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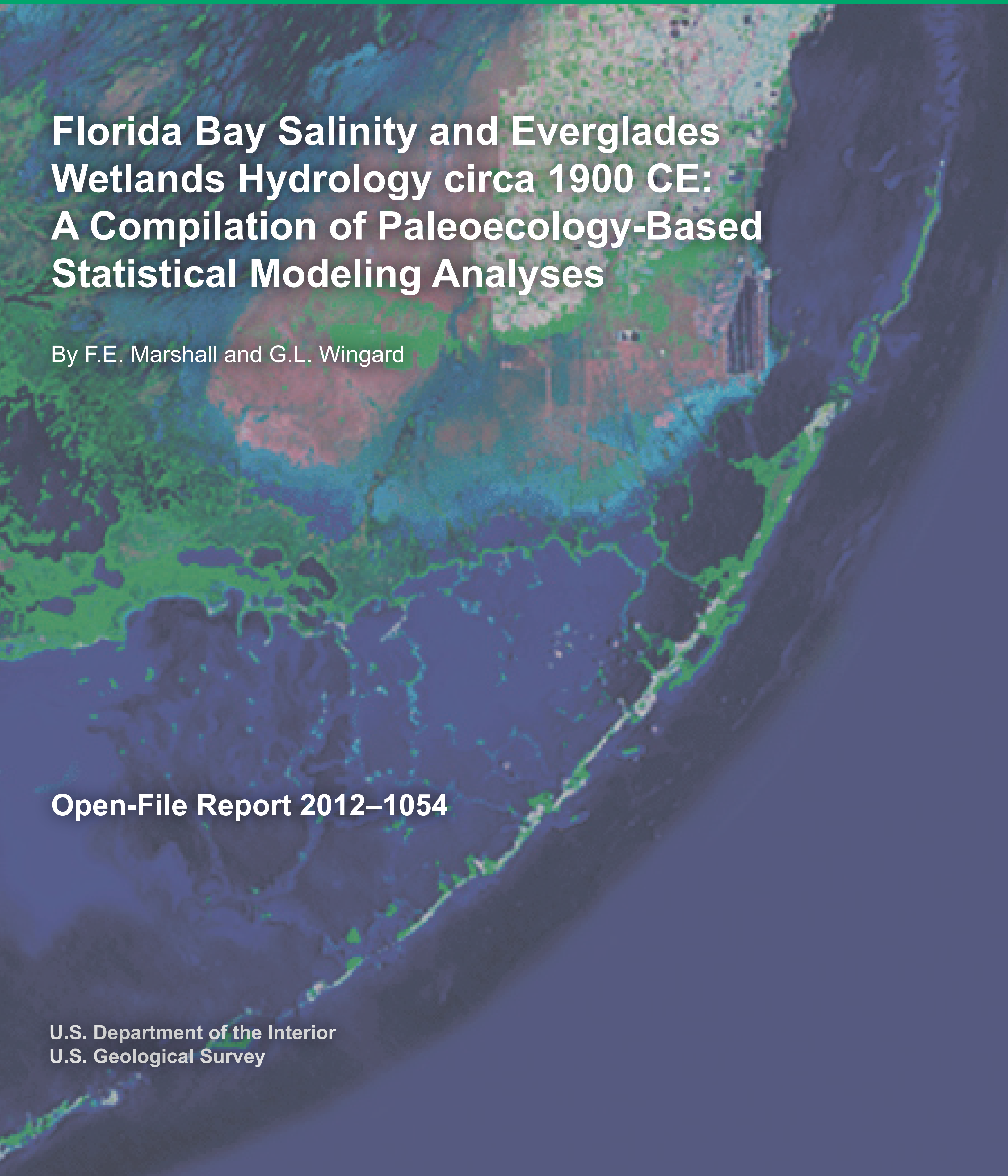

Florida Bay Salinity and Everglades Wetlands Hydrology circa 1900 CE: A Compilation of Paleoecology-Based Statistical Modeling Analyses

By F.E. Marshall and G.L. Wingard

Open-File Report 2012–1054

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Abstract

Throughout the 20th century, the Greater Everglades Ecosystem of south Florida was greatly altered by human activities. Construction of water-control structures and facilities altered the natural hydrologic patterns of the south Florida region and consequently impacted the coastal ecosystem. Restoration of the Greater Everglades Ecosystem is guided by the Comprehensive Everglades Restoration Plan (CERP), which is attempting to reverse some of the impacts of water management. In order to achieve this goal, it is essential to understand the predevelopment conditions (circa 1900 Common Era, CE) of the natural system, including the estuaries. The purpose of this report is to use empirical data derived from analyses of estuarine sediment cores and observations of modern hydrologic and salinity conditions to provide information on the natural system circa 1900 CE. A three-phase approach, developed in 2009, couples paleosalinity estimates derived from sediment cores to upstream hydrology using statistical models prepared from existing monitoring data. Results presented here update and improve previous analyses. A statistical method of estimating the paleosalinity from the core information improves the previous assemblage analyses, and the system of linear regression models was significantly upgraded and expanded.

The upgraded method of coupled paleosalinity and hydrologic models was applied to the analysis of the circa-1900 CE segments of five estuarine sediment cores collected in Florida Bay. Comparisons of the observed mean stage (water level) data to the paleoecology-based model's averaged output show that the estimated stage in the Everglades wetlands was 0.3 to 1.6 feet higher at different locations. Observed mean flow data compared to the paleoecology-based model output show an estimated flow into Shark River Slough at Tamiami Trail of 401 to 2,539 cubic feet per second (cfs) higher than existing flows, and at Taylor Slough Bridge an estimated flow of 48 to 218 cfs above existing flows. For salinity in Florida Bay, the difference between paleoecology-based and observed mean salinity varies across the bay, from an aggregated average salinity of 14.7 less than existing in the northeastern basin to 1.0 less than existing in the western basin near the transition into the Gulf of Mexico. When the salinity differences are compared by region, the difference between paleoecology-based conditions and existing conditions are spatially consistent.

Introduction

The Greater Everglades Ecosystem of south Florida includes Everglades National Park (ENP), which has been recognized worldwide for its unique characteristics and species. ENP has been designated an International Biosphere Reserve, a World Heritage Site, and a Wetland of International Importance (Davis and Ogden, 1994). This unique ecosystem has been impacted by water management practices in south Florida. Drainage projects for flood control and land reclamation beginning around the start of the 20th century altered the natural hydrologic and salinity patterns and negatively impacted the biota (Davis and others, 2005; McIvor and others, 1994; Ogden and others, 2005; Sklar and others, 2005; Willard and others, 2006). The reduction in freshwater stored upstream has caused the saltwater-freshwater transition zone to migrate landward (Parker and others, 1955). In the estuaries, particularly Florida Bay, average salinities have increased measurably, and this increase has been attributed to this reduction in freshwater flow (McIvor and others, 1994; Rudnick and others, 2005).

Restoration of the Greater Everglades Ecosystem was authorized by Congress in the Water Resources Development Act of 2000 and is guided by the Comprehensive Everglades Restoration Plan (CERP) (U.S. Army Corps of Engineers, 1999, 2000). The CERP was developed to address, in part, the issues surrounding current water management in south Florida. The primary CERP goal is to restore the timing, quantity, quality, and distribution of freshwater to the remaining parts of the original ecosystem so that they approximate the predevelopment conditions as closely as possible. If successful, the restored result will be flow and stage (water level) in the wetlands and a salinity regime in Florida Bay similar to a natural Greater Everglades Ecosystem. The Southern Coastal System Subteam (a CERP multiagency group) is tasked with developing performance measures and targets for restoration of the southern estuaries, including Florida Bay, and it has identified salinity as “the most important physical parameter in determining species and community composition in south Florida’s coastal waters.” (See *http://www.evergladesplan.org*.)

To focus on the need to develop restoration performance measures and targets based on the natural system hydrology and salinity, a method was developed to couple paleoecologic data with linear regression models derived from current system hydrology (Marshall and others, 2009). Since 2009, the method of deriving the paleosalinity estimates has been improved and the system of hydrologic models has been upgraded and enhanced. This report presents the results of a reexamination of the single core discussed in Marshall and others (2009) and an additional four sediment cores collected in Florida Bay using the improved methods.

Study Area and Data

The study area for this project is Everglades National Park (ENP), located at approximately 25^{o} to 26^{o} N. latitude and 80^{o} 30’ to 81^{o} W. longitude. Included within the area of study are freshwater marshes, mangrove ecotones, and the Florida Bay estuary (fig. 1). Outside of the boundaries of ENP, the construction of extensive drainage features began circa 1900 and continued into the 1970s to reclaim south Florida wetlands for agricultural and urban development projects. Numerous studies have shown that this alteration of the natural hydrolgy has negatively impacted the unique Everglades ecosystem (Davis and Ogden, 1994; Schaffranek and others, 2001; Davis and others, 2005; Ogden and others, 2005; Renken and others, 2005; Sklar and others, 2005; Willard and others, 2006; Willard and Bernhardt, 2011).

