.4	30.9	29.7	31.5	22.8	16.0	22.4	24.4	16.5	22.3	21.5
54	27.29	29.8	28.6	30.5	33.5	34.1	35.6	27.8	24.1	28.5	30.4	23.7	26.3	26.9
56	26.09	27.46	28.4	30.2	31.5	32.5	31.0	22.7	15.0	23.2	25.8	15.0	22.8	23.8
58	25.63	27.54	28.4	30.6	32.3	32.0	32.0	23.6	15.9	24.1	27.0	17.2	23.8	23.7
60	27.86	31.23	29.7	31.6	33.2	33.6	34.8	27.1	23.7	29.0	29.7	24.8	null	27.9
62	28.11	28.15	27.7	30.3	31.0	32.4	31.8	23.7	18.8	26.6	28.9	18.5	23.9	26.7
64	29.06	29.29	29.6	32.3	31.9	34.8	36.2	28.0	22.8	27.6	29.9	21.1	24.8	27.1
66	30.08	31.87	31.8	33.7	33.9	36.1	34.8	30.8	26.4	30.4	32.6	25.5	28.5	33.3
68	30.89	31.09	32.0	33.7	33.7	34.8	33.4	31.2	27.9	31.7	32.0	26.4	28.5	31.8
70	32.54	33.42	34.2	34.8	35.7	36.9	35.7	32.9	30.8	34.0	35.2	29.0	29.7	33.3

Table 3.11-2: Yearly statistical summary

Site	Count	Average (psu)	Minimum (psu)	Median (psu)	Maximum (psu)	Range (psu)	st dev	Coef. of Variation
0	35039	28.73	18.14	28.48	38.2	20.06	4.47	0.16
1	35035	27.92	9.75	28.53	36.72	26.98	4.83	0.17
4	31770	30.58	21.81	31.25	37.97	16.15	4.26	0.14
5	29496	30.24	1.45	30.25	37.3	35.85	4.18	0.14
6	28255	28.72	15.78	27.84	37.87	22.1	4.88	0.17
8	15784	35.62	31.94	35.58	40.06	8.12	1.39	0.04
10	32842	35.2	23.46	35.82	38.1	14.64	1.77	0.05
12	35040	32.51	18.28	33.09	38.71	20.43	3.12	0.10
13	27767	32.29	19.71	32.75	37.68	17.68	3.07	0.10
14	35023	20.75	0.86	21.46	34.75	33.89	7.11	0.34
16	35040	23.89	3.59	25.46	35.6	32.01	6.51	0.27
18	35039	31.29	20.86	31.48	37.03	16.17	2.77	0.09
19	13907	32.5	6.52	32.7	37.05	30.53	2.9	0.09
20	34325	33.85	22.98	33.89	38.37	15.4	2.37	0.07
22	34968	21.18	4.69	21.59	33.83	29.14	5.71	0.27
24	35039	22.34	4.19	22.73	35.83	31.64	5.9	0.26
26	35040	26.93	7.45	27.15	37.69	30.24	4.64	0.17
28	35007	20.94	4.07	21.74	35.31	31.23	5.77	0.28
30	35007	20.94	4.07	21.74	35.31	31.23	5.77	0.28
32	35040	26.27	8.3	26.34	37.5	29.19	4.99	0.19
34	35040	30.69	18.41	30.84	38.2	19.79	3.42	0.11
35	733	28.91	25.39	28.7	32.21	6.83	1.7	0.06
36	35038	33.9	26.52	34.04	39.41	12.89	2.43	0.07
37	728	33.31	29.69	33.26	35	5.31	0.8	0.02
40	35040	20.14	1.08	20.89	34.84	33.76	5.98	0.3
42	35040	20.61	3.75	21	41.88	38.13	6.22	0.3
44	35040	27.25	11.26	26.99	37.9	26.64	4.58	0.17
45	10432	28.71	0.59	28.57	37.45	36.86	4.86	0.17
46	33442	27.22	12.18	27.01	37.85	25.67	4.82	0.18
48	32244	33.28	24.19	33.88	38.42	14.24	3.19	0.1
50	24493	23.15	6.42	22.81	36.98	30.56	5.94	0.26
52	35040	24.22	7.11	23.94	37.33	30.22	6.07	0.25
54	34552	29.23	17.42	29.07	38.51	21.09	4.24	0.14
55	8291	30.13	14.13	29.85	37.03	22.91	2.93	0.1
56	35040	25.12	1.89	26.17	38.39	36.5	6.72	0.27
58	35040	25.83	10.15	26.31	38.46	28.31	6.49	0.25
60	30820	29.69	13.89	29.88	38.01	24.12	4.17	0.14
61	5523	30.56	21.89	31.07	34.73	12.84	2.59	0.08
62	35025	26.66	0.03	28.26	36.84	36.81	6.25	0.23
64	35040	28.81	0.56	29.18	39.28	38.72	5.04	0.17
66	35040	31.45	19.1	32.59	38.24	19.13	3.73	0.12
67	5491	32.68	21.99	32.88	36.37	14.38	2.38	0.07
68	35040	31.39	20.85	32.29	36.88	16.04	2.91	0.09
70	34312	33.49	25.77	34.28	37.9	12.13	2.66	0.08

3.2 Monthly Summaries

November 2006

In November 2006, salinities ranged from 19.3 to 35.4 psu with an average of 26.5 psu ($\sigma = 4.48$) (**Table 3.11-1)**. Salinity remained below 20 psu in Fender Point. Manatee Bay and Barnes Sound maintained salinity below 30 psu while salinities in Card Sound were between 30 to 35 psu.
There was an increase of salinity in comparison with November 2005 (**Appendix I, Figure 3.2-1**). Salinty was 30 to 35 psu in the East part of the bay with a peak over 35 psu around Adams key instead of 25 to 30 psu in November 2005.

December 2006

Salinity recorded this month was very close to the average salinity in November 2006 with a value of 26.8 psu ($\sigma = 5.75$) (**Table 3.11-1)**. The minimum was value lower 15.7 psu and the maximum value was 35.61 psu. Salinity remained below 20 ppt in the area between Princeton and Mowry Canals (**Appendix I, Figure 3.2-2**). Salinities increased when moving offshore wit salinities above 31 ppt at the mid bay sites. The highest salinity was found at Site 10 on Adams Keys approaching 36 psu. Salinity in Card sound and Manatee Bay were the same than In November 2006. December 2006 had higher salinity than December 2005.

January 2007

Average salinity was 27.5 psu ($\sigma = 5.33$) with the lowest salinity near Fender Point (18.3 psu) and the highest at Adams Key (35.9 psu) (**Table 3.11-1)**. Near shore sites between Black point and Convoy point increased with no salinities recorded below 18 psu (**Appendix I, Figure 3.2-3**). January was the last month of a seven months estuarine period in Biscayne Bay. All the sites located north of Black Point had salinities above 24 psu. Salinities also increased in Manatee Bay, Barnes Sound and Card Sound.
February 2007

Salinity was higher in February 2007 than the previous three months (29.9 psu) ($\sigma = 3.91$) (**Table 3.11-1)**. Near shore sites all had salinity greater than 22.6 psu (BISC 42) with all sites north of Black Point greater than 25 psu (**Appendix I, Figure 3.2-4**). Sites between the C-102 and Military Canals exhibited the lowest salinities. Salinities increased over 35 psu moving offshore and over 30 psu going south in Card Sound and Manatee Bay. The highest salinity was measured at Adams Key (35.7 psu).

March 2007

In March 2007, salinity was highest in the southeast region of Biscayne Bay (**Appendix I, Figure 3.2-5**) and decreased closer to shore and in Manatee Bay. The lowest salinity (26.8 psu) was measured in the mangrove just north of Military Canal. (**Table 3.11-1)**. Salinities increased offshore to approximately 36 psu in the mid bay region. This month had higher salinity than March 2006.

April 2007

Average salinity in April 2007 increase to 32.8 psu (σ = 3.10) (**Table 3.11-1)**. The east side of the Biscayne Bay had salinities above 35 psu. Minimum salinity for this month was 27.2 psu north of Military Canal (**Appendix I, Figure 3.2-6**). All the sites north of Black point had salinities above 30 psu. The highest salinity was measured at site 8 (36.9 psu) in Card Sound. Manatee Bay and Barnes Sound had salinity above 33 psu.
Biscayne Bay had a salinity 5 psu higher in April 2007 than in April 2006.

May 2007

The average salinity in the Bay for May 2007 was 33.1 psu (σ = 3.10) which was the highest average monthly salinity over the entire sampling period from November 2006 to December 2007. (**Table 3.11-7)**. The highest salinity was measured for the mid bay region (37.3 psu) (**Appendix I, Figure 3.2-1**). This was the highest average monthly salinity at any site between November 2006 and December 2007. Salinity was high throughout the Bay, including Manatee Bay, Barnes Sound and Card Sound with no salinities under 36 psu.

June 2007

In June 2007 salinities ranged between 19.4 and 35.4 psu. (**Table 3.11-1)**. The lowest salinities were found in Fender Point (**Appendix I, Figure 3.2-8**). The highest salinity was found on Adams Key. Between May 2007 and June 2007, the salinities in the mangrove decreased from over 25 to 20 psu. Salinities in Manatee Bay, Barnes Sound and Card Sound ranged from 31 to 35 psu.
Salinities recorded in June 2006 were higher than salinities in June 2007 with values above 35 psu from the east region of the bay to Manatee Bay.

July 2007

In July 2007, salinities decreased in the mangrove zone and the north part of the bay. The lowest salinity were found at the nearshore sites and ranged from 14.9 to 20 psu between Mowry Canal and Deering Estate (**Appendix I, Figure 3.2-9**). The highest salinity was 36 psu on Adams Key. Most of the southeast portion of the bay had salinities between 30 to 35 psu. Manatee Bay, Barnes Sound and Card Sound had salinities between 26.8 and 31.2 psu (**Table 3.11-1)**.

August 2007

Salinities in the mangrove region were slightly higher than July 2007 with a minimum of 20.1 psu in Fender Point. All sites between Mowry Canal and Deering Estate had salinities ranging from 20 to 25 psu. (**Appendix I, Figure 3.2-10**). The maximum salinity was 36.7 psu on Adams Key. Salinity increased moving offshore. Card Sound and Manatee Bay had salinities between 26 and 32 psu.

September 2007

This month had salinities very close the previous month salinities, showing almost the same variations around the bay. The lowest salinity was also recorded in Fender Point (20.9 psu) and the highest on Adams Key (35.5 psu). (**Table 3.11-1)**. Nearshore sites located between the C-100 and Mowry Canal had salinity ranging from 20 to 25 psu (**Appendix I, Figure 3.2-11**). Salinity decreased in Card Sound, Barnes Sound and Manatee Bay with the highest being 29.9 psu.

November 2007

In November 2007, salinity decreased throughout Biscayne Bay with only 3 sites having salinity above 30 psu (Site 10: 32.6 psu, Site 20: 30.1 psu and Site 36: 30 psu). Near shore sites ranged from 9.5 to 12.1 psu between Mowry Canal and Black Point, and 15 to 18.2 psu north to Black Point. (**Appendix I, Figure 3.2-12**). Salinity in Manatee Bay and Barnes Sound was less than 25 psu.

Table 3.2-1 : Salinity Site Average by Wet/Dry Seasons and Water Year

Site	Dry Season 2006-2007	Wet Season 2007	Water Year 2006-2007
0	31.3	26.2	28.7
4	32.9	28.9	30.9
6	34.0	26.4	30.2
8	34.9	34.5	34.7
10	36.0	34.4	35.2
12	33.1	31.3	32.2
14	23.2	17.6	20.4
16	25.6	21.2	23.4
18	32.0	29.9	31.0
20	34.6	32.7	33.6
22	23.4	18.4	20.9
24	24.6	19.4	22.0
26	28.5	24.7	26.6
28	23.4	18.1	20.8
30	24.0	18.9	21.4
32	28.1	23.9	26.0
34	31.9	28.9	30.4
36	35.5	32.5	34.0
40	22.8	17.1	19.9
42	23.2	17.5	20.3
44	29.5	24.8	27.2
46	29.9	24.6	27.3
48	34.7	31.1	32.9
50	27.9	19.6	23.7
52	27.7	20.8	24.3
54	31.3	26.8	29.1
56	29.6	21.2	25.4
58	29.8	22.2	26.0
60	31.7	27.0	29.4
62	29.9	23.9	26.9
64	31.9	25.9	28.9
66	33.2	29.6	31.4
68	32.8	29.9	31.4
70	34.8	32.1	33.4
Average	29.9	25.4	27.6
Minimum	22.8	17.1	19.9
Maximum	36.0	34.5	35.2
Std Dev	4.12	5.36	4.68

3.3 Water Year

3.31 Dry Season 2006-2007A

Average dry season salinity for the 2006-2007 water year is 29.9 psu (**Table 3.2-1**). Dry season salinity was calculated by averaging monthly values from November 1, 2006 to May 31, 2007. Salinity ranged from a high of 36.0 (Site 10), to a low of 22.8 (Site 40). There are no sites with salinity less than 20 psu during the dry season. Salinity is lowest in the area between Princeton and Military Canals (**Appendix I,** Figure 3.31-1). These sites (22, 24, 28, 30, 40, and 42), maintain an average dry season salinity below 25 psu. The lowest salinities for both the wet and dry seasons were recorded at site 40. From there, the salinity increased to the north, south, and east. Nearshore sites maintain salinities less than 30 psu as far north as the C-100 canal.

There are 10 sites with salinities greater than 30 psu, with varying increases/decreases. Site 18 increases from its wet season low of 29.9 psu to a high of 32 psu. Salinity at site 34 increases from a wet season value of 28.9 to 31.9, an increase of 3.0 psu. A much larger range in salinity was recorded at site 64, from 25.9 to 31.9, or an increase of 6. These two sites are located closer to shore (2015 m and 2800 m, respectively) and farther away from any ocean outlet than any other site with salinity greater than 30 ppt. There are two sites (36 & 10) where average salinity is marine (35 psu) or greater during the dry season of 2006-2007. There is far less variability between sites than reported for the annual average for the wet season. There is only a 13.2 psu difference between the minimum and maximum salinity sites and all sites are grouped between 20 psu and 36 psu.

3.32 Wet Season 2007

Average wet season salinity for the 2006-2007 water year was 25.4 psu (**Appendix I, Figure 3.32-1 and Table 3.2-1**). The wet season average was calculated by taking the average of monthly values from June 1, 2007 to October 31, 2007. There were no sites that had an average wet season salinity less than 17.1 psu. Average salinity was actually higher during the wet season of 2007 than the dry season that preceded it. Zones of salinities less than 25 psu retracted into the area between Goulds and Mowry canal (**Appendix I, Figure 3.32-1**). The lowest salinities were again found around Fender Point. Salinity was found to rapidly increase in an offshore direction. Most of the bay, including Manatee Bay, Barnes Sound, and Card Sound, maintained salinities between 20-25 psu.

Salinity ranged between 17.1 psu (Site 40) and 34.5 psu (Site 8), a difference of 17.4 psu. During the wet season, salinity decreased at most of the sites that are within 500 meters of shore. Sites that were greater than 500 meters from shore showed consistent increases in salinity.

Average salinity for June 2007 was 27.5 psu (**Table 3.11-1**). The minimum salinity was 17.1 psu (Site 40), and the maximum was 34.5ppt (Site 08). Salinity was high throughout Biscayne Bay in June 2007. Most of the bay had a salinity range between 35-40 psu (**Appendix I, Figure 3.32-2**). There were small areas of lower salinity (between 20-25 psu), measured near Fender Point, the embayments north of Black Point, and north of the C100 Canal. Manatee Bay, Barnes Sound, and Card Sound salinities remained high (30-40 psu).

Between June and July 2007, salinity decreased noticeably. The average salinity in July 2007 was 23.5 psu (**Table 3.11-1**). The minimum salinity was 14.9 psu (Site 50) and the maximum was 36 psu (Site 10). The area of lowest salinity (10-15 psu) was centered around Fender Point (**Appendix I, Figure 3.33-3**). The area with interpolated salinity less than 20 psu extends from C-103 (Mowry Canal) to north of Black Point. Only areas with open exchange with the ocean and a small area of Barnes Sound did not exhibit a decrease in salinity.

Salinity increased throughout the bay in August 2007, with an average salinity of 27.1 psu (**Table 3.11-1**). The minimum salinity was 20.1 psu (Site 40) and the maximum was 36 psu (Site 10). Most of Biscayne Bay had a salinity range of 30-35 psu during this month (**Appendix I, Figure 3.33-4**). The salinity between Military Canal and north of Black Point remained under 20 psu.

Average salinity was 28.2 psu in September 2007 (**Table 3.11-1**). Minimum salinity was 20.9 psu at Site 40. Maximum salinity was 35.5 psu at site 10. The area between Military Canal and north of Black Point remained at less than 20 psu.

Salinity decreased significantly in the bay from September to October 2007. Average salinity through out the bay was 20.3 psu as apposed to September which measured 28.2 psu. A large estuarine zone stretching from Turkey point North to Deering point was the largest in area in 2007. This may be a result of the largest amount of canal discharge into the bay in the past two years at 82.80 Kaf. (Table 4.1-4)

4.0 Estuarine Zone along the Western Shoreline

4.1 Producing an Estuarine Zone in Biscayne Bay for CERP

The CERP Biscayne Bay Coastal Wetlands project and the RECOVER Southeast Estuaries teams have developed performance measures for Biscayne Bay that include re-establishing a persistent estuarine zone along the western shoreline of portions of Central and Southern Biscayne Bay. In the area between Turkey Point and Shoal Point the restoration goal is establishing a zone of mesohaline (5-15 psu) conditions and lower salinity in the tidal creeks. These targets were then defined for the area of the shoreline east to between 250 m and 500 m. Both wet and dry season targets were established in the area between Turkey Point and Shoal Point, where the wet season target is average salinity of 20 psu in an area extending 500 m from shore and the dry season target is and average salinity of 20 psu in an area extending 250 m from shore (**Figure 4.1-1**).

An estimated average daily canal flow rate of 1,051 cfs is required to meet the wet season target and an average estimated daily canal flow rate of 346 cfs is required to meet the dry season target (Meeder *et al*. 2002).

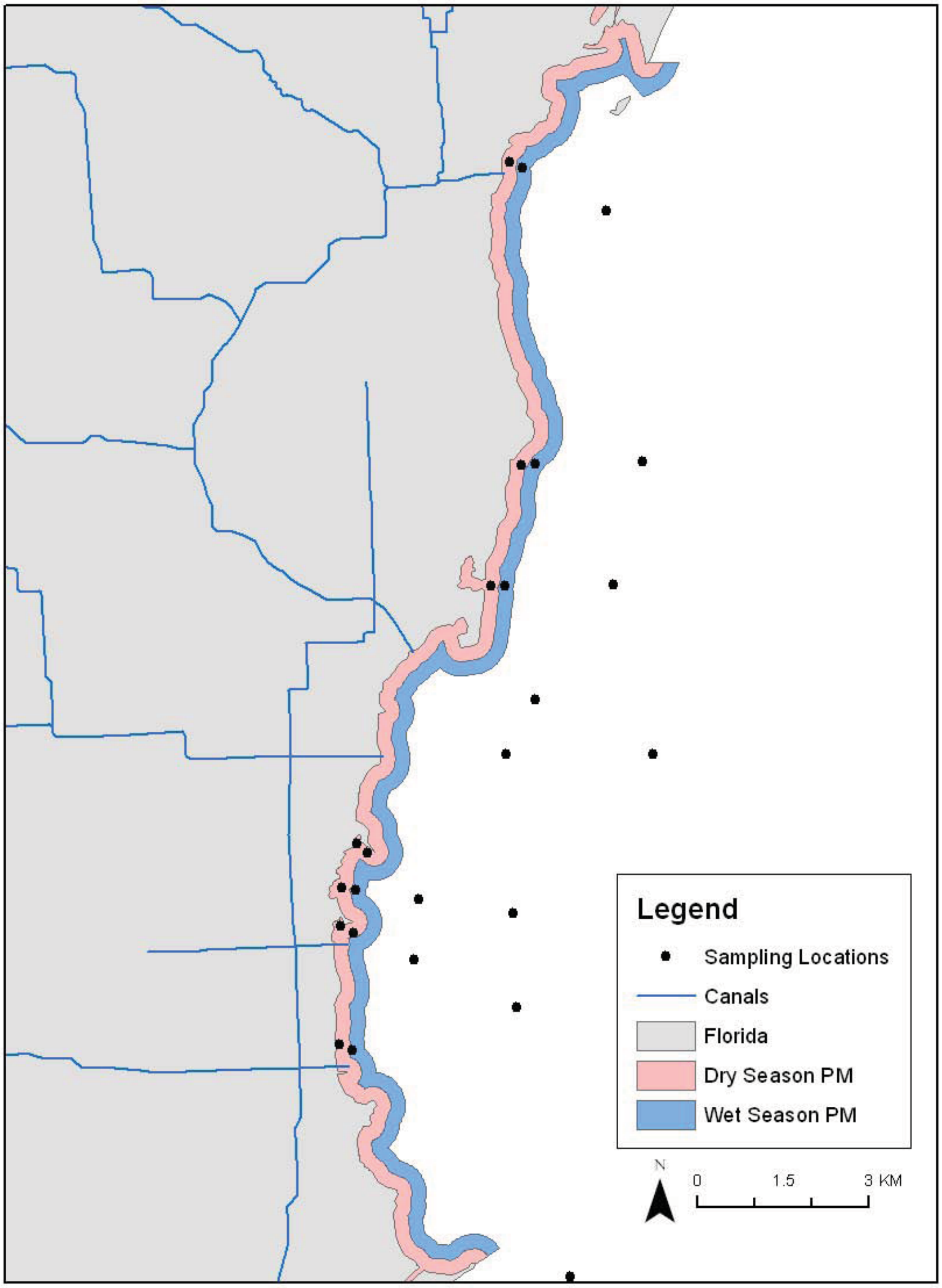


Figure 4.1-1. Dry and wet season performance measures. The performance measure for Biscayne Bay during the dry season is to have an estuarine zone stretching from the shoreline to 250 m offshore, and 500 m during the wet season.

Although an estuarine zone has been produced in Biscayne Bay every wet season since this project began, the size, shape and extent of it vary depending on flow and hydrographic conditions. Based on a review of the following figures it is apparent that the area of lower salinity is also maintained by both surface and groundwater input. .

Because the target area seems to be maintained by groundwater input, it is dramatically affected by the seasonal drawdown. On October 15 the stage at the south Miami-Dade structures is lowered from 2.2 ft to 1.4 ft and remains this way until the end of November. At the beginning of December the stage is raised to 1.8 ft where it remains until April 15. These changes are evident in the average monthly discharge rates for the stages in South Miami-Dade County and in the size of the estuarine zone **(Table 4.1-2 and Table 4.1-1, respectively)**

The water year of 2007 saw some drastic fluctuations through out the months. The effect of the mass short period discharge from the canals was easily picked out when looking at the estuarine zones for 2007. The discharge levels hit there highest in the past two years. Octobers salinity levels dropped off by 7.9 psu from September. November saw an estuarine zone that was approximately 2/3 the size of Octobers. This suggests that saltwater impact on the estuarine zone was greater than that of the freshwater influx. Discharge from canals is putting fresh water into the bay at high levels for short periods of time but once the bay is cut off from the discharge we are seeing a quick reduction in areas with less than 20 psu.

Table 4.1-1. Estuarine areas by month for the period of record. Area is in acres. This information has been derived from interpolations calculated in ArcGIS.

	Est. Area of Salinity <20 psu
	(acres)
2004	
September	204
October	2738
November	1841
December	247
2005	
June	4186
July	3406
August	3214
September	3335
October	5368
November	1481
December	110
2006	
January	91
July	2255
August	1960
September	2036
October	1013
November	53
December	811
2007	

January	298
June	34
July	3684
October	5646
November	1968
December	442

Table 4.1-2: Average Monthly Canal Discharge in Kaf (summed for S20F, S20G, S21A, S21, and S123)

	Monthly Discharge (Kaf)				
	2004	2005	2006	2007	2008
January		7.80	12.17	10.54	4.74
February		3.68	15.16	10.23	6.04
March		7.78	9.21	1.90	5.61
April		2.64	7.10	9.49	17.50
May		3.39	7.06	9.99	1.91
June		121.21	7.29	74.96	31.80
July	7.35	66.72	73.48	52.31	
August	66.07	103.68	45.39	16.29	
September	71.68	105.48	64.36	42.10	
October	77.56	70.55	34.84	82.80	
November	47.28	25.36	28.54	44.48	
December	27.86	22.72	18.35	6.79	

There are two problems associated with meeting the aforementioned restoration target. First, the discharge calculated to be necessary to establish an estuarine zone between Turkey Point and Shoal Point in the performance measure is likely to be an underestimate.Second, the distribution of the estuarine zone is non-linear. The performance measure dictates a 500 m wide estuarine zone from Turkey Point to Shoal Point during the wet season and 250 m wide during the dry season. The estuarine zone does not extend all the way north to Shoal Point and south to Turkey Point: it flows out further from the shoreline between C-103 and Black Point, likely due to canal discharge (**Figure 4.1-23**). Because groundwater seems to be an underlying controlling feature of the area, decreasing or eliminating the seasonal drawdown for agriculture would be expected to extend the presence of an estuarine zone further into the dry season. This would be expected to last for some number of months depending on the groundwater level upstream and rainfall. Seasonal agriculture has almost been eliminated in these basins by development, which routes water to the Bay more quickly. Once all agriculture has left the basin decreasing or eliminating the seasonal agriculture may be practical.

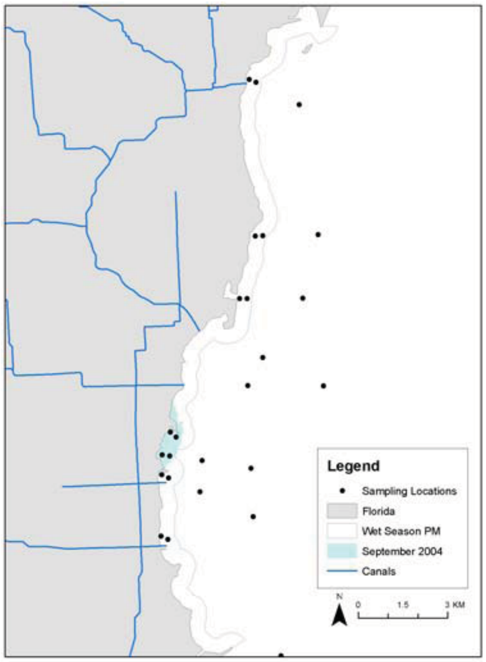


Figure 4.1-2. Estuarine zone in September 2004.

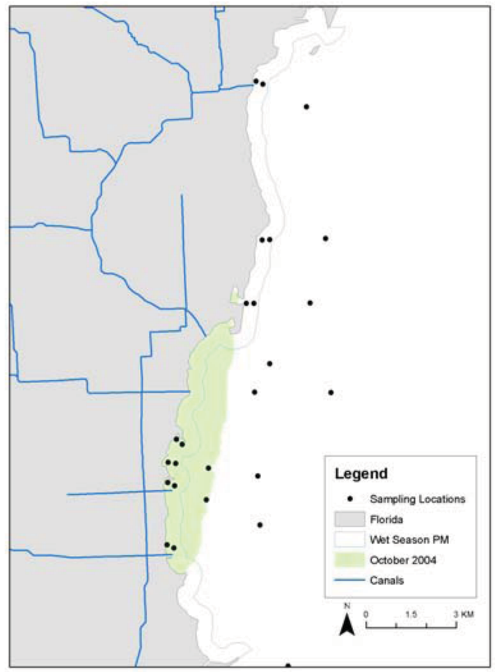


Figure 4.1-3. Estuarine zone in October 2004.

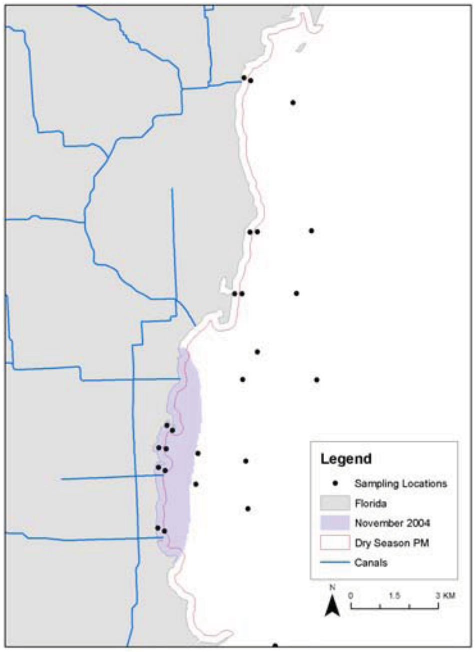


Figure 4.1-4. Estuarine zone in November 2004.

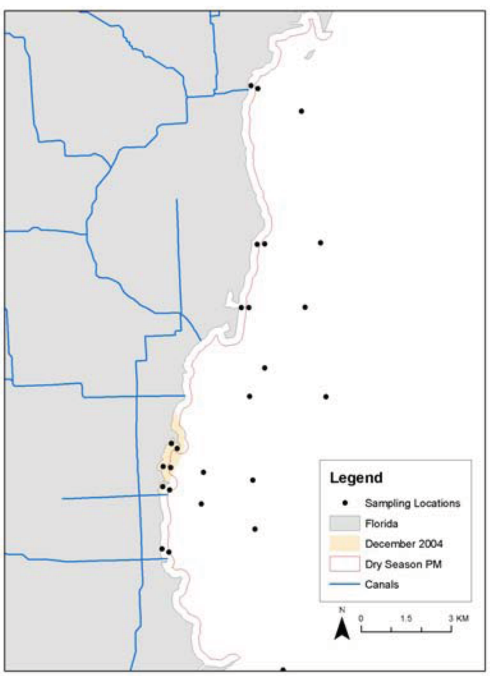


Figure 4.1-5. Estuarine zone in December 2004.

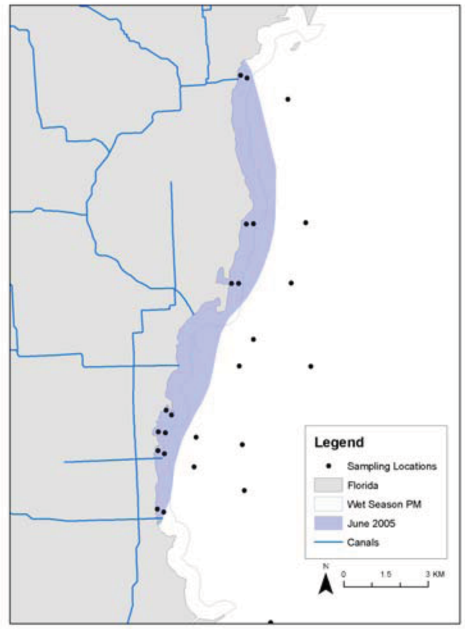


Figure 4.1-6. Estuarine zone in June 2005.

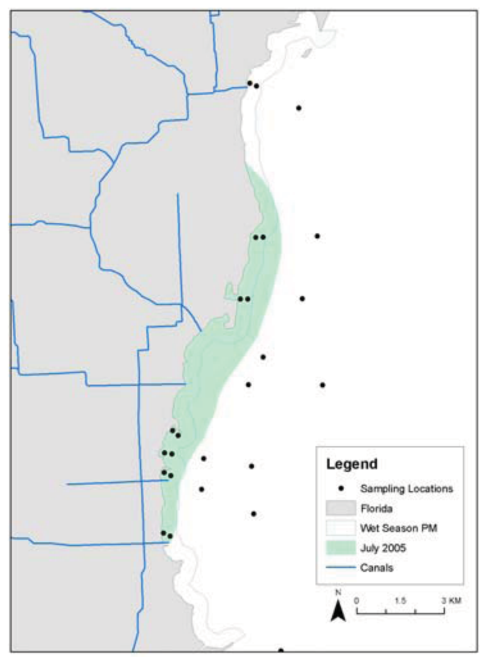


Figure 4.1-7. Estuarine zone in July 2005.

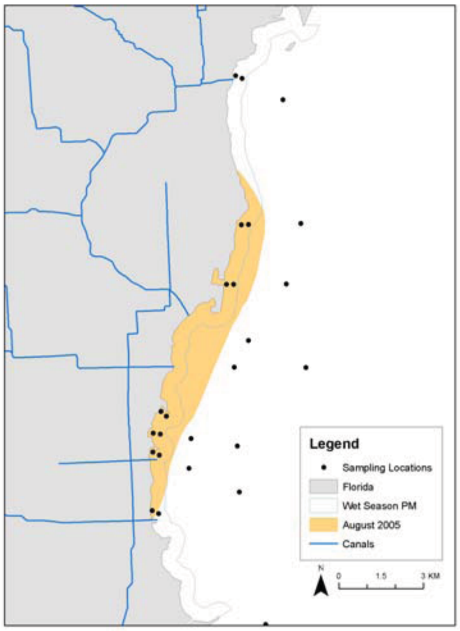


Figure 4.1-8. Estuarine zone in August 2005.

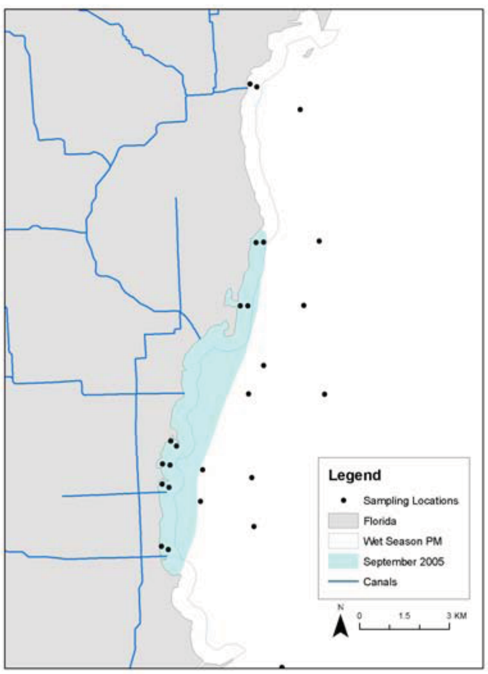


Figure 4.1-9. Estuarine zone in September 2005.

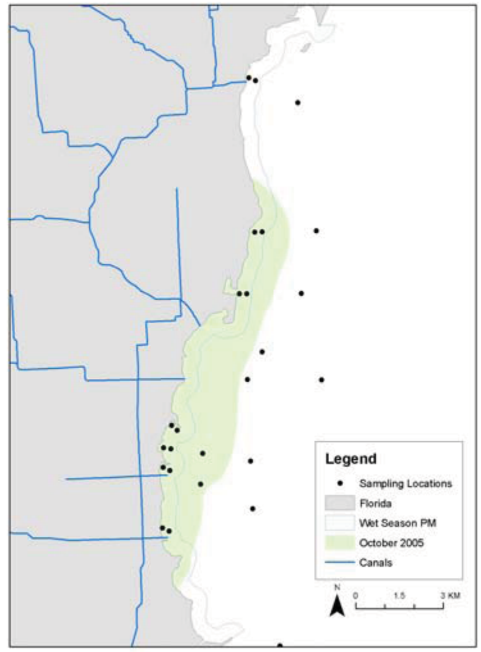


Figure 4.1-10. Estuarine zone in October 2005.

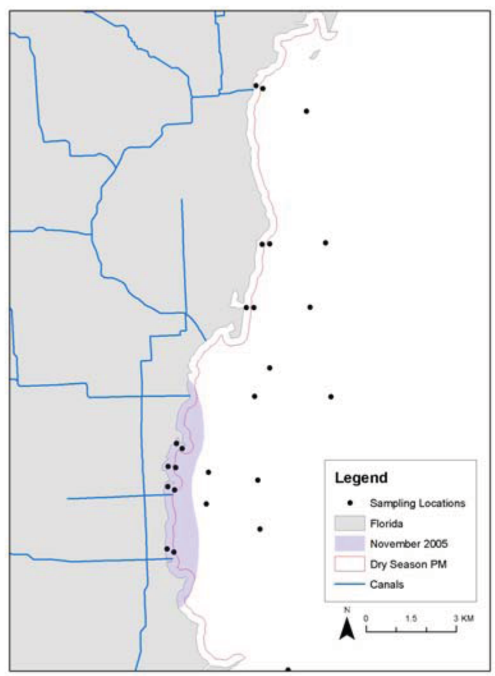


Figure 4.1-11. Estuarine zone in November 2005.

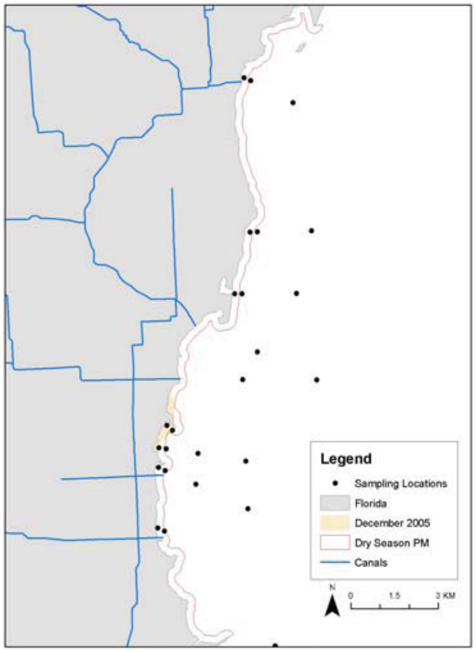


Figure 4.1-12. Estuarine zone in December 2005.

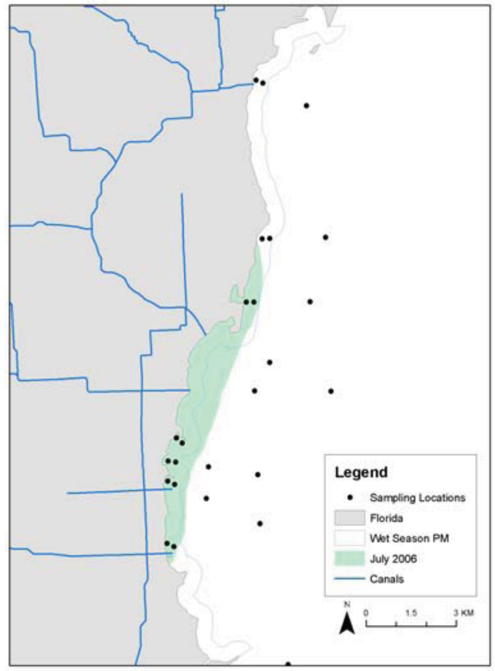


Figure 4.1-14. Estuarine zone in July 2006.

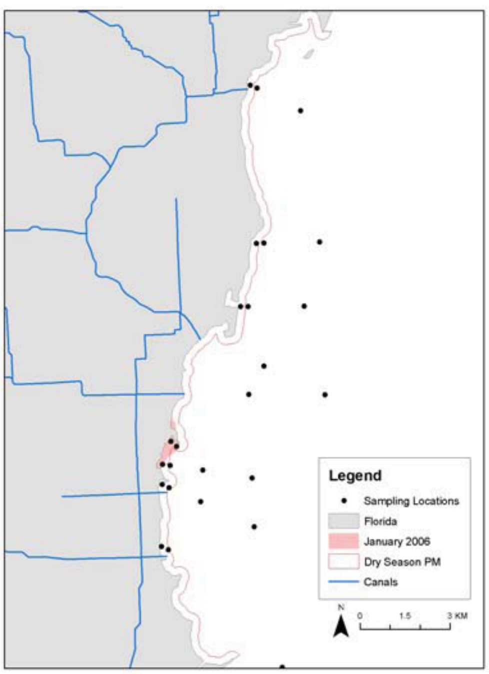


Figure 4.1-13. Estuarine zone in January 2006.

