Variations in Mangrove Peat Salinity from April 1997 to April 2003: A Spatial Analysis.

Harney River Estuary, Everglades National Park.

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Gordon H. Anderson[1], Thomas J. Smith III[2] and Paul D. Teague[3]

[1,2] U.S. Geological Survey, Florida Integrated Science Center CWRS, Miami FL. email: gordon_anderson@usgs.gov and email: tom_j_smith@usgs.gov [3] National Park Service Everglades National Park Homestead, FL. email: paul_teague@nps.gov

Abstract

Geographic Information System (GIS) spatial analysis methods was used to observe salinity variations found in peat soil across the mangrove-marsh ecotone adjacent to the Harney River estuary, Everglades National Park from April 1997 through March 2003. Water specific conductance (mS/cm) was analyzed using surface and groundwater samples collected from 30 cm and 60 cm depths at 5 sites (SW1, SW2, SW3, SW4, and SW5). Part of the two year sampling period was used to develop a time series of soil pore water salinity for each site. Surface water was also collected on a bi-weekly basis. Data from an adjacent peat pore water monitoring station (Harney River Mangrove Core Site) was used to compare pore water salinity with surface water salinity. Spatial salinity contour maps were created using ArcGIS software. Data from an adjacent peat pore water monitoring station (Harney River Mangrove Core Site) was used to compare pore water salinity with surface water salinity. Monthly rainfall, evaporation, and potential evapotranspiration data were also analyzed. Spatial and temporal variations of water salinity were observed in relation to soil exchange sites, vegetation, topographic and seasonal freshwater flows. Spatial salinity contour maps provided a synoptic picture of the salinity gradient across the mangrove ecotone and vertical profile. Over the study period, we observed the near-shore sites had the greatest maximum aggregate salinity (~35 ppt). However, at the depth of 30 cm and 60 cm, while the interior sites indicated lower aggregate salinity values (14-16 ppt). The data also indicated 2.1-2 month time lag at the onset of the wet season between the 30 cm and 60 cm salinity at all sites.

Study Area

Figure 1.

Typical pore water sample site

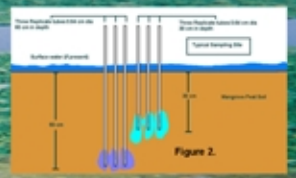

Figure 2.

Introduction

Hydrodynamics of the tidal cycle, freshwater inflows and local rainfall are the principal physical forces that determine the marsh-mangrove interface or ecotone in the southwestern coastal region of Everglades National Park

Study evaluates salinity (mS/cm) spatial and temporal variations across the mangrove-marsh ecotone near the Harney River estuary. Temperature data was found significantly less variable and not used for this analysis (avg SW1 30 cm, 26.4 C high; SW3 30 cm, 24.54 C)

In April 1997, soil pore water salinity and temperature bi-weekly sampling was started. Periodic sampling is still on-going.

Samples were collected along the 250 m boardwalk transect, located near the Harney River.

Study has a sampling design of five pore water sample sites: SW1, SW2, SW3, SW4 and SW5, regularly spaced from the river across the ecotone (figure 1).

To assist with sampling design, each soil pore water sampling site has three replicate tubes at both 30 cm and 60 cm depths (figure 2).

Ancillary salinity data from HR (NPS), SH4 and SH5 (USGS) gages. Rain data from HR. (permanent adjacent monitoring gages).

Methods

At each soil pore water site, three water samples at 30 cm and 60 cm were extracted and tested for salinity and temperature.

The sample site replicate salinity samples were aggregated in day site sample.

Data was subdivided into four salinity data groups: Surface water (SW), 30 cm (30)and 60 cm (60), and groundwater (GW). For each sampling day sample, four input text files were created. The input text files in order of data fields: HR, SW1, SH4, SW2, SW3, SW4, SW5 and SH5. Each field salinity day sample is spatially represented by UTM coordinates.

The maximum possible sample fields for surface water is eight; six for 30 cm and 60 cm and three for groundwater. There were six years of sample day periods (n=170) for each four sampling subgroups (total n=680 sample files). Sampling subgroup files were imported into GIS software (*Arc View ESRI, Inc*) and each file was converted into grid contour file utilizing an Inverse Distance Weighting (IDW) algorithm.

Contour grid boundaries were set at the riverbank and excluded the river from the transect contouring (except for surface water). The width of the contour was set by the actual transect width to create a narrow contoured corridor. After the contour were created, they were exported in a .jpeg format files to create a *graphical animation format*

Acknowledgements

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The use of firm, trade and brand names in this poster presentation is for identification purposes only and does not constitute endorsement by the U.S. Government.

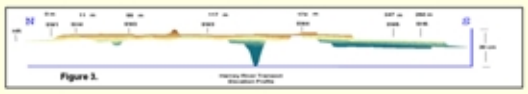


Figure 3.

