Determining the extent of saltwater influence on groundwater in Dr. Von D. Mizell-Eula Johnson State Park

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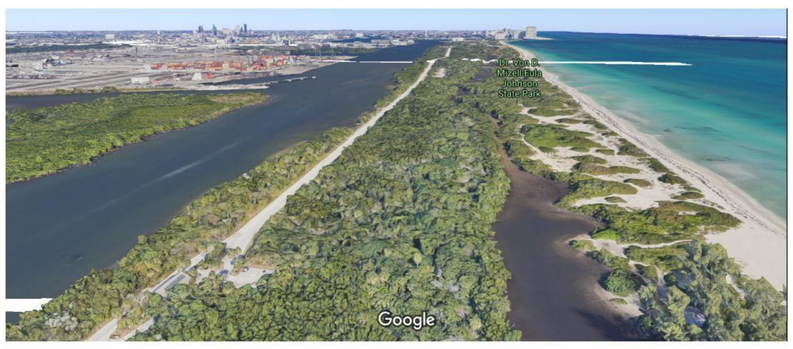
Research Question

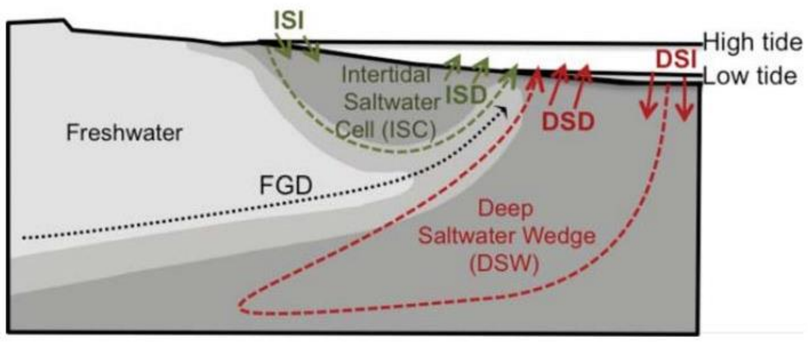
How do tidal changes influence the Freshwater-Saltwater Interface of coastal barrier islands? Can understanding the groundwater dynamics within Dr. Von D. Mizell-Eula Johnson State Park benefit current and future protection and restoration plans?



(Google, n.d.).

Introduction

- As a barrier island, Dr. Von D Mizell-Eula Johnson State Park (DVDMEJ) is at risk for changes resulting from stressors such as hurricanes, sea-level rise, and anthropogenic land modifications.
- The park consists of 312.69 acres of land, including 2.3 miles of oceanfront shoreline
- Protecting water quality and quantity, including restoring hydrology to a feasible level, as well as restoring and maintaining the natural communities within the park are management goals set by the Florida Department of Environmental Protection (FDEP, 2012, p. 8).
- Some of the natural communities within the park include beach dunes, coastal strands, mangrove swamps, and maritime hammocks. (FDEP, 2012, p. 22-31).
- The semi-diurnal tidal cycle of the region and the three bodies of water that border and transect the park pose a unique opportunity to investigate the influence of the ocean, creek and ICW on the freshwater lens at the central parts of the island.
- There is currently no known literature and little to no underlying data for this aspect of the park.



Groundwater regions and flow components in an unconfined coastal aquifer (Abarca et al., 2013).

Project Goals

- Map out the transition of groundwater from saline to freshwater in the park's subsurface flow.
- Studies of other regions have shown tides to influence the freshwater-saltwater interface (FWSWI) and the velocity of submarine groundwater discharge (SGD) (Abarca et al., 2013; Guo et al., 2019; Han et al., 2018).

Methods

- Survey DVDMEJ using ground penetrating radar to establish a water table baseline (Johnson, 1992).
- Establish transects
  - From the eastern shore of the Atlantic Ocean to the eastern shore of Whiskey Creek.
  - From the western shore of Whiskey Creek to the eastern shore of the ICW.
- Install piezometers incrementally across each east-west transect.
- Collect data in situ, ideally from at least one entire tidal cycle from each quarter-lunar-cycle.
  - If possible, groundwater samples will be collected for spectrophotometry examination.