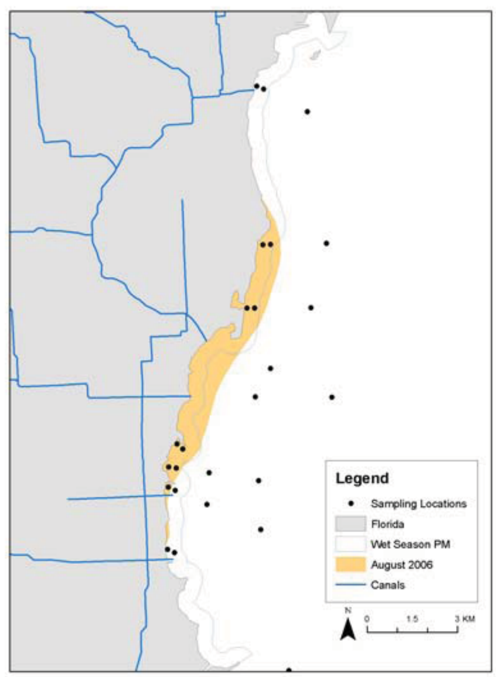


Figure 4.1-15. Estuarine zone in August 2006..

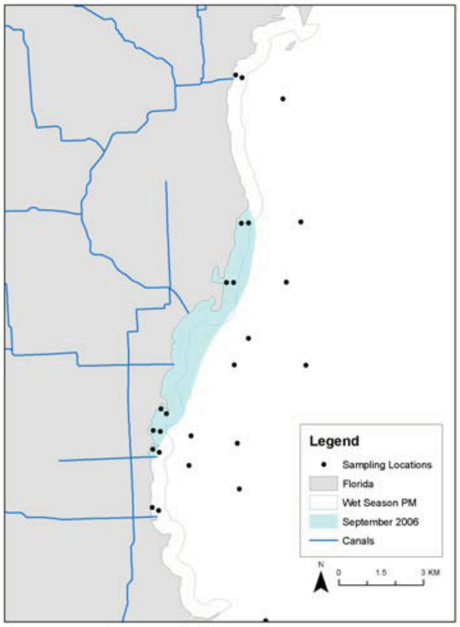


Figure 4.1-16.Estuarine zone inSeptember 2006

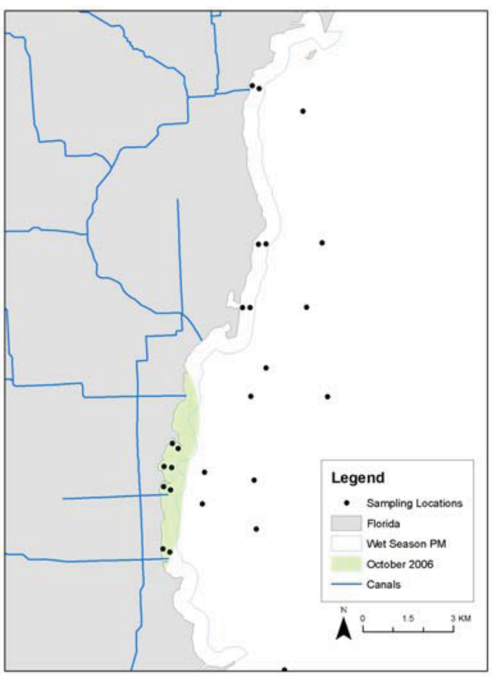


Figure 4.1-17. Estuarine zone in October 2006.

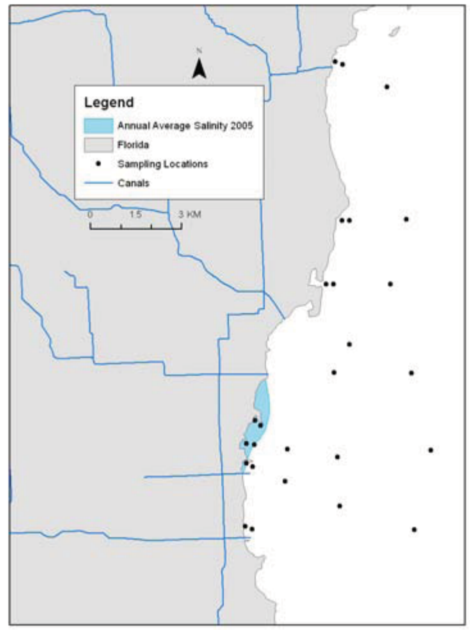


Figure 4.1-18. Estuarine zone for water year 2005 (June 1, 2005 – May 31, 2006).

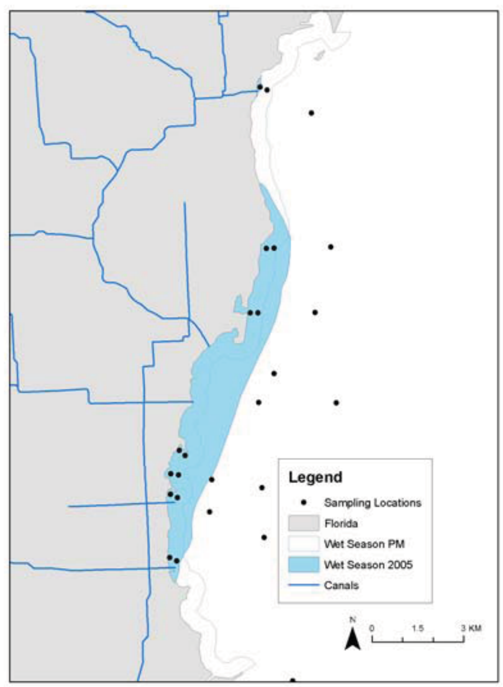


Figure 4.1-19. Estuarine zone for wet season 2005 (June 1, 2005 – October 31, 2005).

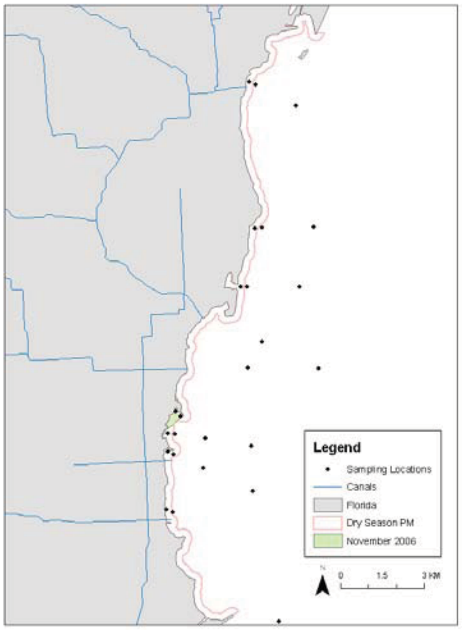


Figure 4.1- 20. Estuarine Zone in November 2006.

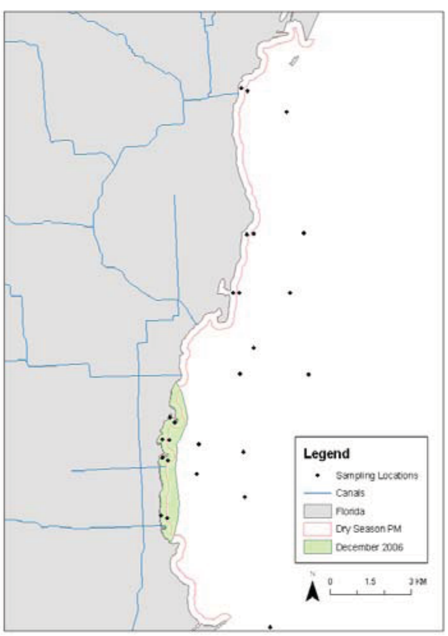


Figure 4.1 -21. Estuarine Zone in December 2006.

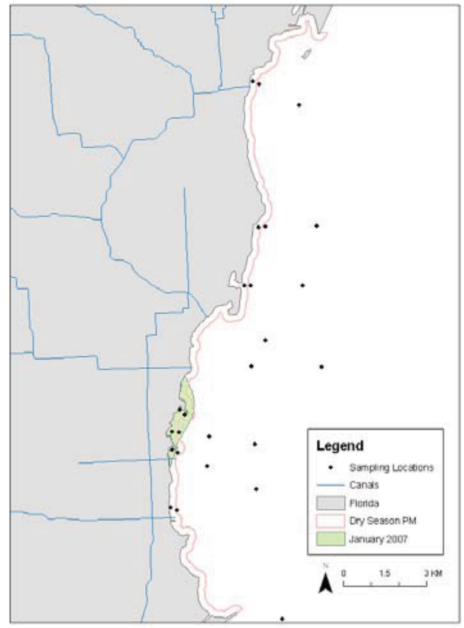


Figure 4.1- 22. Estuarine Zone in January 2007.

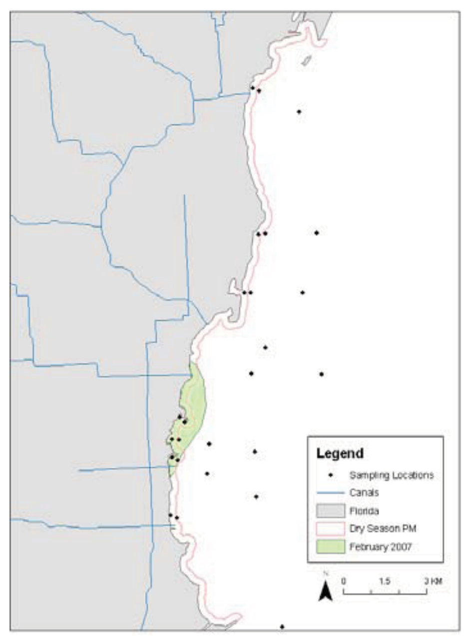


Figure 4.1- 23. Estuarine Zone in February 2007.

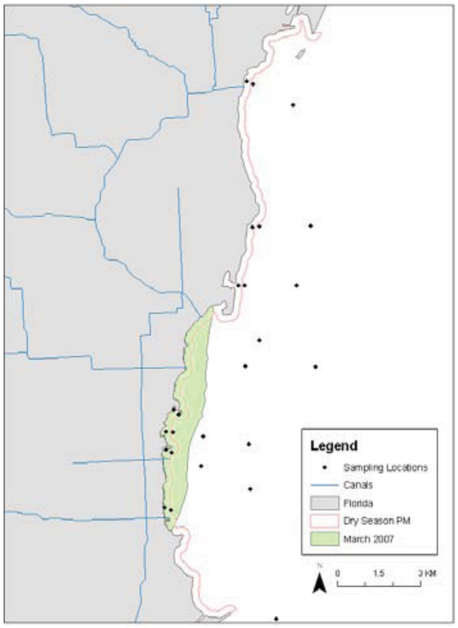


Figure 4.1- 24. Estuarine Zone in March 2007.

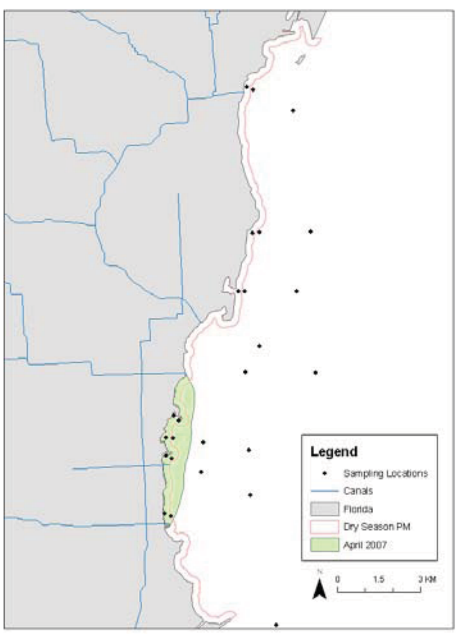


Figure 4.1- 25. Estuarine Zone in April 2007.

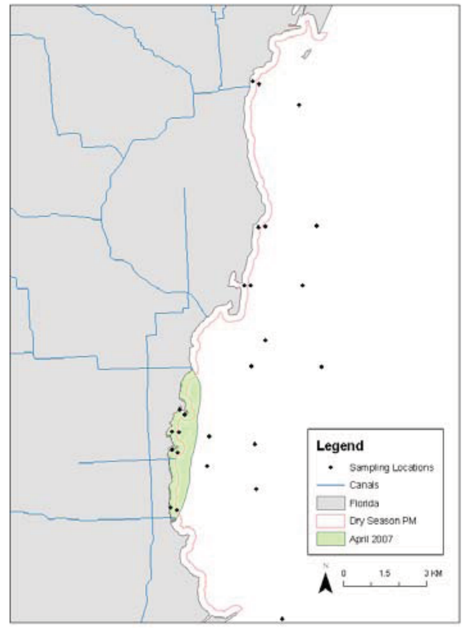


Figure 4.1- 26. Estuarine Zone in May 2007.

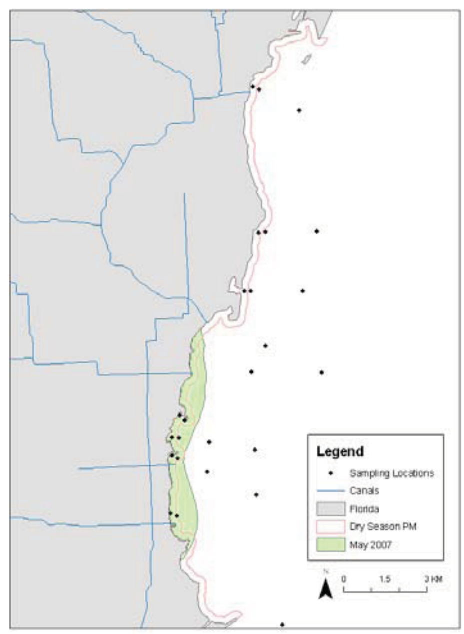


Figure 4.1- 27. Estuarine Zone in June 2007.

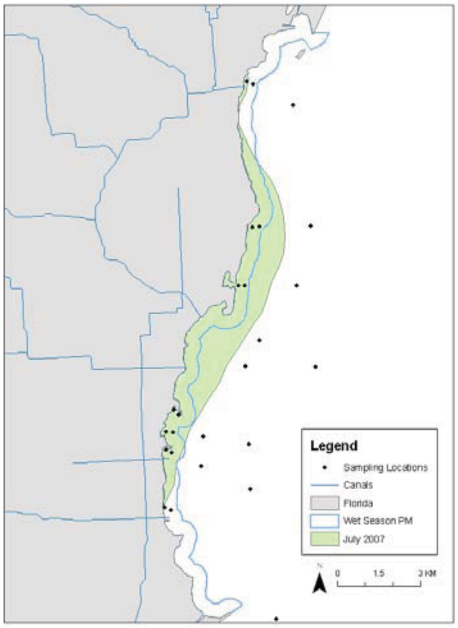


Figure 4.1- 28. Estuarine Zone in July 2007.

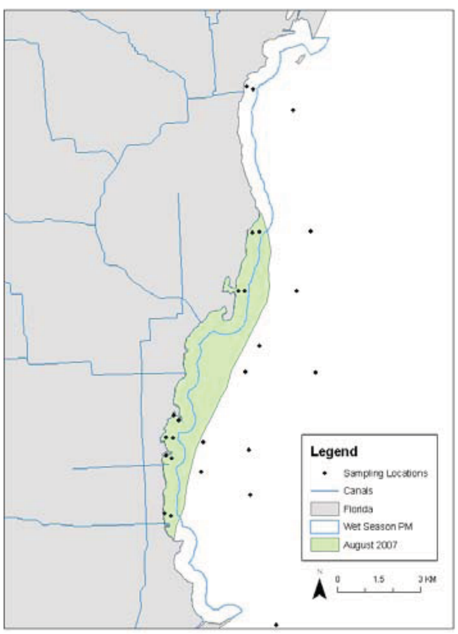


Figure 4.1- 29. Estuarine Zone in August 2007.

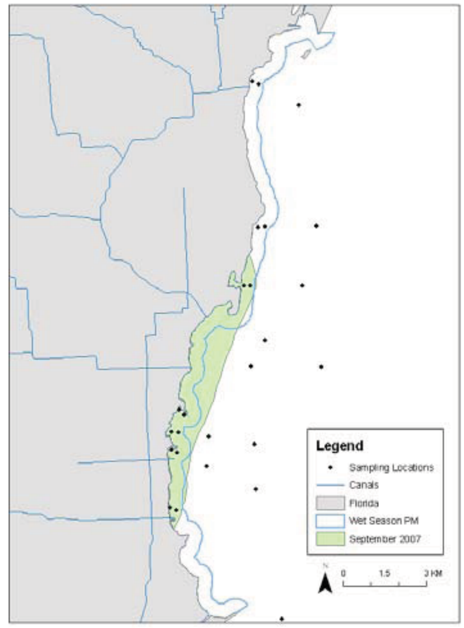


Figure 4.1- 30. Estuarine Zone in September 2007.

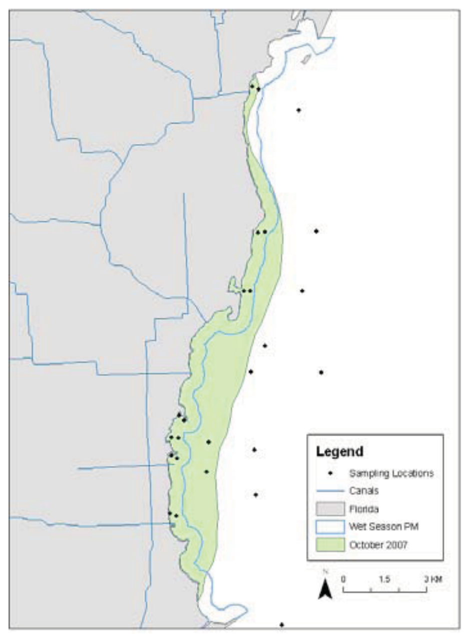


Figure 4.1- 31. Estuarine Zone in October 2007.

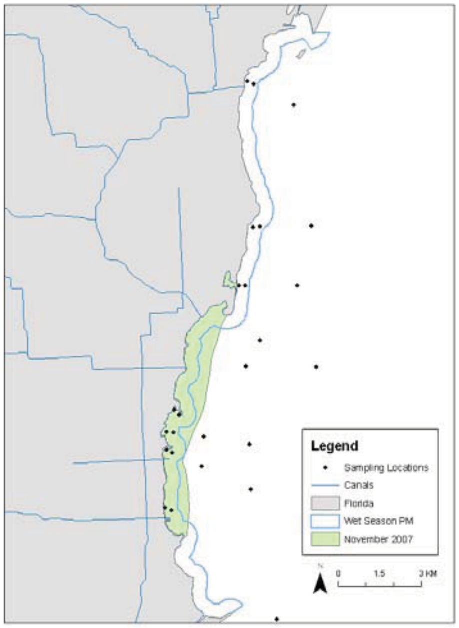


Figure 4.1- 32. Estuarine Zone in November 2007.

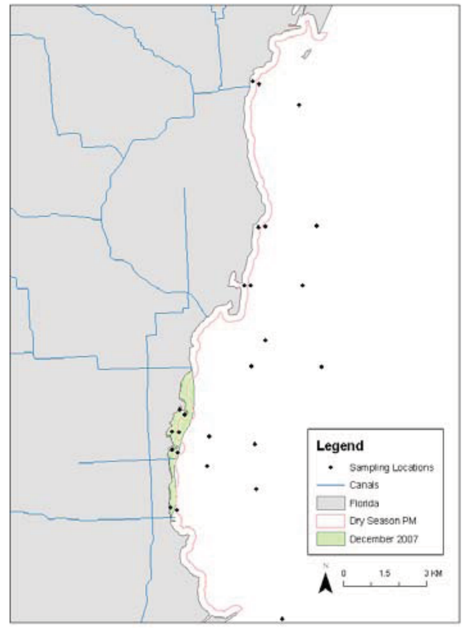


Figure4.1-33.Estuarine Zone in December 2007.

5.0 Spatial Salinity Relationships

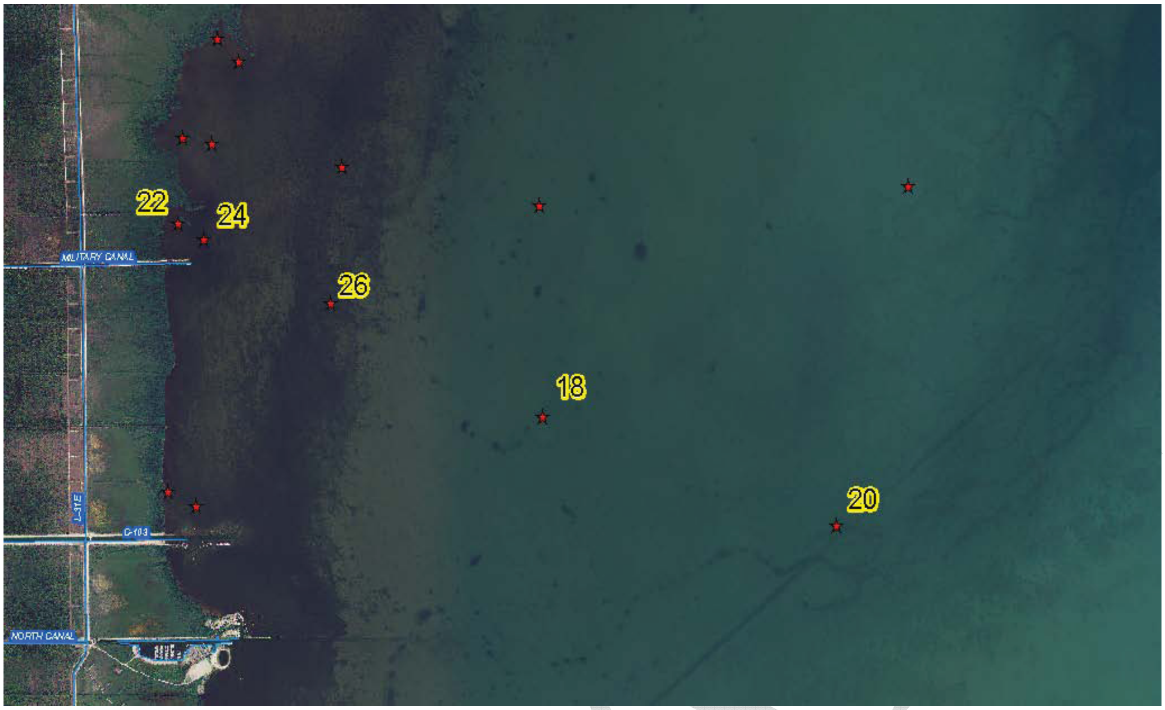


Figure 5.1-1 A transect north of convoy point extending to 3 kilometers off-shore.

Lets look at 4 sites, whose locations range from very near shore, 120 meters, out to 3 kilometers.

Table 5.1.1. Distance from shore

Site	Distance from shoreline
22	120 meters
24	360 meters
26	1360 meters
18	3160 meters
20	5590 meters

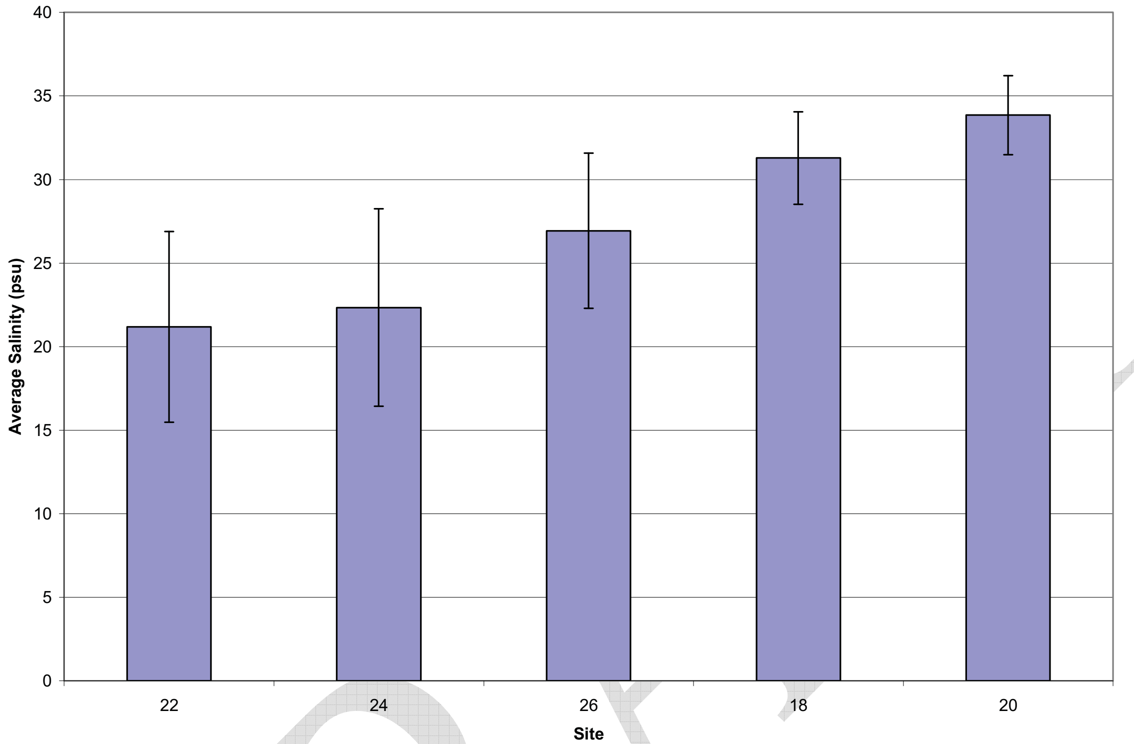


Figure 5.1-2
Average Salinity by site along the transect with standard deviation shown.

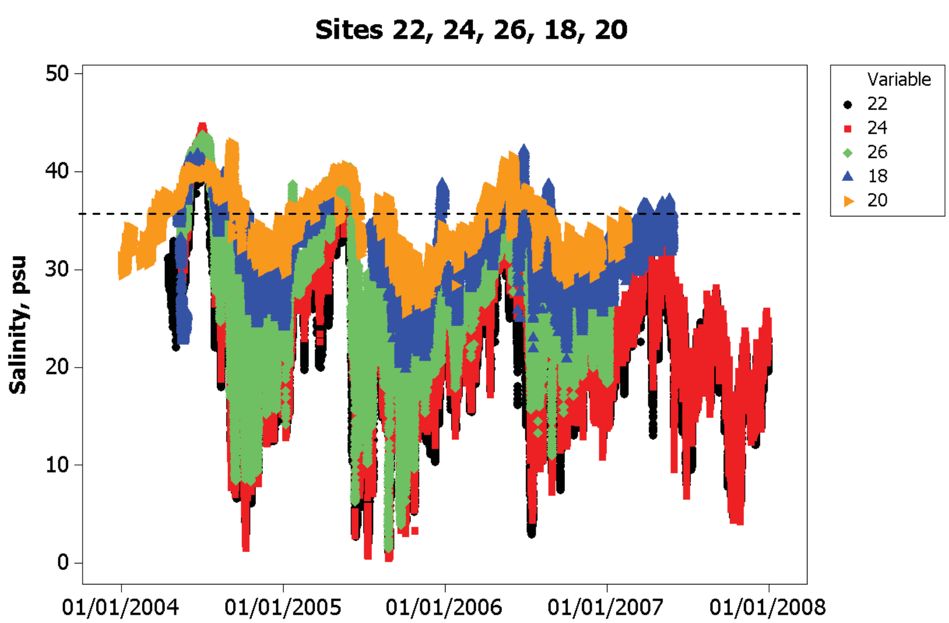


Figure 5.1-3 Shows actual data plotted over time.

This plot of benthic data shows 2 things. There are periods of hypersalinity, which extend 3 kilometers from shore, and the salinity pattern evident in the nearshore environ is faithfully translated offshore – the same patterns of lower and higher salinity are apparent.

The importance of comparing these two plots is that when data is averaged it lowers the net salinity. Actual measurements record hypersalinity (salinity above 35psu) while averaged salinity never exceeds 35 psu.

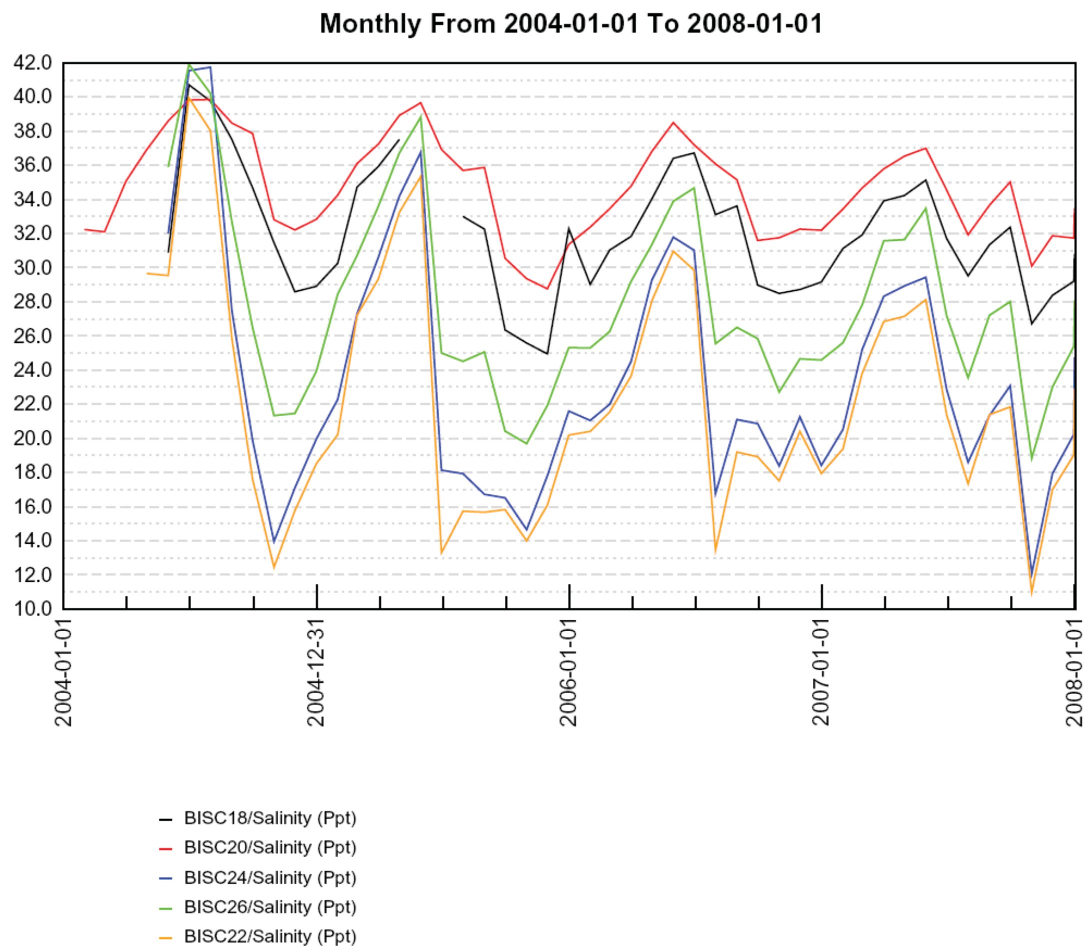


Figure 5.1-4 Monthly averaged salinity by site for the period of record

This shows the difference and importance of how the actual data is examined. When salinity is averaged over the period of record by site, hypersalinity events disappear; When sites are averaged by month hypersalinity events become apparent.

Transect 30, 32, 34, 36

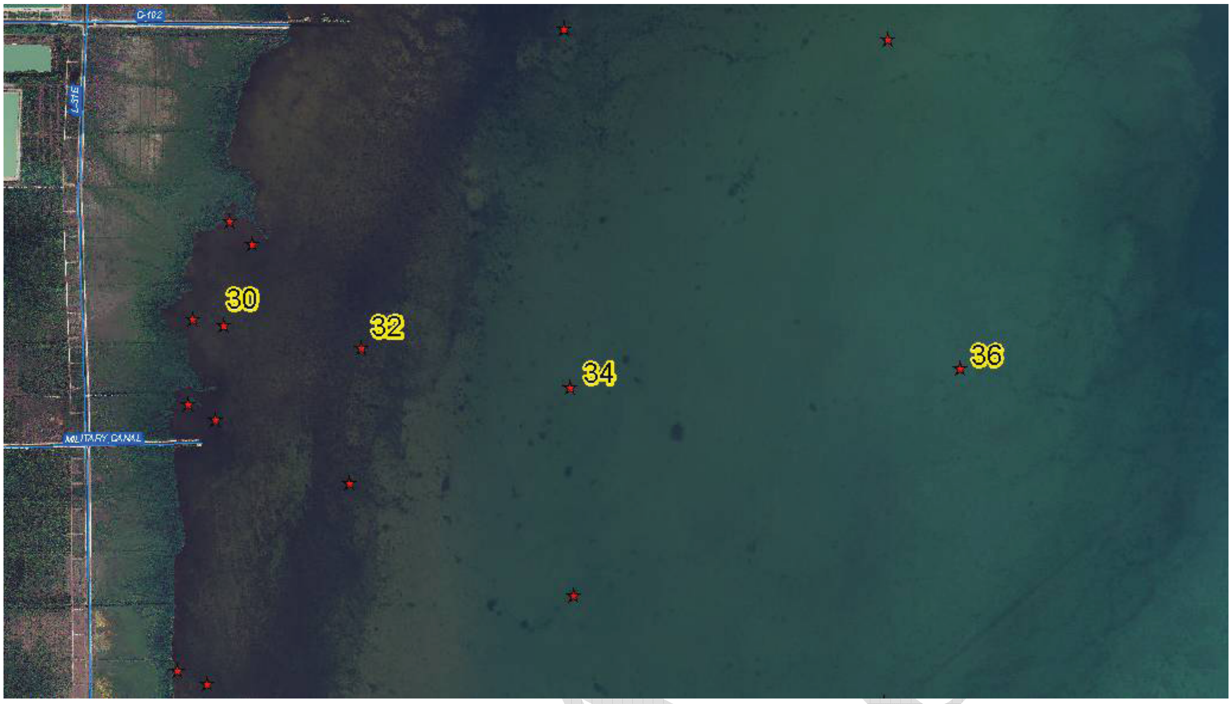


Figure 5.1-5 Sites along the next transect north

Table 5.1-2

Sites	Distance from shoreline
30	380 meters
32	1450 meters
34	3070 meters
36	6120 meters

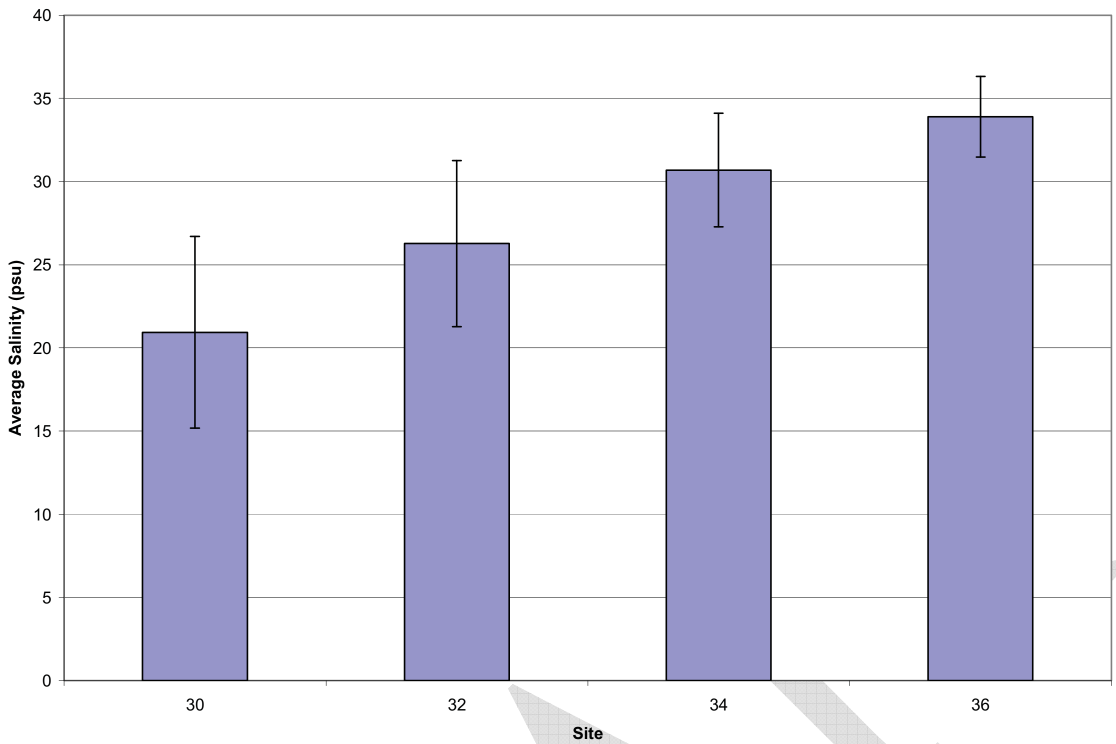
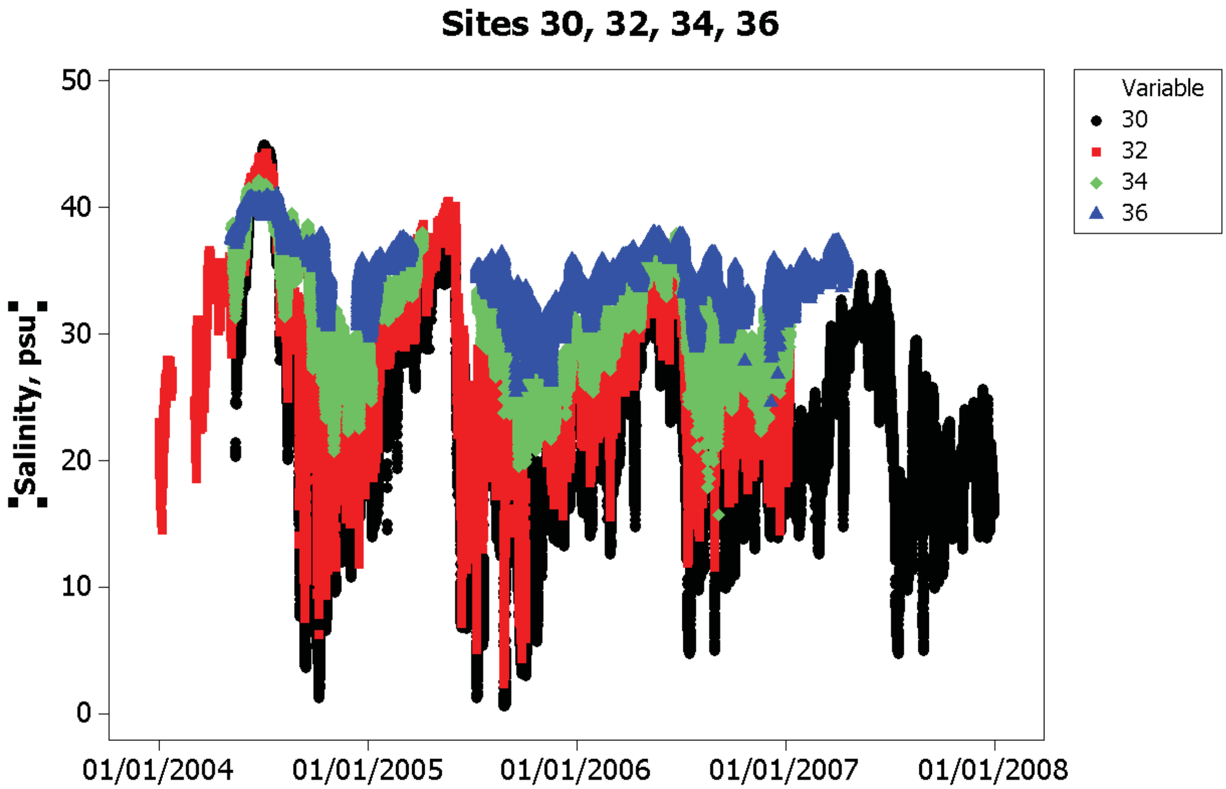


Figure 5.1-6 Salinity Averaged by site for a slightly northern transect.