Data

Chart 1: Correlation of Harney River salinity with sample sites along mangrove-marsh transect

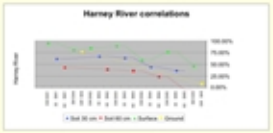


Table 1: Summary sample statistics

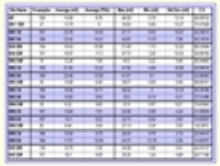
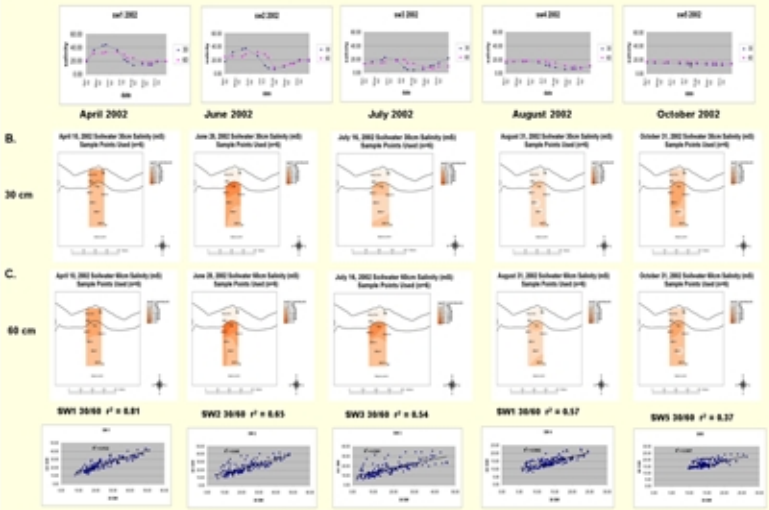


Chart 2: Monthly sample salinity (mS/cm) and Rainfall (HR)

Chart 3: Soil Salinity (mS/cm) change at soil depths of 30 cm and 60 cm, April to October 2002, A. chart of soil water fluctuation; B. Horizontal salinity transect contour at 30 cm soil depth; C. Horizontal salinity transect at 60 cm soil depth.



Observations and Discussion

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Periodic and overall variations of salinity

Seasonal rainfall is the principal physical forcing function to moderate soil salinity. Yearly annual rainfall exhibits a bi-seasonal weather pattern (wet=June-October; dry=November to May). Yearly average rainfall for study area (Apr-Mar) was 1587 mm (Y99-00:max 2029 mm; Y98-99: min 1292 mm). June and September had four largest monthly rainfall totals (n=72) over six years (Sept 99 recorded 571 mm) and the greatest monthly impact on soil pore water salinity.

Secondary physical factors include: tidal inundation (SW1 and SW2 most directly impacted, especially at spring tides); overland interior freshwater flow and drainage; soil type-red mangrove peat (SW1-SW4 2 m and SW5 savegrass, 2.5 muck-mangrove peat) permeability (Hydraulic k: SW1 least and SW5 greatest), evapo-transpiration rate; stochastic events (T.S. Harvey Sept 1999); localized topography (slight berm between SW2 – SW3 and low areas between SW3-SW4 and SW5; figure 3).

Spatial variations of salinity

Salinity Variability was observed at 2-D inter-site horizontal profile (SW1-SW5 transect), and 3-D intra-site vertical profile (0 cm, 30cm, and 60 cm soil pore water).

Inter-site variation

Averaged site Salinity and variability decreases from the Harney River to coast marsh (Chart 1). Surface water salinity is strongly correlated with the Harney River at all sites. 30 cm soil pore water correlates at until SW3 and breaks down; 60 cm pore water poorly correlates with Harney River at all sites. (x=0.5). Highest average salinity at site SW1 30 cm (14.1 mS) and SW1 60 cm (14.2 mS) and lowest average salinity at SW4 cm (7.9 mS) and SW4 cm (8.3 mS). (Table 1).

Intra-site variation

SW1 shows largest average salinity difference between 30 cm and 60 cm (2.2 mS; SW1 0.62 mS). SW1, SW2 and SW3 (SW4 and SW5 less variable) show late spring separation between 30 cm and 60 cm. 30 cm salinities jumps sharply (April or May) and then falls sharply with the wet season rain pulse in June or July. 60 cm soil water salinity also rises in late spring, but it is dampened Chart 3-A. Salinities equalize in July and August (1-2 month lag period), then 30 cm salinity continue to drop through the wet season at a greater slope than the 60 cm salinity. In October-November salinities are roughly equalized again until next year's late spring (Chart 3-B). Scatter plots (Chart 3-C) indicate at each site, salinity between 30 cm/60cm to have a decreased relationship across the transect from the river. (SW1 r^2= 0.81;SW5 r2=0.37)

Future Work

Study has collected six years of salinity and temperature data and has determined principal seasonal and site variability. Important to utilize these data with needs of Everglades science and restoration purposes and coastal estuary studies. Current Everglades projects that can benefit from pore water salinity study are mangrove soil water quality study (see Sand et al poster); mangrove vegetation study (Smith); Hydraulic soil conductivity study (Anderson); LTER-Everglades related studies. (Twilley et al).

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