$\delta^{15}N$ OF EASTERN OYSTERS AS A TRACER FOR ANTHROPOGENIC INFLUENCE AND INTERVENTION THROUGH TIME IN THE GUANA RIVER

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Introduction

$\delta^{15}N$ analysis is a useful tool in investigating the history of nutrient dynamics within near shore coastal ecosystems. Analysis of a modern temporal record of Eastern Oyster (*Crassostrea virginica*) shell material is utilized to assess the viability of $\delta^{15}N_{shell}$ variation as a means of assessment for watershed health and nutrient variability. By analyzing $\delta^{15}N$ values, we establish $\delta^{15}N$ values for an estuary system where nitrogen variation is not well documented despite concerns about water quality related to nutrient loading.

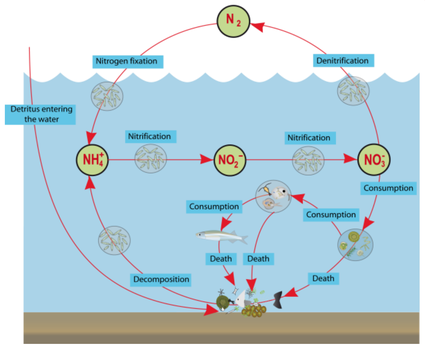
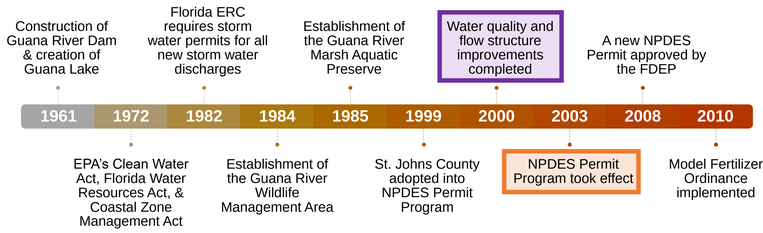


Figure 1. The aquatic nitrogen cycle. Atmospheric nitrogen (N_2) is fixed into ammonium (NH_4) which is fixed into nitrite (NO_2) and nitrate (NO_3) which is consumed. Each step in the nitrogen cycle causes nitrogen fractionation, allowing for the tracing of the nitrogen cycle through $\delta^{15}N$. From Sohm et al., 2011.

The Guana River Estuary



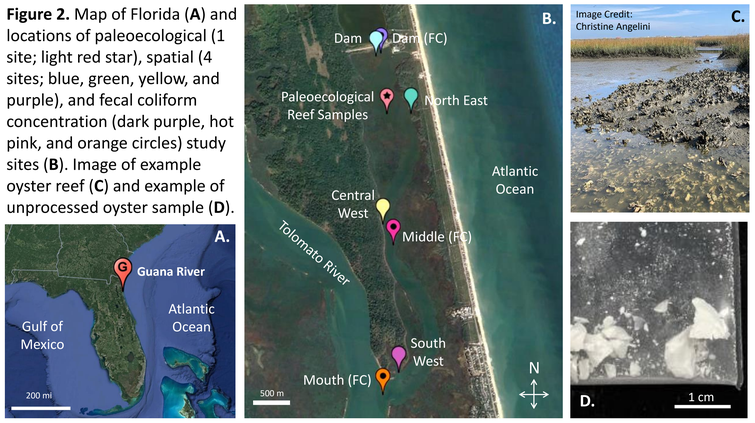


Figure 2. Map of Florida (**A**) and locations of paleoecological (1 site; light red star), spatial (4 sites; blue, green, yellow, and purple), and fecal coliform concentration (dark purple, hot pink, and orange circles) study sites (**B**). Image of example oyster reef (**C**) and example of unprocessed oyster sample (**D**).

Main Research Interests:

- How has nitrogen cycling changed with new environmental regulations and policies?
- How have pollutants affected $\delta^{15}N$ in oyster populations?
- How do $\delta^{15}N$ and $\delta^{13}C$ vary spatially within the Guana River, a ~3 mile long river?