Three types of data are utilized in the estimation of historical hydrologic and salinity conditions in the Everglades ecosystem.

1. Paleoecologic data – These data are obtained from sediment cores collected by the U.S. Geological Survey (USGS) from locations in Florida Bay. Over 20 sediment cores have been collected in Florida Bay by the USGS since 1994 (Wingard and others, 2007) and from these, 5 were selected for the analyses: Crocodile Point, Rankin Lake, Russell Bank, Taylor T24, and Whipray Basin (fig. 1A; table 1). All paleoecologic data related to the project can be found at *http://sofia.usgs.gov/exchange/flaecohist/*.

2. Hydrologic monitoring station data – A number of long-term hydrologic monitoring stations have been established in the Everglades freshwater marshes and the mangrove transition zone. The stage data are collected by ENP and reported to the South Florida Water Management District (SFWMD) (fig. 1A; table 2). Three of the stage stations – CP (Craighead Pond), P33, and TSBstage (stage monitoring station where the Taylor Slough Bridge flow is monitored) – are considered to be "primary" stage stations because of their importance in simulating hydrologic conditions in the freshwater marshes as well as the salinity in Florida Bay.

   For this project, upstream freshwater flows into the Everglades wetlands are measured (1) along Tamiami Trail (all data collected by SFWMD) and (2) at the headwaters of Taylor Slough at the ENP Bridge (collected by ENP and reported to SFWMD). The Shark River Slough (SRS) flow value represents a water budget calculated from six stations along Tamiami Trail (the northern border of the ENP) as follows: SRS = [(S12A +S12B + S12C + S12D) + S333 - S334]. These stage and flow data are available on the SFWMD DBHYDRO data portal (*http://www.sfwmd.gov/org/ema/dbhydro/index.html*). Downstream flow data for the mangrove creeks flowing into northeast and central Florida Bay are collected by the USGS and are available on the South Florida Information Access (SOFIA) Web site (*http://sofia.usgs.gov/*). Flow monitoring station locations are shown on figure 1A and presented in table 3.

3. Salinity monitoring station data – A number of long-term salinity monitoring stations have been established in Florida Bay. Data collected by two programs are used for the paleoecology-based evaluations. The first is the ENP Marine Monitoring Network (MMN), which has 15 fixed-structure salinity monitoring stations in Florida Bay (table 4; fig. 1A). Data at these stations are collected at 10-minute increments and have been averaged to daily values for the purposes of model development. Details about these data can be found in Everglades National Park (1997a, b) and Smith (1997, 1998, 1999, 2001), and the data are available from South Florida Natural Resources Center (SFNRC) by request (EVER_data_request@nps.gov).

   A second long-term salinity dataset for Florida Bay is the South Florida Coastal Water Quality Monitoring Network. The network was initiated in 1993 by the Southeast Environmental Research Center at Florida International University (FIU) (fig. 1B; table 5) (Jones and Boyer, 2001). These data are monthly grab samples from specific locations in the bay that are analyzed for a variety of water quality constituents, including salinity. Beginning with fiscal year 2010, the monitoring network was assumed by SFWMD, and the number of monitoring sites within the network was reduced (D. Rudnick, SFWMD, oral commun., 2010); these data are referred to herein as the FIU/SFWMD data.

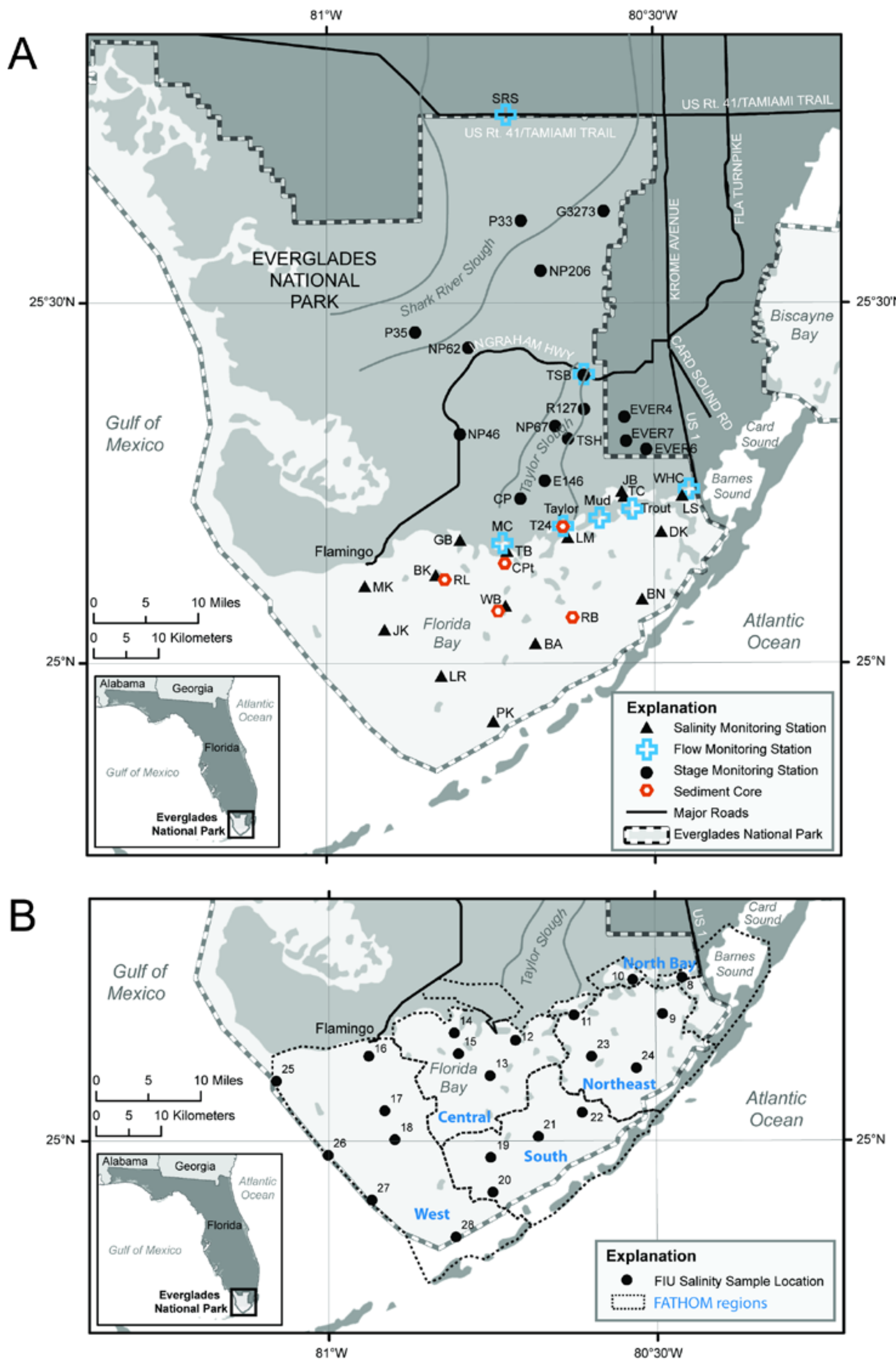

Figure 1. A. Map of Everglades National Park (ENP) showing the location of the daily ENP Marine Monitoring Network salinity stations, the USGS core locations in Florida Bay, and the ENP and South Florida Water Management District (SFWMD) stage and flow monitoring stations in the Everglades wetlands. B. Map of Florida Bay showing the location of the monthly Florida International University (FIU)/SFWMD stations and the aggregated FATHOM basins (Briceño and Boyer, 2010).

Note that the Practical Salinity Scale is used throughout this report, and therefore salinity has no units (UNESCO, 1985). One Practical Salinity Unit (psu) is approximately the same as one part per thousand (ppt).

Data (salinity plus other water quality components) from the South Florida Coastal Water Quality Monitoring Network were used for a principal components analysis of Florida Bay (Briceño and Boyer, 2010) that subdivided the bay into five regions. These regions are based on the aggregated basins from the FATHOM mass balance model developed by Cosby and others (2010) (fig. 1B). The individual ENP MMN stations and the FATHOM regions are used in the development of the salinity targets and performance measures for the Southern Coastal Systems Subteam of RECOVER (REstoration COordination and VERification) and therefore are important considerations in the analyses discussed in this report.

Methods

Each of the five sediment cores was analyzed using a three-phase approach (fig. 2). The methodology was originally developed using the Whipray Basin sediment core, and the details are presented in Marshall and others (2009). The initial analyses for each of the five cores discussed herein were conducted using semiquantitative paleosalinity assessments, limited data for hydrology and salinity model development, and preliminary statistical models to couple the paleosalinity estimates based on faunal assemblage analysis with regression models (Marshall and others, 2009; Marshall, 2010a, b). For this report, the databases used for model development were updated and the period of record extended. In addition, a more complex statistical method was employed for the faunal paleosalinity estimates. These updates and improvements are described below.