.

Figure 5.1-7 Actual Data by site for a second transect further north

This data shows that the coastal nearest shore site, Number 30 has the highest variation going from zero to hypersaline conditions while the site farthest off shore reflects a more stable condition. We see again the same general pattern. The salinity in the Bay moves up and down as a whole, season to season. Further, hypersaline events can occur as far out as 6 km. These hypersalinity events that occur represent stress on aquatic organisms who must fight an uphill osmoregulatory gradient. Fish maintain an internal salinity around 11 to 13 psu. If the surrounding waters are above or below this value, the fish have to expend osmo-regulatory energy to maintain function, which is an important metabolic stress. Different species have adapted to different salinity regimes. Hypersaline events represent stress to some degree to all species, and can adversely affect or eliminate juvenile species which are undergoing rapid growth and development. Mortality or extirpation may be result.

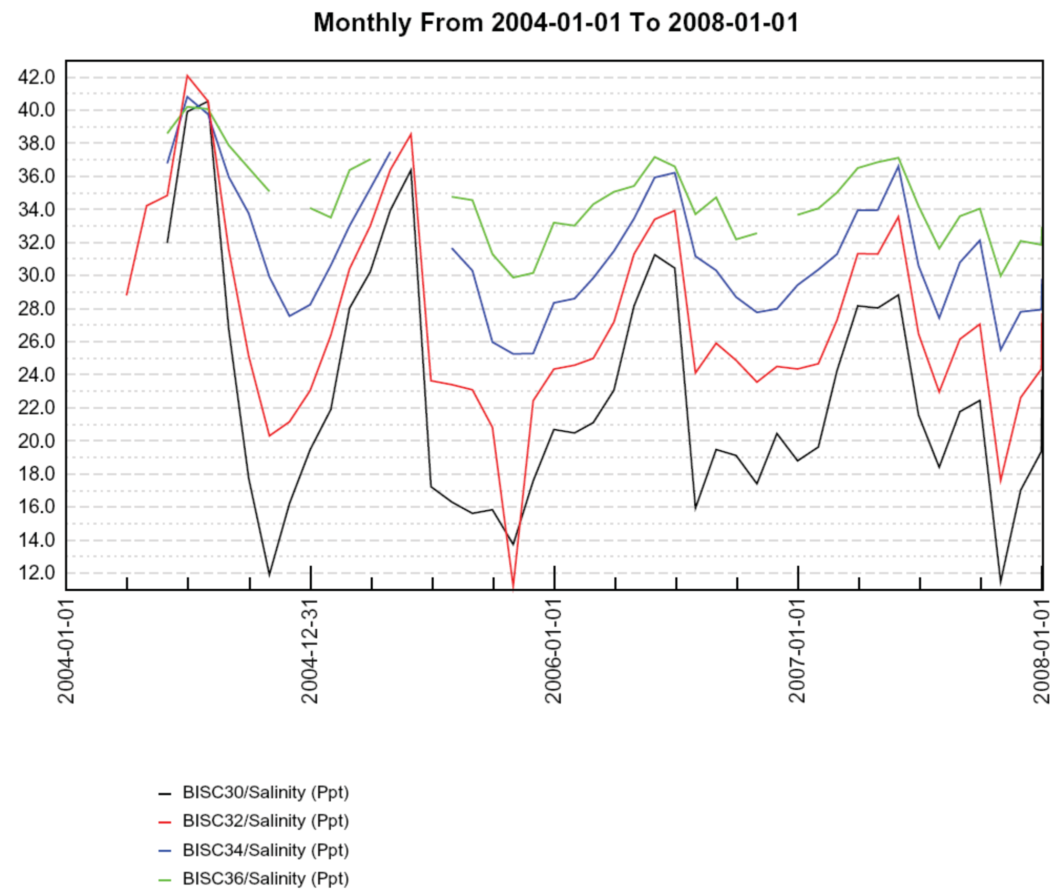


Figure 5.1-8 Salinity Averaged by Month by site

This data shows the same patterns seen in the other transect so it is apparent that this is not a localized pattern.

Zones 2- 3

Comparison of Southern Mangrove Salinity Sites with Northern Mangrove Salinity Sites

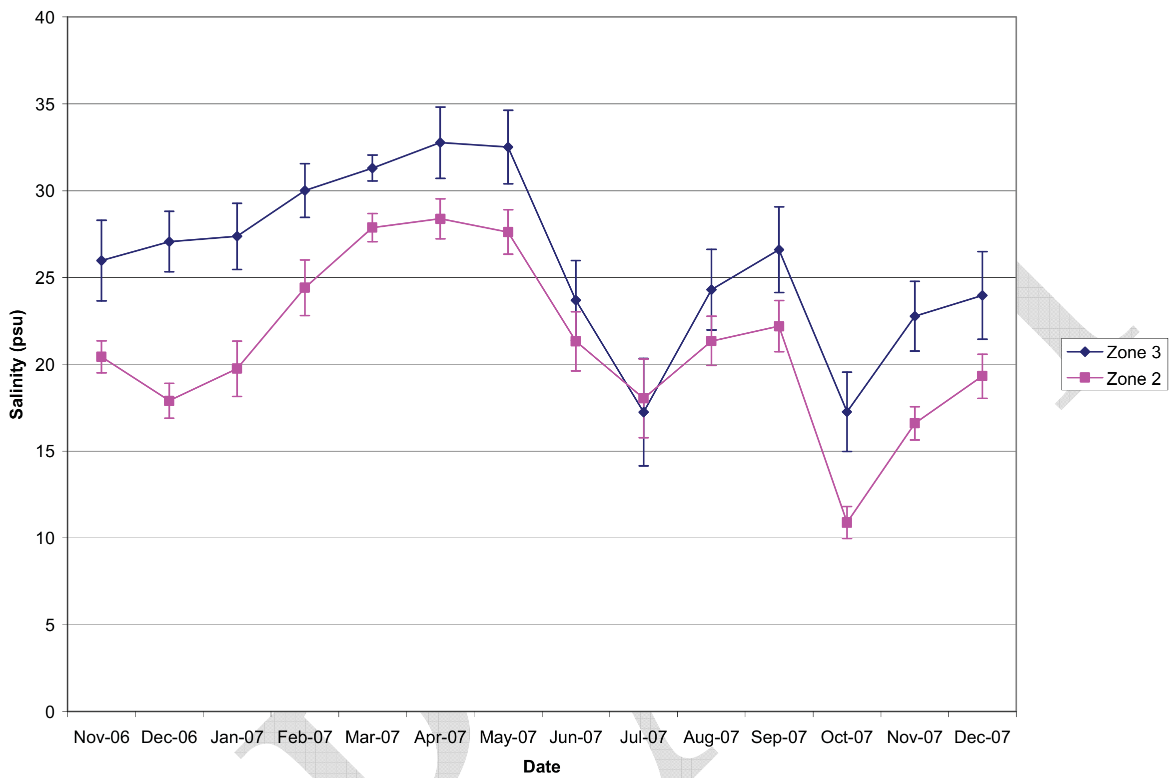


Figure 5.1-9 Salinity sites south of Black Point, Zone 2 and Salinity site north of Black Point, Zone 3 plotted with one standard deviation bars.

Most of the monthly data are significantly different from these two zones. These differences are likely reflective of the influence of canal flow and possibly groundwater flow. Most of the sites to the south, except sites 14 and 16 are removed from canal discharge however more water moves to the south than north of Black Point. Mangrove salinity north of Black Point is higher than that to the south. This is important in reviewing CERP project design proposals and in assessing water needs for the coastal areas.

5.1 Biscayne Bay Nearshore Salinity Monitoring Network Optimization

Introduction

BISC staff worked in conjunction with Greg Graves of the South Florida Water Management District and Elmar Kursbach of the U. S. Army Corps of Engineers to review the information available and determine the need for site redistribution. After compiling and reviewing this information it was vetted with scientists using the data generated to determine how well the current and proposed sites fit the needs of the biological commuity using the data. These scientists were from the University of Miami, NOAA National Marine Fisheries Service (NMFS), and the NOAA Atmospherice and Oceanographic and Meteriological Laboratory (AOML). The intended purposes of the Monitoring and Assessment Plan (MAP) are to document restoration-induced change and to provide data amenable to adaptively managing the operation of constructed features. The originally conceived continuous salinity monitoring network in Biscayne Bay was configured to provide a better understanding of the nearshore environs heretofore undocumented to this intensity or extent. The current salinity sampling project in Biscayne Bay was primarily designed to look at the regional effects of the entire Comprehensive Everglades Restoration Plan (CERP) on Biscayne Bay and Biscayne National Park. As CERP and the focus of the MAP evolved, the direct project effects were added to the scope of the work to be evaluated as part of the MAP. As a result, the layout of the salinity sampling network was accordingly re-evaluated. The new sampling design outlined in this paper aims to provide data to better assess the Biscayne Bay Coastal Wetlands (BBCW) features.

Background

The BBCW Project is proposed to be implemented in phases, Phase I occurring in the relative near-term and Phase II several years later. Phase I has been further subdivided into three major sub-units (Deering Estates, C-1 Flowway, and L31E Culverts) each of which is proceeding on its own schedule. In addition, the last three years of continuous salinity data have provided a greatly improved insight into the processes affecting the bay, most principal among those being documentation of the significant if not dominant role that groundwater flow can play in the Bay's nearshore salinity regime. The extent of these findings was not expected.

The MAP was always conceived as a flexible and dynamic plan - as things change and as learning increases, the MAP would be reconfigured as appropriate. In this era of constricting financial resources monitoring conducted under the MAP must be continuously reviewed and evaluated to ensure that it remains scientifically sound, properly focused, and able to provide answers to new questions as they emerge. Specifically, the MAP has been asked to assure that changes brought about by implementation of BBCW Phase I will be appropriately addressed.

Methods:

Sites were reviewed for their proximity to the proposed Phase one of the Biscayne Bay Coastal Wetlands project features to ensure that the coastline was adequately covered by sampling sites. Previous work with a MAP sub-team to review project site locations and evaluate station density to optimize stations recommended that the end-uses for the data should be considered when evaluating network design. Correlations between sites was used to examine potential overlap from adjacent locations and was used as one factor to identify duplicative data streams and to suggest an improved distribution of locations to better focus on the proposed project features. Seasonal patterns were also examined to identify site locations that were providing comparatively more relevant information. However, it was also a goal not to make changes to the existing network that might otherwise compromise its integrity.

Eight sites were relocated to optimize the existing network. These changes incur a zero cost increase. Decisions were based on (1) examination of the 2004 through 2006 data, (2) logistics of accessing of proposed new sites, (3) proximity to Phase I projects and other areas of concern, and (4) history of individual sites that have proven problematical to operate or maintain. Descriptions of sites discontinued, sites moved and new sites are presented by region reflected in Phase 1 of the Biscayne Bay Coastal Wetlands proposal. Each instrument collects continuous conductivity, temperature and depth every 15 minutes. These instruments are deployed on a three week rotation schedule. The number of readings per wet or dry season was used to create histograms by 2 ppt binning which was used in the analysis. Data was plotted by month for the 2006 calendar year, a year when there were no severe storms to disrupt data collection. Other data was used as available.

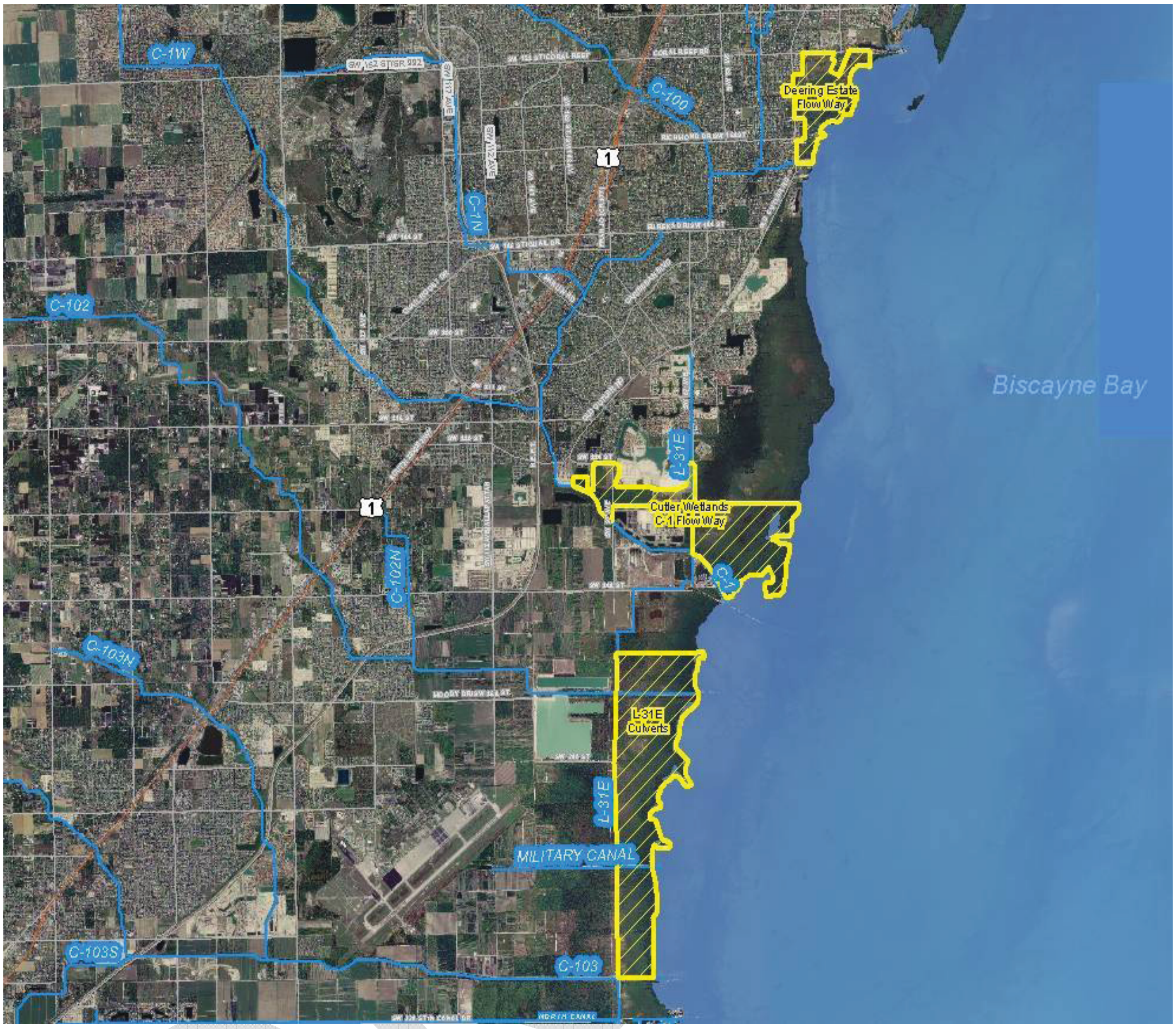


Figure 5.1-1: Acceler8 whole area

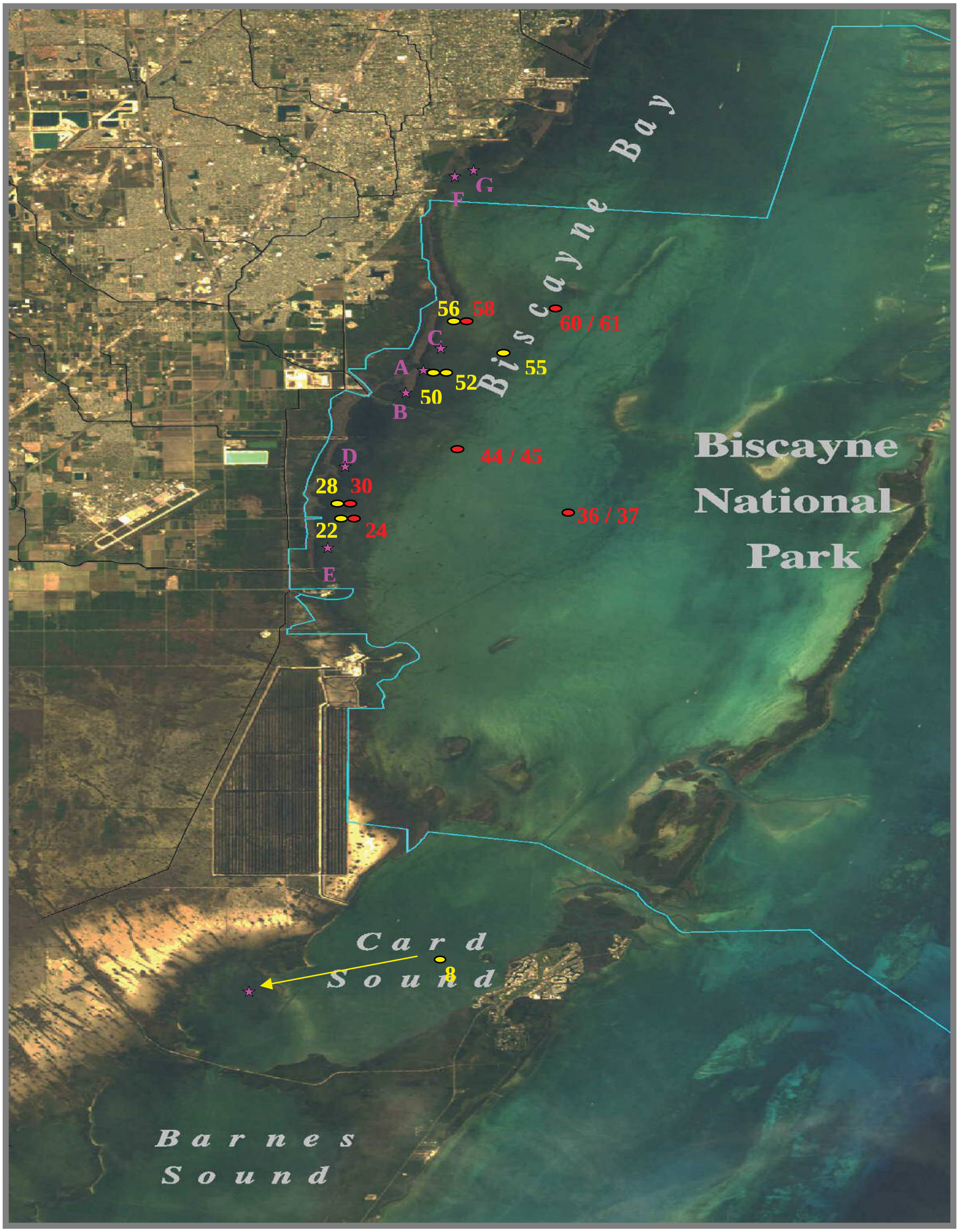


Figure 5.1-2: Biscayne Bay aerial with site locations

Table 5.1-1: Correlation coefficient between sites

	Stn_1	Stn_2	N	dS	R	R_lo	R_hi	P	distance(m)	std_dS
Hourly	BISC50	BISC52	21001	-0.5	0.98	0.98	0.98	0	251	1.75
Daily	BISC50	BISC52	879	-0.5	0.98	0.98	0.98	0	251	1.5
Monthly	BISC50	BISC52	32	-0.5	0.99	0.99	1	0	251	0.8
Hourly	BISC56	BISC58	22750	-0.3	0.98	0.98	0.98	0	254	1.72
Daily	BISC56	BISC58	950	-0.3	0.98	0.98	0.99	0	254	1.5
Monthly	BISC56	BISC58	32	-0.3	0.99	0.98	1	0	254	0.9
Hourly	BISC60	BISC61	16566	-0.1	0.95	0.95	0.95	0	0	1.44
Daily	BISC60	BISC61	704	-0.1	0.95	0.94	0.96	0	0	1.4
Monthly	BISC60	BISC61	28	0.1	0.91	0.82	0.96	0	0	1.8
Hourly	BISC44	BISC45	16563	1.1	0.87	0.87	0.88	0	0	3.18
Daily	BISC44	BISC45	707	1.1	0.93	0.92	0.94	0	0	2.3
Monthly	BISC44	BISC45	28	1.3	0.96	0.91	0.98	0	0	1.6
Hourly	BISC36	BISC37	12426	0.2	0.87	0.86	0.87	0	0	1.49
Daily	BISC36	BISC37	553	0.2	0.9	0.88	0.92	0	0	1.2
Monthly	BISC36	BISC37	23	0.2	0.96	0.9	0.98	0	0	0.8
Hourly	BISC28	BISC30	21942	-0.8	0.98	0.98	0.98	0	253	1.58
Daily	BISC28	BISC30	918	-0.8	0.99	0.99	0.99	0	253	1.3
Monthly	BISC28	BISC30	32	-0.8	0.99	0.98	0.99	0	253	1.2
Hourly	BISC22	BISC24	21895	-1.4	0.97	0.97	0.97	0	249	2.05
Daily	BISC22	BISC24	916	-1.4	0.98	0.98	0.98	0	249	1.8
Monthly	BISC22	BISC24	32	-1.5	0.99	0.98	1	0	249	1

Deering Estates Area

New Site F

A new bottom recorder site designation will be assigned to the site located at latitude 25° 36.956’W, longitude 80° 18.122’N (NOTE: these latlongs are approximate).

New Site G

A new bottom recorder site designation will be assigned to the site located at latitude 25° 37.236’W, longitude 80° 17.850’N (NOTE: these latlongs are approximate).

Figure 5.1-3: Deering Estate map

Figure 5.1-4: Sites location in Deering Estate area

C-1 Flowway Area

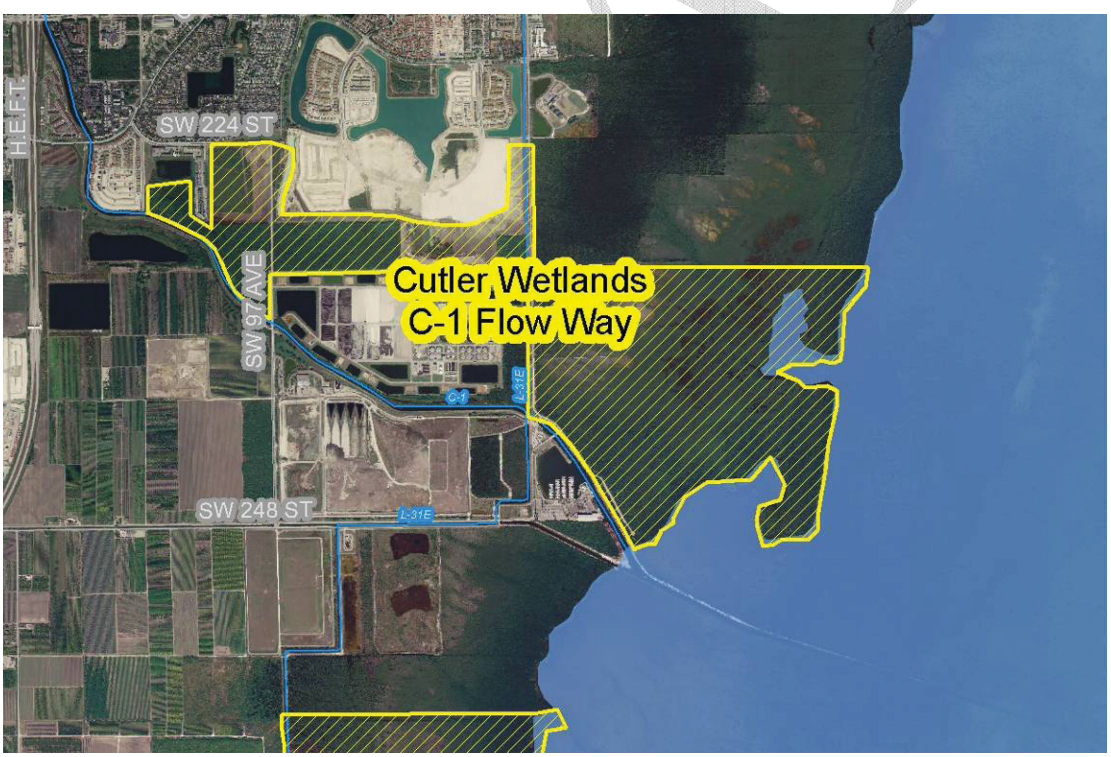


Figure 5.1-5: C-1 flow way map

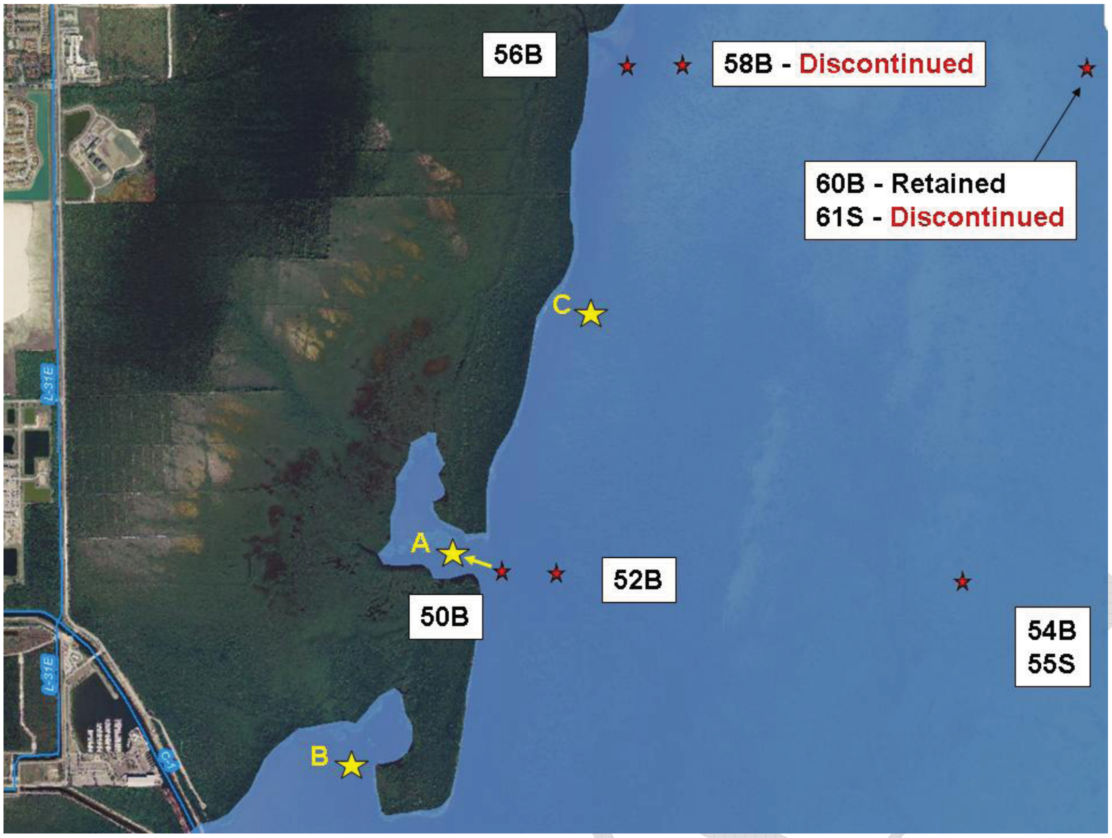


Figure 5.1-6: Existing, discontinued and new proposed site location in vicinity of C-1 Flow-way.

New Site B

A new bottom recorder site designation will be assigned to the site located at latitude 25˚ 32.233’W, longitude 80˚ 19.095’N. This site is located at a transition zone between an area of fairly dense thalassia and a sparsely vegetated mud bottom. This area shows benthic characteristics of very low salinity with coverage consisting of a freshwater algae *Chara*, *Ruppia*, and very sparse *Thallasia*

New Site C

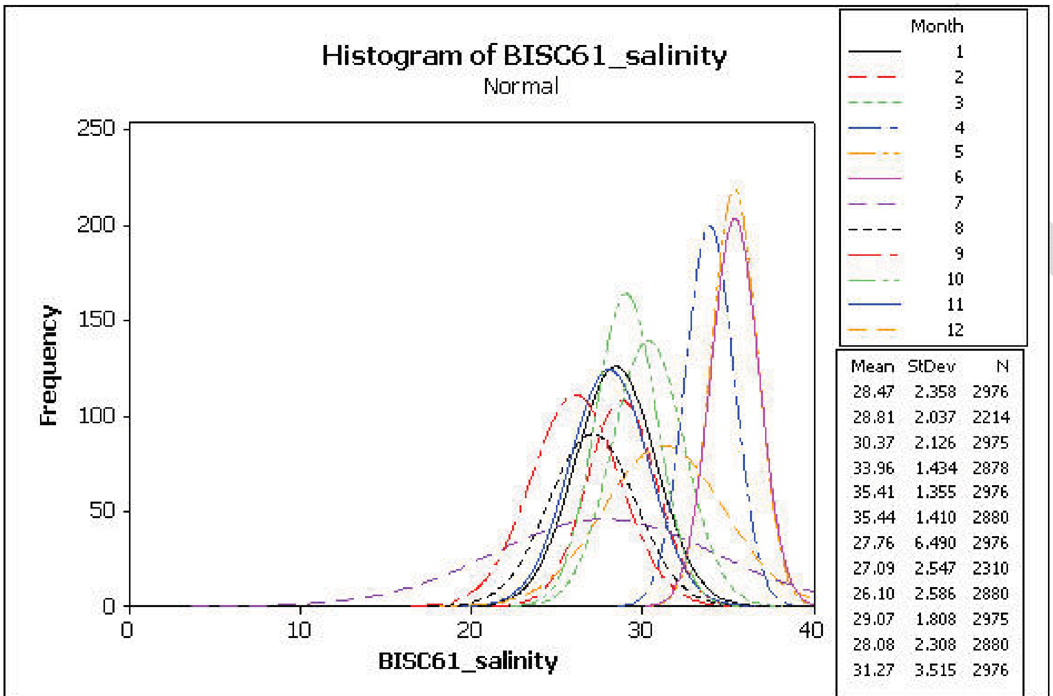
A new bottom recorder site designation will be assigned to the site located at latitude 25˚ 32.754’W, longitude 80˚ 18.839’N.

Site BISC58B – discontinued

BISC58 and BISC56 are producing data which are generally very similar (Figure 3). This will free up a recorder for use at New Site B.

Site BISC61S – Discontinued

There is little expectation of a change in surface salinity at this site. This top salinity recorder tracks the surface recorder at BISC55S (Figure 4). This will free up a recorder for use at New Site C.


Histogram of BISC61_salinity
Normal
Frequency
250
200
150
100
50
0
0
10
20
30
40
BISC61_salinity
Month
1
2
3
4
5
6
7
8
9
10
11
12
Mean StDev N
28.47 2.358 2976
28.81 2.037 2214
30.37 2.126 2975
33.96 1.434 2878
35.41 1.355 2976
35.44 1.410 2880
27.76 6.490 2976
27.09 2.547 2310
26.10 2.586 2880
29.07 1.808 2975
28.08 2.308 2880
31.27 3.515 2976

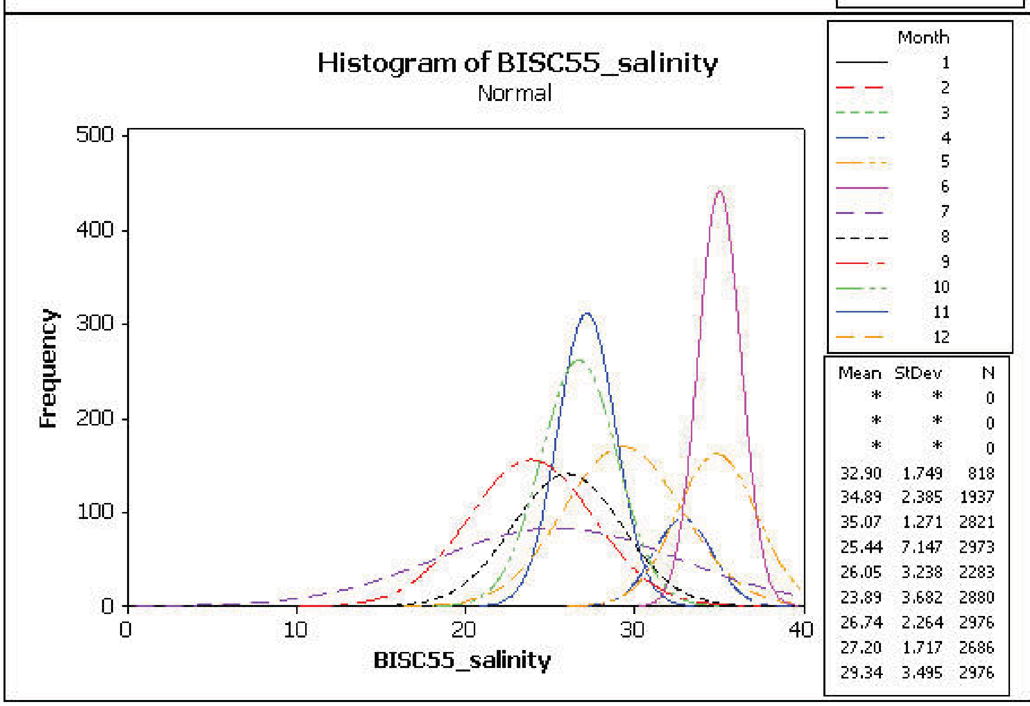

Histogram of BISC55_salinity
Normal
Frequency
500
400
300
200
100
0
0
10
20
30
40
BISC55_salinity
Month
1
2
3
4
5
6
7
8
9
10
11
12
Mean StDev N
* * 0
* * 0
* * 0
32.90 1.749 818
34.89 2.385 1937
35.07 1.271 2821
25.44 7.147 2973
26.05 3.238 2283
23.89 3.682 2880
26.74 2.264 2976
27.20 1.717 2686
29.34 3.495 2976

Figure 5.1-7: Sites BISC61S and BISC55S generate similar data. Complete sets of data for these two sites does not exist in one calendar year; top graph is 2006 data. BISC61S will be discontinued.

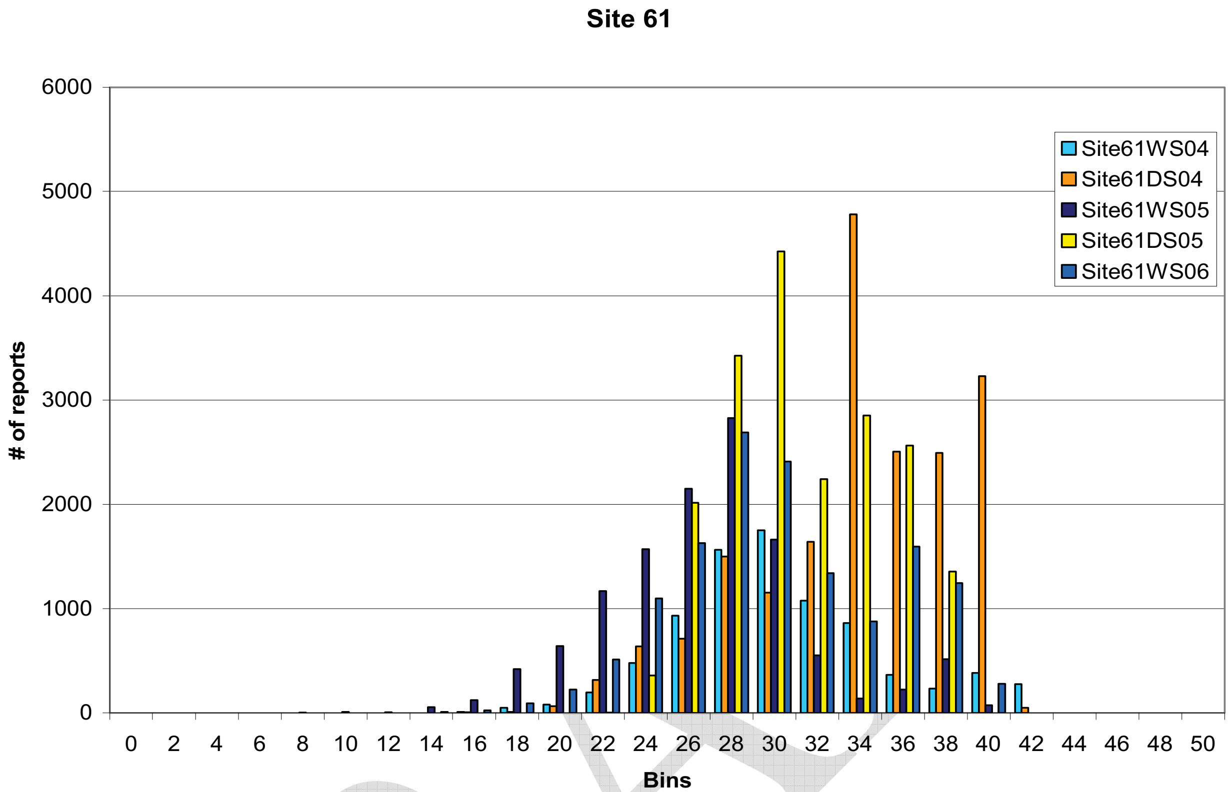
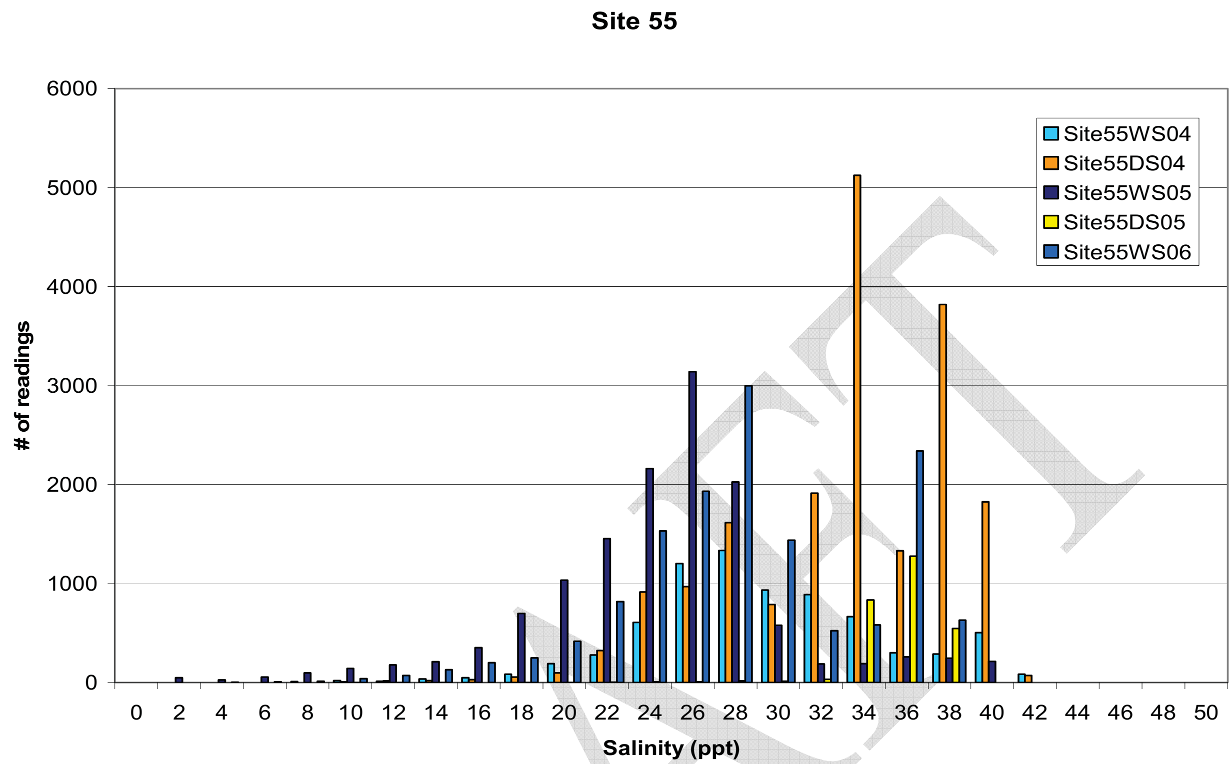
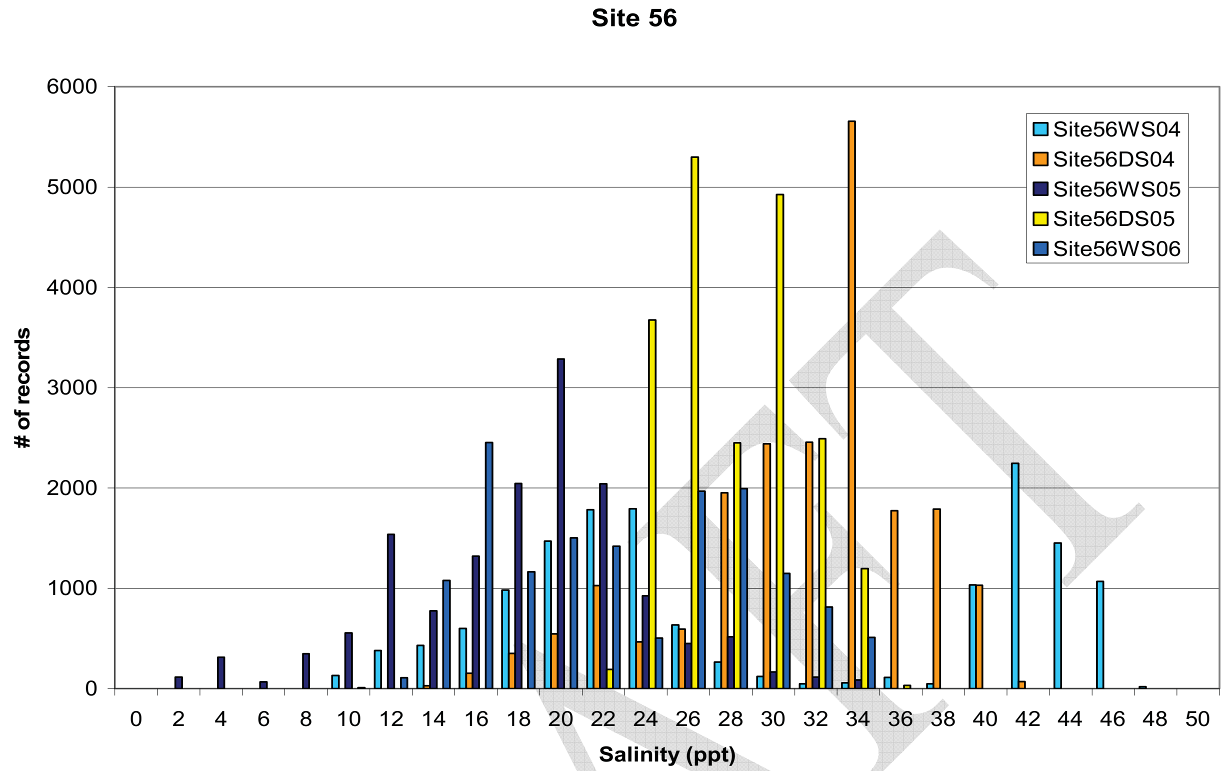


Figure 5.1-8: Sites BISC61S and BISC55S generate similar data.