Water Quality Monitoring

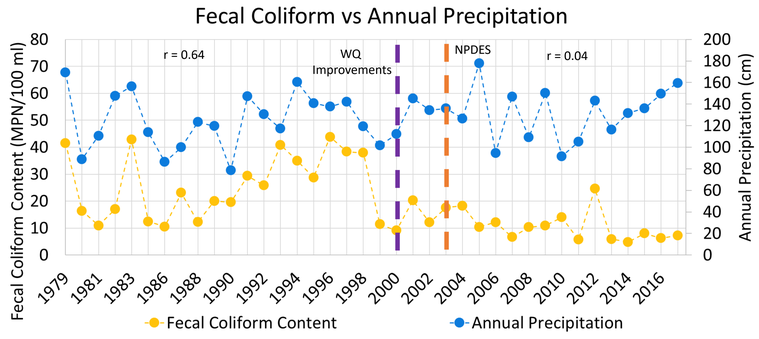


Figure 4. Fecal coliform values (MPN/100 ml) within a 5-mile radius of the paleoecological reef study site (Fig. 2) from 1979-2017 (yellow; left x-axis). Total annual precipitation (cm) from 1979-2017 (blue; right x-axis). In 2000, water quality and flow structure improvements through the Guana Basin Master Plan were completed (purple). In 2003, St. Johns County implemented their NPDES Permit (orange). Fecal coliform data from the FDEP. Annual total precipitation from NOAA.

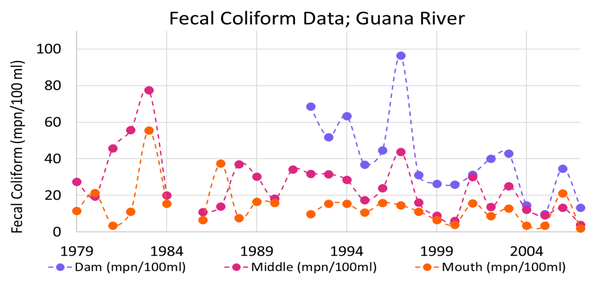
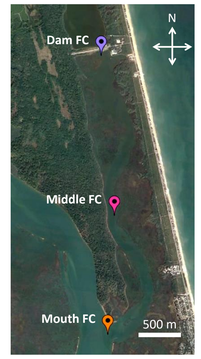


Figure 5. Fecal coliform values (MPN/100 ml) at three sites in the Guana River. The Dam (purple; n=180) is located closest to the dammed off portion of the Guana River and has higher fecal coliform concentrations than the middle of the river (hot pink; n=258) or the mouth of the river (orange; n=254). Fecal coliform concentrations collected by the Florida Department of Environmental Protection.