Phase I – Develop the Paleosalinity Time Series

Five cores were selected for the paleosalinity analysis from the subset of cores available (fig. 1A; table 1). The criteria for selection were (1) location near a salinity monitoring station; (2) a reliable age model (ideally based on lead-210, pollen, and carbon-14; Whipray Basin core is the exception with no pollen analysis); and (3) statistically significant molluscan fauna present in the circa-1900 CE segment of the core (ideal >100 individuals). The age models (Wingard and others, 2007) were used to identify the core segments representing the circa-1900 CE time period, and the paleosalinity estimates for these portions of the core were extracted for use with the linear regression models.

The first step in Phase I is to obtain paleoecologic data from the core segments representing circa 1900 CE (fig. 2). The initial sediment core analyses relied on a semiquantitative assessment of the salinity regimes represented by the molluscan fauna present in each core segment (see Marshall and others, 2009, for example). In areas such as Florida Bay, however, where most species are euryhaline, this method often produces a general “polyhaline assemblage” assessment – the common salinity regime of overlap for the wide-ranging species. This method is not useful in distinguishing subtle differences in salinity regimes between sites. To overcome this problem, a statistical method, based on the modern analog approach (Hutson, 1979), was developed and used on the five cores discussed in this report.

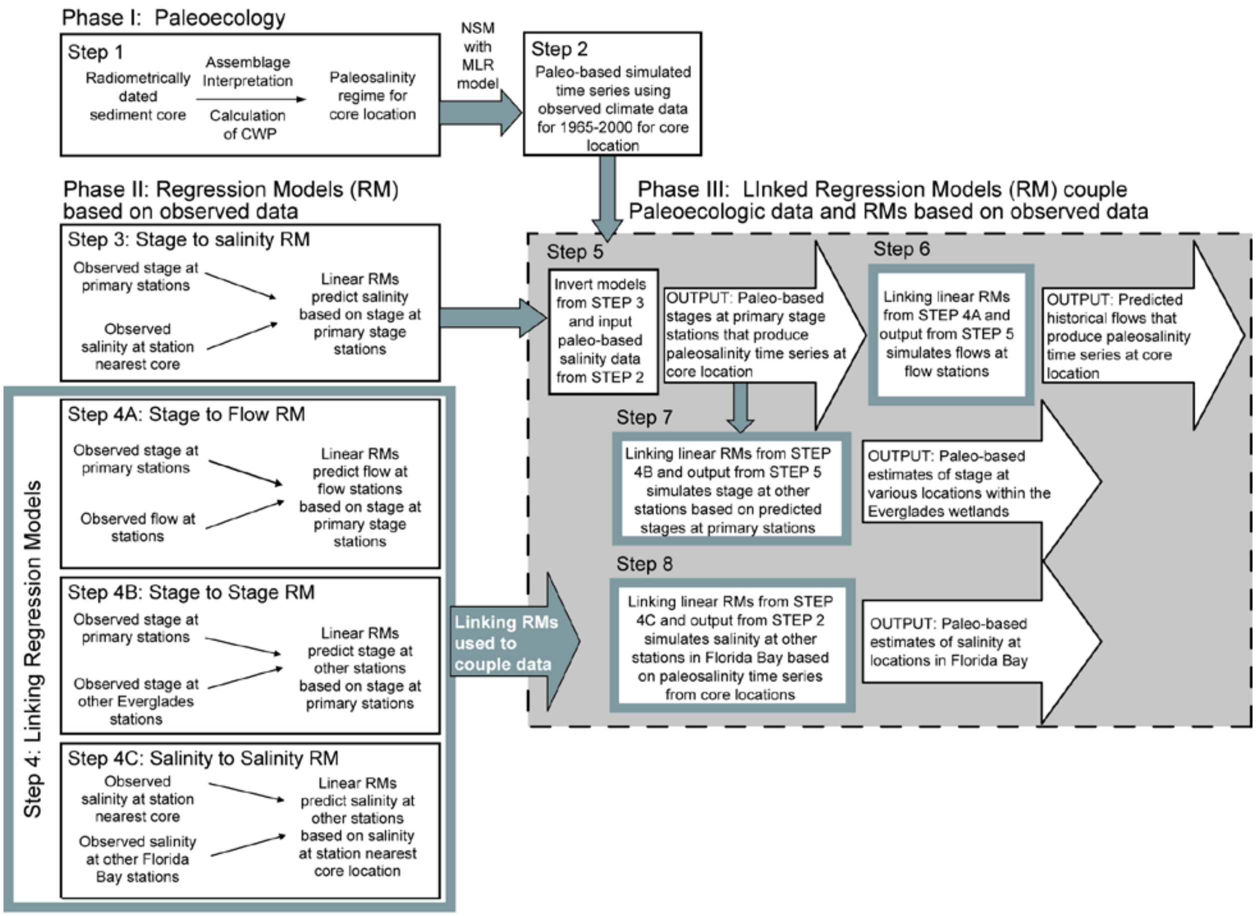

Figure 2. Flowchart indicating the steps involved in coupling the paleoecological data from a single core (Phase I) to the regression models (RMs) (Phase II) to produce estimates of flow, stage, and salinity conditions (Phase III) prior to disturbance of the natural drainage in the Greater Everglades Ecosystem. These steps are repeated for each core analyzed. The primary stage stations referred to below are CP, P33, and TSBstage. The outputs are daily averages for the Rankin Lake (RL), Taylor T24, and Whipray Basin (WB) cores, and monthly averages for the Crocodile Point (CPt) and Russell Bank (RB) cores, as determined by the salinity monitoring station associated with each core (see table 1). CWP, cumulative weighted percent; NSM, Natural System Model; MLR, multiple variable linear regression.

Details of the method (referred to as the cumulative weighted percent, or CWP) and a test of its ability to accurately predict salinity are presented in Wingard and Hudley (2011) and summarized here. After cores are collected they are cut into 2-centimeter (cm) increments, and individual increments are analyzed for their molluscan faunal content. The preservational state of the faunal remains is characterized, and the worn and fragmented specimens are excluded from the analyses. The molluscan fauna in the core samples are then compared to the modern mollusk dataset, which includes records of the occurrence and observed salinities of living mollusks in the south Florida estuaries (appendix; see also Wingard and Hudley (2011) for summary data, or *http://sofia.usgs.gov/exchange/flaecohist/* for raw data). The modern data are divided into two sets – the CONFID and the FULL. The CONFID dataset contains species with 10 or more salinity observations and a 95 percent confidence interval of <5 salinity units ± the mean salinity; whereas FULL includes any taxa for which we have salinity data. The average salinity from the FULL and (or) CONFID dataset for each species in a core sample is multiplied by the percent abundance of the species (adjusted to 100 percent when the no-modern-analog data are excluded), these values are summed for all the species in a sample interval, and the resulting value divided by 100 to produce an average salinity estimate for that interval of the core (appendix; steps are illustrated in Wingard and Hudley, 2011, fig. 2).

An optional additional step in the CWP is to add species weighting factors to the species in the CONFID dataset, based on observations and descriptive statistics of species preferences. The goal is to refine the data on estuarine species that have the ability to tolerate a wide range of salinities. Two separate sets of species weights were developed – nearshore and basin (Wingard and Hudley, 2011). The weighting factors enter the calculations for the CONFID dataset at the step where the average salinity value for each species is multiplied by its adjusted percent abundance. The data for each species in each sample are again summed and divided by 100 and result in the SW-CWP – the species weighted salinity estimate. These variations create four possible combinations of CWP average salinity estimates that can be used as output to the linear regression models: CWP FULL, CWP CONFID, SW-CWP Nearshore, and SW-CWP Basin (appendix).

The suite of four mean CWP and SW-CWP estimates was calculated for the circa-1900 CE interval in each core (table 6). Only the CWP CONFID, however, was used as output to the linear regression models because we have higher confidence in salinity estimates associated with the CONFID versus FULL modern dataset (Wingard and Hudley, 2011). In addition, using the SW-CWP requires a greater number of assumptions be made about which weighting factor to apply. We feel the CWP CONFID represents a less manipulated, more conservative estimate of the paleosalinity.

Step 2 in Phase I develops a paleosalinity time series for the salinity monitoring station located nearest to each sediment core (fig. 2). The time series are derived from multiple variable linear regression (MLR) models (Marshall and others, 2011) using hydrologic data from the SFWMD Natural System Model (NSM), in combination with existing wind and Key West sea surface elevation data for 1965-2000 as model input. The NSM/MLR salinity values are adjusted using the CWP CONFID mean paleosalinity estimates from each core. For the MMN or FIU/SFWMD station associated with each core, equal bias is incorporated into each value of the 1965 to 2000 NSM/MLR time series such that the average NSM/MLR salinity is the same as the average paleosalinity estimates (table 6). Equal bias adjustment means that the same value is added to or subtracted from each salinity value from the NSM/MLR salinity time series (table 6, last column). This provides a simulated day-to-day salinity variability to the paleosalinity average estimates at stations associated with the Whipray Basin, Rankin Lake, and Taylor T24 cores or monthly salinity variability at stations associated with the Russell Bank and Crocodile Point cores. For the Russell Bank analysis the adjusted NSM/MLR time series was modified further by linear interpolation using the distance of the sediment core site from the FIU/SFWMD22 and FIU/SFWMD23 monitoring stations.