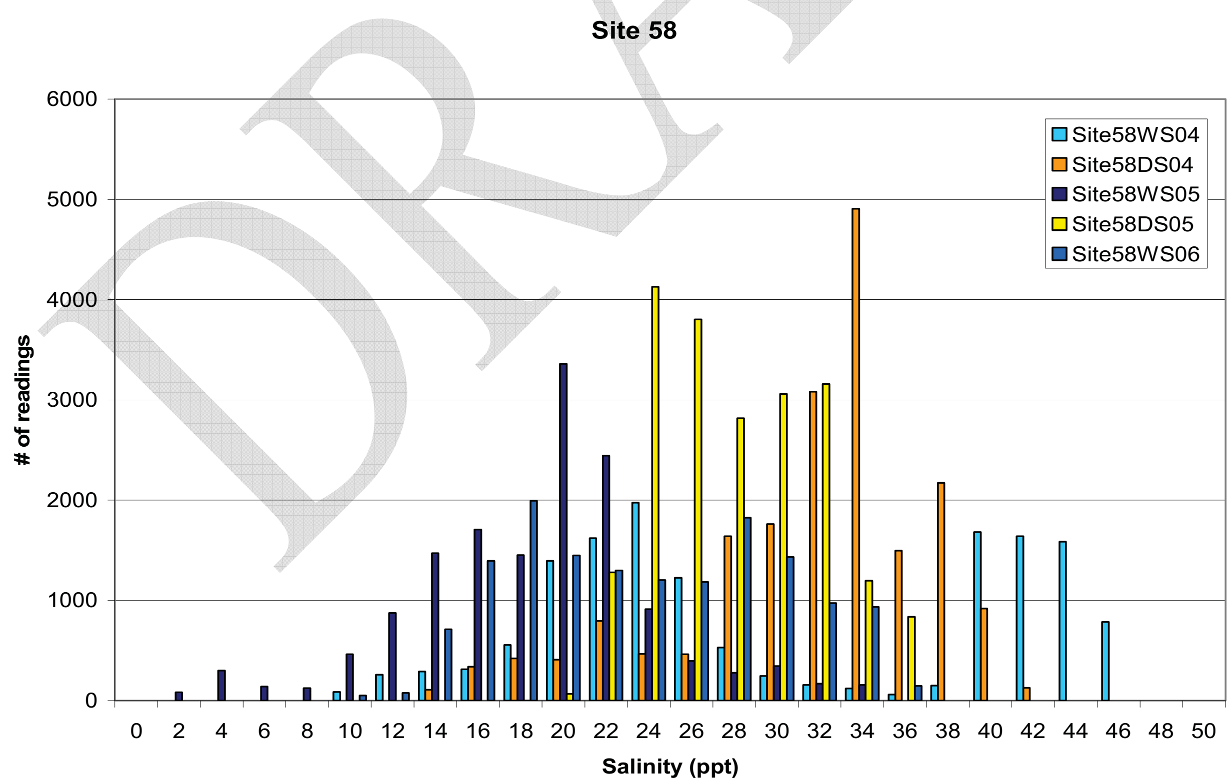


Figure 5.1-9: Sites BISC56B and BISC58B generate similar data. BISC58 will be discontinued.

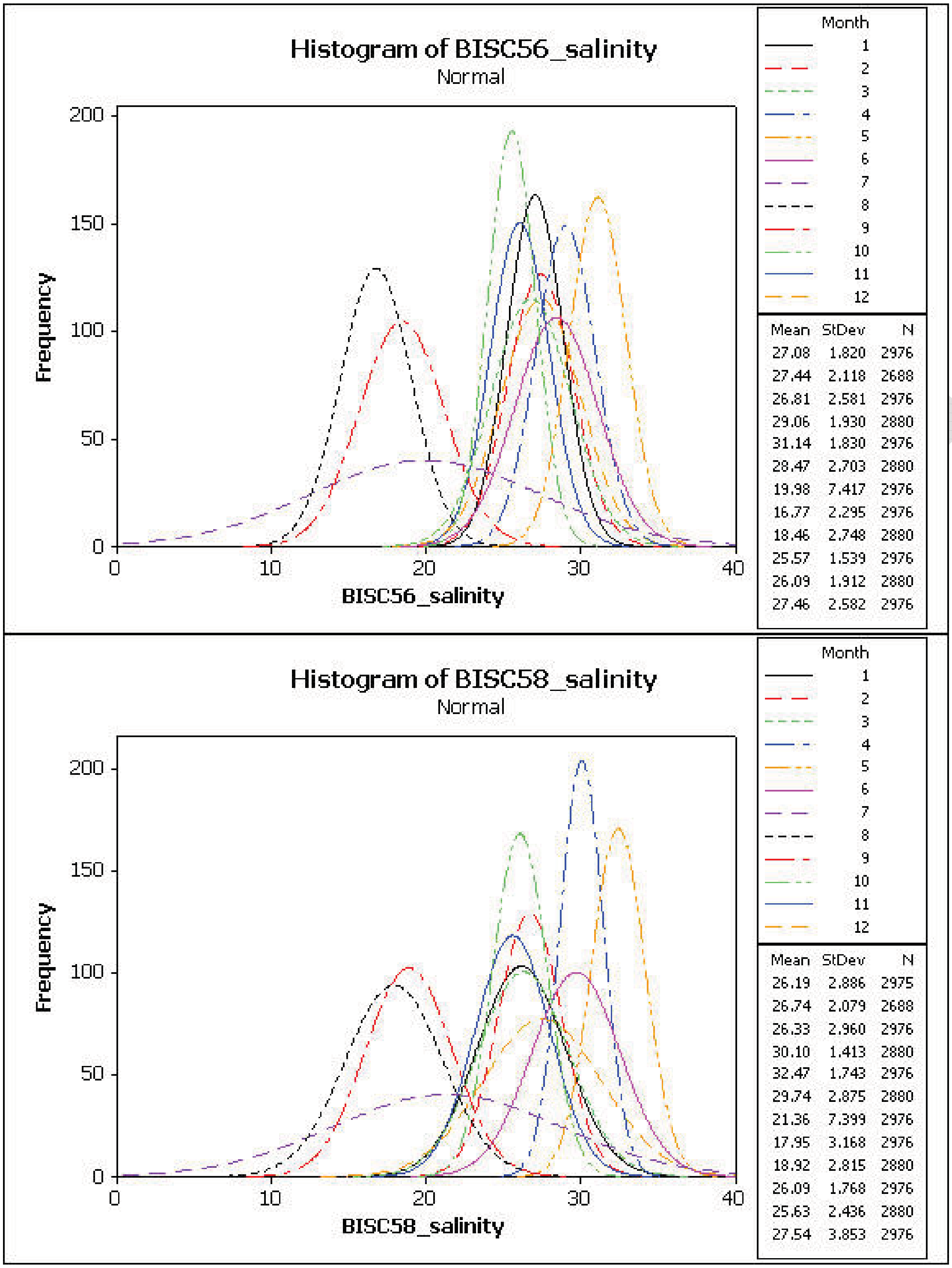
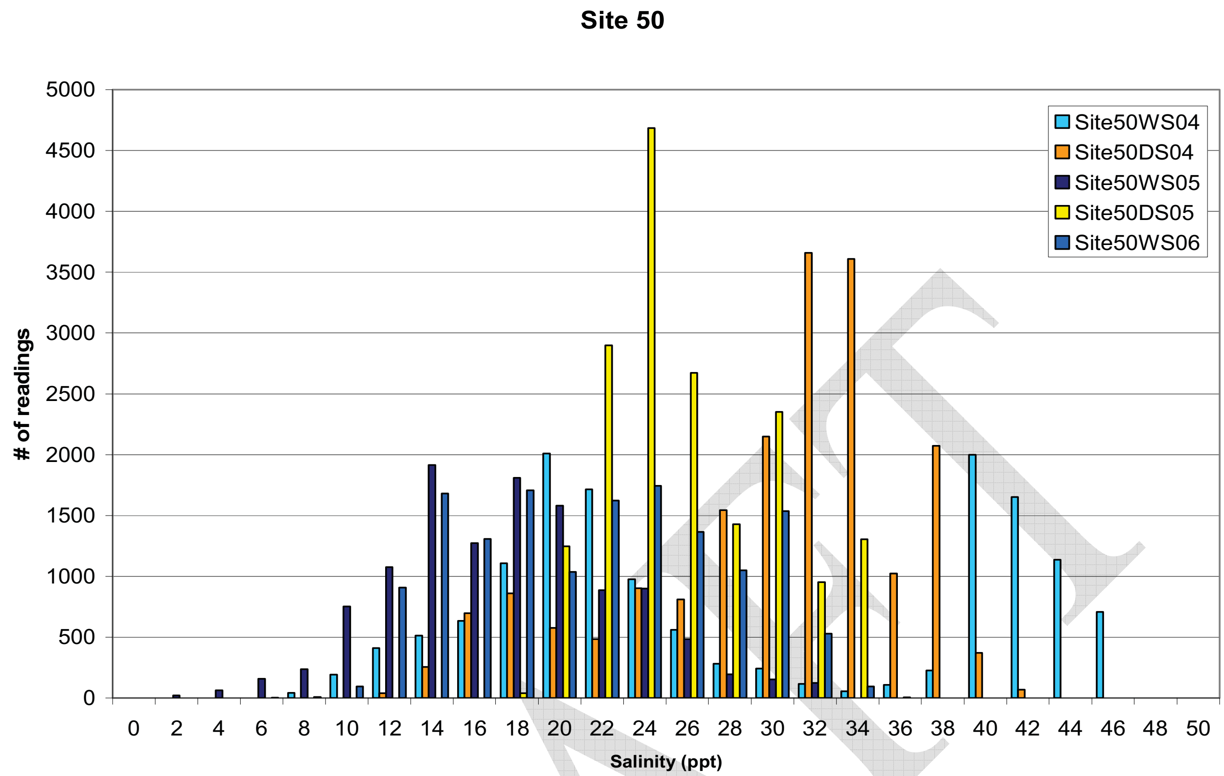


Figure 5.1-10: Sites BISC56B and BISC58B generate similar data. BISC58 will be discontinued.



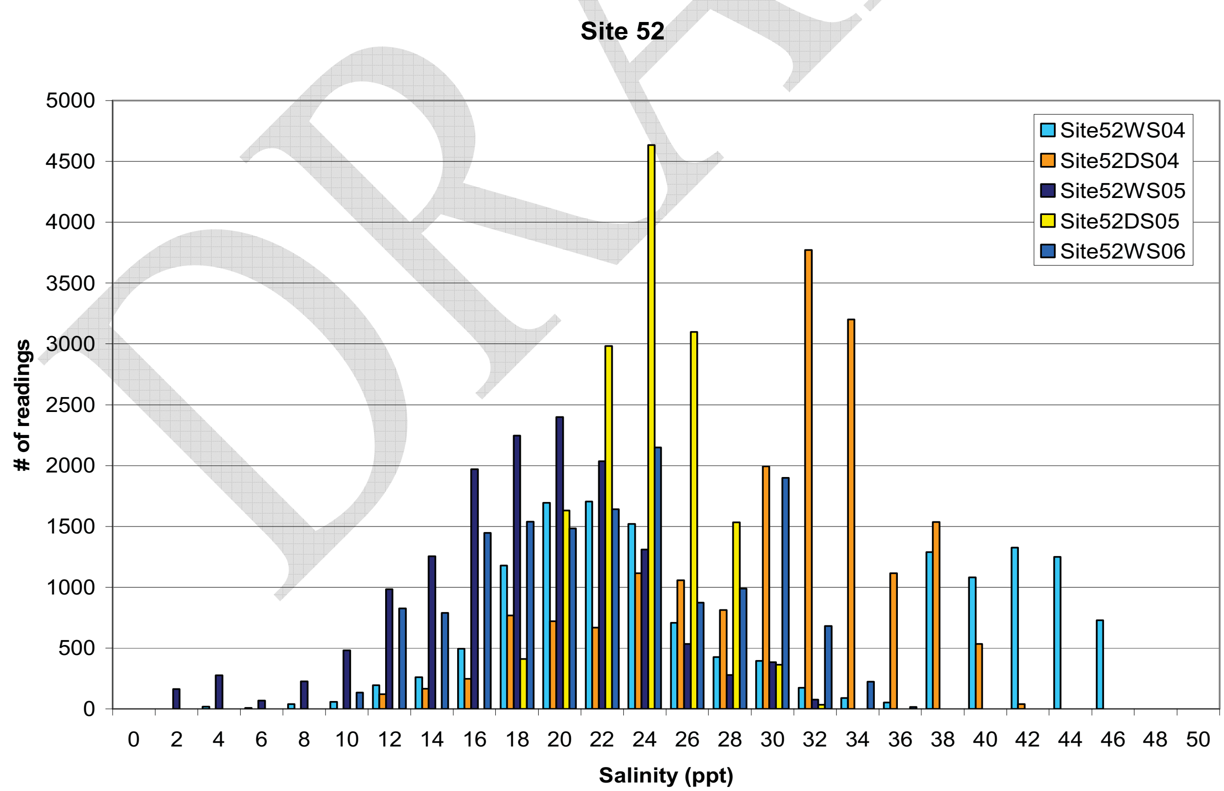


Figure 5.1-11: Sites BISC50 and BISC52 generate similar data. BISC50 will be moved.
Site BISC50B – discontinued

This bottom recorder site designation will be retired. BISC50 and BISC52 are producing data which are generally very similar save that BISC52, being further from shore, is somewhat more saline (Figure 1). A new site will be established at Site A (Figure 2), which is closer inshore. This will effectively replace Site 50 which was very similar to Site 52.

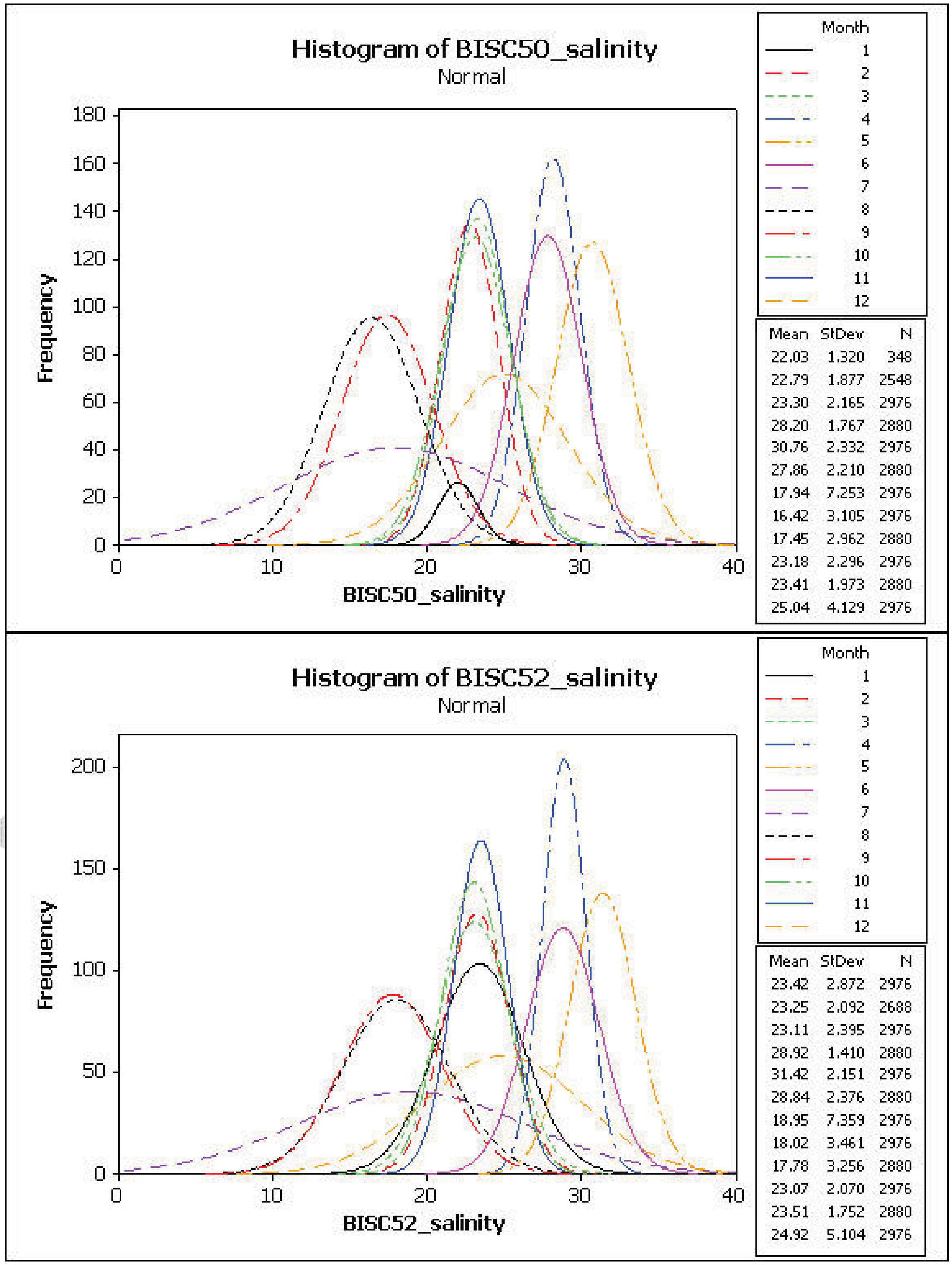


Figure 5.1-12: Sites BISC50 and BISC52 generate similar data. BISC50 will be moved.

L31-E Culvert Area (Figures 8a, 8b)

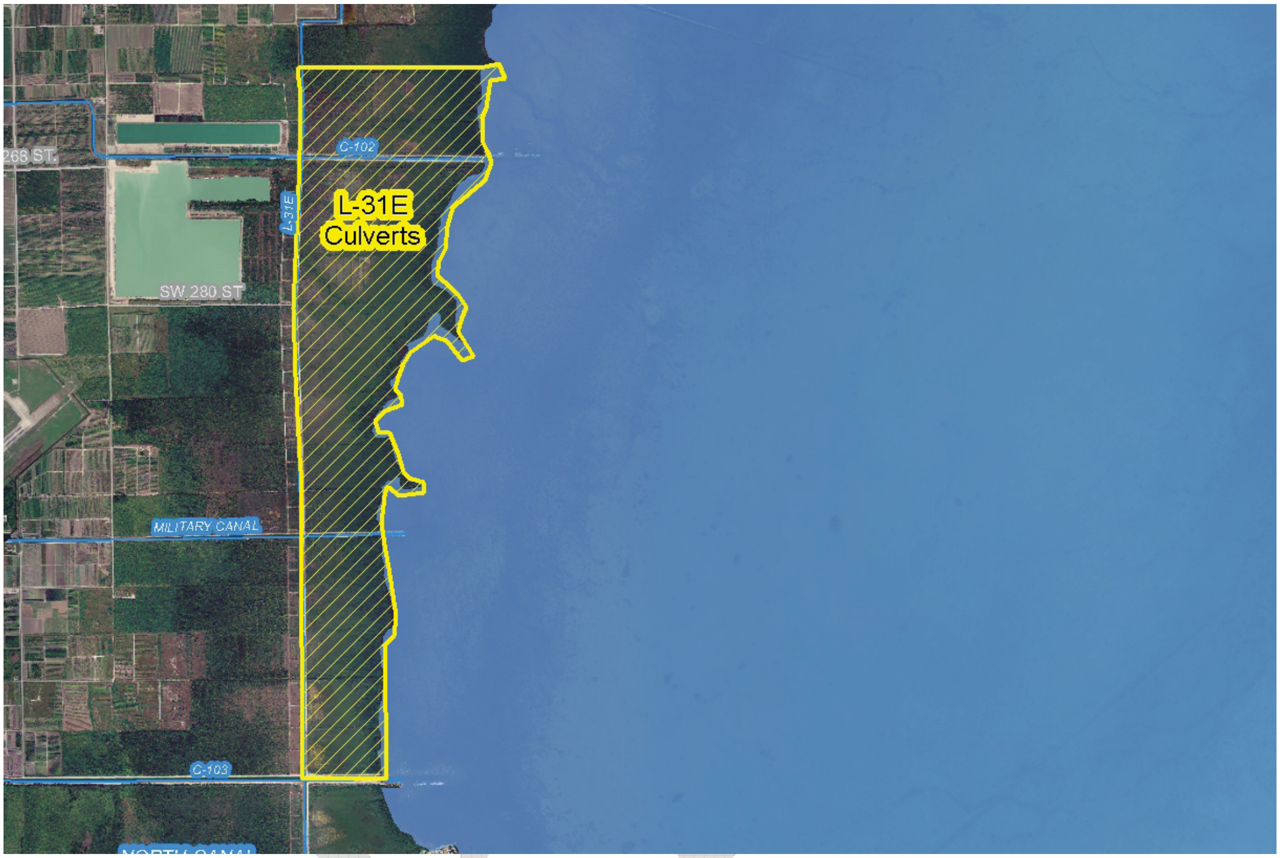


Figure 5.1-13: L31-E Culvert map.

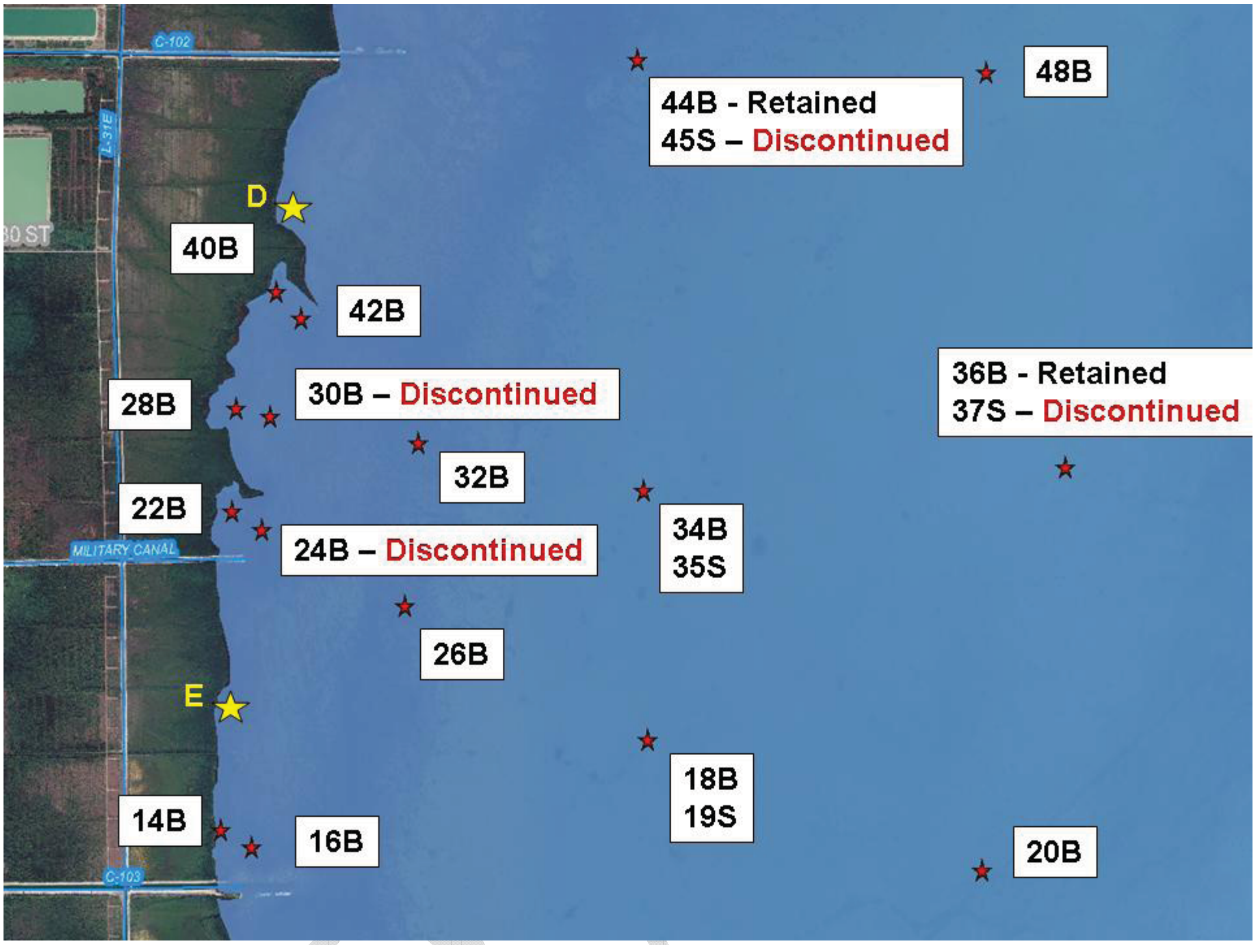


Figure 5.1-14: Existing, discontinued and new proposed site location in vicinity of L31E culverts.

Site BISC45S – discontinued

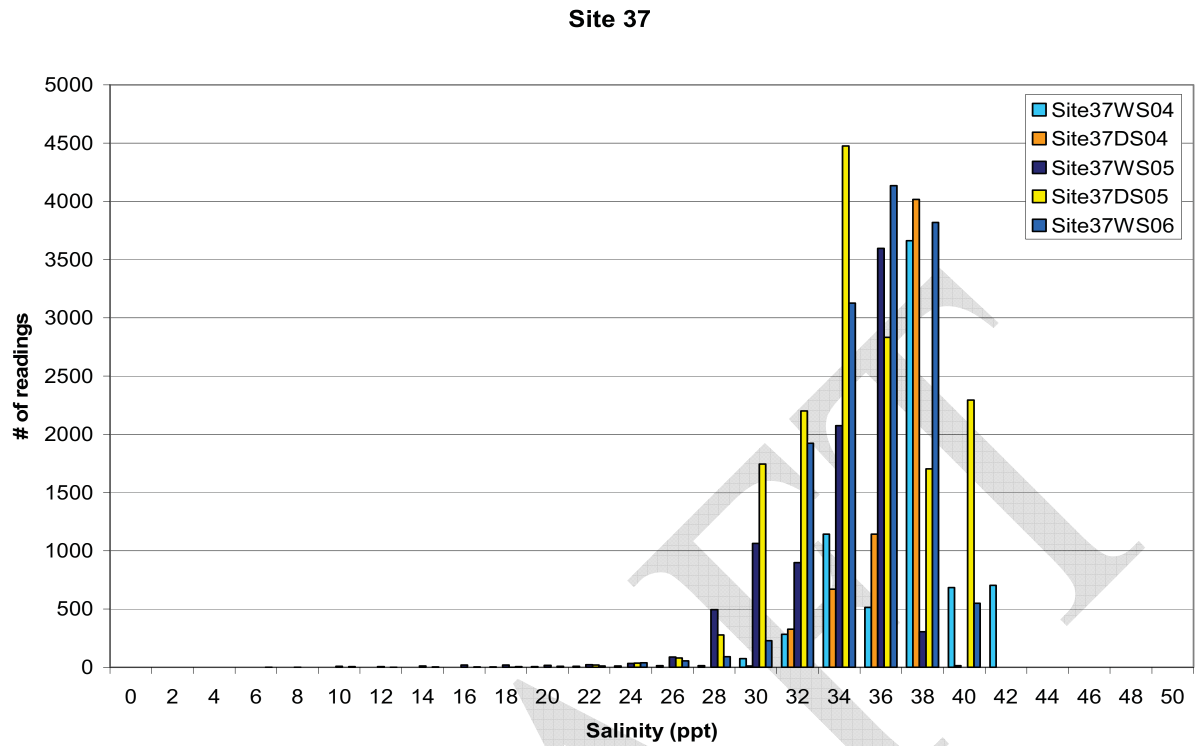
BISC45S is a top-measuring salinity site located far from shore. The site is physically difficult to manage. Problems with buoy adversely affects data quality.

New Site D

A new bottom recorder site designation will be assigned to the site located at latitude 25° 30.601'W, longitude 80° 20.086'N.

New Site E

A new bottom recorder site designation will be assigned to the site located at latitude 25° 28.856'W, longitude 80° 20.380'N.



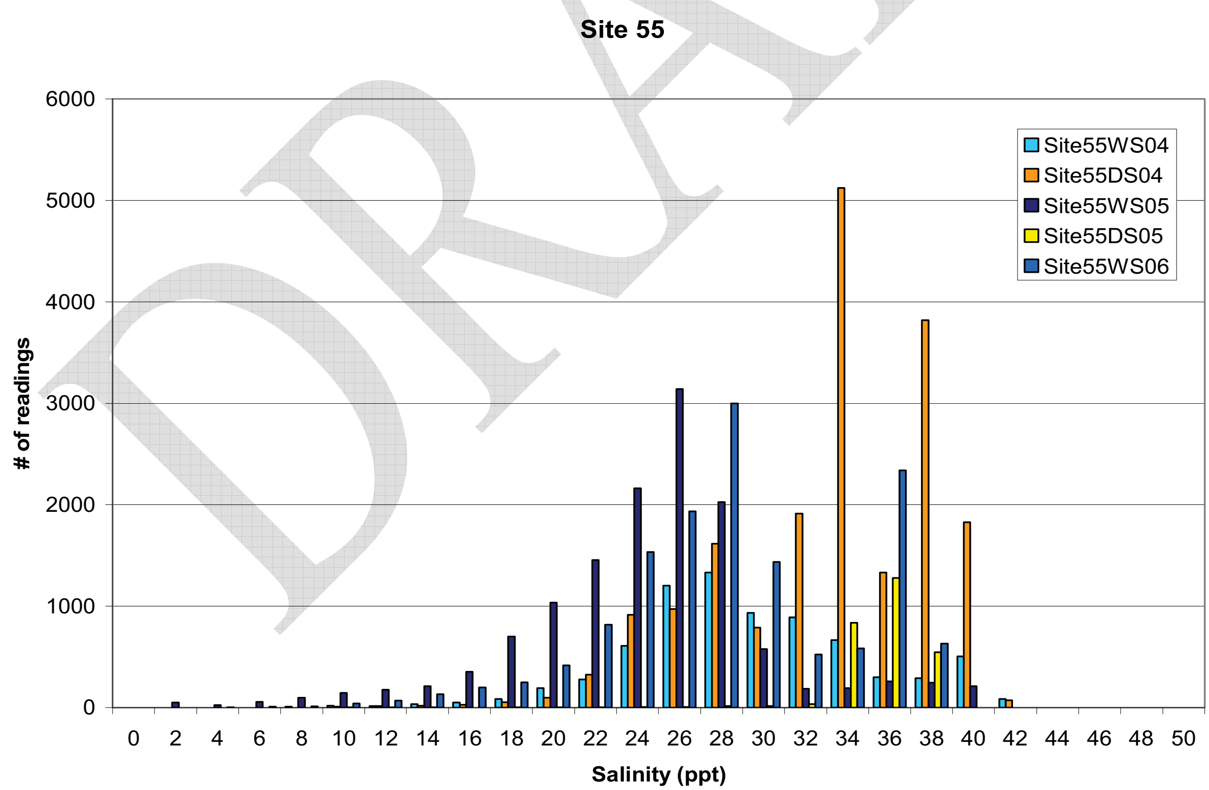


Figure 5.1-15: Sites BISC37S and BISC55S track surface salinity; BISC55S is better located to evaluate salinity changes in the surface waters. BISC37S will be discontinued.

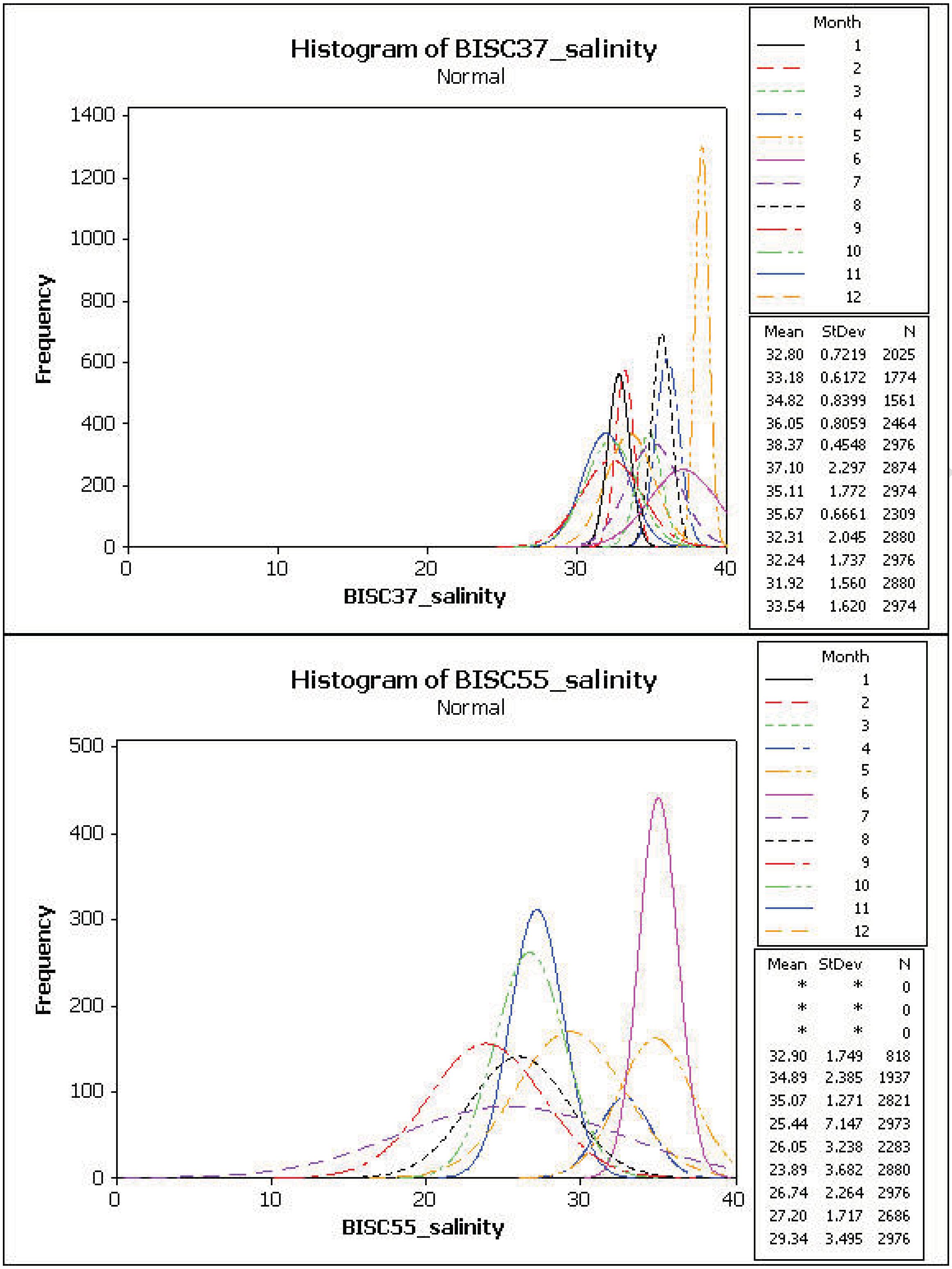
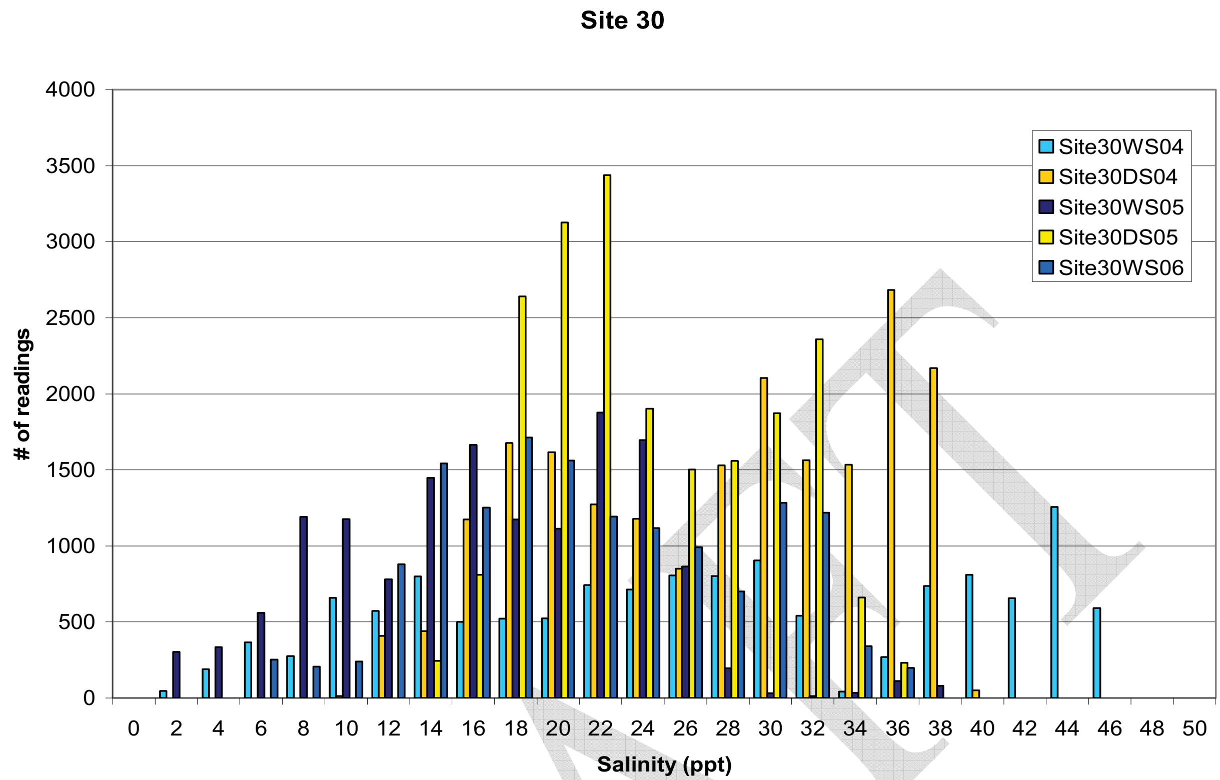


Figure 5.1-16: Sites BISC37S and BISC55S track surface salinity; BISC55S is better located to evaluate salinity changes in the surface waters. BISC37S will be discontinued.