$\delta^{15}N$ and $\delta^{13}C$ Spatial Results

Data from Hallie Fischman

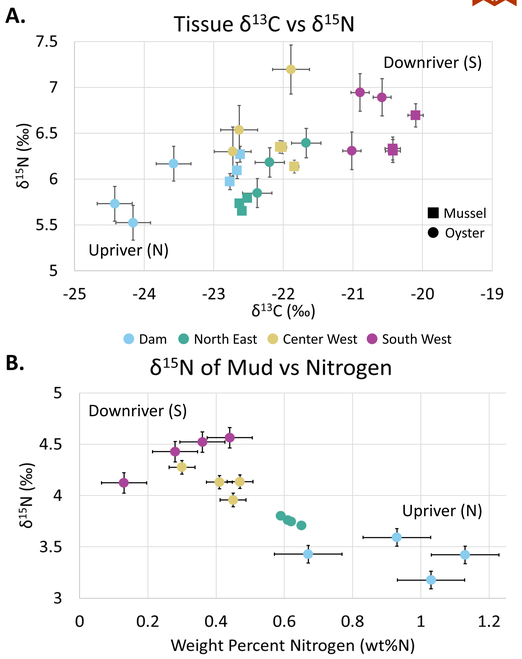


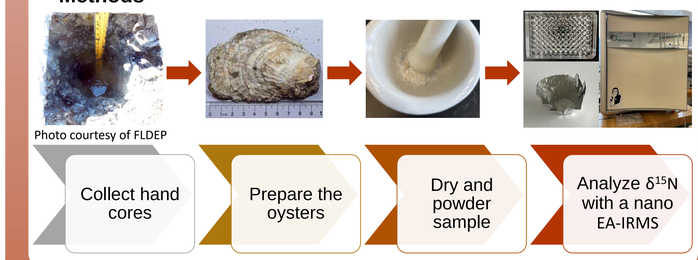
Figure 3. $\delta^{15}N$ (‰) vs $\delta^{13}C$ (‰) of oyster (circle) and mussel (square) tissue samples (**A**). Weight percent of nitrogen vs $\delta^{15}N$ (‰) in sediment at each of the 4 sample sites (B). See figure 2 for sample locations.

Paleoecological Sample Analysis

Paleoecological Study Samples:

- Hand cores collected from depths of 15-35cm beneath the living oyster reef layer (0-15cm) accessed the well-preserved paleoecological oyster reef record (Fig. 2).
- Individual shells are dated using bomb pulse radiocarbon dating
- 24 total oyster shell samples ranging from 1990-2013 in age

Methods



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PALEONTOLOGICAL RESEARCH INSTITUTION

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Paleoecological Results

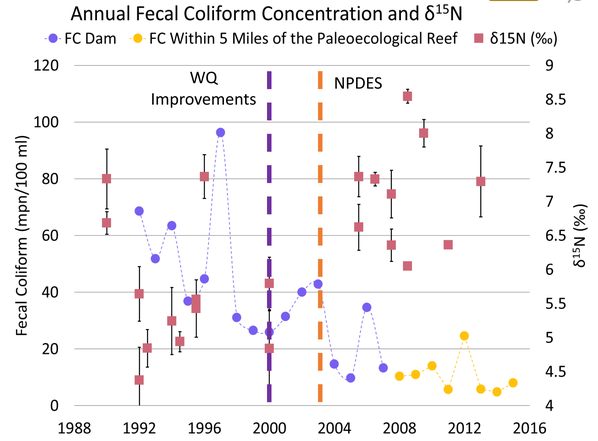

Figure 6. $\delta^{15}N$ values (‰) through time (year) of 24 Eastern Oyster shells dated using 14C from 15-35 cm depth in the paleoecolgical reef site (light red circles) with standard error bars (black). Between 1992 and 2013, $\delta^{15}N$ is highly variable. Between 1992-2000, there are generally lower $\delta^{15}N$ values with an average value of 5.40‰. Between 2005-2013, there are generally higher $\delta^{15}N$ values with an average value of 7.02‰. Standard error ranges between ±0.1‰ and ±0.5. Average annual fecal coliform concentrations (MPN/100ml) from the Dam (FC) site (purple) and from all fecal coliform measurements within 5-mile radius of the paleoecological reef site (yellow) on the right y-axis. All data is through time.

Conclusions

- New regulations causes less untreated storm water runoff to enter the estuary (proxied by fecal coliform content) which causes **less synthetic fertilizer** ($\delta^{15}N$ = 0-2‰) to enter the system, **driving $\delta^{15}N$ values upward**.
- **Oyster shell material is a viable material for temporal nutrient cycling studies**

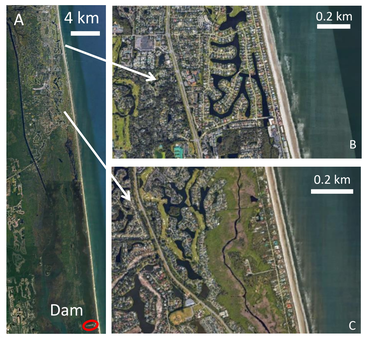

Figure 8. The Guana River (A) ~15 miles upriver from the dam (B) and ~10 miles from the dam (C).

References

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