Temporal and Spatial Salinity Patterns in Joe Bay, Everglades National Park

by Mark Zucker, Stephen Huddleston, and Amarys Acosta

ABSTRACT - Joe Bay is the primary hydrologic connection between the southern Everglades and northeastern Florida Bay. Joe Bay is connected to Florida Bay through Trout Creek—the main contributor of flow to northeastern Florida Bay. Salinity measurements are collected by the USGS as part of ongoing Coastal Integrated Network monitoring efforts. Funding for continuous salinity monitoring within estuarine creeks flowing into Joe Bay was provided by the Everglades National Park (ENP) Critical Ecosystems Studies Initiative (CESI).

Salinity-based performance measures have been developed to assess the effects of Everglades restoration on the coastal areas of ENP. Multiple regression models have been developed that use independent variables to predict salinity at selected ENP Marine Monitoring Stations. The purpose of the current effort is to determine whether the salinities in Joe Bay are representative of salinity over larger areas. As part of this effort, ArcGIS is currently being utilized by the USGS to summarize salinity survey data collected by motor boat in conjunction with available ancillary salinity data collected from fixed monitoring locations in Joe Bay.

As part of the current effort, Joe Bay has been divided into four polygons that represent eastern, central, and western Joe Bay, and Snag Bay. The average salinity value of each polygon, determined from the salinity survey data, will be compared against the average salinity values at the fixed monitoring locations. Specifically, statistical tests will be used to determine whether the average salinities from the fixed monitoring stations and the average salinities for the polygons are analogous; if so, GIS could potentially be used to aerially extrapolate data from fixed monitoring stations.

The evaluation of temporal and spatial salinity patterns in Joe Bay will benefit restoration as follows:

- The analysis further addresses uncertainty in salinity measurements derived from models.
- The methods employed here can be utilized in other coastal areas.
- The results of this analysis may suggest that additional assessment tools such as GIS, regression models, and hydrodynamic models could be used together to evaluate whether a more natural hydrologic regime has been achieved for the coastal waters of ENP.

METHODS - Salinity surveys were performed using boat-mounted flow-through systems equipped with a water quality monitor for collection of salinity and temperature. Position is determined using a Global Positioning System unit (GPS) which interfaces with the hand held water quality monitor. Data collection occurs every 5 seconds and is stored in the data acquisition system. The accuracy of all instrumentation is verified before and after each salinity survey. The aerial coverage of a typical salinity survey is available for December 1, 2004 (Fig. 1). Fifteen minute, daily mean, and monthly mean salinity values from fixed monitoring stations were collected by the USGS in Joe Bay. Discrete salinity measurements, 15 minute, and daily mean values for the ENPJB Weather Station was provided by Miami-Dade DERM and the South Florida Water Management District (SFWMD), respectively. Published salinity survey data are available on the USGS SOFIA data exchange web page (http://sofia.usgs.gov/exchange/coastal_grads/salindex.html).

Spatial summary statistics were extracted from each of the four polygons (Fig. 2) using ArcGIS (Fig. 3). Evaluations included: 1) a comparison of ENPJB and the polygons representing eastern, central, and western Joe Bay; 2) a comparison of the paired daily mean values from 2003 to 2007 for the fixed monitoring stations in Joe Bay (years/seasons); 3) a comparison of mean monthly values from 1999 to 2007 for the fixed monitoring stations in Joe Bay (years/seasons). Correlation analysis, box plots by year and season, as well as non-parametric statistics were employed. The Wilcoxon Signed Rank (WSR) test was used to determine differences in the median value.

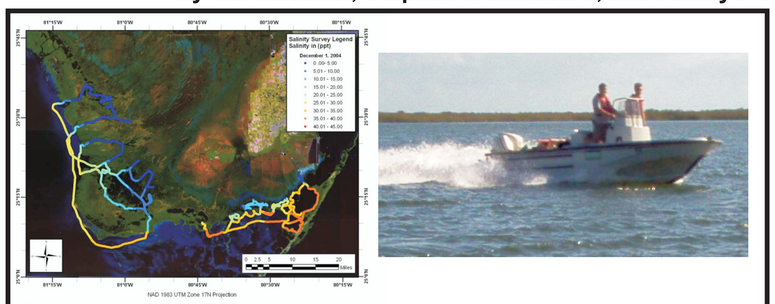

Figure 1: An example of a salinity survey conducted on December 1, 2004.

Data Analysis Visualization from 8/29/2007 Salinity Survey

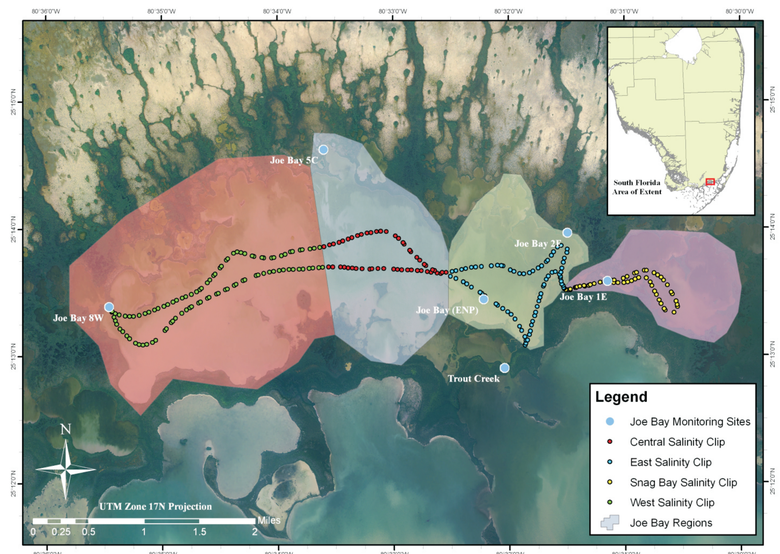

Figure 2: Map of Joe Bay and the four polygons used to summarize salinity data.