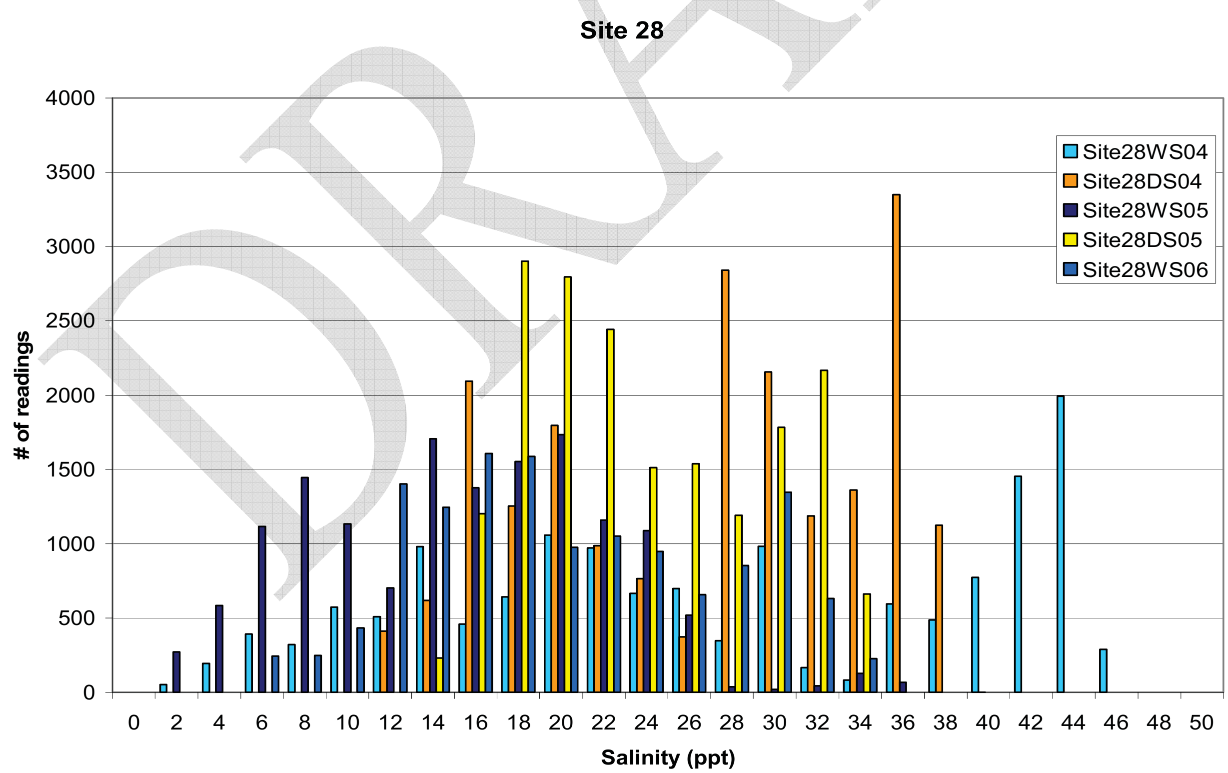


Figure 5.1-17: Sites BISC30B and BISC28B generate similar data; Discontinuing BISC30B will improves distribution along BISC 28- BISC 34 transect.

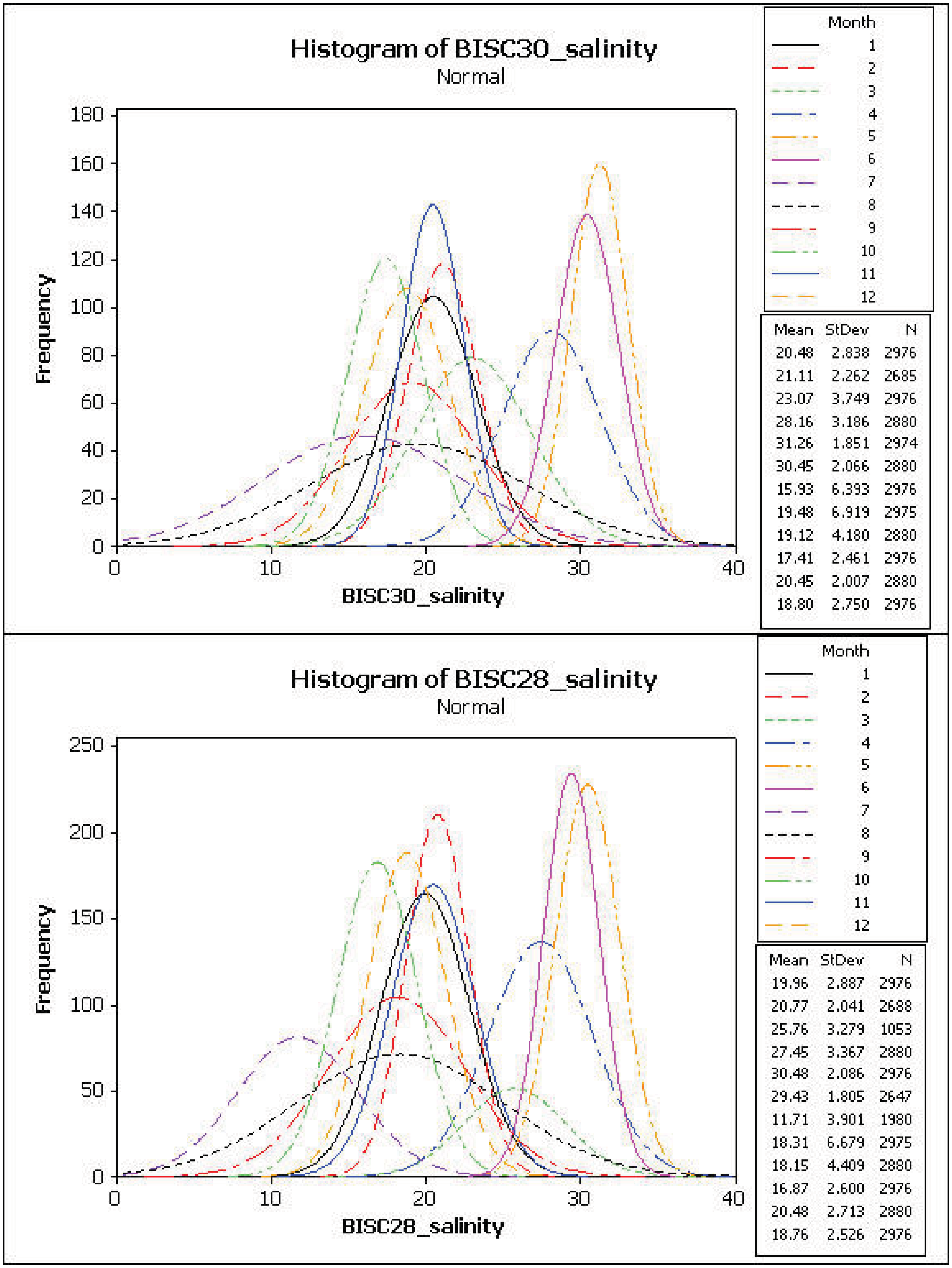
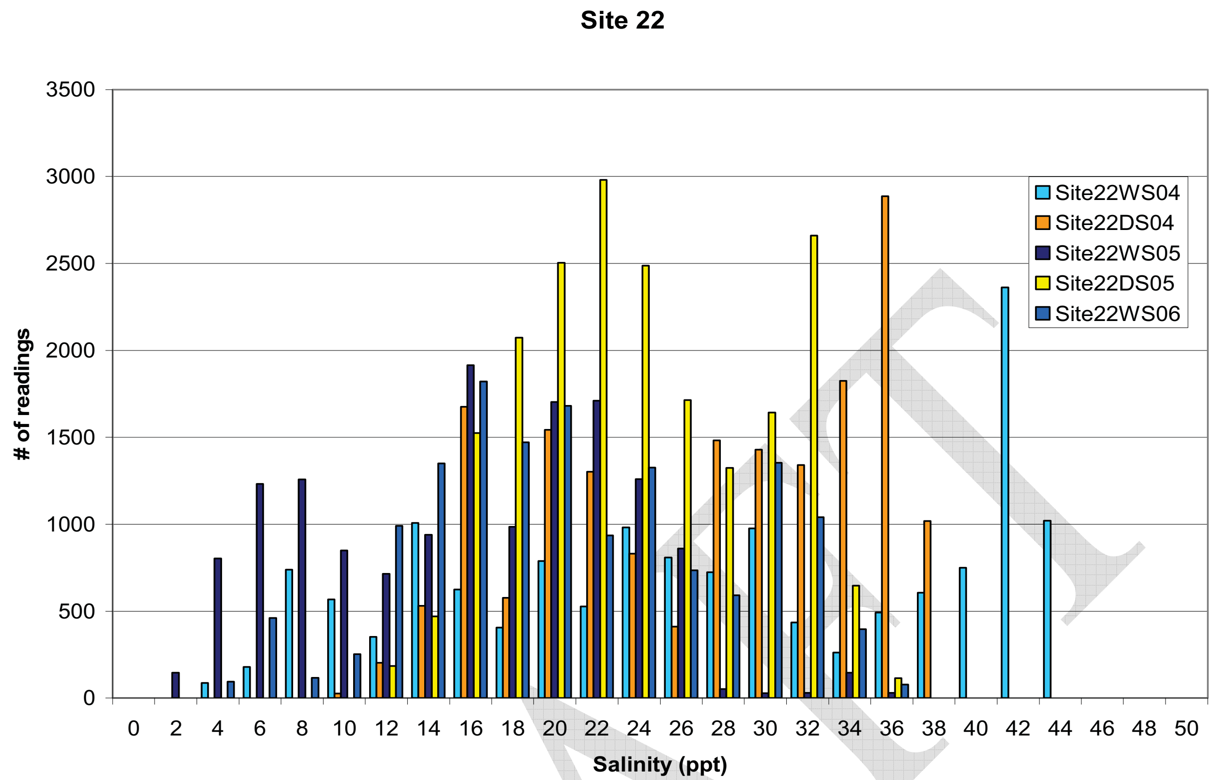


Figure 5.1-18: Sites BISC30B and BISC28B generate similar data; Discontinuing BISC30B will improves distribution along BISC 28- BISC 34 transect.



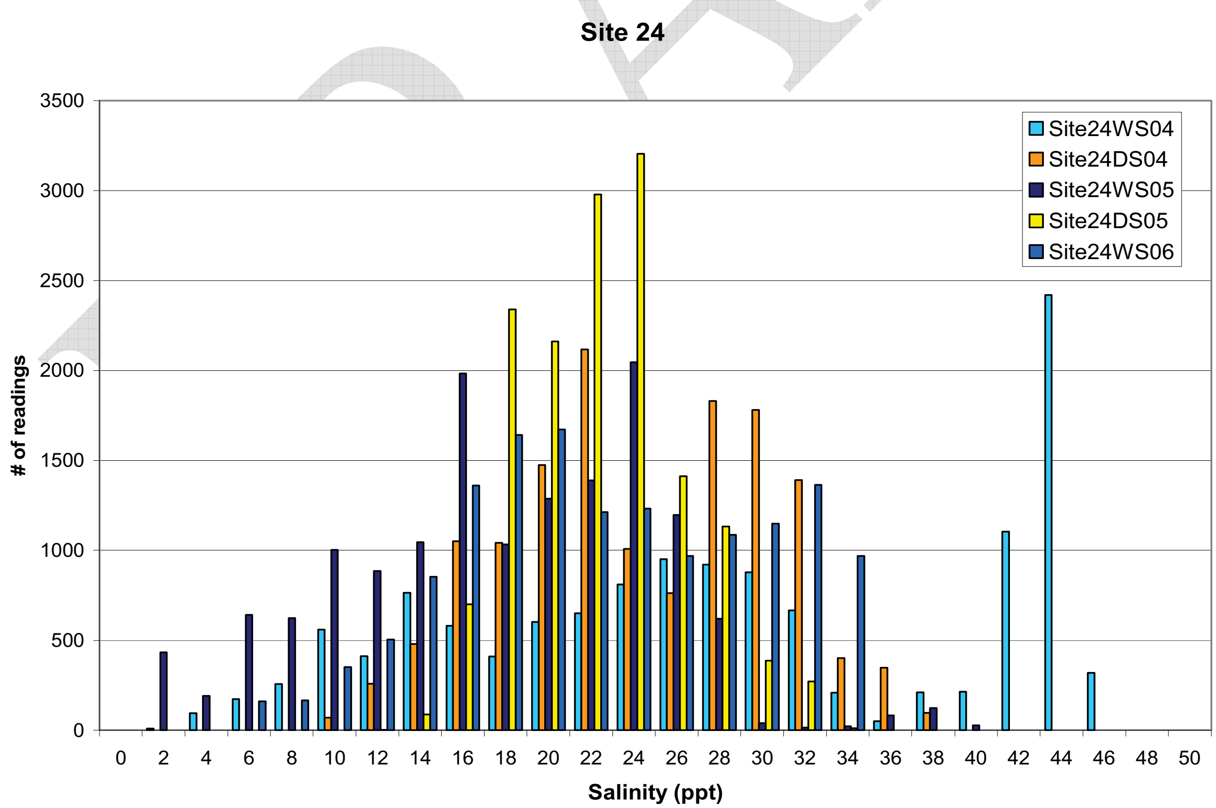


Figure 5.1-19: Sites BISC24B and BISC22B generate similar data. BISC24B will be discontinued.

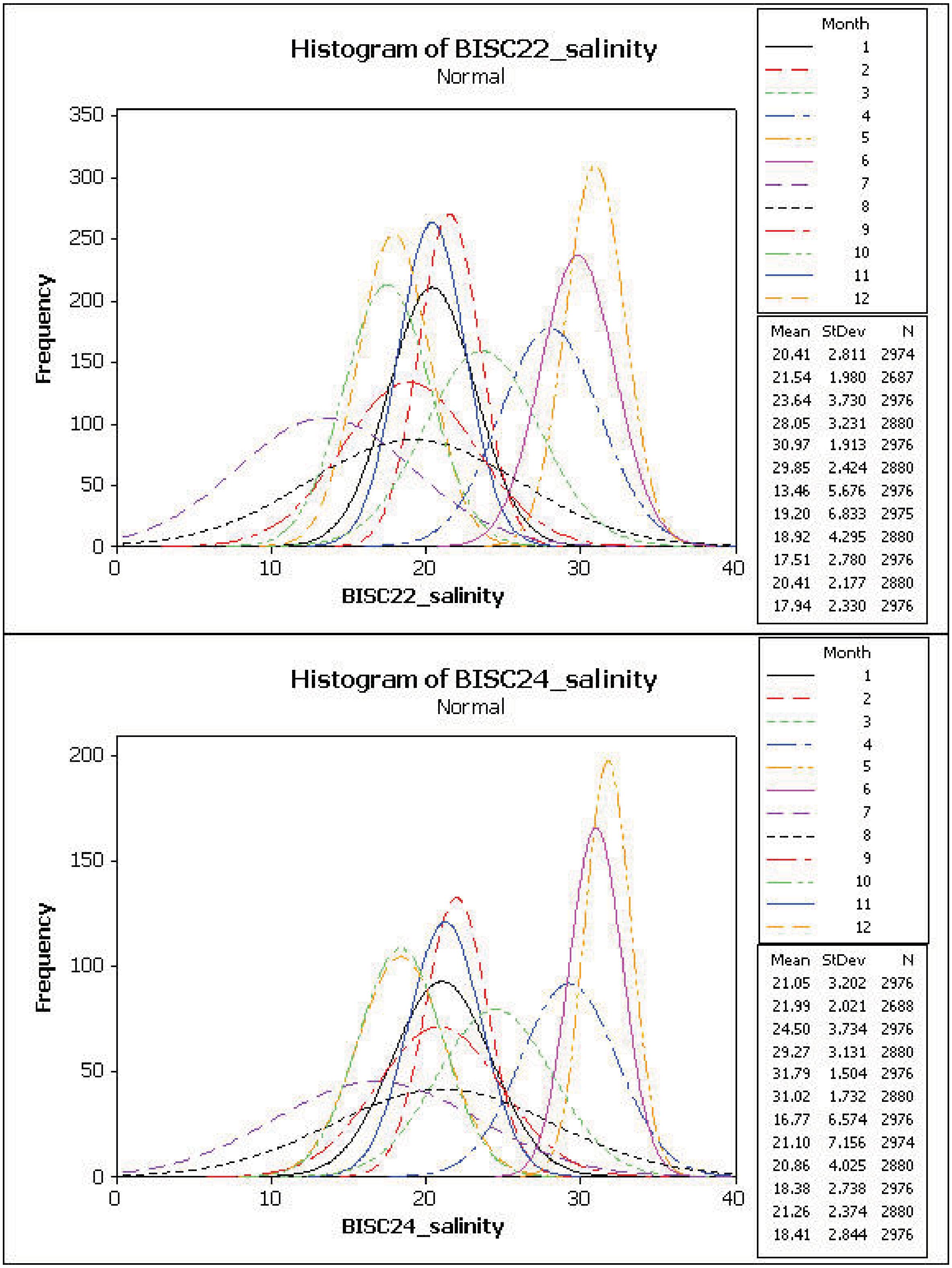


Figure 5.1-20: Sites BISC24B and BISC22B generate similar data. BISC24B will be discontinued.

Southern Zone

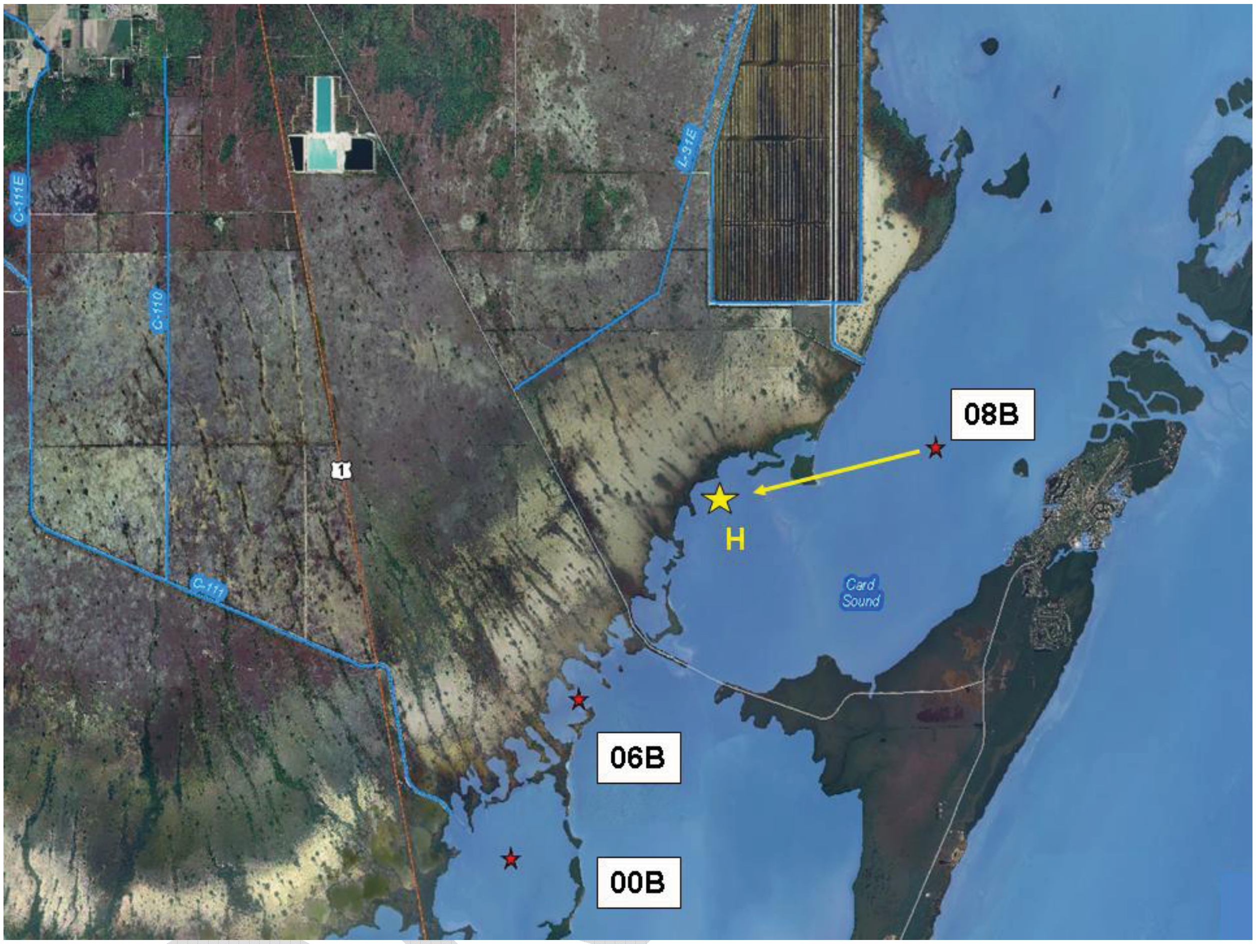


Figure 5.1-21: Site BISC08B is difficult to maintain and will be moved to new site H (location shown is approximate).

Final Re-Allocation of Sites Following Biological Review

After the biological review some sites were altered to better meet the needs of biological users while still maintaining data integrity and sampling logistics. Final site locations are found in Figures 13, 14 and 15.

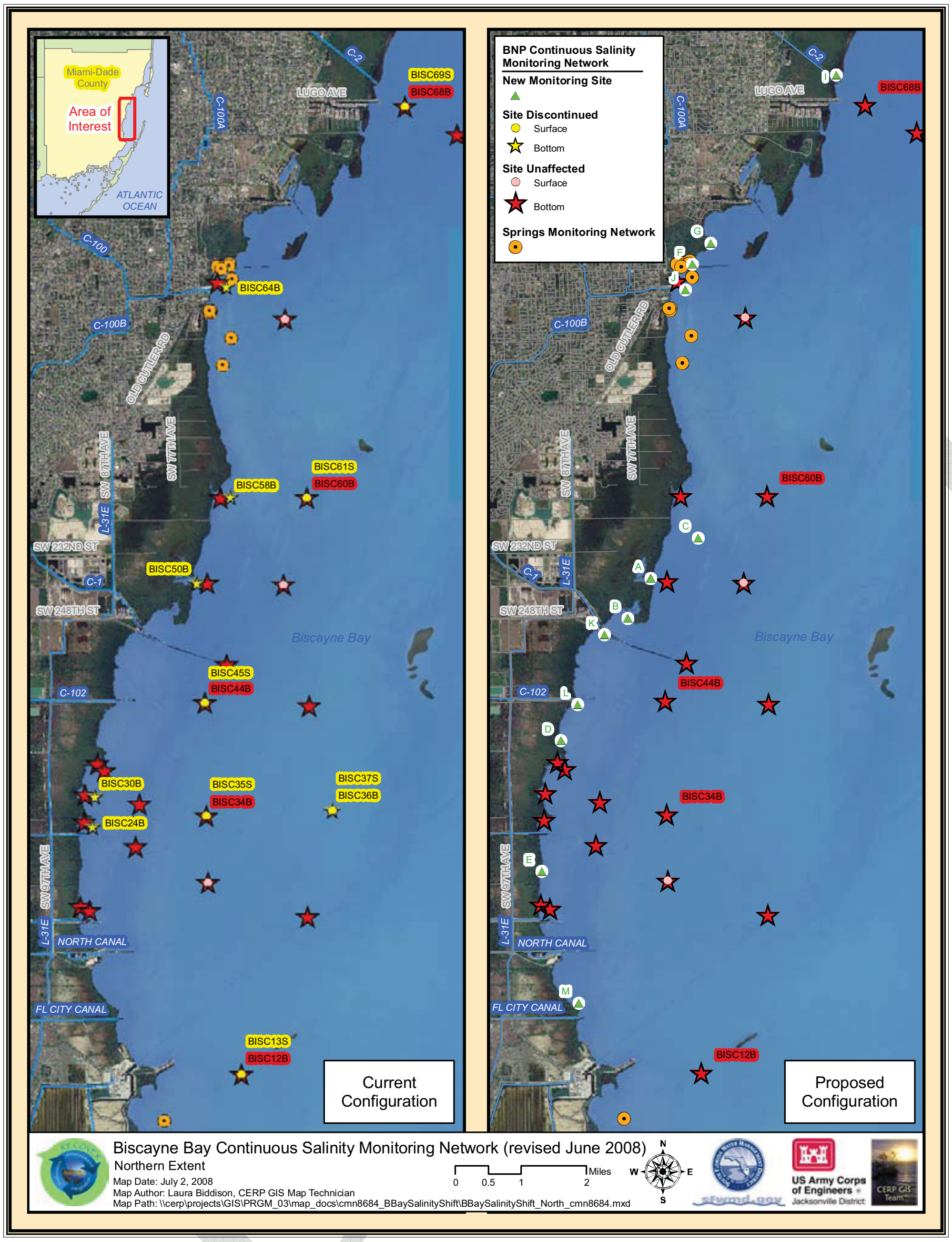

Current Configuration
Proposed Configuration
BNP Continuous Salinity Monitoring Network
New Monitoring Site
Site Discontinued
Surface
Bottom
Site Unaffected
Surface
Bottom
Springs Monitoring Network
Biscayne Bay
Area of Interest
ATLANTIC OCEAN
Biscayne Bay Continuous Salinity Monitoring Network (revised June 2008)
Northern Extent
Map Date: July 2, 2008
Map Author: Laura Biddison, CERP GIS Map Technician
Map Path: \\cerp\projects\GIS\PRGM_03\map_docs\cmn8684_BBaySalinityShift\BBaySalinityShift_North_cmn8684.mxd
Miles
US Army Corps of Engineers
Jacksonville District

Figure 5.1- 22

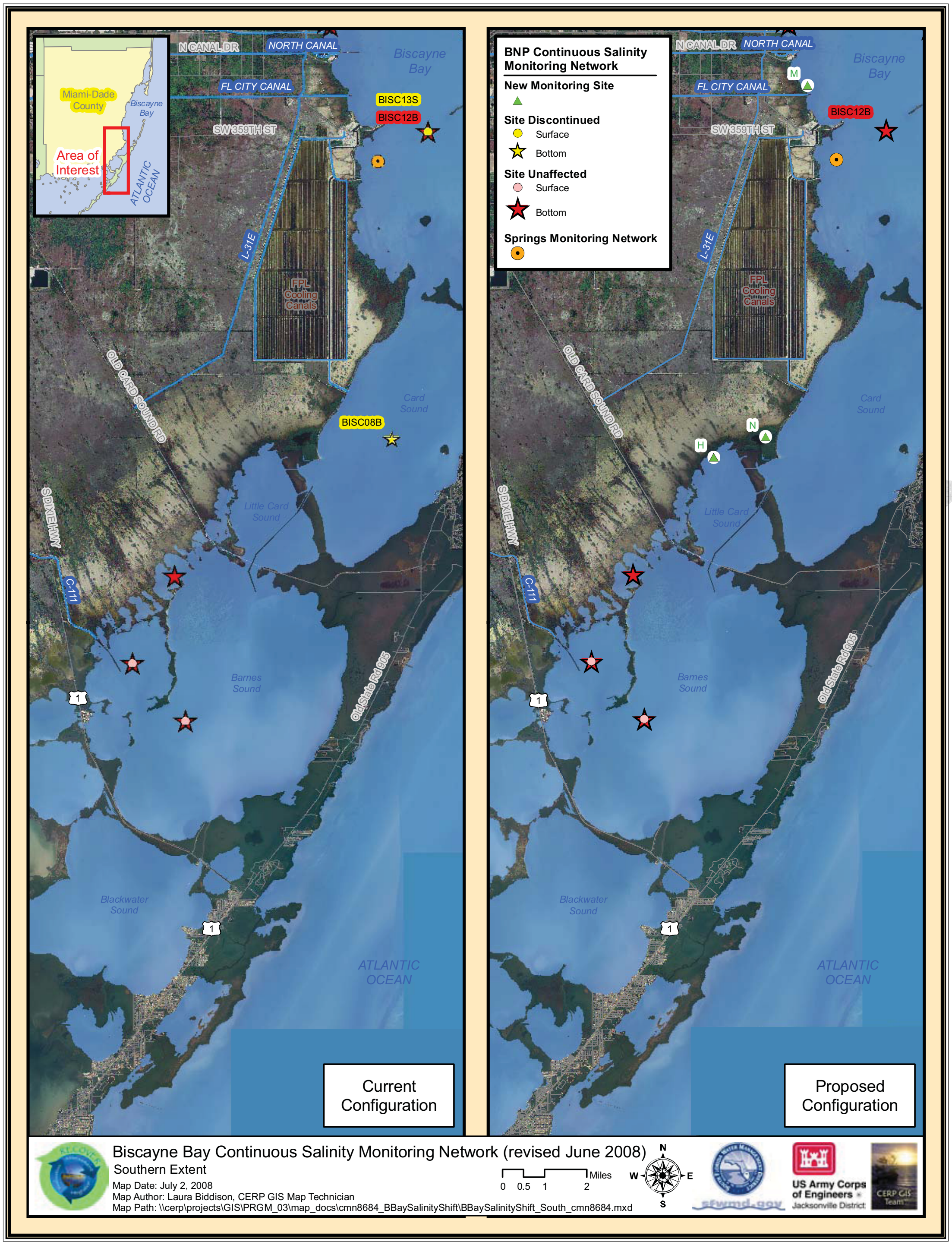

BNP Continuous Salinity Monitoring Network
New Monitoring Site
Site Discontinued
Surface
Bottom
Site Unaffected
Surface
Bottom
Springs Monitoring Network
Current Configuration
Proposed Configuration
Biscayne Bay Continuous Salinity Monitoring Network (revised June 2008)
Southern Extent
Map Date: July 2, 2008
Map Author: Laura Biddison, CERP GIS Map Technician
Map Path: \\cerp\projects\GIS\PRGM_03\map_docs\cmn8684_BBaySalinityShift\BBaySalinityShift_South_cmn8684.mxd
Miles
0 0.5 1 2
BISC13S
BISC12B
BISC08B
N CANAL DR
NORTH CANAL
FL CITY CANAL
SW 359TH ST
L-31E
FPL Cooling Canals
OLD CARD SOUND RD
S DIXIE HWY
C-111
Biscayne Bay
Card Sound
Little Card Sound
Barnes Sound
Blackwater Sound
Old State Rd 905
ATLANTIC OCEAN
Miami-Dade County
Area of Interest
US Army Corps of Engineers
Jacksonville District

Figure 5.1-23

6.0 Conclusion

In reviewing the data several important pieces of information stand out. The continued availability of an estuarine zone seems to be tied to the implementation of the seasonal drawdown. In the fall, prior to the seasonal drawdown there is a large and sometimes extensive estuarine zone, when the seasonal drawdown is implemented the estuarine zone is eliminated. In wet years there is a persistence of some area of estuarine salinity through into January. It is very likely this would be much longer and greater if groundwater were not drawn down early. There is an area where the sites, (site 28, 30, 40, 42) have lower salinity that persists even though they are far from point source canals. These sites also have very low variation. The mangrove zones show much more stable salinity. The wet season has the highest salinity with some extreme hyper-saline events. The effects of increased freshwater during the wet season does not seem to affect these high salinity events until late July or August, which would correspond to the regional effects on ground water. All of these separate pieces of information argue for the importance of groundwater to salinity. Groundwater may represent a very small percentage of freshwater that now currently flows into the Bay, however it seems that it has a critical impact on benthic salinity. Benthic salinity is an important structuring feature of most of the biotic communities of Biscayne Bay. It is therefore very important that groundwater flow be maintained and increased if possible as well as overall total freshwater flow. It is also important to draw out the length of time that groundwater flows into the Bay during the end of the wet season.

7.0 Works Cited

Browder, J.A. and H.R. Wanless. 2001. Science survey team report, pp. 65-230. *In*: Biscayne Bay Partnership Initiative. Survey Team Final Reports. Florida Atlantic University, Joint Center for Environmental and Urban Problems. 307 pp + appendices.

Buchanan, T. J., and H. Klein. 1976. Effects of water management on fresh-water discharge to Biscayne Bay. In: Biscayne Bay: Past / Present / Future. A. Thorhaug, and A. Volker, (eds.). Biscayne Bay Symp. I. University of Miami Sea Grant Program Spec. Rep. 5. University of Miami, Coral Gables, FL. 271-277.

Christian, J., J.F. Meeder, and A. Renshaw. 2004. Nearshore epibenthic vegetative cover in southern Biscayne Bay. Report to the South Florida Water Management District, West Palm Beach. Southeastern Environmental Research Program, Florida International University, Miami, Florida. 60 p+appendices.

Gaiser, E. and M.S. Ross. 2004. Water flow through coastal wetlands. Annual report to Everglades National Park. Southeast Environmental Research Center, Florida International University. Miami, Fl. 59 pp+ figs.

Kohout, F.A., and Kolipinski, M.C., 1967. Biological zonation related to groundwater discharge along the shore of Biscayne Bay, Miami, Florida. Pp 488-499, *In:* Estuaries, American Association for the Advancement of Science Publ. No. 83.

Kushlan, J.A. and F.J. Mazzotti. 1989. Historic and present distribution of the American crocodile in Florida. Journal of Herpetology 23:1-7.

Luo, J. and J.E. Serafy. 2003. Time series analysis and statistical modeling of salinity and canal discharges in Biscayne National Park. NPS-CESU Agreement: H5000000494/0006. University of Miami, Miami, FL.

Meeder, J.F., P.W. Harlem, and A. Renshaw. 2001. Historic creek watershed study, Final Results: Year 1. Report to South Florida Water Management District, West Palm Beach, Florida. Southeast Environmental Research Program, Florida International University.

Odum,W.E. and E.J. Heald. 1975. The detritus-based food web of an estuarine mangrove community. Pp. 265-286 *in* L. Cronin (ed), Estuarine Research. Academic Press, New York.

Parker, G. G., G. E. Ferguson, and S. K. Love. 1955. Water resources of southeastern Florida with special reference to the geology and groundwater of the Miami area. Water Supply Paper 1255, U. S. Geological Survey, U. S. Government Printing Office Washington D.C. 965pp.

Parker, G.G. 1974. Hydrology of the predrainage system of the Everglades in southern Florida. Pp. 18-27 *in* P.J. Gleason (ed), Environments of South Florida: Past, Present, and Future. Miami Geological Society, Mem. 2.

Ross, MS., J.F. Meeder, J.P. Sah, P.I Ruiz and G.J. Telesnicki. 2000. The southern saline Everglades revisited: a half-century of coastal vegetation change. Jour. Veg. Sci. 11:101-112.

Ruiz, J.F. and M.S. Ross. 2004. Hydrologic Restoration of the Biscayne Bay Coastal Wetlands: Mosquito and Drainage Ditch Inventory and Recommendations. Final Report. Southeast Environmental Research Program, Florida International University, 13p.

Serafy, J.E., C.H. Faunce, and J.J. Lorenz. 2003. Mangrove shoreline fishes of Biscayne Bay, Florida. Bull. of Mar. Science 72:161-180.

Serafy, J.E. and J.S. Ault, P. Ortner, and R. Curry. 2001. Coupling Biscayne Bay's natural resources and fisheries to environmental quality and freshwater inflow management, pp. 163-174. *In*: Biscayne Bay Partnership Initiative. Survey Team Final Reports. Florida Atlantic University, Joint Center for Environmental and Urban Problems. 307 pp + appendices.

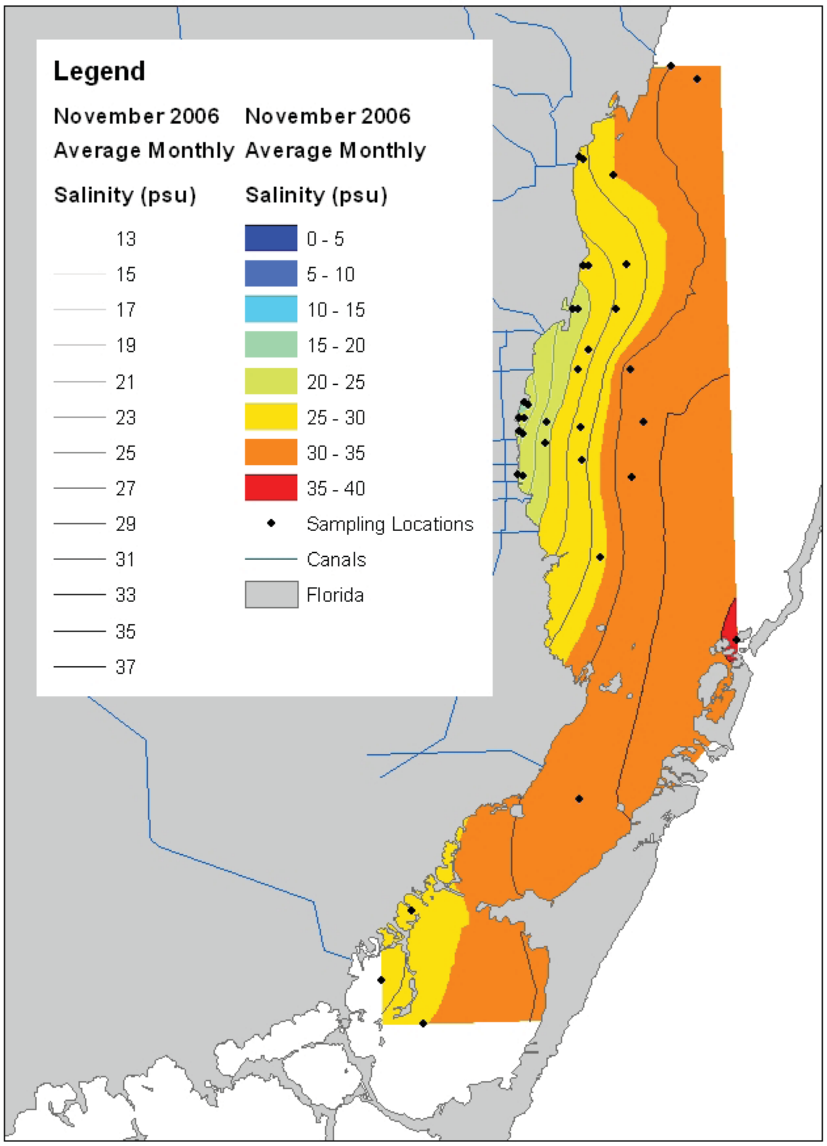
SFWMD 1995. An Update of the Surface Water Improvement Management Plan for Biscayne Bay, Florida.. Technical Supporting Document and Appendices. South Florida Water Management District. 3301 Gun Club Road West Palm Beach Florida.