The underlying assumption in the use of the NSM model hydrologic output and observed wind and sea surface elevation data of 1965-2000 is that the regional climate associated with the hydrology and salinity during the circa-1900 period was similar to the climate of 1965-2000; therefore the natural (unmanaged) hydrology and salinity conditions should be similar to the circa-1900 hydrology and salinity. The long-term regional precipitation data in the upper watershed of the Everglades (NCDC Division 4) indicate that precipitation patterns were similar for the periods 1895-1950 and 1960-2000 (Enfield and others, 2001; Basso and Shultz, 2003). Analysis of plots of the Atlantic Multidecadal Oscillation (AMO) showed that the AMO conditions for 1965-2000 were also similar to the AMO conditions for the approximately 30-year period beginning around 1900 (Enfield and others, 2001; Obeysekera and others, 2006).

Phase II – Develop the System of Hydrology and Salinity Regression Models

In the second phase of the methodology, systems of regression models are developed from observed hydrololgy and salinity data for use with each sediment core analysis (fig. 2). There are four sets of simple and multiple linear regression models that link paleosalinity estimates to the upstream hydrology (stage and flow) and salinity at other stations throughout Florida Bay: stage-to-salinity, stage-to-flow, stage-to-stage, and salinity-to-salinity models (fig. 2, steps 3 and 4).

The stage-to-salinity regression models that are inversed are unique to each sediment core evaluation; hence there are five different stage-to-salinity models for the primary stage stations. For the upgraded stage-to-salinity models (step 3, fig. 2), the trend in the observed salinity data (tables 4 and 5) used for model development was statistically significant and was therefore included in the upgraded models (table 2 for stage). Because the inversed stage-to-salinity models are the first models in the linked modeling system, accounting for the salinity trend in this manner incorporates into the model the effects of sea level rise as well as any other trend in in the salinity data.

The stage-to-flow models are common to all evaluations (step 4A, fig. 2). For stage-to-flow relationships, new multiple linear regression models were developed for Shark River Slough at Tamiami Trail (SRS), Taylor Slough at Taylor Slough Bridge (TSB), and monitored tidal creeks in the mangrove fringe of north Florida Bay using the observed stage values at CP, P33, and TSB. For the new stage-to-flow models, stage values were averaged to monthly values, then squared as an independent variable transformation resulting in a significant improvement in model goodness-of-fit. Squared, cubed, and fourth-power stage variables were evaluated for use in the flow models along with linear stage terms and the linear trend. The stage-to-flow models that included squared independent variable stage terms provided the highest R^2 and the least amount of error (over- or under-estimation) of simulated high and low flow values for calibration/verification runs. The transformed (squared) stage values were then used with lagged (previous month) and unlagged (same month), nontransformed stage values to develop the updated MLR flow models. Coefficents in the flow regession models remained linear, maintaining the linear regression structure of the multiple variable model.

Stage-to-stage models also are common to all evaluations (step 4B, fig. 2). They are simple linear regression models between the three primary stage stations (CP, P33, and TSBstage) and other stage stations in the freshwater marsh and mangrove fringe. These models are common to all five core evaluations and remain unchanged from the original core evaluations.

Similar to the set of stage-to-salinity models (step 3, fig. 2), the set of salinity-to-salinity models also is unique to each sediment core evaluation (step 4C, fig. 2). This means that different sets of salinity-to-salinity models were developed for each core analysis. For Whipray Basin, Rankin Lake, and Taylor T24 core sites, 15 models were developed using MMN daily salinity station data (table 4), and for Russell Bank and Crocodile Point core sites, 21 models were developed using the FIU/SFWMD monthly salinity station data (table 5).

Phase III – Link Paleosalinity Time Series to System of Hydrology and Salinity Models to Produce Paleoecology-Based Stage, Flow, and Salinity

For Phase III, the paleoecology-based salinity time series values developed in Phase I for each of the five sediment core analyses were input to the system of models developed in Phase II (fig. 2). This produces spatially comprehensive time-series estimates of paleoecology-based stage and flow in the Everglades wetlands and salinity throughout Florida Bay. The specific model-based outputs are as follows:

1. Daily and monthly mean stage at CP, P33, and TSBstage, and daily stage at all other stage stations (tables 7 and 8);
2. Monthly average flow at all flow stations (table 8);
3. Daily salinity at all MMN stations in Florida Bay for the Whipray Basin, Rankin Lake, and Taylor T24 cores (table 7);
4. Monthly salinity at all FIU/SFWMD stations in Florida Bay for the Russell Bank and Crocodile Point cores (table 8); and
5. Daily or monthly mean salinity averaged spatially over the MMN and FIU/SFWMD stations, respectively, in each FATHOM region (tables 7, 8, and 9).

For each sediment core analysis, mean values for these outputs were compared by parameter and station to observed data to quantify the difference between the existing conditions and the paleoecology-based conditions (tables 7 and 8).

Results

The systems of models in Phase III produce time series simulations of paleoecology-based stage, flow, and salinity. Paleoecology-based simulations are estimates of the hydrologic conditions needed in the Everglades freshwater marshes to produce salinity conditions in Florida Bay that were similar to the circa-1900 period represented by the mollusks in the analyzed core segments, before drainage projects were implemented in south Florida. The underlying assumption is that the climatic conditions of 1965-2000 were similar to the circa-1900 period, for which there is solid supporting evidence.

Simple summary statistics were developed for each paleoecology-based time series of hydrology and salinity data, for each core evaluation. Tables 7 and 8 compare the mean and standard deviation for observed data and paleoecology-based hydrology and salinity model system output for each of the sediment core analyses, for equal length periods. There is general consistency in the mean values for each parameter though there is variation in the individual estimates. All paleoecology-based mean values for stage and flow parameters in tables 7 and 8 are greater than the observed data when compared over periods of equal length. Similarly, all paleoecology-based mean values for salinity in tables 7 and 8 are less than the mean of the observed data, for equal length periods of comparison.

When the differences between paleoecology-based parameters and observed data are compared for the daily analyses (table 7), the average paleoecology-based stage ranges from 0.6 to 1.6 feet higher, with the smallest increase at EVER7 and the largest increase at TSBstage compared to observed data. Paleoecology-based flow increases are highest for SRS (range of increase: 401-2539 cfs) and Trout Creek (range of increase: 470-1460 cfs) compared to observed data (tables 7 and 8). The paleoecology-based flow increases for the other tidal creeks are much smaller, with increases ranging from about 48 – 218 cfs (tables 7 and 8). The smallest reduction in paleoecology-based salinity values compared to observed data (about 1-3 salinity units) is at the western stations, which receive the greatest influence from the open connection to the Gulf of Mexico (tables 7 and 8). The largest differences in the paleoecology-based values are seen at the nearshore embayments with Terrapin Bay (TB) averaging 11 salinity units less.

When the differences between paleoecology-based stage and observed data for the monthly analyses are compared, the average increase in stage is between 0.3 and 1.2 feet (table 8), generally less than the daily-based stage increase data in table 7. Monthly average flow increases are also smaller than the daily flow increases. However, average salinity decreases for monthly based analyses are similar to the daily based average decreases. When the average salinity decreases are compared after aggregation to FATHOM regions (table 9), the salinity decreases are similar for both daily and monthly simulations compared to observed data, except for the Crocodile Point simulation of the FATHOM Northeast Bay region.

Summary and Future Efforts

In this study, five previously completed efforts coupling paleoecology and statistical modeling were revisited with updated methods that reduced the uncertainty in the paleoecology-based outputs and expanded the spatial domain of the model system simulations. This allowed all of the sediment cores to be analyzed similarly and consistently. The CWP approach for estimating average salinity conditions for a core segment provided a more quantitative method for characterizing the paleosalinity information, compared to the initial molluscan assemblage evaluations presented in Marshall and others (2009). Although the three-phase methodology for simulating paleoecology-based hydrology and salinity parameters did not change, the system of models within the methodology was updated, new models were developed, and the model system was applied uniformly across the sediment cores. While there is general consistency among the average values of model-generated, paleoecology-based hydrology and salinity parameters, there are also differences between cores. Identified sources of uncertainty include uncertainty in the core-based CWP paleosalinity estimates, uncertainty generated by the level of correlation between the data from a salinity station associated with a core and the data from hydrology or salinity stations that are being simulated by the model, and uncertainty in the model system output based on the capability of the individual models to simulate the hydrology and salinity parameters.

The products of this effort are five independent estimates of paleoecology-based Everglades hydrology (stage and flow) and Florida Bay salinity circa 1900 CE. The next step is to compare the ability of each model to simulate observed conditions (goodness-of-fit) by using weighted output from the model systems. The result will produce estimates of Everglades freshwater stage and flow and Florida Bay salinity that combine the information obtained from each independent core analysis. A synthesis of the data presented here will provide the Southern Coastal Systems Subteam of RECOVER with empirically based information on the natural system hydrology, including the historical salinity patterns in Florida Bay and the associated hydrologic conditions in the Everglades wetlands required to produce those salinities. This information is an important component of setting salinity targets and performance measures for restoration.