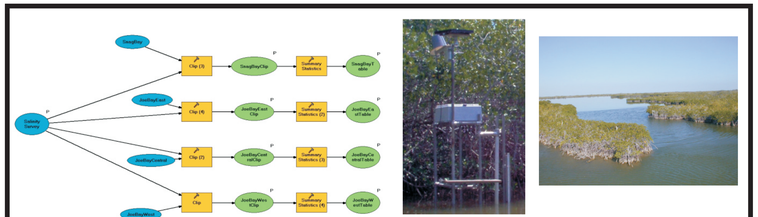

Figure 3: Conceptual model used for summarizing spatial salinity data in ArcGIS. (Pictures from Joe Bay 2E and Joe Bay 8W)

Mark Zucker
U. S. Geological Survey
3110 SW 9th Ave.
Fort Lauderdale, FL 33315
(954) 377-5952 (w)
mzucker@usgs.gov

This author would like to thank Shane Ploos, Christian Lopez, Carrie Boudreau, Jeff Woods, Stephen Huddleston, and Amarys Acosta for their continued support, talent, and dedication to coastal projects. A special thank you to the various reviewers of the abstract/poster and to Christian Avila at Miami-Dade DERM and Robin Bennet at SFWMD for providing data sets used in this poster.

SOFIA South Florida Information Access Integrated Science

Website: http://sofia.usgs.gov/

Results - Correlation analysis was performed on the daily mean values from the fixed monitoring stations (JB1E, 2E, 5C, 8W, ENPJB) for years 2003 to 2007. The lowest and highest correlation coefficients for the data without regard to season ranged from 0.87 (Trout/JB8W) to 0.96 (JB1E and JB8W). Although the fixed monitoring sites in Joe Bay are correlated, the WSR test using five years of paired data (Fig. 4 A-B) indicated differences between the median values for all sites (p-value < 0.05). When the daily mean values were grouped by season (Wet = May - October, Dry = November to April) only the median values for Joe Bay 1E and ENPJB were not significantly different in the wet season (p-value 0.0993) while the median values for Joe Bay 2E and Joe Bay 5C were not significantly different in the dry season (p-value .3534).

When the fixed monitoring stations were compared to the respective polygons (USGS and DERM data), the WSR test indicated that the median values for the available data and by season (Fig. 5) were not significantly different (p-value < 0.05). When station ENPJB was compared to the respective polygons, (USGS data only) only the median values for ENPJB and eastern Joe Bay (Fig. 6) were similar (p-value 0.0609).

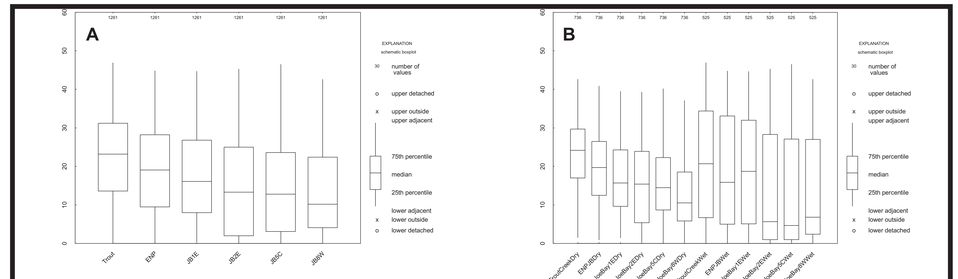

Figure 4A - B: Box plots of daily mean salinity values for years 2003-2007, wet, and dry season.

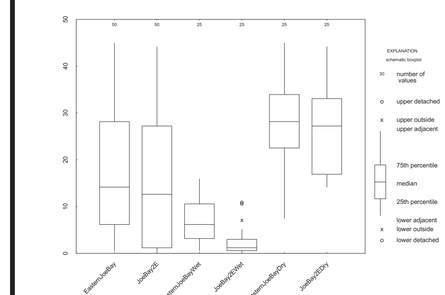

Figure 5: Box plot of salinity data from Joe Bay 2E and eastern Joe Bay for all available data and by season.

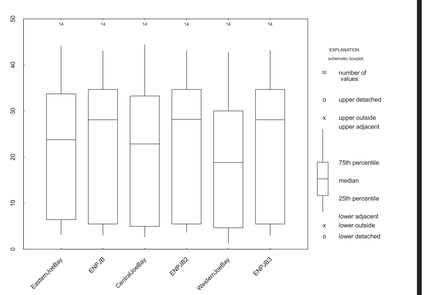

Figure 6: Box plots of salinity data from ENPJB and the respective polygons in Joe Bay.

Summary - The purpose of this poster was to address the question of whether salinity data collected at a fixed location, in this case ENPJB, can be extended to represent a larger area within Joe Bay. The results indicate that ENPJB may represent eastern Joe Bay but not central or western Joe Bay. Differences observed between the fixed monitoring stations within Joe Bay may be a result of comparing salinity measurements from an open water body to salinity measurements confined within estuarine creeks which may or may not be subjected to different seasonal water sources or processes (i.e. C-111/Taylor Slough, Florida Bay, ground water interaction, and evaporation). The findings presented here may be further refined by including DERM and ENPJB data for years 1999 to 2002. Incorporating regression equations in regional models to predict salinity for the southern Everglades has been acknowledged (*Interim Goals-Appendix, indicator 4.1*) and the need for a numerical/hydrodynamic model along with continued field monitoring of salinity is required to evaluate current and future changes in salinity as a result of Everglades restoration.