Data Management

To be compiled in Microsoft Excel:

- Air pressure
- Air temperature
- Date and time of sampling
- Dominant plant community
- GPS coordinates
- Ground surface temperature
- Groundwater salinity and temperature
- Hydraulic head
- Piezometer depth
- Precipitation data
- Sediment composition
- Soil composition
- Soil conductivity
- Wind speed
- Spectrophotometry data
  - (if permissible)

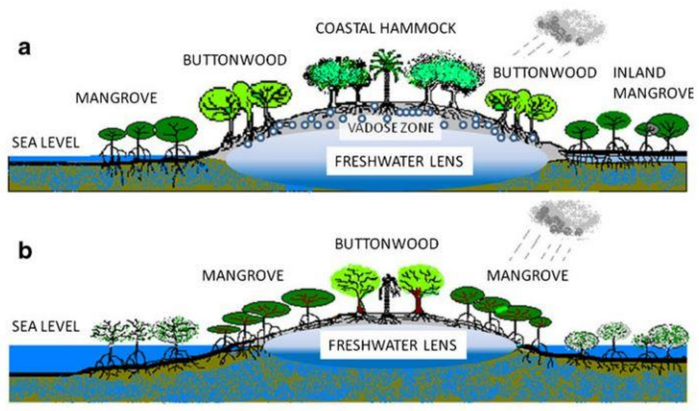
Implications

- Sea level rise and saltwater intrusion can have noticeable affects on the species composition of coastal forests across Florida (Saha et al., 2011; Wendelberger & Richards, 2017).
- Freshwater flow through coastal forests should be closely monitored and managed to mitigate increasing groundwater and soil salinity.
- Understanding groundwater dynamics within can provide insight into natural changes that could be expected in DVDMEJ communities.

(Deitsch, 2020)
Atlantic coast of Dr. Von D. Mizell-Eula Johnson State Park

Required Equipment

- Digital Balance
  - (for soil and sediment analysis)
- Field Journal
  - (for data collection)
- Gas-Powered Auger with Extension Attachment
  - (for placement of piezometers)
- Google Photos
  - (for GPS and backup data collection)
- Ground Penetrating Radar
  - (for mapping water table)
- Handheld Anemometer
  - (for measuring wind speed and air temperature)
- Mallet
  - (for placing piezometers)
- Microsoft Excel
  - (for data management)
- PVC Piping
  - (will serve as piezometers)
- Sediment Collection Jars
- Sediment Sieve
- Soil Collection Jars
- Soil Conductivity Meter
- Soil Drying Oven
- Soil Knife
  - (for soil collection)
- Spectrophotometer
- Spectrophotometer Cuvettes
- Wagon
  - (for transporting samples and equipment)
- Water Level Meter with Conductivity and Temperature Gauge
- Water Sampling Jars
  - (for spectrophotometry)



a: Sketch of a coastal hammock on an elevated rise flanked by buttonwood forests at intermediate elevations and mangrove forests at sea level. Also shown are the vadose zone (with water drops), freshwater lens (where shading indicates increasing brackishness towards the bottom of lens), and seawater.

b: Shows a rise in sea level that decreases the volume available to hold freshwater (shrinking of the freshwater lens), with consequent mortality of coastal hammocks and the migration of buttonwoods and mangroves along with the decrease in the freshwater lens. Elevation exaggerated in illustration to indicate water pools (Saha et al., 2011).

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References

- Abarca, E., Karam, H., Hemond, H. F., & Harvey, C. F. (2013). Transient groundwater dynamics in a coastal aquifer: The effects of tides, the lunar cycle, and the beach profile. *Water Resources Research*, 49(5), 2473-2488. https://doi.org/10.1002/wrcr.20075
- Florida Department of Environmental Protection. (2012, December 14). *John U. Lloyd Beach State Park: Approved unit management plan.* https://floridadep.gov/sites/default/files/12.14.2012%20Approved%20Plan.pdf
- Google. (n.d.). [3D Google Map of Dr. Von D. Mizell-Eula Johnson State Park]. Retrieved April 13, 2020, from https://goo.gl/maps/BHJDpvDJ7u6Rricz8
- Guo, Q., Huang, J., Zhou, Z., & Wang, J. (2019). Experiment and numerical simulation of seawater intrusion under the influences of tidal fluctuation and groundwater exploitation in coastal multilayered aquifers. *Geofluids*, 2019, 1-17. https://doi.org/10.1155/2019/2316271
- Han, Q., Chen, D., Guo, Y., & Hu, W. (2018). Saltwater-freshwater mixing fluctuation in shallow beach aquifers. *Estuarine, Coastal and Shelf Science*, 207, 93-103. https://doi.org/10.1016/j.ecss.2018.03.027
- Johnson, D. G. (1992). *Use of ground-penetrating radar for water-table mapping, Brewster and Harwich, Massachusetts*. U.S. Dept. of the Interior, U.S. Geological Survey. https://pubs.usgs.gov/wri/1990/4086/report.pdf
- Saha, A., Saha, S., Sadle, J., Jiang, J., Ross, M., Price, R., Sternberg, L., & Wendelberger, K. (2011). Sea level rise and South Florida coastal forests. *Climatic Change, 107*(1), 81-108. https://doi.org/10.1007/s10584-011-0082-0
- Wendelberger, K., & Richards, J. (2017). Halophytes can salinize soil when competing with glycophytes, intensifying effects of sea level rise in coastal communities. *Oecologia, 184*(3), 729-737. https://doi.org/10.1007/s00442-017-3896-2