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Table 1. Sediment core locations, sample data, and associated salinity monitoring stations used in the analyses. (Data on individual samples available in appendix. Cores shown on figure 1A.)

Sediment Core Name	Map Symbol	Core ID	North Latitude (NAD83)	West Longitude (NAD83)	Depth in cm of interval(s) used in analysis	No. specimens in original sample(s)2	Percent of original included in CONFID3	Percent of original included in FULL3	Associated Monitoring Station1
Crocodile Point	CPt	FB295 16B	25:8:19.32	80:43:41.16	48-58	433-446	87-89	95-97	FIU/SFWMD 12
Rankin Lake	RL	GLBW601 RL1	25:06:58.14	80:49:10.56	32-42	331-1876	77-80	83-88	MMN BK
Russell Bank	RB	FB295 19B	25:3:50.04	80:37:29.28	92-110	113-203	29-53	76-87	FIU/SFWMD 22
Taylor T24	T24	FB594 24	25:11:24	80:38:21.48	38-44	187-210	77-80	86-88	MMN LM
Whipray Basin	WB	FB697 25B	25:4:16.32	80:44:18.6	36-46	39-581	35-53	90-97	MMN WB

[1] Monitoring station information is shown in tables 4 and 5.

[2] Number of mollusk specimens in original sample, excluding worn and fragmented specimens, prior to removing no-analog species.

[3] See text for discussion, section "Phase I."

Table 2. Information on stage station locations included in the analyses. Data collected by Everglades National Park. (Stations shown on figure 1A.)

Stage Station Name	North Latitude (NAD83)	West Longitude (NAD83)	Region	Ground Surface Elevation, ft NGVD29	Mean Stage Value, POR, ft NGVD29[1]	Number of Days in POR	Starting Date of Record
CP	25:13:38	80:42:14	Transition Zone	-0.12	1.2	10669	10/1/1978
E146	25:15:13	80:40:01	Taylor Slough	0.3	1.2	5426	3/24/1994
EVER4	25:20:32	80:32:42	Transition Zone	1.8	2	7599	11/10/1993
EVER6	25:17:49	80:30:42	Transition Zone	1.5	2	6162	12/24/1991
EVER7	25:18:31	80:32:33	Transition Zone	1.9	2.2	5934	12/24/1991
G3273	25:37:35	80:34:33	Shark River Slough	7	6	9215	3/14/1984
NP206	25:32:38	80:40:20	Shark River Slough	6	5.24	11966	1/1/1978
NP46	25:19:05	80:47:46	Transition Zone	1.3	1.43	11035	9/16/1998
NP62	25:26:17	80:46:59	Shark River Slough	4.2	2.45	13199	9/16/1988
NP67	25:19:45	80:39:02	Taylor Slough	3.4	2.14	5795	1/1/1991
P33	25:36:48	80:42:09	Shark River Slough	4.9	5.99	20358	2/15/1953
P35	25:27:34	80:51:53	Shark River Slough	0.83	1.62	20335	2/16/1953
R127	25:21:11	80:36:24	Taylor Slough	1.5	2.25	8529	4/11/1984
TSBstage	25:24:01	80:36:24	Taylor Slough	3.5	3.2	10767	1/1/1978
TSH	25:18:38	80:37:51	Shark River Slough	1.4	2	4831	3/12/1994

[1] Mean is for Period of Record (POR) of the data (start date through December 31, 2009).

Table 3. Information on flow stations included in the analyses. (Stations shown on figure 1A.)

[USGS, U.S. Geological Survey; SFWMD, South Florida Water Management District; ENP, Everglades National Park]

Flow Station Name	Map Symbol	North Latitude (NAD83)	West Longitude (NAD83)	Mean Flow Value POR, cfs1	Number of days in POR	Starting Date of Record	Agency Collecting Data
McCormick Creek	MC	25:10:03	80:43:55	24	5036	10/26/1995	USGS
Mud Creek	Mud	25:12:09	80:35:01	32	4925	10/15/1995	USGS
Shark River Slough (Tamiami Trail)[2]	SRS	25:45:43	80:43:33	1047	11708	10/12/1978	SFWMD
Taylor River	Taylor	25:11:27	80:38:21	39.9	4955	10/8/1995	USGS
Taylor Slough Bridge	TSB	25:24:06	80:36:24	53	17624	10/1/1960	ENP
Trout Creek	Trout	25:12:53	80:32:01	203	4931	2/1/1996	USGS
West Highway Creek	WHC	25:14:33	80:26:50	46	4923	2/17/1996	USGS

[1] Mean flow in cubic feet per second (cfs) is for Period of Record (POR) of the data (start date through December 31, 2009

[2] For Shark River Slough, a water balance calculation based on multiple stations is used.
SRS=[S12T + S333 – S334]

Table 4. Everglades National Park (ENP) Marine Monitoring Network (MMN) Florida Bay stations and associated daily salinity data included in analyses. FATHOM regions are areas that aggregate individual daily and monthly station data. (Stations and FATHOM regions are shown on figure 1.)

MMN Salinity Station Name	Map Symbol	North Latitude (NAD83)	West Longitude (NAD83)	FATHOM Region[1]	Mean Salinity Value, POR[2]	Number of days in POR	Starting Date of Record
Bob Allen Key	BA	25:01:34	80:40:54	South Bay	34.6	4207	9/9/1997
Buoy Key	BK	25:07:16	80:50:01	Central Bay	35.2	4032	9/7/1997
Butternut Key	BN	25:05:18	80:31:07	Northeast Bay	31.65	6799	2/8/1990
Duck Key	DK	25:10:54	80:29:22	Northeast Bay	30.2	6586	7/14/1988
Garfield Bight	GB	25:10:12	80:47:48	Central Bay	30.9	4600	3/6/1996
Joe Bay	JB	25:13:28	80:32:28	Northeast Bay	15.2	4878	7/14/1988
Johnson Key	JK	25:02:43	80:54:41	West Bay	35.9	6428	7/25/1989
Little Madeira Bay	LM	25:10:25	80:37:56	North Bay	24.2	7139	8/25/1988
Little Rabbit Key	LR	24:58:53	80:49:31	West Bay	36.2	4175	9/11/1997
Long Sound	LS	25:13:59	80:27:27	North Bay	19.5	7259	7/14/1988
Murray Key	MK	25:06:21	80:56:31	West Bay	34.4	3753	10/21/1997
Peterson Key	PK	24:55:06	80:44:45	West Bay	35.9	6543	7/25/1989
Terrapin Bay	TB	25:09:18	80:43:30	Central Bay	25.3	6231	9/12/1991
Trout Cove	TC	25:12:41	80:31:49	North Bay	19.9	7314	7/14/1988
Whipray Basin	WB	25:04:42	80:43:38	Central Bay	36.4	6742	4/6/1989

[1] Cosby and others (2010).

[2] Salinity recorded as Practical Salinity System (no salinity units are used). Mean is for Period of Record (POR) of the data (start date through December 31, 2009).

Table 5. Florida International University /South Florida Water Management District (FIU/SFWMD) Florida Bay stations and associated monthly salinity data included in analyses. (Stations shown on figure 1B.)

FIU / SFWMD Salinity Station Name	Number on Map	North Latitude (NAD88)	West Longitude (NAD88)	FATHOM Region1	Mean Salinity Value, POR2	No. of Months in POR	Month / Year Record Started
Butternut Key	24	25:06:06	80:31:53	Northeast Bay	30.2	214	March 1991
Captain Key	22	25:02:24	80:36:51	South Bay	33.5	212	April 1991
Duck Key	9	25:10:37	80:29:30	Northeast Bay	31.1	235	March 1991
East Cape	25	25:05:01	81:04:50	West Bay	34.5	204	July 1992
Garfield Bight	14	25:09:02	80:48:33	Central Bay	33.9	212	March 1991
Joe Bay	10	25:13:28	80:32:12	North Bay	14.7	212	March 1991
Johnson Key Basin	17	25:02:33	80:54:55	West Bay	35.7	236	March 1991
Little Madeira Bay	11	25:10:31	80:37:37	North Bay	24.2	213	March 1991
Long Sound	8	25:13:39	80:27:42	North Bay	19.6	220	March 1991
Murray Key	16	25:07:06	80:56:23	West Bay	34.7	221	March 1991
Old Dan Bank	28	24:52:.02	80:48:26	West Bay	35.7	204	July 1992
Oxfoot Bank	26	24:58:51	81:00:06	West Bay	35.1	204	July 1992
Park Key	23	25:07:05	80:35:59	Northeast Bay	29.7	235	April 1991
Peterson Keys	20	24:55:46	80:45:02	South Bay	36.4	221	March 1991
Porpoise Lake	21	25:00:24	80:40:53	South Bay	35.9	221	March 1991
Rabbit Key Basin	18	25:00:09	80:54:00	West Bay	36	236	March 1991
Rankin Lake	15	25:07:17	80:48:10	Central Bay	35.8	236	March 1991
Sprigger Bank	27	24:55:07	80:56:06	West Bay	35.4	204	July 1992
Terrapin Bay	12	25:08:25	80:42:58	Central Bay	33.1	213	March 1991
Twin Key Basin	19	24:58:40	80:45:13	South Bay	36.4	220	April 1991
Whipray Basin	13	25:05:29	80:45:17	Central Bay	36	221	March 1991

[1] Cosby and others (2010).