Smith, H.M.. 1896. Notes on Biscayne Bay, Florida, with reference to its adaptability as the site of a marine hatching and experiment station. Report of the Commissioner [U.S. Commission of Fish and Fisheries] for the year ending June 30, 1895. 21. Pp 169_191.

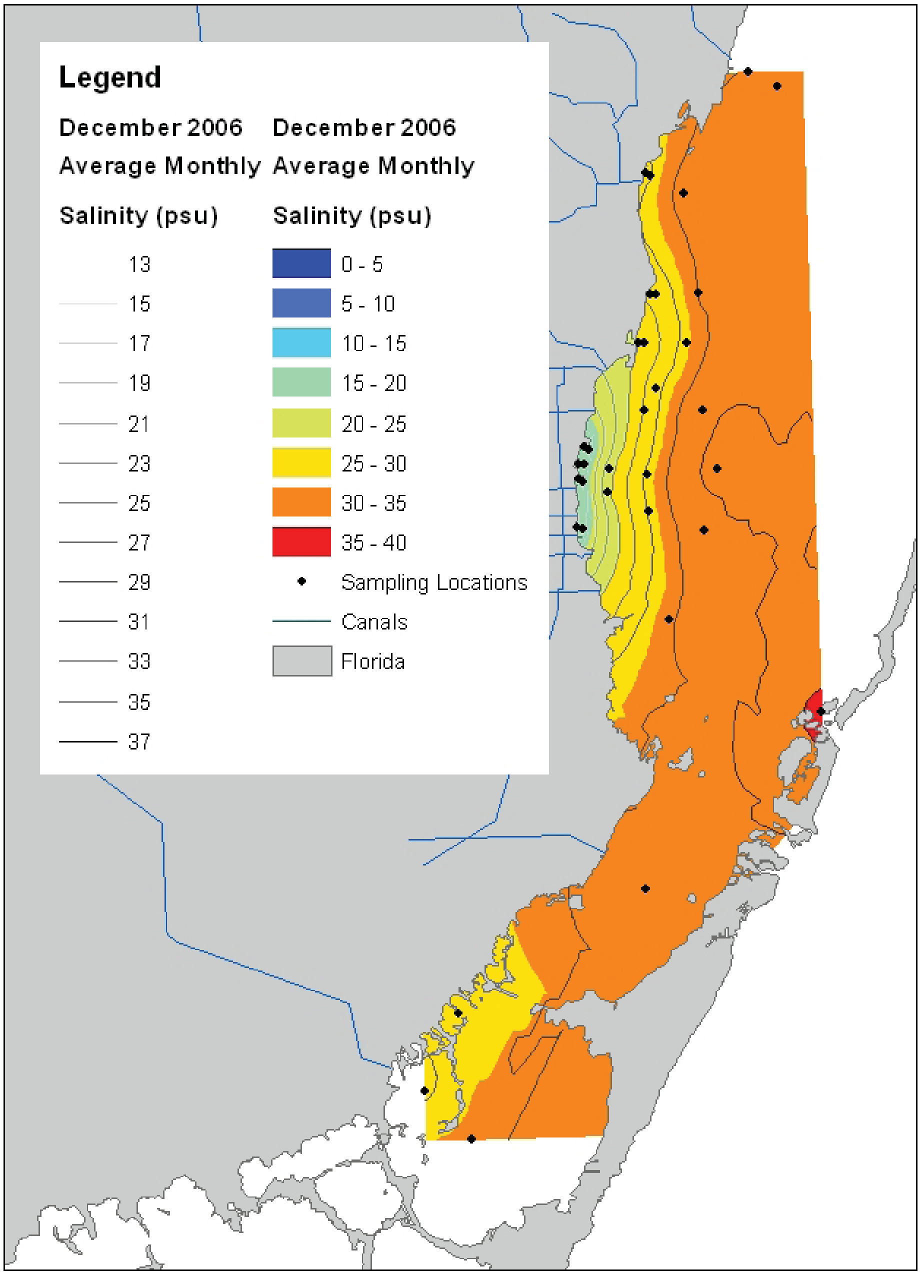
Teas, H.J. 1976. Productivity of mangroves in Biscayne Bay. Pp. 103-112. *In*: Thorhaug, A., and A. Volker (Eds). Biscayne Bay: Past, Present and Future. Sea Grant Special Report No. 5. University of Miami, Florida. 315 p.

Wanless, H.R., 1976. Geologic setting and recent sediments of the Biscayne Bay region. p. 1-32, *In*: Thorhaug, A., and Volker, A. (Eds). Biscayne Bay: Past, Present and Future. Sea Grant Special Report No. 5. University of Miami, Florida. 315

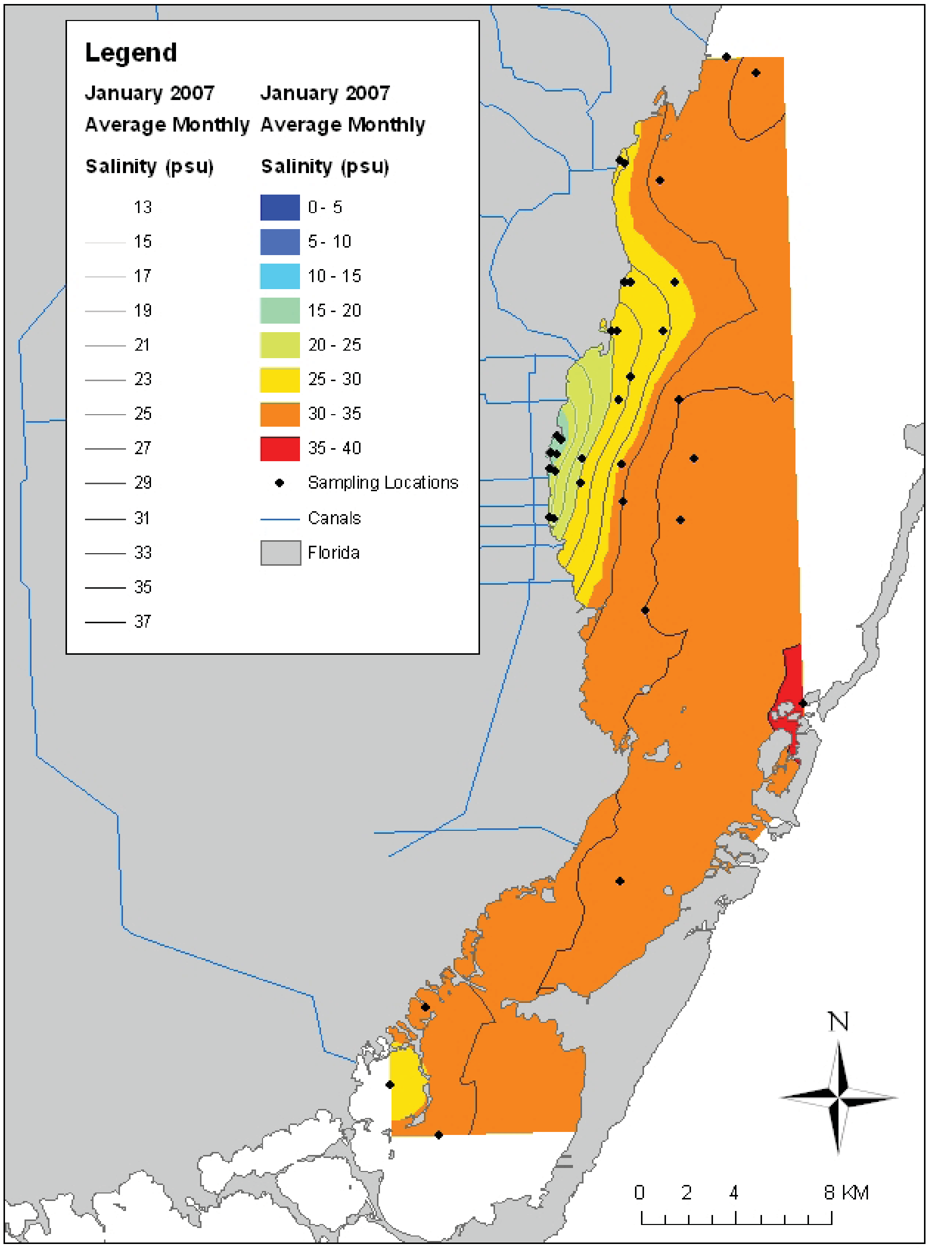
Appendix I – Figures



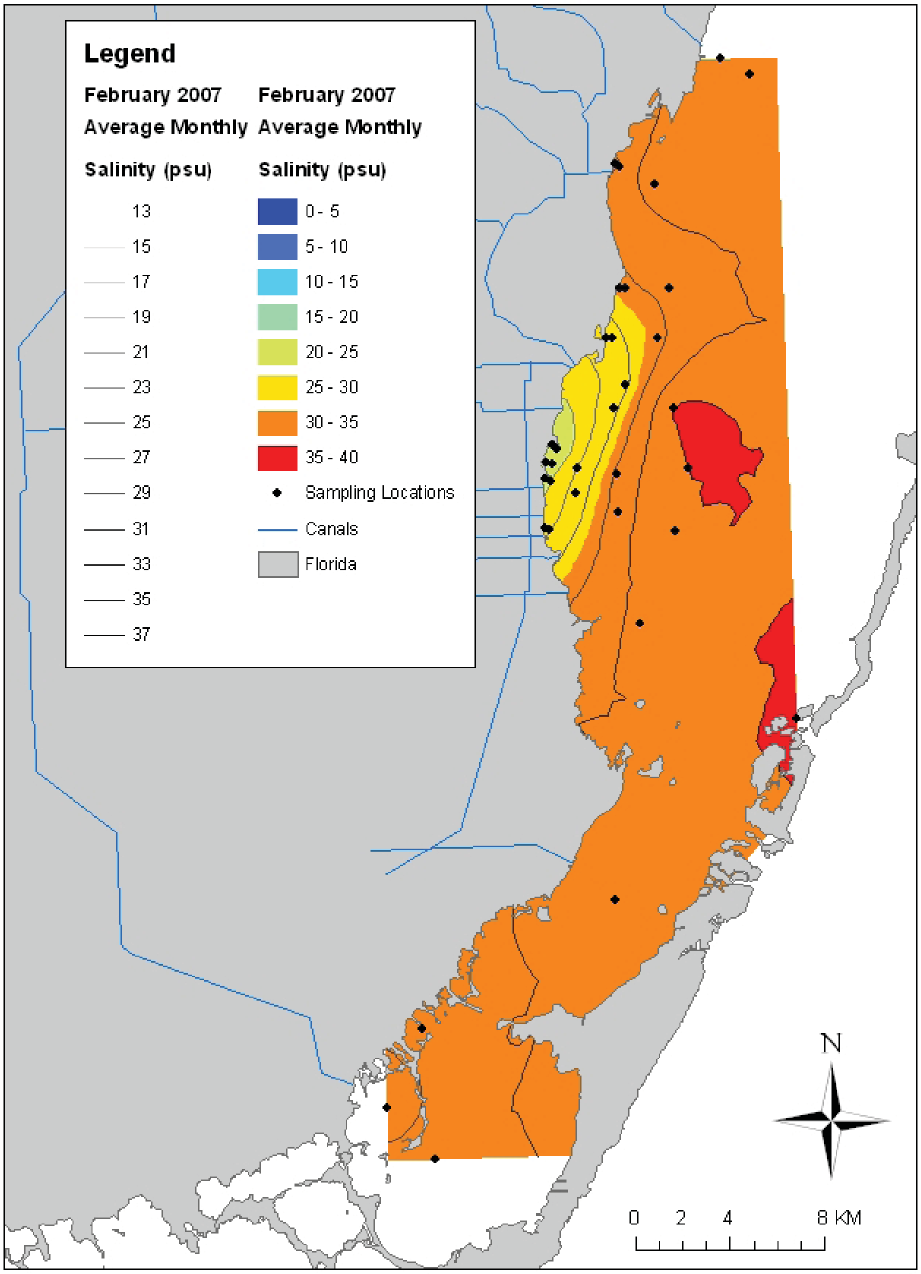
Appendix I, Figure 3.2-1. Interpolated average salinity in Biscayne Bay for November 2006. Data from 32 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



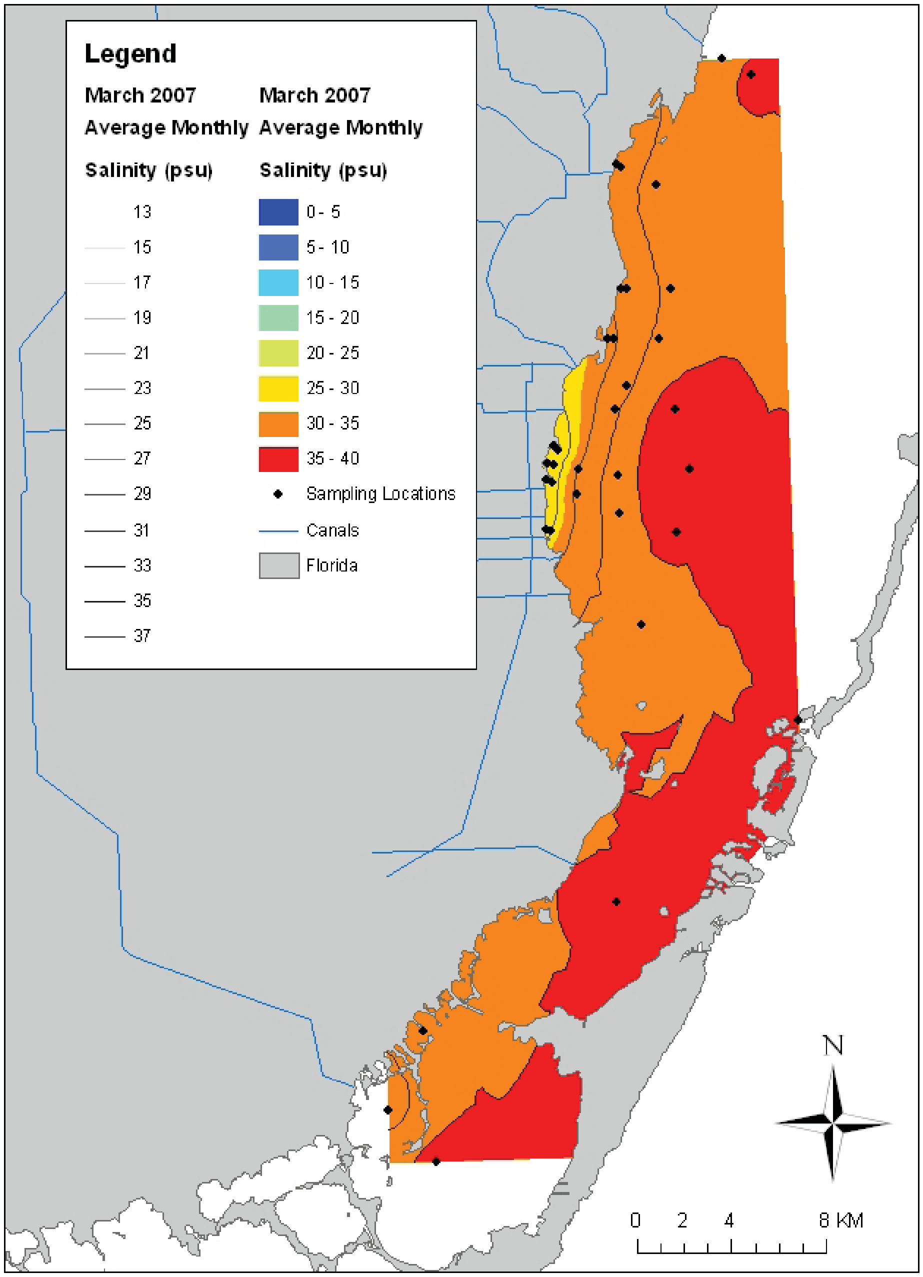
Appendix I, Figure 3.2-2. Interpolated average salinity in Biscayne Bay for December 2006. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



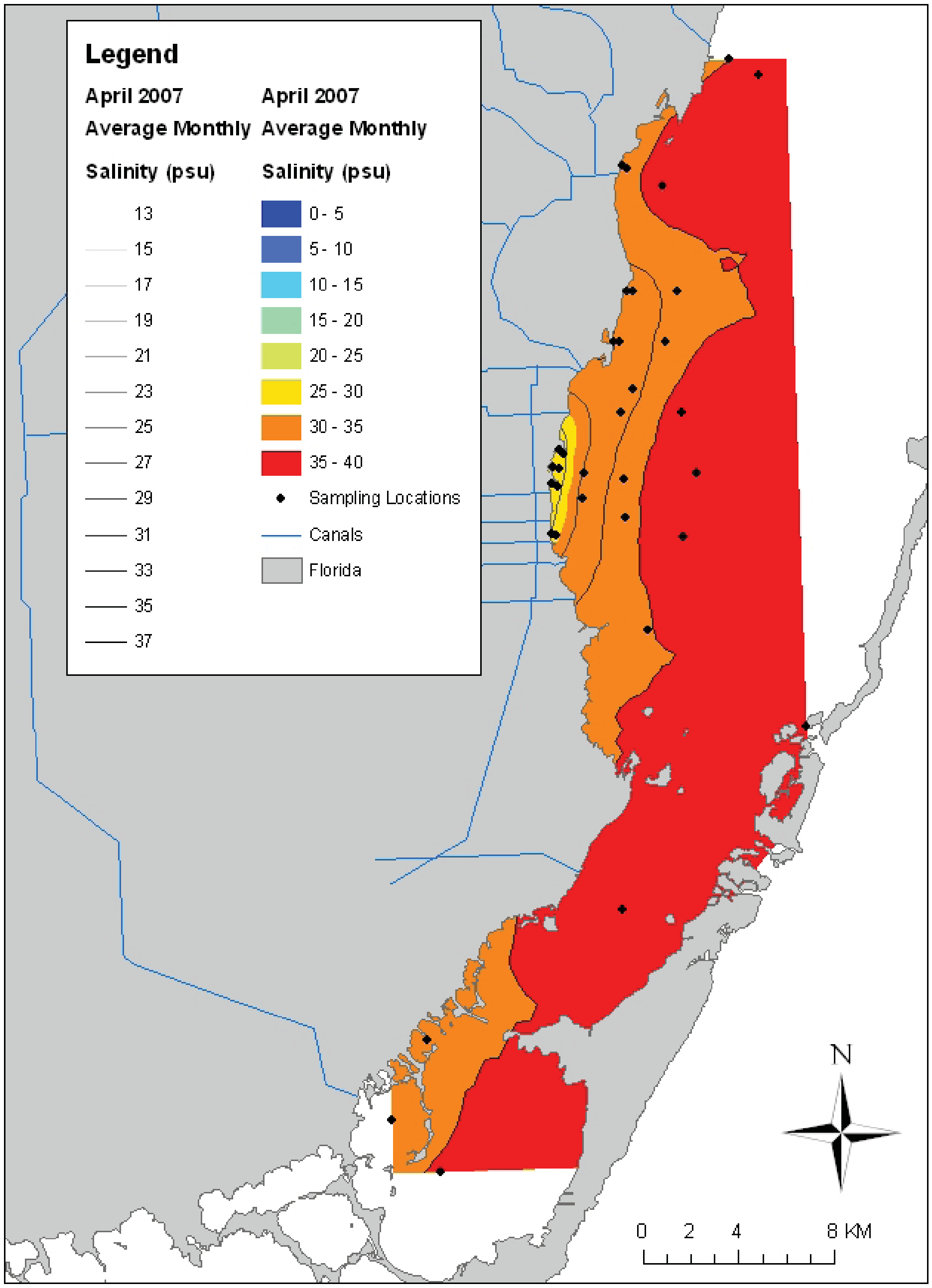
Appendix I, Figure 3.2-3. Interpolated average salinity in Biscayne Bay for January 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



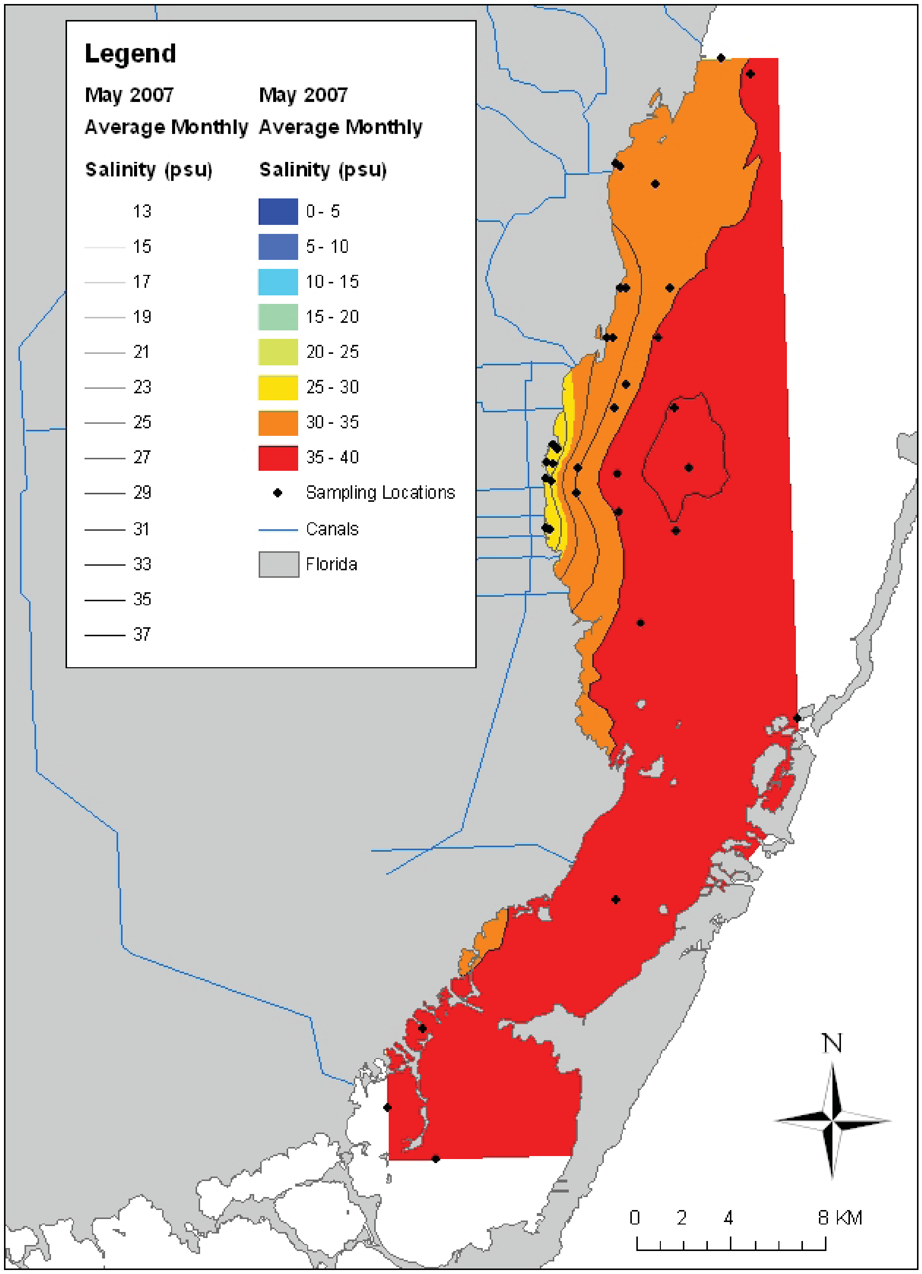
Appendix I, Figure 3.2-4. Interpolated average salinity in Biscayne Bay for February 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



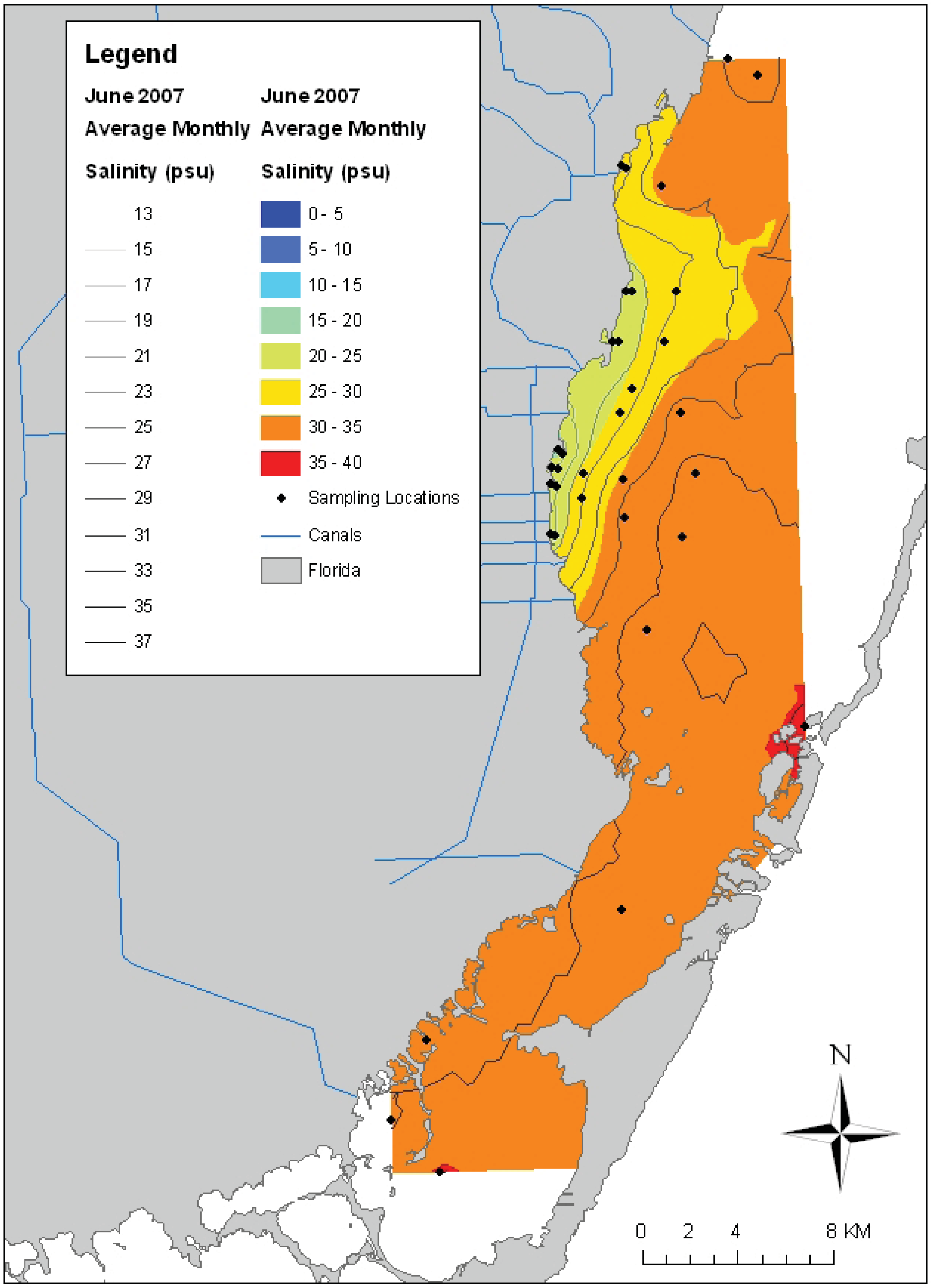
Appendix I, Figure 3.2-5. Interpolated average salinity in Biscayne Bay for March 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



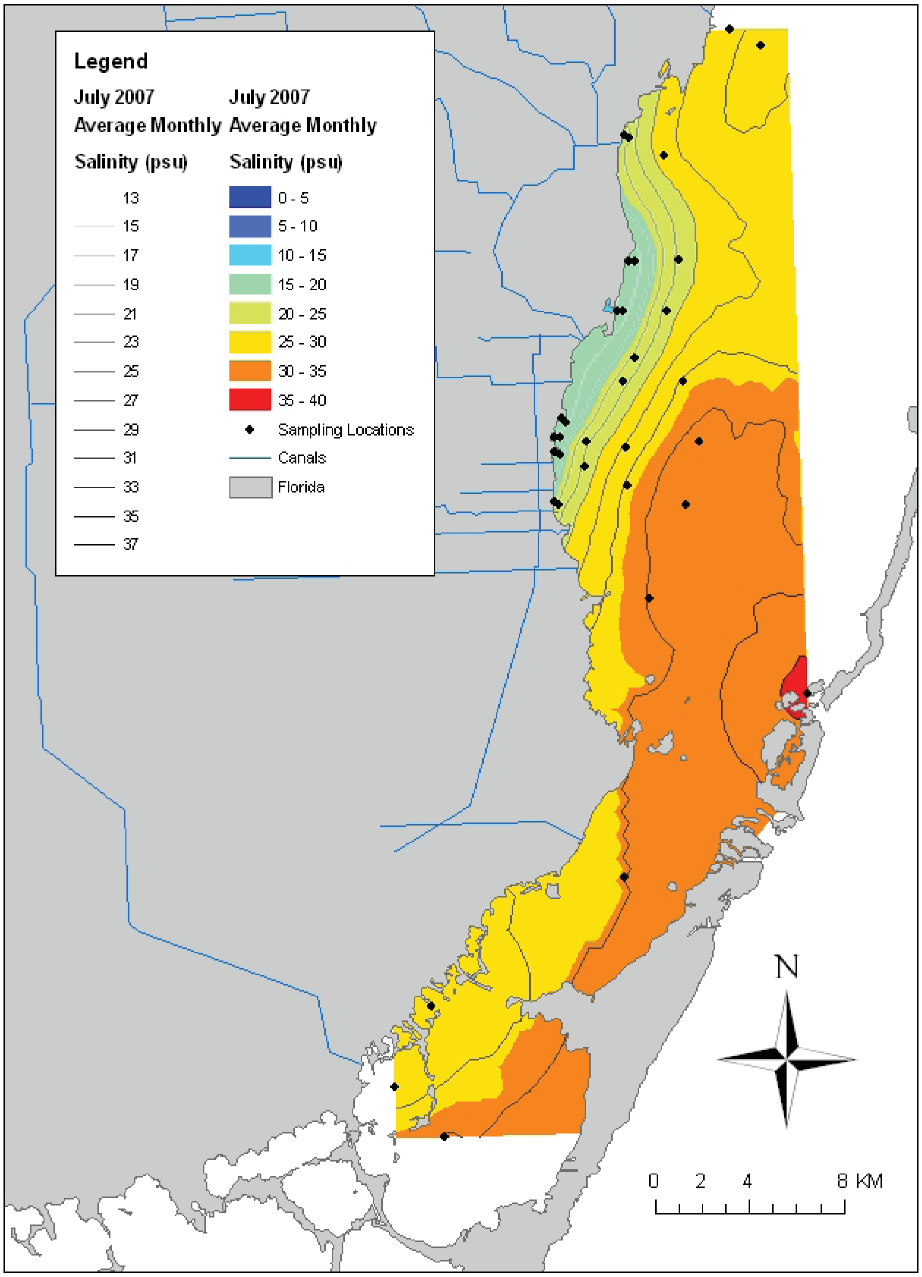
Appendix I, Figure 3.2-6. Interpolated average salinity in Biscayne Bay for April 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



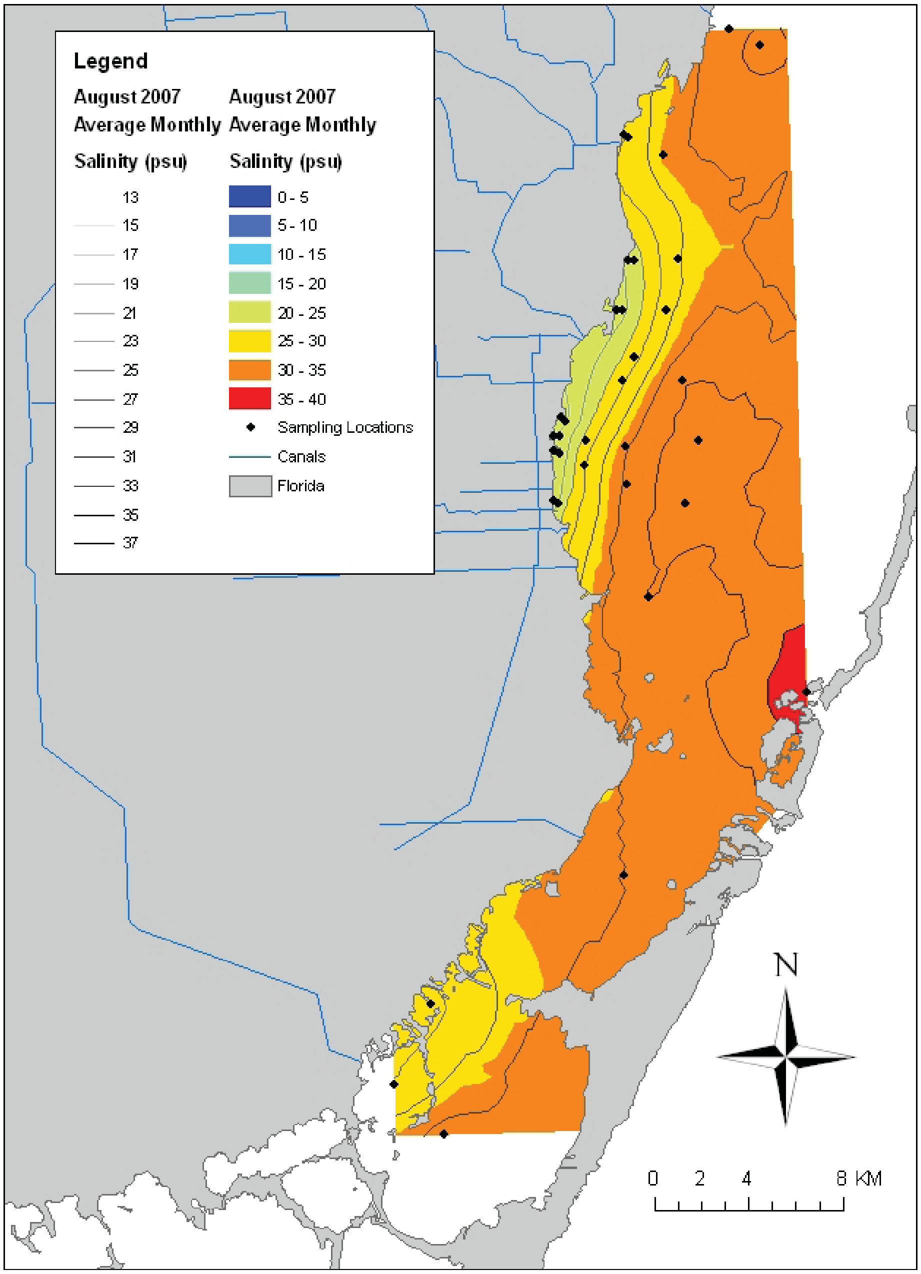
Appendix I, Figure 3.2-7. Interpolated average salinity in Biscayne Bay for May 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



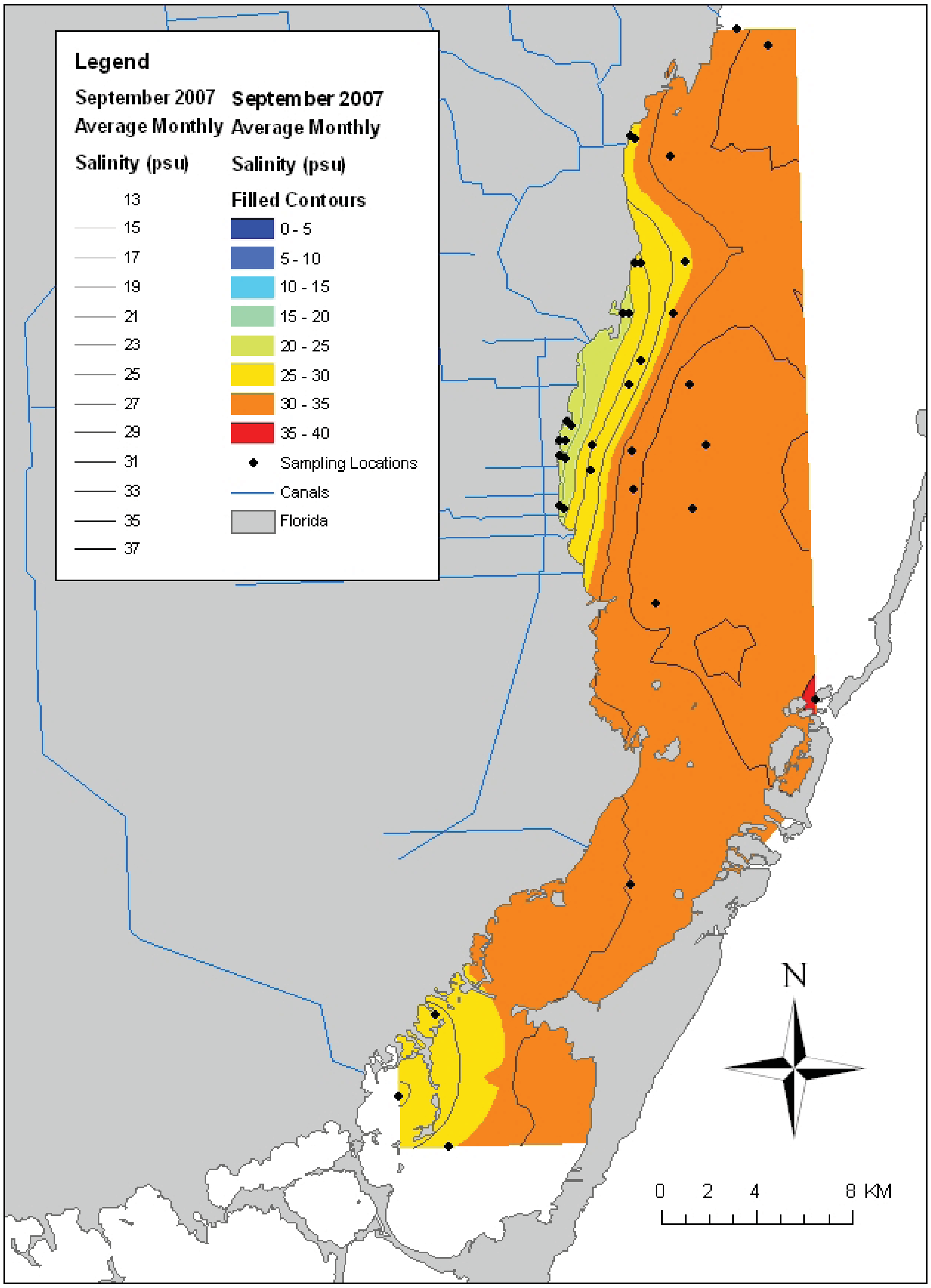
Appendix I, Figure 3.2-8. Interpolated average salinity in Biscayne Bay for June 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