[2] Salinity recorded as Practical Salinity System (no salinity units are used). Mean is for Period of Record (POR) of the data (start date through December 31, 2009).

Table 6. Comparison of observed salinity, model-derived salinity, and paleosalinity estimates.

Core Name[1]	Associated Salinity Station[2]	Temporal Resolution of Data	Observed Mean Salinity, POR[3]	NSM/MLR Mean Salinity (1965-2000)	Paleosalinity Estimates for circa-1900 CE Interval[4]				NSM Salinity Adjustment for Paleosalinity Time Series[6]
					CWP FULL Mean[5]	CWP CONFID Mean[5]	SW-CWP Nearshore Mean[5]	SW-CWP Basin Mean[5]	
Crocodile Point	FIU / SFWMD 12	Monthly	33.2	27.6	28.8	26.5	18.1	N/A**	-1.1
Rankin Lake	MMN BK	Daily	35.2	30.4	28.3	28.3	N/A**	34.7	-2.1
Russell Bank	FIU / SFWMD 22	Monthly	33.4*	28.1	28.0*	26.4*	N/A**	32.3*	-1.7
Taylor T24	MMN LM	Daily	24.2	17.7	17.2	16.5	8.5	N/A**	-1.5
Whipray Basin	MMN WB	Daily	36.4	31.8	30.6	29.5	N/A**	36.2	-2.3

[1] Core locations are given in table 1 and shown on figure 1A.

[2] Marine Monitoring Network (MMN) salinity stations are listed in table 4 and FIU/SFWMD stations in table 5, and shown on figure 1.

[3] Values from tables 4 and 5.

[4] Data used to derive cumulative weighted percent (CWP) estimates and the summary data are shown in appendix. For details of method see Wingard and Hudley (2011).

[5] See text for discussion, section "Phase I."

[6] Value shown is SFWMD Natural System Model/multiple variable linear regression (NSM/MLR) mean salinity (1965-2000) minus CWP CONFID Mean values. This value is used to adjust the NSM to derive the paleosalinity time series.

* Distance adjusted (see explanation in text).

** Weighting factor not applicable to these sites (see explanation in text).

Table 7. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Everglades National Park (ENP) Marine Monitoring Network (MMN) salinity data (daily). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Whipray Basin			Rankin Lake			Taylor T24			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev	
Stage, ft (NGVD29)												Increase (ft)
	CP	observed	7338	1.2	0.5	7375	1.2	0.5	7318	1.2	0.5	
		paleo-estimate	7338	2.5	0.7	7375	1.5	0.9	7318	2.1	0.4	
		(paleo - observed)		1.3			0.3			0.9		0.8
	E146	observed	2233	1.3	0.4	2266	1.3	0.4	2259	1.3	0.4	
		paleo-estimate	2233	2.1	0.4	2266	1.9	0.4	2259	2.0	0.3	
		(paleo - observed)		0.8			0.6			0.7		0.7
	EVER4	observed	2415	2.2	0.4	2448	2.2	0.4	2441	2.2	0.4	
		paleo-estimate	2415	3.0	0.4	2448	2.8	0.4	2441	2.9	0.3	
		(paleo - observed)		0.8			0.6			0.7		0.7
	EVER6	observed	2898	2.1	0.4	2942	2.1	0.4	2931	2.1	0.4	
		paleo-estimate	2898	2.9	0.3	2942	2.7	0.3	2931	2.9	0.3	
		(paleo - observed)		0.9			0.6			0.8		0.8
	EVER7	observed	2812	2.3	0.4	2838	2.3	0.4	2845	2.3	0.4	
		paleo-estimate	2812	2.9	0.3	2838	2.7	0.3	2845	2.9	0.3	
		(paleo - observed)		0.7			0.5			0.6		0.6
	G3273	observed	5932	6.0	1.1	5969	6.0	1.1	5843	6.0	1.0	
		paleo-estimate	5932	7.6	1.1	5969	7.0	1.3	5843	6.9	0.7	
		(paleo - observed)		1.6			1.1			0.9		1.2
	NP206	observed	8521	5.1	1.4	8563	5.1	1.4	8483	5.2	1.4	
		paleo-estimate	8521	7.3	1.2	8563	6.3	1.4	8483	6.3	0.8	
		(paleo - observed)		2.1			1.2			1.2		1.5
	NP46	observed	5049	1.4	0.6	5077	1.4	0.6	4959	1.4	0.6	
		paleo-estimate	5049	2.3	0.6	5077	1.8	0.8	4959	2.3	0.4	
		(paleo - observed)		0.9			0.4			0.9		0.7

Table 7. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Everglades National Park (ENP) Marine Monitoring Network (MMN) salinity data (daily). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Whipray Basin			Rankin Lake			Taylor T24			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev	
Stage (cont.)	NP62	observed	6466	2.5	0.9	6480	2.5	0.9	6423	2.5	0.8	
		paleo-estimate	6466	3.9	0.9	6480	2.9	1.1	6423	4.0	0.7	
		(paleo - observed)		1.4			0.5			1.4		1.1
	NP67	observed	3124	2.3	0.6	3154	2.3	0.6	3157	2.3	0.6	
		paleo-estimate	3124	3.4	0.5	3154	3.0	0.6	3157	3.3	0.4	
		(paleo - observed)		1.1			0.7			1.0		0.9
	P33	observed	12346	6.0	0.7	12375	6.0	0.7	12286	6.1	0.7	
		paleo-estimate	12346	7.5	0.8	12375	6.7	0.9	12286	6.9	0.5	
		(paleo - observed)		1.4			0.7			0.8		1.0
	P35	observed	12495	1.6	0.6	12515	1.6	0.6	12440	1.6	0.6	
		paleo-estimate	12495	2.6	0.5	12515	2.1	0.6	12440	2.2	0.3	
		(paleo - observed)		1.0			0.5			0.6		0.7
	R127	observed	5252	2.3	0.7	5290	2.3	0.7	5156	2.3	0.7	
		paleo-estimate	5252	3.4	0.8	5290	2.7	1.1	5156	3.4	0.6	
		(paleo - observed)		1.1			0.4			1.1		0.9
	TSBstage	observed	8071	3.2	1.1	8087	3.2	1.1	8025	3.2	1.1	
		paleo-estimate	8071	5.2	1.2	8087	3.8	1.5	8025	5.4	0.9	
		(paleo - observed)		2.1			0.6			2.2		1.6
	TSH	observed	1945	2.2	0.5	1941	2.2	0.5	1970	2.2	0.5	
		paleo-estimate	1945	3.2	0.5	1941	2.9	0.5	1970	3.1	0.4	
		(paleo - observed)		1.0			0.7			0.9		0.9
Flow, cfs												Increase (cfs)
	MC	observed	60	9.7	61.4	61	9.9	60.9	60	9.7	61.4	
		paleo-estimate	60	225.9	113.5	61	168.6	107.3	60	121.2	58.2	
		(paleo - observed)		216.2			158.7			111.5		162.1

Table 7. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Everglades National Park (ENP) Marine Monitoring Network (MMN) salinity data (daily). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Whipray Basin			Rankin Lake			Taylor T24			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev	
Flow (cont.)	Mud	observed	41	47.7	35.5	42	47.3	35.2	42	47.2	35.2	
		paleo-estimate	41	212.1	72.3	42	172.1	73.2	42	128.5	38.2	
		(paleo - observed)		164.4			124.8			81.2		123.5
	SRS	observed	264	1089.9	1174.5	265	1089.4	2152.0	265	1089.4	1172.3	
		paleo-estimate	264	3628.9	1935.9	265	2750.6	1172.3	265	2059.0	1095.8	
		(paleo - observed)		2539.0			1661.2			969.6		1723.3
	Taylor	observed	50	46.3	38.6	61	37.4	40.4	51	46.4	38.2	
		paleo-estimate	50	236.8	83.6	61	166.8	89.3	51	146.1	43.4	
		(paleo - observed)		190.5			129.3			99.7		139.9
	Trout	observed	41	331.1	265.2	42	328.7	262.4	42	328.7	262.4	
		paleo-estimate	41	1791.4	594.3	42	1357.7	594.8	42	1018.8	288.7	
		(paleo - observed)		1460.3			1029.0			690.1		1059.8
	TSB	observed	427	47.5	72.6	427	47.6	72.5	426	47.6	72.6	
		paleo-estimate	427	220.4	123.9	427	104.9	88.6	426	265.5	126.9	
	WHC	observed	39	70.9	62.4	40	70.5	61.6	39	70.9	62.4	
		paleo-estimate	39	237.8	82.5	40	188.0	84.2	39	171.7	49.6	
		(paleo - observed)		166.9			117.4			100.8		128.4
Salinity												Decrease
	BA	observed	1125	33.2	5.5	1133	33.2	5.5	1132	33.1	5.5	
		paleo-estimate	1125	27.3	3.2	1133	28.1	3.0	1132	29.0	2.3	
		(paleo - observed)		-5.9			-5.0			-4.2		-5.0
	BK	observed	1168	33.7	4.5	1174	33.6	4.5	1180	33.6	4.5	
		paleo-estimate	1168	28.7	3.3	1174	26.7	4.0	1180	29.6	2.3	
		(paleo - observed)		-5.0			-6.9			-4.0		-5.3

Table 7. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Everglades National Park (ENP) Marine Monitoring Network (MMN) salinity data (daily). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Whipray Basin			Rankin Lake			Taylor T24			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev	
Salinity (cont.)	BN	observed	3575	31.5	8.6	3639	31.4	8.6	3497	31.0	8.3	
		paleo-estimate	3575	24.1	5.2	3639	24.4	4.1	3497	24.7	3.3	
		(paleo - observed)		-7.3			-7.0			-6.3		-6.9
	DK	observed	3536	28.9	9.1	3521	29.0	9.1	3438	28.5	8.9	
		paleo-estimate	3536	23.1	5.5	3521	22.7	3.8	3438	23.1	3.9	
		(paleo - observed)		-5.9			-6.3			-5.4		-5.8
	GB	observed	1627	29.0	9.5	1279	29.4	10.2	1285	29.3	10.2	
		paleo-estimate	1627	20.2	5.6	1279	19.4	6.4	1285	21.2	4.6	
		(paleo - observed)		-8.8			-10.0			-8.2		-9.0
	JK	observed	3338	35.4	4.7	1486	34.2	3.7	1491	34.2	3.7	
		paleo-estimate	3338	34.2	3.3	1486	29.3	2.9	1491	32.4	1.3	
		(paleo - observed)		-1.2			-4.9			-1.7		-2.6
	LM	observed	4011	24.2	11.0	4013	24.2	10.9	3905	23.1	10.2	
		paleo-estimate	4011	15.6	7.1	4013	16.3	5.8	3905	13.8	10.2	
		(paleo - observed)		-8.6			-8.0			-9.3		-8.6
	LR	observed	1155	34.4	3.2	1167	34.4	3.2	1164	34.4	3.2	
		paleo-estimate	1155	31.8	1.9	1167	30.2	3.5	1164	33.3	1.2	
		(paleo - observed)		-2.6			-4.2			-1.1		-2.6
	LS	observed	4102	18.0	10.8	4153	17.9	10.8	4041	17.2	10.3	
		paleo-estimate	4102	13.3	6.1	4153	10.3	6.1	4041	10.8	5.0	
		(paleo - observed)		-4.7			-7.6			-6.4		-6.2
	MK	observed	966	33.1	4.0	966	33.1	4.0	966	33.1	4.0	
		paleo-estimate	966	30.1	1.9	966	28.7	2.6	966	31.3	1.2	
		(paleo - observed)		-3.0			-4.4			-1.8		-3.1
	PK	observed	3428	35.9	3.4	918	34.5	2.9	917	34.5	2.9	
		paleo-estimate	3428	33.0	2.1	918	32.1	1.8	917	33.3	1.0	
		(paleo - observed)		-2.9			-2.5			-1.3		-2.2

Table 7. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Everglades National Park (ENP) Marine Monitoring Network (MMN) salinity data (daily). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Whipray Basin			Rankin Lake			Taylor T24			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev	
Salinity (cont.)	TB	observed	3046	23.9	11.3	3110	23.8	11.2	3129	23.7	11.2	
		paleo-estimate	3046	12.6	6.0	3110	11.6	6.5	3129	13.0	5.2	
		(paleo - observed)		-11.3			-12.2			-10.7		-11.4
	TC	observed	3305	18.5	13.1	4154	19.1	13.1	4037	18.3	12.6	
		paleo-estimate	3493	11.8	6.2	4154	9.8	7.6	4037	10.0	5.9	
		(paleo - observed)		-6.7			-9.3			-8.3		-8.1
	WB	observed	3553	36.6	7.8	1142	34.4	5.8	1141	34.4	5.8	
		paleo-estimate	3553	28.3	5.5	1142	28.4	4.0	1141	29.6	2.5	
		(paleo - observed)		-8.3			-6.0			-4.8		-6.4
	FATHOM C	observed	853	31.4	7.6	853	31.4	7.6	853	31.4	7.6	
		paleo-estimate	853	23.2	5.0	853	22.3	5.4	853	24.0	3.9	
		(paleo - observed)		-8.3			-9.1			-7.4		-8.3
	FATHOM NB	observed	3526	20.3	11.4	3540	20.3	11.4	3442	19.5	10.8	
		paleo-estimate	3526	13.8	6.8	3540	12.1	6.4	3442	11.7	5.6	
		(paleo - observed)		-6.5			-8.2			-7.9		-7.5
	FATHOM NE	observed	2862	29.9	8.6	2828	30.0	8.6	2820	29.5	8.3	
		paleo-estimate	2862	23.0	4.8	2828	23.1	3.3	2820	23.6	3.4	
		(paleo - observed)		-6.9			-6.8			-5.9		-6.6
	FATHOM S	observed	1125	33.2	5.5	1132	33.2	5.5	1132	33.1	5.5	
		paleo-estimate	1125	27.3	3.2	1132	28.1	3.0	1132	29.0	2.3	
		(paleo - observed)		-5.9			-5.0			-4.2		-5.0
	FATHOM W	observed	747	33.7	3.2	747	33.7	3.2	747	33.7	3.2	
		paleo-estimate	747	31.9	1.9	747	30.3	2.5	747	32.7	1.2	
		(paleo - observed)		-1.7			-3.4			-1.0		-2.0

Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank			Crocodile Point			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	
Stage, ft (NGVD29)									Increase (ft)
	CP	observed	265	1.2	0.6	265	1.2	0.6	
		paleo-estimate	265	1.9	0.9	265	1.5	0.8	
		(paleo - observed)		0.7			0.3		0.5
	E146	observed	79	1.3	0.4	79	1.3	0.4	
		paleo-estimate	79	2.0	0.5	79	1.7	0.5	
		(paleo - observed)		0.7			0.4		0.6
	EVER4	observed	181	2.1	0.5	181	2.1	0.5	
		paleo-estimate	181	2.5	0.7	181	2.2	0.6	
		(paleo - observed)		0.4			0.2		0.3
	EVER6	observed	106	2.1	0.4	106	2.1	0.4	
		paleo-estimate	106	2.7	0.4	106	2.4	0.4	
		(paleo - observed)		0.7			0.4		0.5
	EVER7	observed	106	2.2	0.4	106	2.2	0.4	
		paleo-estimate	106	2.8	0.3	106	2.6	0.4	
		(paleo - observed)		0.6			0.3		0.4
	G3273	observed	200	6.0	1.0	199	6.0	1.0	
		paleo-estimate	200	7.4	1.3	199	6.3	1.0	
		(paleo - observed)		1.4			0.3		0.8
	NP206	observed	314	5.1	1.3	313	5.1	1.3	
		paleo-estimate	314	6.9	1.4	313	5.7	1.1	
		(paleo - observed)		1.8			0.6		1.2
	NP46	observed	417	1.4	0.5	417	1.4	0.5	
		paleo-estimate	417	2.0	0.8	417	1.6	0.7	
		(paleo - observed)		0.6			0.2		0.4

Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank N	Russell Bank Mean	Russell Bank Std Dev	Crocodile Point N	Crocodile Point Mean	Crocodile Point Std Dev	Average Difference of (paleo - observed)
Stage (cont.)	NP62	observed	429	2.4	0.9	429	2.4	0.9	
		paleo-estimate	429	3.4	1.1	429	2.9	1.0	
		(paleo - observed)		1.0			0.5		0.7
	NP67	observed	118	2.2	0.6	118	2.2	0.6	
		paleo-estimate	118	3.1	0.6	118	2.7	0.7	
		(paleo - observed)		0.9			0.5		0.7
	P33	observed	430	6.1	0.7	429	6.1	0.7	
		paleo-estimate	430	7.2	0.9	429	6.4	0.7	
		(paleo - observed)		1.1			0.4		0.8
	P35	observed	430	1.6	0.6	429	1.6	0.6	
		paleo-estimate	430	2.4	0.6	429	1.9	0.5	
		(paleo - observed)		0.8			0.3		0.5
	R127	observed	198	2.2	0.7	198	2.2	0.7	
		paleo-estimate	198	3.0	1.0	198	2.5	0.9	
		(paleo - observed)		0.8			0.3		0.5
	TSBstage	observed	274	3.2	1.0	274	3.2	1.0	
		paleo-estimate	274	4.3	1.3	274	3.6	1.2	
		(paleo - observed)		1.1			0.5		0.8
	TSH	observed	66	2.2	0.5	66	2.2	0.5	
		paleo-estimate	66	2.9	0.5	66	2.6	0.6	
		(paleo - observed)		0.8			0.4		0.6
Flow, cfs									Increase (cfs)
	MC	observed	60	9.7	61.4	60	9.7	61.4	
		paleo-estimate	60	47.7	95.4	60	98.9	95.9	
		(paleo - observed)		38.0			89.2		63.6

Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank			Crocodile Point			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	
Flow (cont.)	Mud	observed	41	47.7	35.5	41	47.7	35.5	
		paleo-estimate	41	151.5	56.8	41	113.7	76.4	
		(paleo - observed)		103.8			66.0		84.9
	SRS	observed	265	1089.4	1172.3	264	1089.9	1174.5	
		paleo-estimate	265	3225.9	1997.3	264	1490.9	1285.7	
		(paleo - observed)		2136.5			401.0		1268.8
	Taylor	observed	50	46.3	38.6	50	46.3	38.6	
		paleo-estimate	50	166.9	67.8	50	119.7	80.1	
		(paleo - observed)		120.6			73.4		97.0
	Trout	observed	41	331.1	265.2	41	331.1	265.2	
		paleo-estimate	41	1123.0	493.2	41	801.6	518.3	
		(paleo - observed)		791.9			470.5		631.2
	TSB	observed	426	47.6	72.6	425	47.7	72.7	
		paleo-estimate	426	130.3	92.3	425	95.8	86.7	
		(paleo - observed)		82.7			48.1		65.4
	WHC	observed	39	70.9	62.4	39	70.9	62.4	
		paleo-estimate	39	159.8	62.4	39	118.5	69.9	
		(paleo - observed)		88.9			47.6		68.2
Salinity									Decrease
	8	observed	120	16.8	9.5	120	16.8	9.5	
		paleo-estimate	120	9.5	5.9	120	11.3	3.4	
		(paleo - observed)		-7.3			-5.5		-6.4
	9	observed	131	29.7	9.3	131	29.7	9.3	
		paleo-estimate	131	20.4	8.5	131	20.6	4.8	
		(paleo - observed)		-9.3			-9.1		-9.2

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Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank			Crocodile Point			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	
Salinity (cont.)	10	observed	117	12.3	11.5	117	12.3	11.5	
		paleo-estimate	117	3.8	4.7	117	5.9	3.8	
		(paleo - observed)		-8.5			-6.5		-7.5
	11	observed	118	22.6	8.5	118	22.6	8.5	
		paleo-estimate	118	12.1	6.0	118	13.6	4.6	
		(paleo - observed)		-10.5			-9.0		-9.7
	12	observed	118	32.0	8.6	118	32.0	8.6	
		paleo-estimate	118	20.9	6.5	118	24.3	4.3	
		(paleo - observed)		-11.1			-7.7		-9.4
	13	observed	121	34.9	7.0	121	34.9	7.0	
		paleo-estimate	121	26.3	6.7	121	27.2	4.2	
		(paleo - observed)		-8.6			-7.7		-8.1
	14	observed	117	32.5	8.7	117	32.5	8.7	
		paleo-estimate	117	23.1	5.3	117	24.5	4.1	
		(paleo - observed)		-9.5			-8.0		-8.8
	15	observed	132	34.9	8.3	132	34.9	8.3	
		paleo-estimate	132	26.8	7.4	132	27.1	4.1	
		(paleo - observed)		-8.1			-7.8		-7.9
	16	observed	121	34.1	4.2	121	34.1	4.2	
		paleo-estimate	121	29.8	3.6	121	30.2	2.3	
		(paleo - observed)		-4.4			-3.9		-4.1
	17	observed	132	35.0	4.2	132	35.0	4.2	
		paleo-estimate	132	31.1	4.2	132	31.2	2.3	
		(paleo - observed)		-3.9			-3.8		-3.9

Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank N	Russell Bank Mean	Russell Bank Std Dev	Crocodile Point N	Crocodile Point Mean	Crocodile Point Std Dev	Average Difference of (paleo - observed)
Salinity	18	observed	132	35.2	3.6	132	35.2	3.6	
(cont.)		paleo-estimate	132	31.7	3.7	132	31.8	2.1	
		(paleo - observed)		-3.4			-3.3		-3.4
	19	observed	120	35.4	4.2	120	35.4	4.2	
		paleo-estimate	120	30.6	3.9	120	31.2	2.5	
		(paleo - observed)		-4.8			-4.2		-4.5
	20	observed	121	35.8	3.5	121	35.8	3.5	
		paleo-estimate	121	31.4	3.5	121	31.9	2.2	
		(paleo - observed)		-4.3			-3.9		-4.1
	21	observed	121	34.9	5.6	121	34.9	5.6	
		paleo-estimate	121	27.5	5.9	121	28.3	3.8	
		(paleo - observed)		-7.4			-6.6		-7.0
	22	observed	117	32.4	6.4	117	32.4	6.4	
		paleo-estimate	117	22.8	5.5	117	27.5	2.7	
		(paleo - observed)		-9.6			-4.9		-7.3
	23	observed	131	28.6	9.7	131	28.6	9.7	
		paleo-estimate	131	18.2	9.2	131	18.6	5.2	
		(paleo - observed)		-10.4			-10.1		-10.2
	24	observed	119	28.7	7.5	119	28.7	7.5	
		paleo-estimate	119	18.7	6.1	119	20.1	4.6	
		(paleo - observed)		-10.0			-8.6		-9.3
	25	observed	106	33.8	3.1	106	33.8	3.1	
		paleo-estimate	106	30.2	3.1	106	30.7	1.9	
		(paleo - observed)		-3.6			-3.2		-3.4

Table 8. Summary statistics for observed and model-produced daily stage, flow, and salinity data for each sediment core paleosalinity analysis using the Florida International University /South Florida Water Management District (FIU/SFWMD) salinity data (monthly). Paleo-estimate minus the observed (paleo - observed) indicates the difference between current and circa-1900 CE values. Values in FATHOM regions are aggregates of the individual daily and monthly station data as indicated on tables 4 and 5.—Continued

Parameter	Station/Station Map Symbol (fig. 1)	Type of data	Russell Bank			Crocodile Point			Average Difference of (paleo - observed)
			N	Mean	Std Dev	N	Mean	Std Dev	
Salinity (cont.)	26	observed	106	34.3	2.7	106	34.3	2.7	
		paleo-estimate	106	31.3	2.7	106	31.7	1.6	
		(paleo - observed)		-3.0			-2.6		-2.8
	27	observed	106	34.7	2.5	106	34.7	2.5	
		paleo-estimate	106	32.3	2.1	106	33.7	0.7	
		(paleo - observed)		-2.4			-1.0		-1.7
	28	observed	106	34.9	2.3	106	34.9	2.3	
		paleo-estimate	106	33.0	1.7	106	34.2	0.6	
		(paleo - observed)		-1.9			-0.7		-1.3
	FATHOM C	observed	36	33.3	6.4	36	33.3	3.6	
		paleo-estimate	36	23.7	4.6	36	25.2	6.4	
		(paleo - observed)		-9.6			-8.1		-8.9
	FATHOM NB	observed	36	16.7	8.2	36	16.7	3.5	
		paleo-estimate	36	8.1	4.2	36	9.8	8.2	
		(paleo - observed)		-8.5			-6.8		-7.7
	FATHOM NE	observed	36	27.1	6.2	36	27.1	2.7	
		paleo-estimate	36	17.7	4.9	36	12.3	6.2	
		(paleo - observed)		-9.4			-14.7		-12.1
	FATHOM S	observed	36	34.4	4.5	36	34.4	2.4	
		paleo-estimate	36	27.7	3.4	36	29.4	4.5	
		(paleo - observed)		-6.6			-5.0		-5.8
	FATHOM W	observed	36	34.4	3.0	36	34.4	1.4	
		paleo-estimate	36	31.0	1.9	36	31.7	3.0	
		(paleo - observed)		-3.4			-2.7		-3.0

Table 9. Comparison of spatially averaged salinity differences (paleo-observed) across FATHOM regions (Cosby and others, 2010). Data here are summarized from tables 7 and 8 FATHOM data. Negative differences indicate a lower salinity from the paleo-estimate compared to the observed. (FATHOM regions are shown on figure 1B.)

FATHOM Region	Whipray Basin	Rankin Lake	Taylor T24	Russell Bank	Crocodile Point
Central	-8.3	-9.1	-7.4	-9.6	-8.1
North Bay	-6.5	-8.2	-7.9	-8.5	-6.8
Northeast	-6.9	-6.8	-5.9	-9.4	-14.7
South	-5.9	-5.0	-4.2	-6.6	-5.0
West	-1.7	-3.4	-1.0	-3.4	-2.7