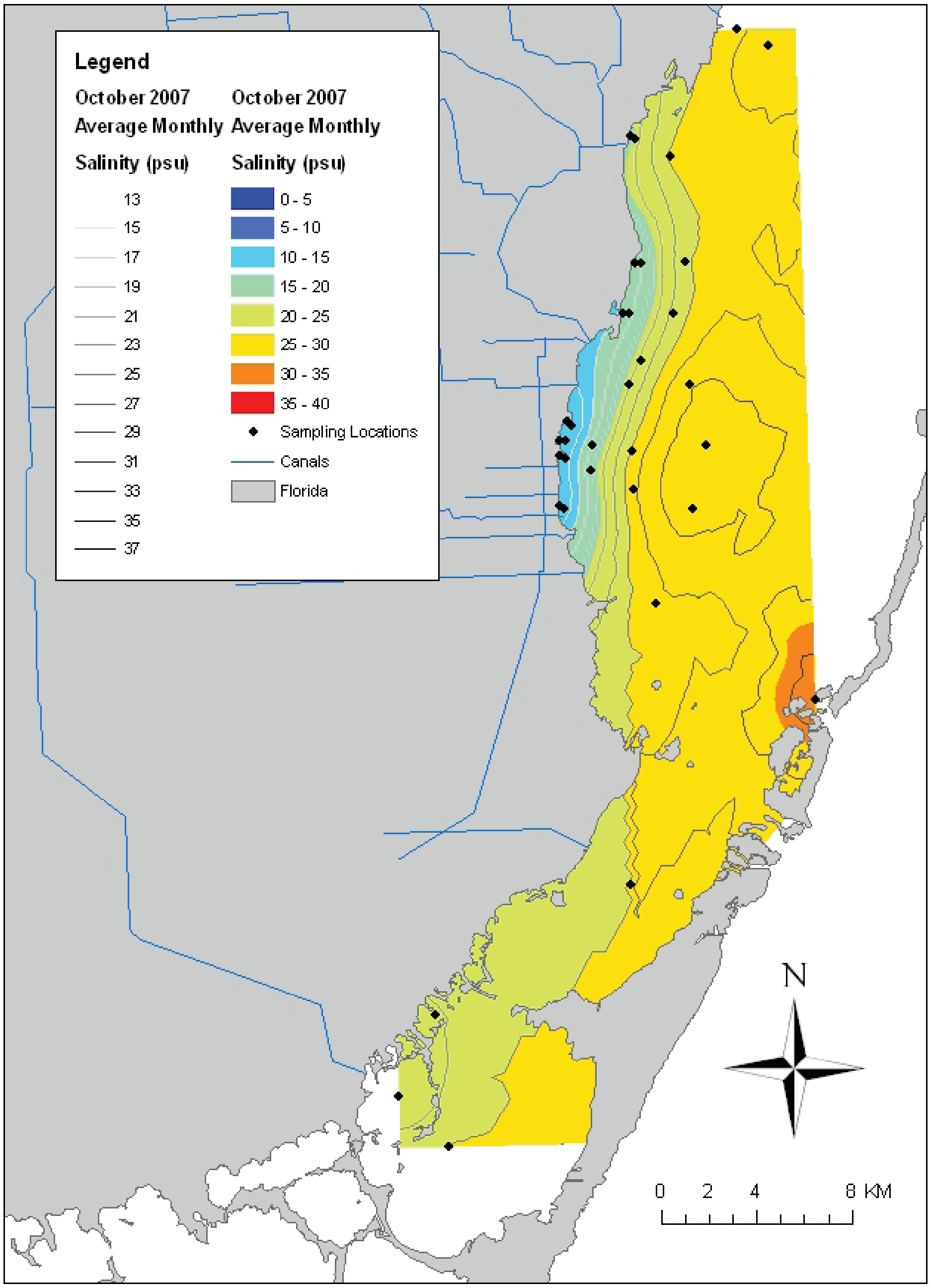
Appendix I, Figure 3.2-9. Interpolated average salinity in Biscayne Bay for July 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



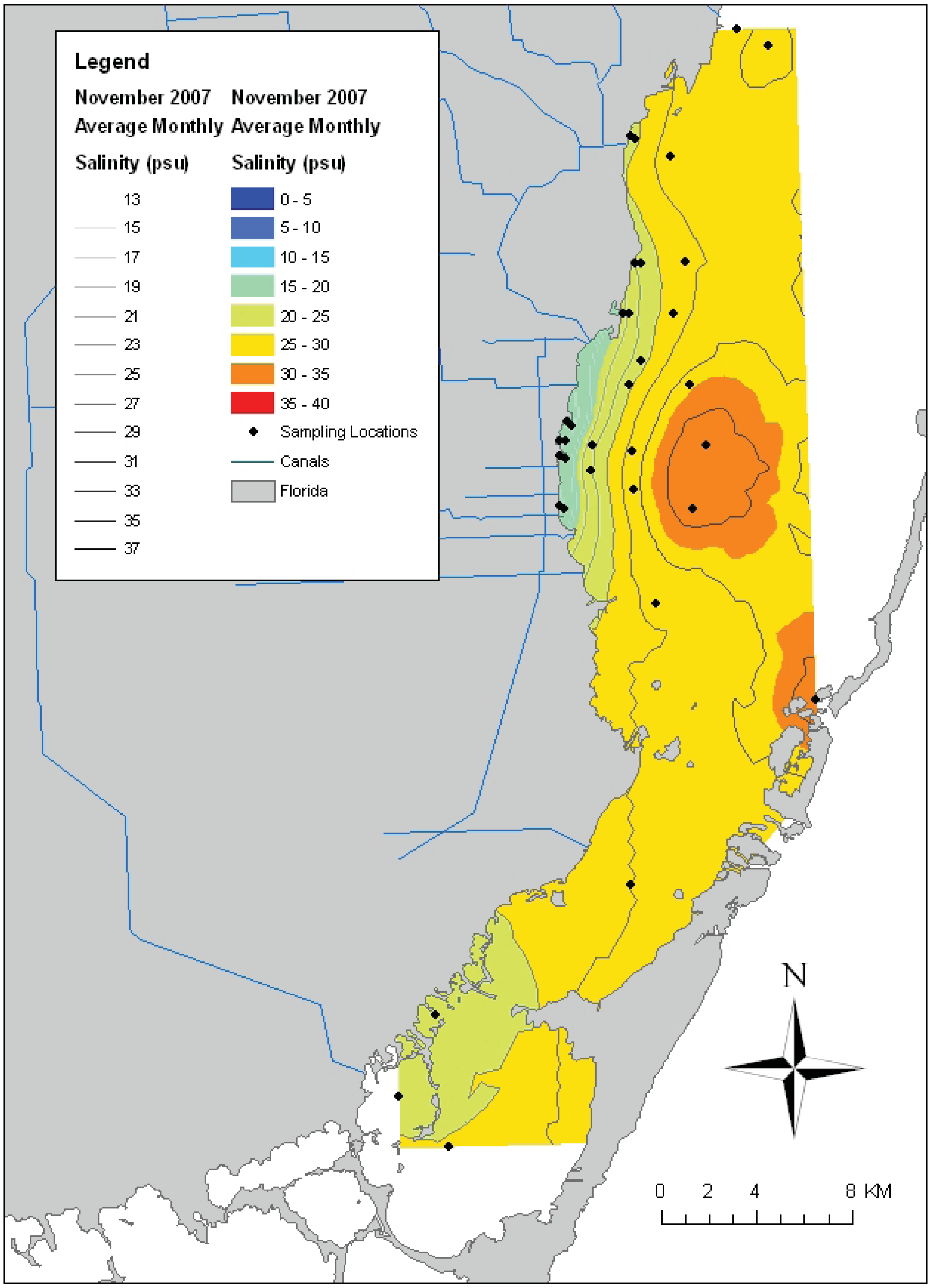
Appendix I, Figure 3.2-10. Interpolated average salinity in Biscayne Bay for August 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



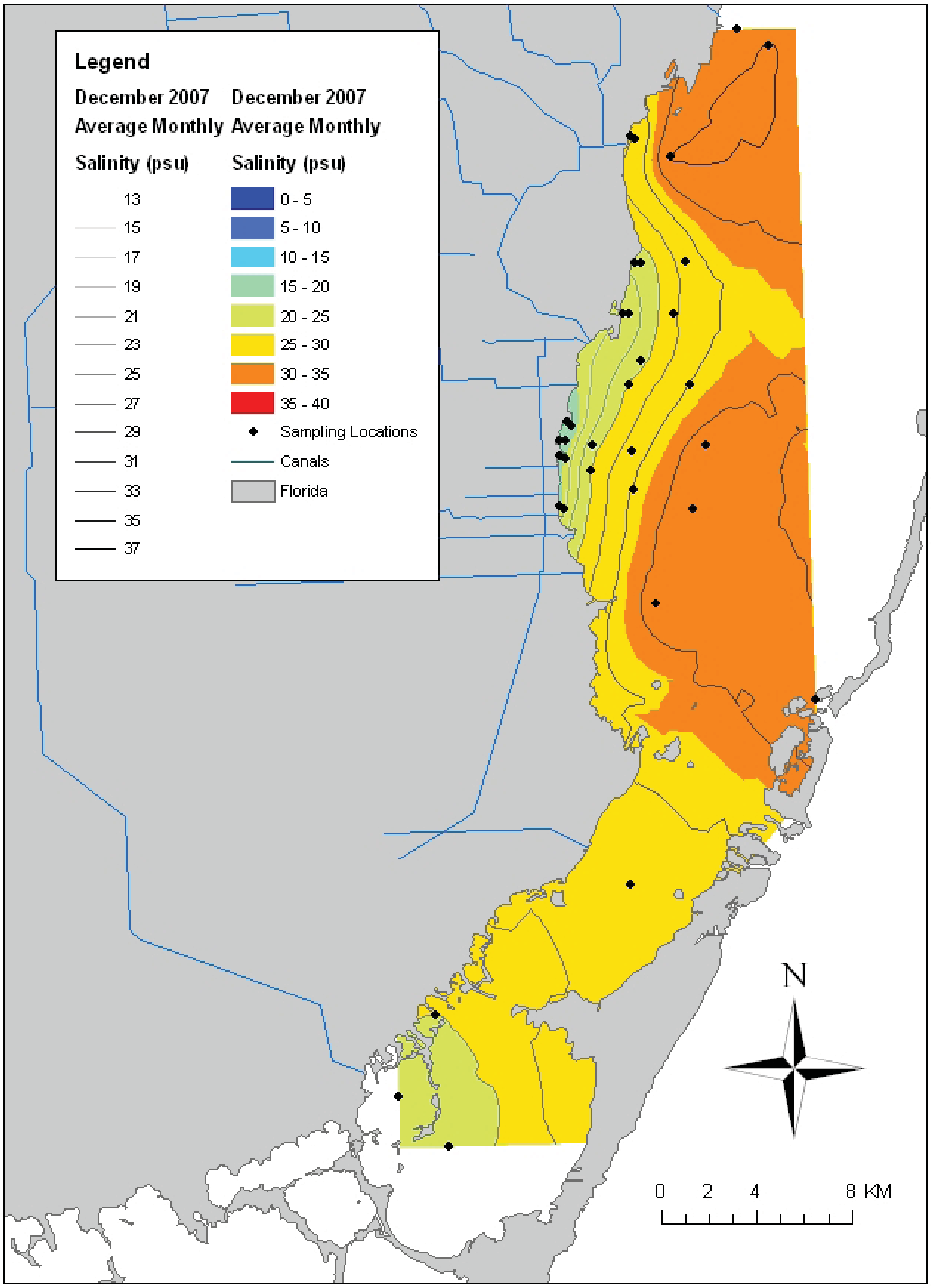
Appendix I, Figure 3.2-11. Interpolated average salinity in Biscayne Bay for September 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



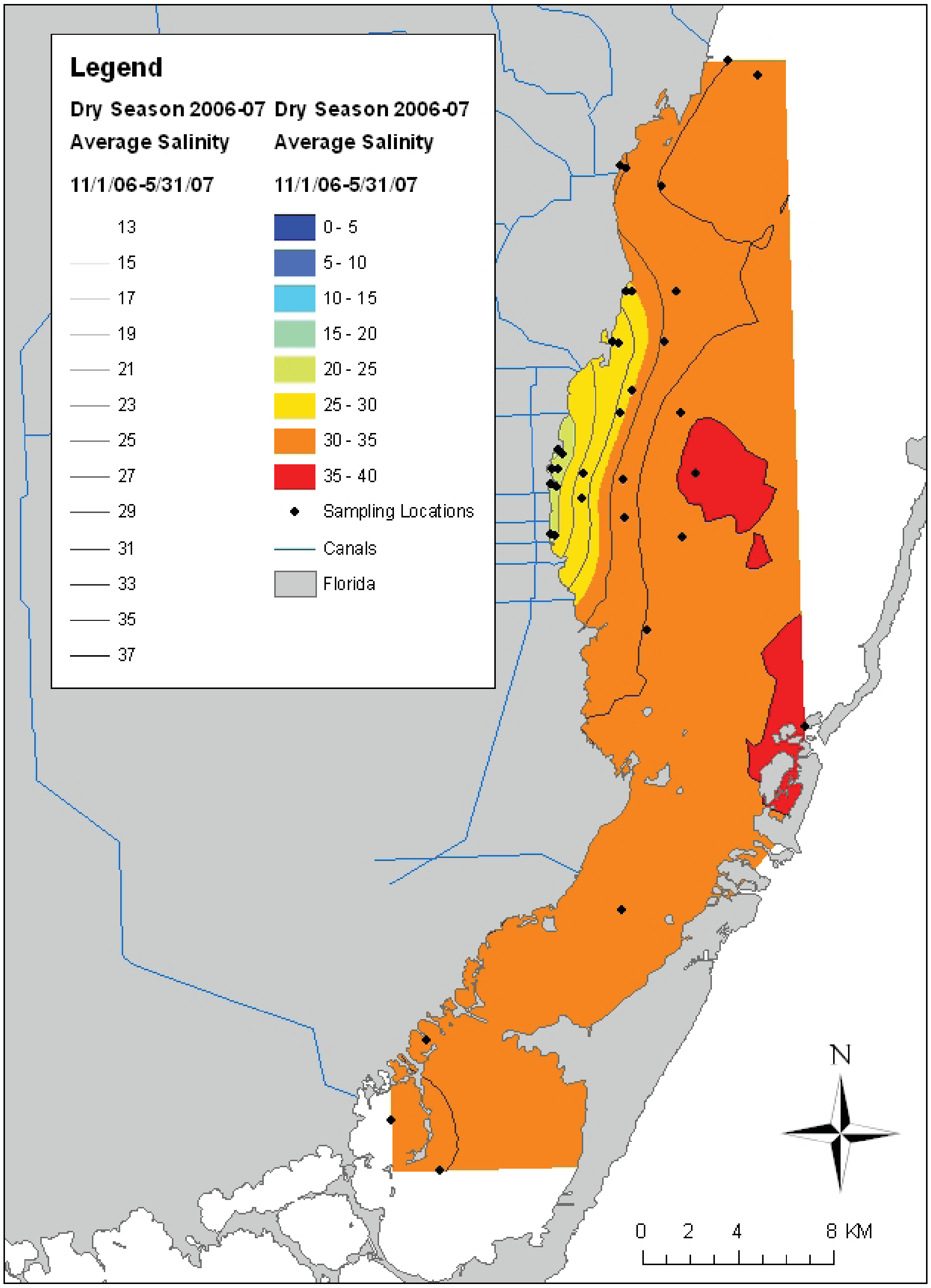
Appendix I, Figure 3.2-12. Interpolated average salinity in Biscayne Bay for October 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



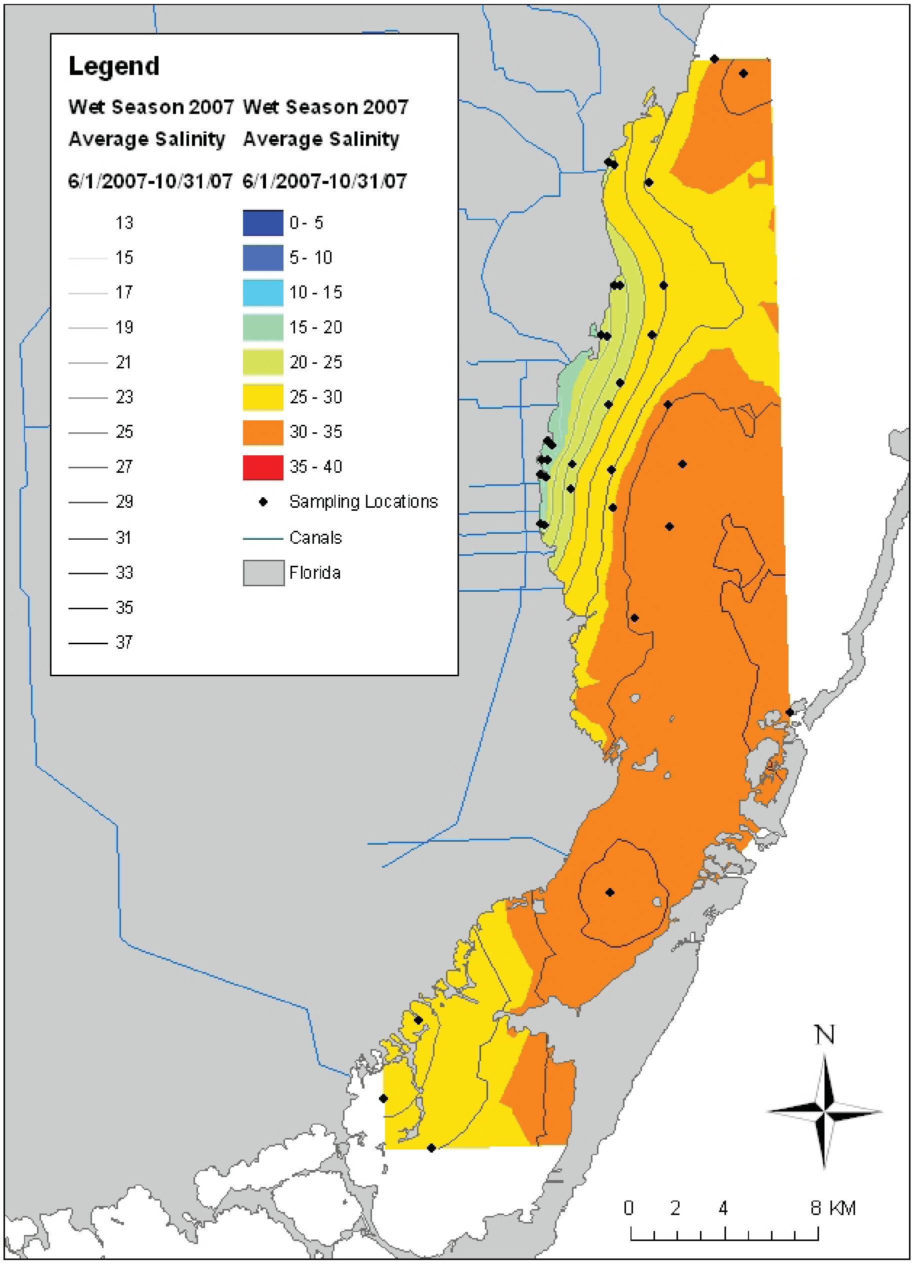
Appendix I, Figure 3.2-13. Interpolated average salinity in Biscayne Bay for November 2007. Data from 32 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



Appendix I, Figure 3.2-14. Interpolated average salinity in Biscayne Bay for December 2007. Data from 33 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire month.



Appendix I, Figure 3.31-1. Interpolated average salinity for Biscayne Bay between November 2006 and May 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire period.



Appendix I, Figure 3.32-1. Interpolated average wet season salinity in Biscayne Bay between June 2007 and October 2007. Data from 34 sites was used in this interpolation. The data was collected in 15 minute intervals and then averaged for the entire period

Appendix II – QA/QC Plan

Biscayne Bay Salinity Monitoring Network Data Collection, Verification, and Validation Quality Assurance and Control Plan

Table of Contents

1.0 Introduction

This is a Quality Assurance/Quality Control (QA/QC) plan for all field data collection, laboratory procedures, data validation and verification for the REstoration COordination and VERification (RECOVER)/Biscayne Bay Salinity Monitoring Network. This plan is also intended to meet the requirements of quality control and assurance of field-testing as outlined by the South Florida Water Management District (SFWMD).

The following plan describes the objectives, functional activities, and specific quality assurance and control procedures for the collection of physical data in Biscayne Bay to support the Monitoring and Assessment Program (MAP) for the Comprehensive Everglades Restoration Plan (CERP). Documents used in preparing this QA/QC plan are listed on the reference page of this document.

2.0 Statement of Project Purpose and Approach

2.1 Purpose

The purpose of the Biscayne Bay Salinity Monitoring Network (BBSMN) program is to provide water quality data results including temperature, water levels, and salinity during a limited but continuous long-term monitoring survey. This project's goals are: 1) to collect physical water quality data (primarily salinity) to allow decisions and inferences to be made with respect to changes in freshwater inflow, 2) to distribute this data in the broadest manner, and 3) to provide this information in a manner most useful to researchers.

2.2 Approach

The study will be conducted with adherence to accepted scientific and engineering principles to provide technically correct and scientifically defensible results. There are 34 sites where data is collected within Biscayne Bay (**Appendix A**). Eleven of the 34 sites within the bay also acquire readings approximately <0.25 meters below water surface via meters placed within a navigational surface buoy. The northernmost site is located south of the Snapper Creek Canal. Sites continue south through the bay to Manatee Bay and Barnes Sound. The sampling sites are set up as a series of east-west transects that radiate outward from canals or other interesting hydrological features. These transects are meant to document a progression of estuarine conditions near shore to marine conditions offshore.

3.0 Calibration Procedures and Frequency

YSI Data Sonde calibration is an essential and integral part of the quality assurance plan. Instruments are targeted for retrieval and calibration on a triweekly schedule of deployment based on weather. Deployment may extend to a four-week period if weather or other unforeseen problems arise. Before deployment, lab technicians verify that all instruments are in proper working condition and that batteries are properly charged (Section 6.1). Battery voltage is noted on the calibration sheet.

3.1 Instrument Calibration

The YSI 6600 and 6000 Data Sondes are calibrated after routine maintenance procedures are performed. Calibration of instruments is performed as needed on a triweekly schedule of deployment. The sondes are multi-parameter instruments programmed to record temperature, conductivity, and depth (See **Appendix B** for sensor specifications). Due to a number of variables, same day calibration and deployment is not possible.

3.1.1 Temperature

The temperature probe is checked on a monthly basis using the laboratory traceable Celsius thermometer. This check is noted in the comment field on the calibration sheet. A temperature reading must be within +/- 0.15 degrees Celsius to be acceptable. If the check does not meet these requirements, the sonde will be checked in a controlled temperature bath. If the sonde still does not prove correct, the associated data will be flagged and the unit will then be sent to the manufacturer for service.

3.1.2 Conductivity

The conductivity probe is calibrated by filling the calibration cup with seawater standard and is adjusted to that value. The calibration is accepted if the sonde reads within +/- 0.5% of the true value of the standard. If the reading does not meet these limits, the problem will be determined and corrected. ***Note:*** Instruments measure conductance and temperature, from these readings the meter then calculates specific conductance and salinity. Conductivity is calibrated using one point. Older technology required two points, because the probes were not linear from zero. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration. However, a zero check is done with deionized water to ensure accurate calibration and is noted on the Calibration Sheet. In the event the zero check does not read zero, the meter is recalibrated.

3.1.3 Depth

Depth is determined using a pressure sensor. To check pressure the sonde is fitted with five feet of tygon tubing filled with water and readings are taken at one-foot intervals. Relative pressure change is noted on the calibration sheet and should be within +/- 0.06 feet. If an incorrect reading is observed, the sensor will be cleaned and rechecked. If the problem is not corrected by cleaning the manufacturer should be contacted for instructions/recommendations. ***Note:*** Currently, depth calibrations are not being performed in this manner. Barometric pressure, taken from a reading in the lab is entered into the Coach program and the depth is calibrated to 0 meters. Pressure offset is noted. This additional step was added to insure the meters were responding over expected measurement range.

3.2 Calibration Standards

The conductivity standard is supplied and calibrated at the Rosenstein School of Marine and Atmospheric Science (RSMAS). This standard is collected in carboys, filtered, and stored at room temperature in the laboratory.

The rinse water used in calibration procedures is de-ionized water obtained from a Millipore Direct-Q Water Filtration System with a conductivity of 0.0 ms.

3.3 Instrument Calibration Records

Instrument calibration response is recorded on lab calibration sheets, which are then placed in the calibration logbook. BISC laboratory technicians maintain this logbook. The format for the calibration sheets is shown on the following page (**Figure 1**). This metadata is also entered into an Access database. A checklist, shown in **Figure 2**, outlines step-by-step procedures used by BISC lab technicians during the calibration process.

Figure 1. Calibration data sheet.

CALIBRATION DATA SHEET

Date (mm/dd/yy) ______ Station Number ______
Instrument Type ______ Sonde ID Number ______
Lab Tech ______ Date Deployed ______ Set up by:

Calibration Information Conductivity	Calibration Results	Post-Calibration Results PreClean	 Clean		Date Post-Cal'd:
Calibration Standard Value				mS/cm	By:
Carbouy Number					
Sensor Reading				mS/cm	
Zero Check				mS/cm	
Cell Constant					
Temperature ^{0} Celsius					
Depth/Pressure					
Battery Voltage					

Notes:

Sample Rate ______ MIN
Delay Sample time ______ **(EST)**

Atmospheric Pressure		
Initial value	Ending value	Difference

DATE RECOVERED ______

DATA FILE NAME ______

Processing Information To Be Filled in By ERDC

	Pressure	Salinity	Temperature
Sensor Offsets:			
Atmospheric Offset	(ERDC)		

Figure 2. Example of Calibration Checklist for YSI 6600 instruments.

Calibration Checklist for 6- Series CTDs	
	SPECIFIC CONDUCTIVITY
	Dry sensor with cloth
	Collect two samples of calibrated seawater, noting the carbuoy #
	Rinse the sensor head with the first sample of calibrated seawater by dipping the probes into the rinse multiple times
	Use a ring stand and clamp to secure the conductivity probe in the second calibration standard sample, making sure the waterline is at the appropriate height.
	In Ecowatch, select 2 – **Calibration**, then 1—**Conductivity**, then 1 – **Specific Conductivity**
	Input the specific conductivity of the standard.
	Allow temperature to equilibrate before calibration
DEPTH	
	Record barometric pressure
	In Ecowatch, select 2 – **Calibration**, then 2 – **Pressure/Abs**
	Input 0.0
	Allow depth to equilibrate before calibration
	After calibration, rinse with de-ionized water and store for deployment
INSTRUMENT DEPLOYMENT	
	If sonde unit passes all checks, assign it to the next deployment station to replace an instrument of similar type
	Use Ecowatch to open menu screen for unattended sampling
	Select 4 – **Status** and select **Date and Time**. Check time against atomic clock. Update if necessary.
	Select 1 – **Interval** and enter 00:15:00 (15 minutes)
	Select 2 –**Start Date** to set the date that data will begin to log to sonde memory
	Select 3 – **Start Time** to set the time that data will begin to log to sonde memory
	Select 4 – **Duration** days = 365
	Select 5 – File and enter the **file name** using the following data file format: LLNNMDDY (Where LLNN is the station identifier – Site **L**ocation and YSI Instrument **N**umber)
	Select 6 – **Site** and enter site number
	Select 7 – **Battery** to make sure that the voltage is suitable for the length of the study
	Make sure you select C – Start Logging to accept your entries and start sonde!

4.0 Data Evaluation, Validation and Reporting

4.1 Data Evaluation

The evaluation of the data occurs after the raw data downloaded from the YSI. The purpose is to ensure the data sent is reporting the correct location and is within acceptable limits according to parameter. This also confirms that the instrument is recording properly. This will be accomplished using the following measures:

1. Lab technicians are to check calibration results to insure that data falls within acceptable limits based on parameter-specific historical data. This check is noted on the calibration sheet.

2. Results from post calibration check will be compared to calibration readings and recorded on the calibration sheet.

The evaluation of data is accomplished through a series of reviews and checks. The results are initially reviewed by the technician performing the data download to spot any outliers and to confirm that the sonde is recording properly. Next, the project manager or senior chemist reviews the data from the perspective of his/her local and historical knowledge. After final review the project manager then decides if the data is acceptable.

4.2 Data Validation

BISC will review and validate the raw data. This will be done by a comparison of the results of simultaneous data during dual deployment and post deployment checks. If valid, the results become part of the BISC laboratory database. The naming convention for each data file is as follows: LL = site/location number, NN = sonde identification number, M = month represented by a letter, DD = day, Y = last digit of the year (See Appendix D).

4.3 Data Reporting

All data will be downloaded upon retrieval of the sondes. Raw data will be stored on the NPS server, in hard copy, and on a CD. The data is saved through the Ecowatch program and then exported to a text file, readable without the Ecowatch software. These will be archived according to NPS standards using the proper file codes. All data will be available to project managers and lab technicians.

5.0 Field and Laboratory Quality Control Checks

Quality control procedures are those steps taken by laboratory and field staff to insure accuracy in data collection and reliability of the data itself.

5.1 Field Quality Control Checks

Quality control checks performed in the field are the following:

1. Field sheets are used to record which sonde is being deployed and which sonde is being retrieved. Each sonde has a unique identification number displayed on the exterior in black marker. These sheets will then be placed in the field logbook. The format used for this data sheet is shown on page 9 in **Figure 3.**

2. Field technicians are to verbally confirm sonde identification upon deployment and retrieval to another field technician in the boat who records this on a field sheet.

3. Sondes will be dual deployed for a minimum of 45 minutes in order to have simultaneous data (four concurrent samples) recorded at each site. Before leaving the lab, field technicians will need to check the clock in the laboratory for the correct time as this is the clock the sondes are set to. This is a necessary step so that field technicians can be certain of when the data sonde is recording.

4. At horizontal deployments, the field technician must place the data sonde so that the conductivity probe is positioned on its side, not directly up or down. This prevents sediment from entering the probe and also keeps air bubbles from getting trapped in the probe.

5.2 Laboratory Quality Control Checks

The lab technician will be responsible for checking field log for discrepancies in deployment or retrieval procedures upon downloading the data. It is also necessary to monitor individual instrument response documented in the calibration and/or maintenance logbook should such problems arise.

The procedures for post calibration check are the same as the calibration procedures shown in **Figure 2**. Post calibration procedures will be performed after data is downloaded. Any variance should be recorded on original calibration sheet to show possible drift in the collected data. If a problem is found during post calibration and cannot be resolved by the lab technician, the instrument will be removed from use and serviced. This will be documented in the maintenance log.

After calibration, units are prepared for deployment. At this time the lab technician places the appropriate size protective cage over the probes. There are short and long cages in the laboratory. The long cages are to be used on all vertical deployment sites while either size can be used for horizontal deployment sites. This ensures that the pressure sensor is at the same distance from the sea floor at each deployment.

Figure 3

RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS

Date: ______________ Field Techs: ______________________

Station #: ______________________ Instrument Type: ____________ (6000, 6600, 600XLM)

Instrument ID: ______________ **Deployed:** ____________ (EST)

Instrument ID: ______________ **Retrieved:** ____________ (EST)

Conditions at Deployment:		Conditions upon Retrieval:	
Air Temp (C):	________	Air Temp (C):	________
Barometric Pressure:	________	Barometric Pressure:	________
Est. Wave Height (ft):	________	Est. Wave Height (ft):	________
Wind Direction:	________	Wind Direction:	________
Wind Speed (k):	________	Wind Speed (k):	________

NOTES:

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***Air temperature, barometric pressure, and wind direction and speed measurements will be taken with a hand-held weather instrument.**

***This information will be entered as meta data into the Field data sheet.**

6.0 Preventive Maintenance

Cleaning and maintenance of all equipment is necessary to insure proper operation and reliable results.

6.1 Field Equipment Maintenance

Routine maintenance and cleaning of each data sonde is performed upon retrieval. Other necessary field equipment is given adequate attention also. These procedures are documented in the maintenance logbook.

Each sonde is externally brushed clean of biotic fouling while in the field. Before deployment, screws are greased and external o-rings visually checked for tearing and loss of elasticity. Battery replacement occurs when the voltage reads 10.5 or below. Should a malfunction occur or service be required, a detailed account of the problem is recorded in the maintenance logbook using the format shown in **Figures 4 and 5** respectively. Instrument service and repair is contracted to YSI if the laboratory technician cannot resolve the problem. The corrections made by YSI will also be documented in the maintenance log upon receipt of the serviced instrument to the park.

Other field equipment that must be maintained includes padlocks and wire cutters. These items are soaked in fresh water upon returning to the lab and oven dried. The locks are then soaked in a lubricant, exercised, and filled with grease.

Figure 4

Instrument Malfunction Log

Unit Number:
Date:
Reported by:
Problem Description:

Amendments or Adjustments:

Figure 5. Abbreviated Service Log Sheet

DATASONDES			
DATE:			
YSI #		BISC #	NOTES
03H 1584	AA	31	
	AB	32	
	AC	33	
	AD	34	
	AE	35	
	AF	36	
03H 1510	AA	37	
	AB	38	
	AC	39	
	AD	40	
	AE	41	
03J 0442	AA	42	
	AB	43	
	AC	44	
	AD	45	

7.0 Reference

South Florida Water Management District, Field Sampling Quality Manual, Section 6, Field-Testing, October 9, 2002.

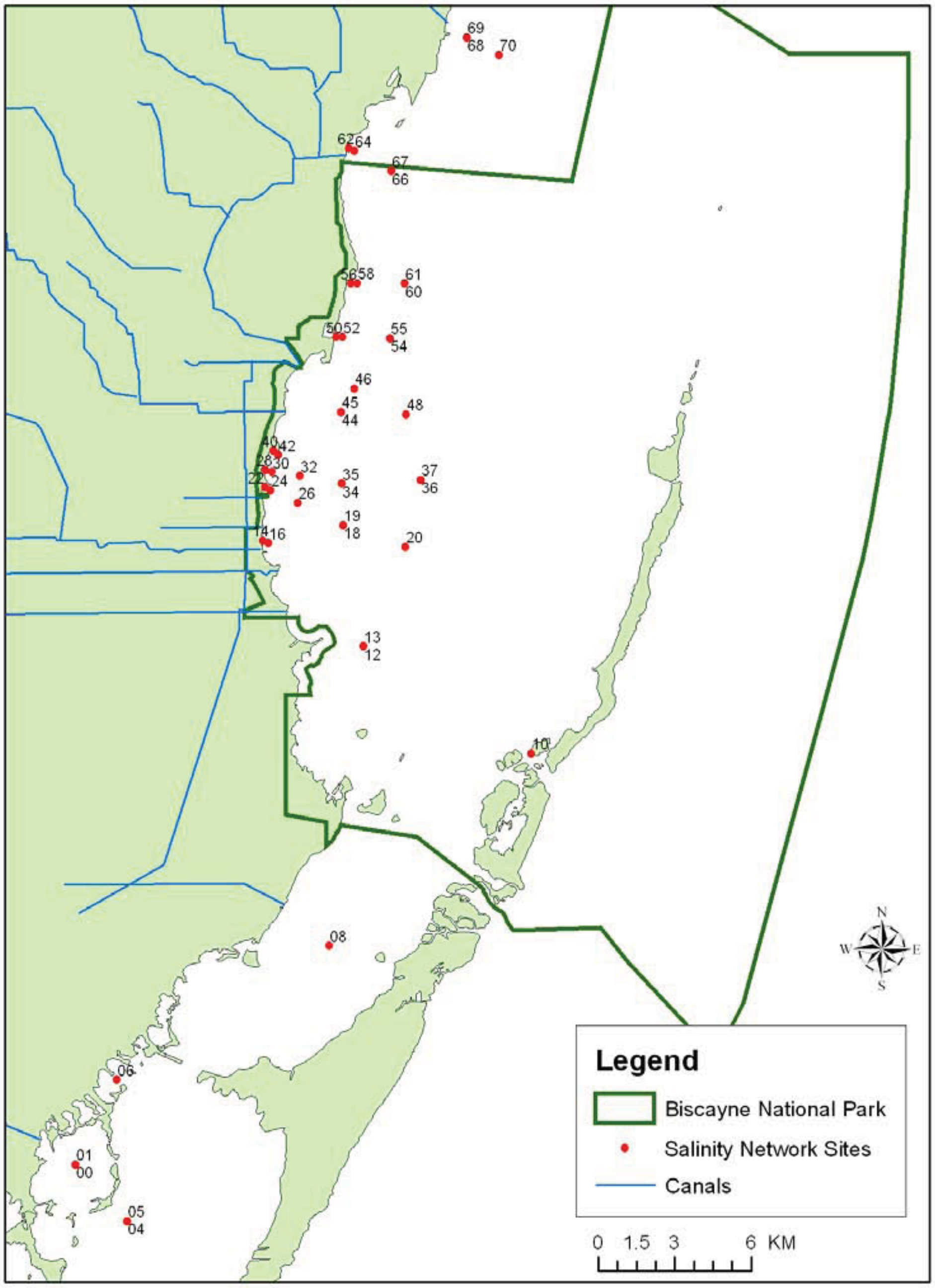
South Florida Water Management District, Generic Quality Assurance Plan prepared for DER and DHRS, Revision No. 2.2, February 1, 1990.

ERDC-WES-USACE, Final Draft Scope of Work: Time and Cost Estimate for Hydrodynamic Field Data Collection in Biscayne Bay, Revised BBCW Salinity Data Collection, December 15, 2003.

Appendix A

Site Locations and Map

Site ID's	Latitude	Longitude	InstrumentType
00	25.25300	-80.41400	Bottom
01	25.25300	-80.41400	Surface
04	25.23300	-80.39400	Bottom
05	25.23300	-80.39400	Surface
06	25.28300	-80.39800	Bottom
08	25.33000	-80.31500	Bottom
10	25.39769	-80.23597	Bottom
12	25.43600	-80.30100	Bottom
13	25.43600	-80.30100	Surface
14	25.47361	-80.34003	Bottom
16	25.47264	-80.33777	Bottom
18	25.47878	-80.30886	Bottom
19	25.47878	-80.30886	Surface
20	25.47103	-80.28453	Bottom
21	25.47103	-80.28453	Surface
22	25.49242	-80.33911	Bottom
24	25.49133	-80.33694	Bottom
26	25.48681	-80.32650	Bottom
28	25.49844	-80.33875	Bottom
30	25.49800	-80.33627	Bottom
32	25.49633	-80.32548	Bottom
34	25.49353	-80.30908	Bottom
35	25.49353	-80.30908	Surface
36	25.49472	-80.27836	Bottom
37	25.49472	-80.27836	Surface
40	25.50533	-80.33577	Bottom
42	25.50375	-80.33400	Bottom
44	25.51886	-80.3094	Bottom
45	25.51886	-80.30936	Surface
46	25.52728	-80.30406	Bottom
47	25.52728	-80.30406	Surface
48	25.51800	-80.28400	Bottom
50	25.54547	-80.31119	Bottom
52	25.54539	-80.30869	Bottom
54	25.54500	-80.29000	Bottom
55	25.54500	-80.29000	Surface
56	25.56444	-80.30531	Bottom
58	25.56447	-80.30278	Bottom
60	25.56428	-80.28417	Bottom
61	25.56428	-80.28417	Surface
62	25.61225	-80.30583	Bottom
64	25.61136	-80.30353	Bottom
66	25.60408	-80.28922	Bottom
67	25.60408	-80.28922	Surface
68	25.65128	-80.25958	Bottom
69	25.65128	-80.25958	Surface
70	25.64500	-80.24700	Bottom
72	25.65444	-80.15967	Bottom
AR	25.38214	-80.16497	Bottom
BS	25.48497	-80.14911	Bottom
BB	25.31839	-80.18439	Bottom
TR	25.49228	-80.10878	Bottom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Salinity Network Sites
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Appendix B
Sensor Specifications

YSI 6600 Data Sonde	
Available Sensors:	Temperature, Conductivity, Dissolved Oxygen, pH, ORP, Ammonium, Nitrate, Chloride, Depth (shallow, medium, deep, shallow vented), Turbidity, Chlorophyll and Rhodamine WT
Operating Environment Medium: Temperature: Depth:	 Fresh, Sea, or Polluted Water -5 to +45 °C 0 to 656 feet (200 meters)
Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH and pH/ORP -20 to +60 °C for pH and pH/ORP sensors
Material:	PVC, Stainless Steel
Diameter:	3.5 inches (8.9 cm)
Length:	19.6 inches (49.8 cm) with no depth, 21.6 inches (54.9 cm) with depth
Weight:	7 pounds (3.18kg) with depth and batteries but no added bottom weight
Computer Interface:	RS-232C, SDI-12
Internal Logging Memory Size:	384 kilobytes (150,000 individual parameter readings)
Power:	8 C-size Alkaline Batteries or External 12 VDC
Battery Life:	Approximately 90 days at 20 C at 15 minute logging intervals, a 40 second DO warm up time, and turbidity and chlorophyll active

Performance Specifications:	
Non-vented Level-Shallow	
Sensor Type:	Stainless steel strain gauge
Range:	0 to 30 feet (9.1 meters)
Accuracy:	+/- 0.06 feet (0.018 meters)
Resolution:	0.001 feet (0.001 meters)
Temperature:	
Sensor Type:	Thermistor
Range:	-5 to 45 °C
Accuracy:	+/- 0.15 °C
Resolution:	0.01 °C
Depth:	200 meters
Salinity:	
Sensor Type:	Calculated from conductivity and temperature
Range:	0 to 70 ppt
Accuracy:	+/- 1.0% of reading or 0.1 ppt, whichever is greater
Resolution:	0.01 ppt

Conductivity:	
Sensor Type:	4 electrode cell with autoranging
Range:	0 to 100 mS/cm
Accuracy:	+/- 0.5% of reading + 0.001 mS/cm
Resolution:	0.001 mS/cm to 0.1 mS/cm (range dependent)
Depth:	200 meters

YSI 6000 Data Sonde	
Available Sensors:	Temperature, Conductivity, Dissolved Oxygen, pH, ORP, Ammonium, Nitrate, Depth (shallow, medium, deep,), Turbidity
Operating Environment Medium: Temperature: Depth:	 Fresh, Sea, or Polluted Water -5 to +45 °C 0 to 500 feet (152 meters)
Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH and pH/ORP -20 to +60 °C for pH and pH/ORP sensors
Material:	PVC, Stainless Steel
Diameter:	3.5 inches (8.9 cm)
Length:	19.5 inches (49.5 cm)
Weight:	6.5 pounds (3.0kg) with batteries
Computer Interface:	RS-232C, SDI-12
Internal Logging Memory Size:	256 kilobytes (150,000 individual parameter readings)
Power:	8 C-size Alkaline Batteries or External 12 VDC
Battery Life:	120 days without dissolved oxygen and turbidity sensor activation
Performance Specifications:	
Non-vented Level-Shallow	
Sensor Type:	Stainless steel strain gauge
Range:	0 to 30 feet (9.1 meters)
Accuracy:	+/- 0.06 feet (0.018 meters)
Resolution:	0.001 feet (0.001 meters)
Temperature:	
Sensor Type:	Thermistor
Range:	-5 to 45 °C
Accuracy:	+/- 0.15 °C
Resolution:	0.01 °C

Salinity:	
Sensor Type:	Calculated from conductivity and temperature
Range:	0 to 70 ppt
Accuracy:	+/- 1.0% of reading or 0.1 ppt, whichever is greater
Resolution:	0.01 ppt
Conductivity:	
Sensor Type:	4 electrode cell with auto ranging
Range:	0 to 100 mS/cm
Accuracy:	+/- 0.5% of reading + 0.001 mS/cm
Resolution:	0.001 mS/cm to 0.1 mS/cm (range dependent)

YSI 600XLM Data Sonde	
Available Sensors:	Temperature, Conductivity, Dissolved Oxygen, pH, ORP, Depth (shallow, medium, shallow vented)
Operating Environment Medium: Temperature: Depth:	 Fresh, Sea, or Polluted Water -5 to +45 °C 0 to 656 feet (200 meters)
Storage Temperature:	-40 to +60 °C for sonde and all sensors except pH and pH/ORP -20 to +60 °C for pH and pH/ORP sensors
Material:	PVC, Stainless Steel
Diameter:	1.65 inches (8.9 cm)
Length:	21.3 inches
Weight:	1.5 pounds (0.7kg) with batteries
Computer Interface:	RS-232C, SDI-12
Internal Logging Memory Size:	384 kilobytes (150,000 individual parameter readings)
Power:	Internal: 4 AA-alkaline cells External: 12 VDC
Battery Life:	Approximately 75 days at 25 C at one-hour logging intervals
Performance Specifications:	
Non-vented Level-Shallow	
Sensor Type:	Stainless steel strain gauge
Range:	0 to 30 feet (9.1 meters)
Accuracy:	+/- 0.06 feet (0.018 meters)
Resolution:	0.001 feet (0.001 meters)
Temperature:	
Sensor Type:	Thermistor
Range:	-5 to 45 °C
Accuracy:	+/- 0.15 °C
Resolution:	0.01 °C

Depth:	200 meters
Salinity:	
Sensor Type:	Calculated from conductivity and temperature
Range:	0 to 70 ppt
Accuracy:	+/- 1.0% of reading or 0.1 ppt, whichever is greater
Resolution:	0.01 ppt
Conductivity:	
Sensor Type:	4 electrode cell with auto ranging
Range:	0 to 100 mS/cm
Accuracy:	+/- 0.5% of reading + 0.001 mS/cm
Resolution:	0.001 mS/cm to 0.1 mS/cm (range dependent)

Appendix C

Meter Identification Numbers

6600							
YSI #		BISC #		YSI #		BISC #	
03H 1584	AA	31		03L0206	AE	66	
	AB	32					
	AC	33		03L0335	AA	67	
	AD	34			AB	68	
	AE	35					
	AF	36		03L0420	AA	69	
					AB	70	
03H 1510	AA	37			AC	71	
	AB	38			AD	72	
	AC	39					
	AD	40		**6000**			
	AE	41					
				92K10641		03	
03J 0442	AA	42		95J37908		06	
	AB	43		95H36050		09	
	AC	44					
	AD	45		97D0445	AD	17	
	AE	46			AI	23	
					AJ	24	
03J 0543	AA	47					
	AB	48		97G0588	AB	25	
	AC	49					
	AD	50		**600**			
	AE	51					
				01D1092	AA		
03J 0611	AA	52			AB		
	AB	53			AC		
	AC	54			AD	A2	
	AD	55			AE		
	AE	56			AF		
					AG	A1	
03J 0675	AA	57			AH		
	AB	58			AI		
	AC	59			AK		
.					AM	B2	
03H2003	AA	60					
	AB	61		01D1102	AA	B3	
					AB	B4	
03L0206	AA	62			AC	B5	

	AB	63			AE	B6	
	AC	64			AF	B7	
	AD	65			AG	B8	
600							
YSI #		BISC #					
01D1102	AH	B9					
	AI	C1					
	AJ	C2					
	AK	C3					
01D0370	AA	C4					
	AB	C5					

* BISC identification numbers have yet to be assigned to the YSI 600XLM units.

Appendix D
Month Naming Convention

January = A
February = B
March = C
April = D
May = E
June = F
July = G
August = H
September = I
October = J
November = K
December = L

Appendix III – Data Processing

Biscayne Bay Salinity Monitoring Network
Data Collection, Verification, and Validation

Table of Contents

1.0 Data Error Categories in Data Review

1.1 Personnel Error

Personnel errors included: 1) Downloaded data being placed in inappropriate columns. Many times different instruments measure different parameters. These parameters are not always reported in the same order. This can cause parameters to be included in inappropriate columns and values for one parameter to be reported as another (i.e. salinity and temperature). 2) Data set duplication. Some data sets were downloaded twice, creating two files containing the same information. And 3) meters being incorrectly calibrated before they are deployed. Meters can be incorrectly calibrated by staff in various ways; inappropriate calibration standard can be used, the value used for calibration could be incorrect, or calibration is not performed.

1.2 Machine Error

Machine errors include: 1) Instruments losing battery power before they are retrieved. This results in loss of data until a new instrument is deployed. 2) When battery power becomes low, meters sometimes miss a measurement. 3) Shifts in sampling time. Meters are set up to take measurements every 15 minutes. The correct timing for these measurements is 0:00, 0:15, 0:30, and 0:45. The meters can drift from this schedule, usually by small increments, and the sampling schedule can change. 4) Leap years are not accounted for. In leap years, February 29th is missing from the data, so all data is shifted one day forward.

1.3 Environmental Error

In this historic review environmental errors were found to have had the largest impact on the sampling data but to have the least number of identified sources. Environmental error can come from various sources including biofouling and drift algae. Biofouling occurs when algae and marine organisms contaminate the sensors on the instrument. This takes many forms including, but not limited to, barnacles, algae, tunicates, and bryozoans. Drift algae can also influence sensor readings. In some areas of the bay, large clumps drift algae tumble along the bottom of the water column. When this group of algae gets caught up on a meter, it can alter conditions around the probe and cause readings that are not consistent with the remainder of the water column.

A series of recommendations were made to try and correct these problems and create a more robust data set. By limiting the amount of time that a probe is deployed, the amount of biofouling can be largely reduced. Deployment periods have been decreased to two weeks. This not only helps reduce biofouling, it also reduces data loss from battery failure. It was also recommended that annual data compilations are passed to a second party to test data readability and to generate data plots for visual inspection for outliers and other problems. These problems would include duplicate data sets, shifted columns, and erroneous data. Some of these problems were easily fixed while others were more difficult. These recommendations have been implemented and are now used as standard procedures when possible.

Table 1. Summary of data error and steps taken by Biscayne National Park to eliminate errors where possible.

Type	Problem	Solution
Personnel	Data placed in inappropriate column	Examine data visually and graphically comparing to historical (predetermined) values
	Data Set Duplication	Examine data visually and graphically comparing to historical (predetermined) values
	Miscalibration	Standardize training for all new technicians. Retain employees. Units are deployed simultaneously for 1 hour to check readings for miscalibration or calibration degradation.
Machine	Loss of power – no data collected	The amount of time each YSI unit is deployed has been decreased. Battery power is checked before each deployment.
	Battery power becomes low – YSI misses a reading	The amount of time each YSI unit is deployed has been decreased. Battery power is checked before each deployment.
	Shifts in sampling time	Data is examined visually and graphically. Problems with shifts in sampling times are noted, but not corrected.
	Leap year error – February 29th missing, data shifted forward 1 day.	Data from leap years is checked and corrected.
Environmental	Biofouling	The amount of time each YSI unit is deployed has been decreased.
	Smothering by drift algae	Sites are cleared of drift algae when a new unit is deployed. The amount of time each YSI unit is deployed has been decreased.

2.0 Data Evaluation and Processing

2.1 Importing Data

Several protocols have been implemented to datasets in order to improve accuracy of the data. Most of these changes are related to how the data is managed and altered after downloading. The aim of organizing the data is to create a complete dataset that spans a complete calendar year.

The first step involved with the data is to upload the data into an excel sheet. The reason for this is to add variables to the data that are not normally downloaded off of the YSI data sonde (**Table 1**). The columns added are filename and date/time. The sonde records time and date on separate rows and must be added to make it applicable to most statistics and graphing programs (**Table 2**). Also at this point the data that was measured before and after the sonde was deployed is deleted. Excel sheets, however, lack the capacity to contain a dataset that encompasses the entire year in a format acceptable to SFWMD. For this reason the data must be stored on Access© sheets.

The data from the sampling events is imported into an access page for the specific site (**Table 3**). Then the data from that page is added to a master page for that site. This master page contains all of the data for that site for the entire year including all overlapped data. At this point the data must be visually inspected to make sure that the columns properly match.

2.2 QA/QC

From this point the data is graphed in SigmaPlot to help identify errors. Each sampling event is graphed in a different color. There is a graph for each of the major variables including temperature, salinity, specific conductivity and depth, versus time. The graphs produced from this step are used later on for data interpolation. In addition, the graphs allow for easy detection of data points recorded prior to actual deployment, that were not deleted. These data points can be easily seen because their depths are at zero. For instance, the top meter falls out of the buoy and onto the bay floor. When this occurs, the depth will dramatically increase and can then be deleted. Sometimes variables from a sampling can be switched when entering them into excel sheets and access books. Since the variables are so different these errors can usually be seen and fixed easily. Any changes that are made to the data based on the graphs are then inputted into a database that will allow us to keep track of what changes were done to the data. In this database any malfunction of the probes is also noted even if the data cannot be fixed.

2.3 Data Calibration and Validation

The data is uploaded to the ftp site that allows for salinity variables to be interpolated and calibrated based on the data from the sampling event immediately after it. This is important since the data over time tends to loose some of its accuracy. This can be done by assuming that the first few data points are correct from each sampling event. Since there are a few overlapping data points between sampling events, the distance between those points can show how much the data has deteriorated. A linear or expositional regression can be used to correct this issue. However if the data points do not overlap, then the information from the pre and post calibration can be used. A linear regression can be made using the information from variance in calibration and post calibration. Once the data has been altered, the data is validated. It is during the validation step that salinity is calculated from the corrected, interpolated conductivity values. The data is now ready to be used by the public.

Table 1. Example of data that is taken directly from a YSI.

Date	Time	Temp	SpCond	Depth	Salinity
M/D/Y	hh:mm:ss	C	mS/cm	m	ppt
3/10/2005	13:45:08	19.16	54.053	1.263	35.8
3/10/2005	14:00:07	19.24	54.035	1.259	35.79
3/10/2005	14:15:08	19.26	54.051	1.255	35.8
3/10/2005	14:30:08	19.32	54.047	1.25	35.8
3/10/2005	14:45:08	19.39	54.01	1.231	35.77
3/10/2005	15:00:08	19.44	54.024	1.226	35.78
3/10/2005	15:15:08	19.51	54.01	1.22	35.77
3/10/2005	15:30:08	19.56	54.004	1.209	35.77
3/10/2005	15:45:08	19.62	54.002	1.201	35.77
3/10/2005	16:00:08	19.64	54.003	1.195	35.77
3/10/2005	16:15:08	19.65	53.968	1.185	35.74
3/10/2005	16:30:08	19.69	53.982	1.178	35.75
3/10/2005	16:45:08	19.69	53.974	1.179	35.75
3/10/2005	17:00:08	19.71	53.974	1.165	35.74
3/10/2005	17:15:08	19.71	53.981	1.156	35.75

Table 2. Example of data from a completed excel sheet. The added columns were site, date/time and filename.

Site	Date	Time	Date/Time	Temp	SpCond	Depth	Salinity		Filename
	M/D/y	hh:mm:ss	M/D/Y hh:mm:ss	C	mS/cm	M	ppt		
00	3/10/2005	13:45:08	3/10/2005 13:45:08	19.16	54.053	1.263	35.8		0012C085
00	3/10/2005	14:00:07	3/10/2005 14:00:07	19.24	54.035	1.259	35.79		0012C085
00	3/10/2005	14:15:08	3/10/2005 14:15:08	19.26	54.051	1.255	35.8		0012C085
00	3/10/2005	14:30:08	3/10/2005 14:30:08	19.32	54.047	1.25	35.8		0012C085
00	3/10/2005	14:45:08	3/10/2005 14:45:08	19.39	54.01	1.231	35.77		0012C085
00	3/10/2005	15:00:08	3/10/2005 15:00:08	19.44	54.024	1.226	35.78		0012C085
00	3/10/2005	15:15:08	3/10/2005 15:15:08	19.51	54.01	1.22	35.77		0012C085
00	3/10/2005	15:30:08	3/10/2005 15:30:08	19.56	54.004	1.209	35.77		0012C085
00	3/10/2005	15:45:08	3/10/2005 15:45:08	19.62	54.002	1.201	35.77		0012C085
00	3/10/2005	16:00:08	3/10/2005 16:00:08	19.64	54.003	1.195	35.77		0012C085
00	3/10/2005	16:15:08	3/10/2005 16:15:08	19.65	53.968	1.185	35.74		0012C085
00	3/10/2005	16:30:08	3/10/2005 16:30:08	19.69	53.982	1.178	35.75		0012C085
00	3/10/2005	16:45:08	3/10/2005 16:45:08	19.69	53.974	1.179	35.75		0012C085
00	3/10/2005	17:00:08	3/10/2005 17:00:08	19.71	53.974	1.165	35.74		0012C085
00	3/10/2005	17:15:08	3/10/2005 17:15:08	19.71	53.981	1.156	35.75		0012C085

Table 3. Example of Access page.

0012C085									
Site	**Date**	**Time**	**Date/Time**	**Temp**	**SpCond**	**Depth**	**Salinity**		**Site**
00	3/10/2005	3:45:08 PM	3/10/2005 15:45:08	19.62	54.002	1.201	35.77		0012C085
00	3/10/2005	4:00:08 PM	3/10/2005 16:00:08	19.64	54.003	1.195	35.77		0012C085
00	3/10/2005	4:15:08 PM	3/10/2005 16:15:08	19.65	53.968	1.185	35.74		0012C085
00	3/10/2005	4:30:08 PM	3/10/2005 16:30:08	19.69	53.982	1.178	35.75		0012C085
00	3/10/2005	4:45:08 PM	3/10/2005 16:45:08	19.69	53.974	1.179	35.75		0012C085
00	3/10/2005	5:00:08 PM	3/10/2005 17:00:08	19.71	53.974	1.165	35.74		0012C085
00	3/10/2005	5:15:08 PM	3/10/2005 17:15:08	19.71	53.981	1.156	35.75		0012C085
00	3/10/2005	5:30:08 PM	3/10/2005 17:30:08	19.74	53.972	1.148	35.74		0012C085
00	3/10/2005	5:45:08 PM	3/10/2005 17:45:08	19.73	53.95	1.146	35.73		0012C085
00	3/10/2005	6:00:07 PM	3/10/2005 18:00:07	19.72	53.932	1.134	35.71		0012C085
00	3/10/2005	6:15:08 PM	3/10/2005 18:15:08	19.7	53.913	1.126	35.7		0012C085
00	3/10/2005	6:30:08 PM	3/10/2005 18:30:08	19.66	53.897	1.122	35.69		0012C085
00	3/10/2005	6:45:08 PM	3/10/2005 18:45:08	19.65	53.89	1.12	35.68		0012C085
00	3/10/2005	7:00:08 PM	3/10/2005 19:00:08	19.62	53.877	1.114	35.67		0012C085
00	3/10/2005	7:15:08 PM	3/10/2005 19:15:08	19.59	53.866	1.113	35.66		0012C085

Appendix IV – Implementation Plan

Biscayne Bay Salinity Sampling Project for the Monitoring and Assessment Plan
Implementation Plan
April 2007

Table of Contents

1.0 Background

Biscayne Bay is the largest estuary on the southeast coast of the Florida peninsula (Figure 1). Biscayne Bay extends from Broward County to the north, through Miami-Dade County and part of Monroe County to the south, where the Bay is marginally connected to Florida Bay (through Jewfish Creek), west of Barnes Sound.

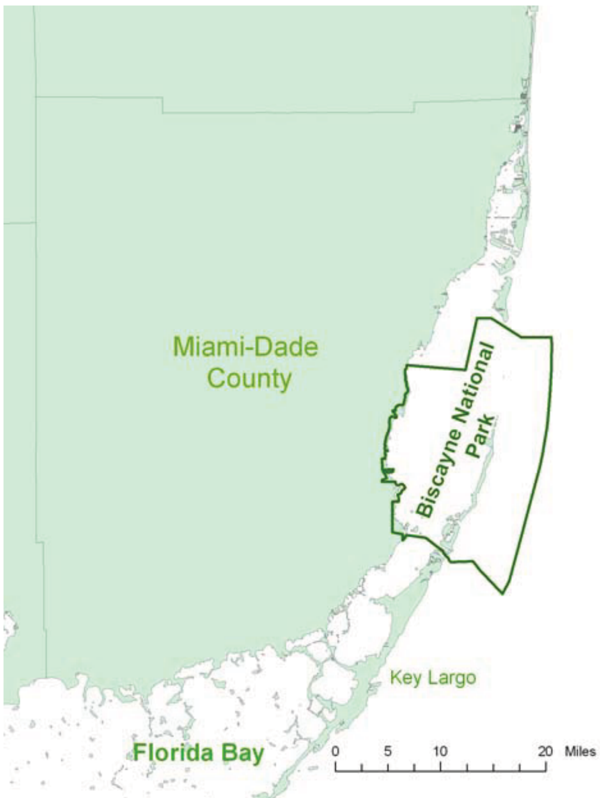

Figure 1: Location map of Biscayne Bay.

Physical processes that can have an impact on the water quality within the system vary both spatially and temporally. Monitoring the salinity conditions and several other water quality parameters of Biscayne Bay is important for documenting the CERP implementation effects in the southern estuarine ecosystem environment.

2.0 Specific Objectives to be Addressed

The purpose of this work is to collect physical water quality data (salinity, conductivity, temperature and depth) at all existing stations to allow decisions and inferences to be made with respect to changes in freshwater inflow. This provides data to other scientists and managers using the broadest manner. This study establishes reference conditions (document temporal and spatial variability of salinity in the near shore region of Biscayne Bay).

3.0 Approach and Methods

3.1 Data Collection and Instruments Calibration

3.1.1 Instrument Location and Deployment

There are 34 sites where data is collected within Biscayne Bay (Figure 2). Eleven of the 34 sites within the bay are also acquiring surface readings at approximately 0.25 meters below the water surface. Sites are located throughout the bay and continue south to Barnes Sound and Manatee Bay. The sampling sites are set up as a series of east-west transects that radiate outward from canals or other interesting hydrological features. These transects are meant to document a progression of estuarine conditions from near shore to marine conditions offshore. There are fourteen sites in the mangrove zone, which are expected to be the first area affected by changes in freshwater delivery to the bay. Twenty sites are located in the central area of the bay. Sites were also chosen as special interest areas, such as Black Point and Turkey Point, and Barnes Sound and Manatee Bay because of their hydrology and proximity to key environmental concerns and changes in water flow.

The multi-probe instruments used for the collection of data are YSI Environmental 6600 Series and 6000 Series. Surface measurements are taken 0.25 meters below the water surface where meters are placed within a specially designed navigational surface buoy. The instruments are also deployed at sites within the bay, on the bay floor. The sites with navigational surface buoys have bottom meters deployed horizontally to reduce interaction with the attachment chain of the buoy. Some bottom sites are still deployed vertically, except in cases where the mean low tide levels will be too shallow, approximately 0.25m to 0.5 meter above the bottom. The distance from the bottom is measured at each site. At those sites where there is horizontal deployment, the meter will be locked onto a concrete paver fitted with two eyebolts. At the far end, the smaller eyebolt will have two UV-black cable ties. The meter is inserted through one cable tie of the eyebolt to hold the meter in the correct position. During horizontal deployment, it is essential the sensor be facing sideways to prevent flow through the opening to the sensor from being blocked by biofouling, bubbles or algae. The end of the meter with the u-bolt is locked to the other eyebolt and secured at both eyebolts with a cable tie.

A cage is screwed onto the base of each meter to protect the sensors. Each cage is equipped with a U-bolt used to lock the meter to an I-pin. Tags are placed on the handle of each meter citing its intended site of deployment for ease of identification once in the field. Those meters that are deployed vertically have a small crab pot buoy attached to the top end of the meter so that it stays upright in the water column.

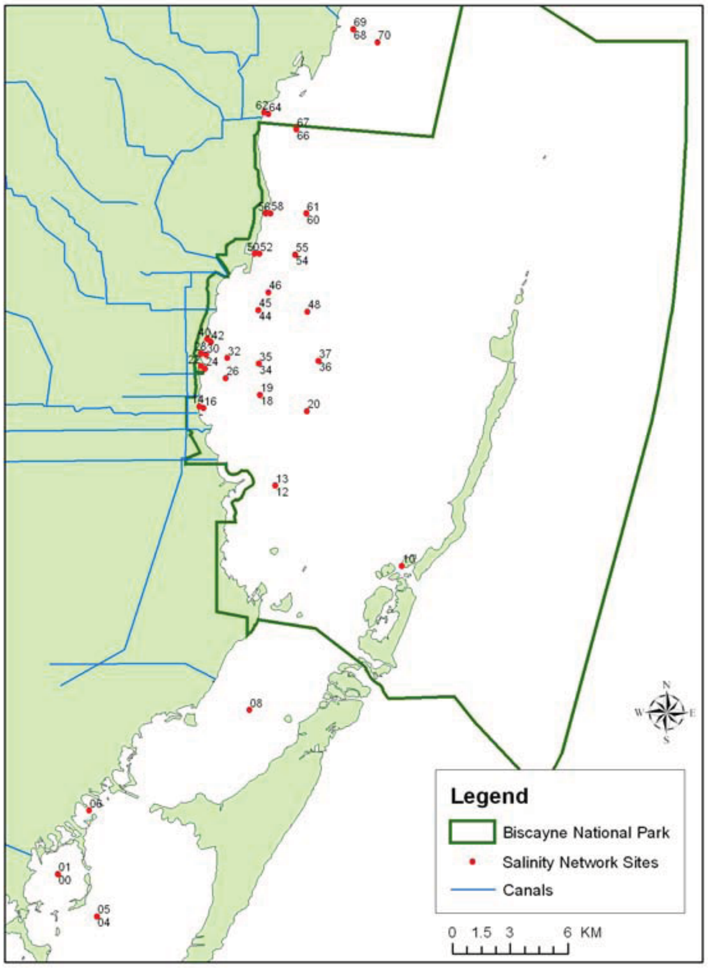

Figure 2: Map showing all the sites in project.

3.1.2 Data collection and Retrieval

YSI 6600 Data Sondes collect continuous conductivity, temperature and depth. These instruments are deployed on a three week rotation schedule. Data is collected in 15 minute intervals. Instruments are overlapped for greater than 4 readings during retrieval/deployment. The retrieved meters are brought back to the lab for uploading of data and post calibration. A post-calibration of instruments is performed at retrieval and a calibration prior to deployment.

3.1.3 Calibration

Instruments undergo post calibration both dirty (just in from the field) and after cleaning. The sensor is placed in the same standard seawater used to calibrate the instrument. A discrete run reports what the meter is reading at present time. Temperature, specific conductivity, depth, and battery levels are recorded onto the calibration sheet (Figure 3), which are later entered into the computer and associated with that particular filename and site. Cell constants are also reviewed and noted on the calibration sheet to ensure there will be no major drift in readings prior to and after calibration.

CALIBRATION DATA SHEET

Date (mm/dd/yy) ____________ Station Number ____________
Instrument Type ____________ Sonde ID Number ____________
Lab Tech ____________ Date Deployed ____________ Set up by:

Calibration Information Conductivity	Calibration Results	Post-Calibration Results PreClean	Clean		
Calibration Standard Value				mS/cm	Date Post-Cal'd:
Carbouy Number					By:
Sensor Reading				mS/cm	
Zero Check				mS/cm	
Cell Constant					
Temperature ^{0} Celsius					
Depth/Pressure					
Battery Voltage					

Notes:

Sample Rate ____________ MIN
Delay Sample time ____________ **(EST)**

DATE RECOVERED ____________

Atmospheric Pressure		
Initial value	Ending value	Difference

DATA FILE NAME ____________

Processing Information To Be Filled in By ERDC

	Pressure	Salinity	Temperature
Sensor Offsets:			
Atmospheric Offset	(ERDC)		

Figure 3: Calibration data sheet.

Post calibration is done twice, once prior to the meter being cleaned of biofouling and then once the meter has been cleaned. The meter is then recalibrated and if necessary, set up to record for the next set of sites. Once calibrated, the instrument is set up in unattended mode with the file name corresponding to site number, instrument number, and date of deployment.

a) Temperature

The temperature probe is checked on a quarterly basis using the laboratory traceable Celsius thermometer. This check is noted in the comment field on the calibration sheet. A temperature reading must be within +/- 0.15 degrees Celsius to be acceptable. If the check does not meet these requirements, the sonde will be checked in a controlled temperature bath. If the sonde still does not prove correct, the associated data will be flagged and the unit will then be sent to the manufacturer for service.

b) Conductivity

The conductivity probe is calibrated by filling the calibration cup with seawater standard and will be adjusted to that value. Conductivity calibrator standard is acquired from YSI Environmental to check the seawater standard intermittently. The calibration is accepted if the sonde reads within +/- 0.5% of the true value of the standard. If the reading does not meet these limits, the problem will be determined and corrected. Conductivity is calibrated using one point. Older technology required two points, because the probes were not linear from zero. The YSI 6600 meets or exceeds advertised conductivity specifications with a single point calibration. However, a zero-check with de-ionized water is done immediately after instrument calibration to ensure proper readings.

c) Depth

Depth is determined using a pressure sensor. Barometric pressure, taken from a reading in the lab is entered into the Coach program and the depth is calibrated to 0 meters. Pressure offset is noted. This additional step was added to ensure the meters were responding over expected measurement range.

d) Weather Data

A portable weather instrument is used to denote deployment time, air temperature, barometric pressure (in mm Hg), and wind speed at the time of retrieval and deployment. Wind direction, wave height and the meter identification number are also recorded onto field data sheets at each deployment site (Figure 4). All the data are entered as metadata. Time is standardized to Eastern Standard Time at the beginning of each deployment trip with the atomic clock in Boulder Colorado. All data are maintained in Eastern Standard Time. Once all meters are deployed within the zone, there is a waiting period of a minimum of one-hour before retrieving the old meter. The waiting period allows a minimum of four-consecutive overlap readings. The meters to be retrieved are then collected, with all relevant environmental data collected as well.

e) Calibration Standards

The conductivity standard is collected by Biscayne Staff and calibrated by the Environmental Lab at Florida International University. This standard is collected in carboys, filtered, and stored at room temperature in the laboratory. The seawater is checked against laboratory-prepared 3.3% potassium chloride solution at a specific conductivity of 50,000 mS/cm (at +/-1%) using the calibration procedures outlined above and in the checklist. This check is performed twice a month by a BISC laboratory technician and noted on the calibration sheet.

The rinse water used in calibration procedures is de-ionized water obtained from a Direct Q Millepore Water Filtration System with a conductivity of 0.0 mS.

After calibration, de-ionized water is used to perform a zero-check. If the readings are not zero when the instrument is placed in the de-ionized water, the meter is recalibrated. The instruments are then prepared for deployment. The lab technicians place the appropriate size protective cage over the probes. The protective cage also serves to ensure that the pressure sensor is at the same distance from the sea floor at each deployment.

RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS

Date: ____________ Field Techs: ______________________

Station #: ____________ Instrument Type: __________ (6000 or 6600)

Instrument ID: _________ **Deployed:** _______ (EST) Filename: __________ Date: _________

Instrument ID: _________ **Retrieved:** _______ (EST) Filename: __________ Date: _________

Conditions at Deployment:		Conditions upon Retrieval:	
Air Temp (C):	____________	Air Temp (C):	____________
Barometric Pressure (in. Hg):	____________	Barometric Pressure:	____________
Est. Wave Height (ft):	____________	Est. Wave Height (ft):	____________
Wind Direction:	____________	Wind Direction:	____________
Wind Speed (k):	____________	Wind Speed (k):	____________

NOTES:

RETRIEVAL AND DEPLOYMENT OF BISCAYNE BAY YSI INSTRUMENTS

Date: ____________ Field Techs: ______________________

Station #: ____________ Instrument Type: __________ (6000 or 6600)

Instrument ID: _________ **Deployed:** _______ (EST) Filename: __________ Date: _________

Instrument ID: _________ **Retrieved:** _______ (EST) Filename: __________ Date: _________

Conditions at Deployment:		Conditions upon Retrieval:	
Air Temp (C):	____________	Air Temp (C):	____________
Barometric Pressure (in. Hg):	____________	Barometric Pressure:	____________
Est. Wave Height (ft):	____________	Est. Wave Height (ft):	____________
Wind Direction:	____________	Wind Direction:	____________
Wind Speed (k):	____________	Wind Speed (k):	____________

NOTES:

Figure 4: Retrieval and Deployment Data Sheet

3.1.4 Data Entry and Transfer

Using YSI Endeco-EcoWatch software, the data are uploaded to the computer. Once connected, the data are uploaded as a data file and exported into a text file. Since salinity is not a variable that can be directly measured, specific conductivity and temperature is used to calculate salinity in the Coach program. According to the YSI Ecowatch Manual, raw conductivity and temperature values are used with each value of specific conductance to generate a value compensated to 25°C. Using a temperature coefficient of 1.91%/C° (TC = 0.0191), the equation is as follows:

Specific Conductance (25°C) = (Conductivity/1 + TC *(T-25))

Once the data have been downloaded off of the sonde, it is imported into Microsoft Excel. Columns for site and filename are added. These columns are added to make graphing easier and to help isolate possible errors caused by instrument malfunctions. A date/time column is also added to associate each data point with a correct time and day when used in graphing and statistical programs. Since the data set contains more rows than excel contains, Microsoft Access is used to create year long data sets.

The data is then uploaded to the Everglades Database, forEVER, where the data undergoes Estimated Linear Interpolation to correct for any data drifts between instrument deployments. It also allows for greater ease in the transfer of data to the DBHydro database for South Florida Water Management District.

Access is also used to create metadata files. These files contain information on weather conditions at deployment and retrieval of the sondes along with information about the calibration of each instrument used at every site. This process makes it possible to see if there were any issues with individual data sondes breaking down on a regular basis because of instrumental errors or if a specific site caused many instruments to break. They also provide weather data for the sites that can be used in future statistical analysis. Raw data are stored on the NPS server, in hard copy, and on a CD.

3.2 Data Verification and Validation

Data are verified and validated before being entered into the Everglades database. Values from instrument calibration and dirty post check are compared to ensure that instrument drift does not exceed the standards set in the Quality Assurance Systems Requirements (QASR) manual (specific conductance $\pm$ 5%). Overlap readings, are also compared ensuring that readings are consistent at each site with no loss of accuracy when instruments are exchanged. If the data does not meet these criteria, it will be coded appropriately.

3.2.1 Data Evaluation

The evaluation of the data occurs after the raw data downloaded from the YSI. The purpose is to ensure the data sent is reporting the correct location and is within acceptable limits according to parameter. This also confirms that the instrument is recording properly. The evaluation of data is accomplished through a series of reviews and checks. The results are initially reviewed by the technician performing the data download to spot any outliers and to confirm that the sonde is recording properly. After final review the project manager then decides if the data is acceptable.

3.2.2 Data Validation

BISC review and validate the raw data. This is done by a comparison of the results of simultaneous data during dual deployment and post deployment checks. If valid, the results become part of the BISC laboratory database. The naming convention for each data file is as follows: LL = site/location number, NN = sonde identification number, M = month represented by a letter, DD = day, Y = last digit of the year. The naming convention ensures that all instruments can be tracked with their individual files to check for instrument error. The naming convention also allows each file to be individually identified later should the file be misplaced or lost and allows any site errors to be tracked through the data.

Data are then graphed to look for outliers and data anomalies. Missing values are checked and indicated with an "M" code.

3.3 Measurable Results

Written quarterly progress reports are submitted to the project manager.
The collected information are analyzed and annual reports are prepared. Cumulative annual reports include: (1) description of field activities and methods employed; (2) data provided to users; (3) analyses of the data; and (4) project results (in the form of tables, figures, and maps) and their interpretation as they relate to CERP and the adaptive management process. Annual reports will initially be given to the project manager in Microsoft Word format; the final version shall be converted to a .pdf file after approval and acceptance by the project manager.

The principal investigator will participate in development of the Annual AT System Status Report when requested and will provide 3 copies of a final report that will include at minimum the following: methods, results and statistical analyses of sampling efforts; conclusions and lessons learned (3 CD-Rom or DVD copies of raw data will also be included). Interpretation of results as they relate to CERP hypotheses from the MAP, the overall effort of CERP implementation, and the adaptive management process will be the major features of the final report.

3.4 Quality Assurance and Quality Control

Quality control procedures are those steps taken by laboratory and field staff to insure accuracy in data collection and reliability of the data itself.

3.4.1 Field Quality Control Checks

Quality control checks performed in the field are the following:

1. Field sheets are used to record which sonde is being deployed and which sonde is being retrieved. Each sonde has a unique identification number displayed on the exterior in black marker. These sheets are then placed in the field logbook. The format used for this data sheet is shown in Figure 4**.**
2. Field technicians are to verbally confirm sonde identification upon deployment and retrieval to another field technician in the boat who records this on a field sheet.
3. Sondes are dual deployed for a minimum of 1-hour in order to have simultaneous data (four concurrent samples) recorded at each site. Before leaving the lab, field technicians will need to check the clock in the laboratory for the correct time as this is the clock the sondes are set to. This is a necessary step so that field technicians can be certain of when the data sonde is recording.
4. At horizontal deployments, the field technician must place the data sonde so that the conductivity probe is positioned on its side, not directly up or down. This prevents sediment from entering the probe and also keeps air bubbles from getting trapped in the probe.

3.4.2 Laboratory Quality Control Checks

The lab technician will be responsible for checking field log for discrepancies in deployment or retrieval procedures upon downloading the data. It is also necessary to monitor individual instrument response documented in the calibration and/or maintenance logbook should such problems arise.

The procedures for post calibration check are the same as the calibration procedures shown in Figure 5. Post calibration procedures will be performed after data is downloaded. Any variance should be recorded on original calibration sheet to show possible drift in the collected data. If a problem is found during post calibration and cannot be resolved by the lab technician, the instrument will be removed from use and serviced. This will be documented in the maintenance log.

Calibration Checklist for 6- Series CTDs	
	SPECIFIC CONDUCTIVITY
	Dry sensor with cloth
	Collect two samples of calibrated seawater, noting the carbuoy #
	Rinse the sensor head with the first sample of calibrated seawater by dipping the probes into the rinse multiple times
	Use a ring stand and clamp to secure the conductivity probe in the second calibration standard sample, making sure the waterline is at the appropriate height.
	In Ecowatch, select 2 – **Calibration**, then 1—**Conductivity**, then 1 – **Specific Conductivity**
	Input the specific conductivity of the standard.
	Allow temperature to equilibrate before calibration
DEPTH	
	Record barometric pressure
	In Ecowatch, select 2 – **Calibration**, then 2 – **Pressure/Abs**
	Input 0.0
	Allow depth to equilibrate before calibration
	After calibration, rinse with de-ionized water and store for deployment
INSTRUMENT DEPLOYMENT	
	If sonde unit passes all checks, assign it to the next deployment station to replace an instrument of similar type
	Use Ecowatch to open menu screen for unattended sampling
	Select 4 – **Status** and select **Date and Time**. Check time against atomic clock. Update if necessary.
	Select 1 – **Interval** and enter 00:15:00 (15 minutes)
	Select 2 –**Start Date** to set the date that data will begin to log to sonde memory
	Select 3 – **Start Time** to set the time that data will begin to log to sonde memory
	Select 4 – **Duration** days = 365
	Select 5 – File and enter the **file name** using the following data file format: LLNNMDDY (Where LLNN is the station identifier – Site **L**ocation and YSI Instrument **N**umber)
	Select 6 – **Site** and enter site number
	Select 7 – **Battery** to make sure that the voltage is suitable for the length of the study
	Make sure you select C – Start Logging to accept your entries and start sonde!

Figure 2: Example of Calibration Checklist for YSI 6600 instruments.