Exploring Spatial Variations in Carbon and Nitrogen Stable Isotopes of Reef-Associated Fishes in the Southeastern USA: A Path to Dynamic Environmental Modeling

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Background

- **Isoscapes,** spatial maps illustrating isotopic variation, play a crucial role in comprehending and applying Stable Isotope Analysis**.**
- **Consumer-based Isoscapes** provide stable, time-averaged background for the study of organisms in higher trophic positions[1]
- **Integration of environmental parameters** in predictive models allows for a wider representation of the isotopic variation without the need for extensive sampling[2,3]

Objectives

1. **Create an Isoscape** of δ^{13}C and δ^{15}N in Reef-Associated fishes

2. **Correlate isotopic variation with environmental parameters** to create predictive models

Target Species

Haemulon aurolineatum
- Feeds near reefs in sandy and grassy benthic areas
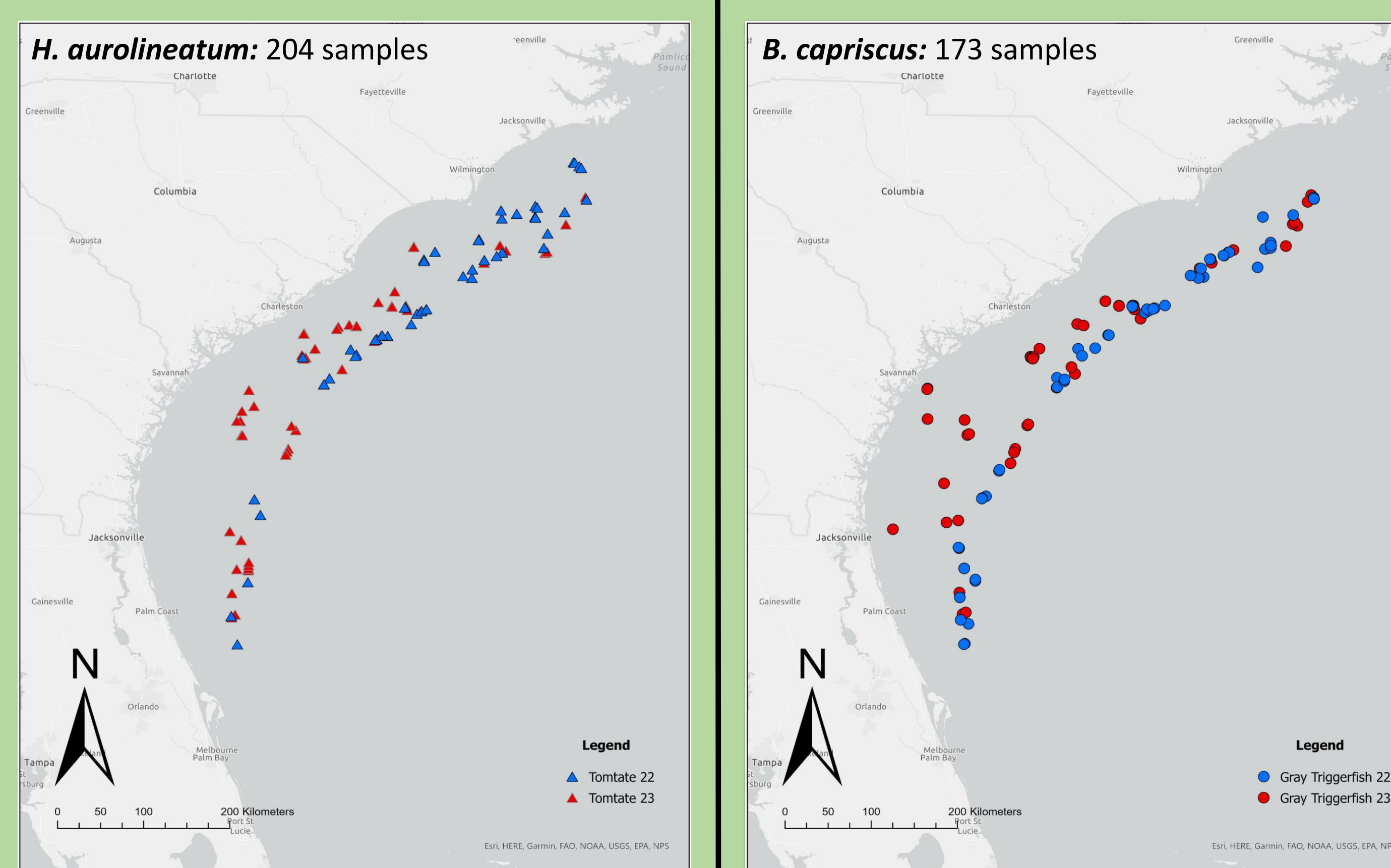- Generalist carnivores: bony fishes, mollusks, decapods, and more[4]

Balistes capriscus
- Reef-associated food sources in spring and summer
- Diet includes bivalves, barnacles, gastropods, echinoderms and more[5]

Selection Criteria:
- **Reliable representatives** of SEUSA due to distribution and abundance
- **Connection** to hard-bottom reefs and transition between substrates
- **Small home ranges** enable good spatial sample distribution
- **Key position in the food web**, feeding on lower trophic levels

Methods

Study Area & Sample Collection:

H. aurolineatum: 204 samples
B. capriscus: 173 samples

Legend
▲ Tomtate 22
▲ Tomtate 23
● Gray Triggerfish 22
● Gray Triggerfish 23

Stable Isotope Analysis:

Muscle samples were dried and homogenized into powder

Small amount will be prepared for analysis in EA-IRMS

Analysis for δ^{13}C and δ^{15}N

Modeling:
- **Application of correlations** with environmental data to find best predictive parameters
- **Creation of GAM** of isotopic variations with parameters that are best predictors (highest R^2)

**Environmental Parameters:**
- **Static**: Longitude, Latitude, Depth
- **Dynamic**: Remote sensing data will be acquired by the **Giovanni online database**; SST, PAR, Chlorophyll Concentration, POM, light attenuation (selection has not been finalized)
  - SST has been shown to be a strong predictor, with high temporal stability
  - PAR can be a strong predictor of δ^{13}C, since it influences photosynthetic fractionation

Significance

- **Understanding trends in δ^{13}C and δ^{15}N** of Reef-associated fishes in the SEUSA.

Hypothesized Trends in the area based on previously recorded trends and the environmental and ecological factors of the SEUSA

δ^{13}C will increase southward (similar to trends in primary producers).
δ^{13}C will increase offshore (due to upwelling influences)
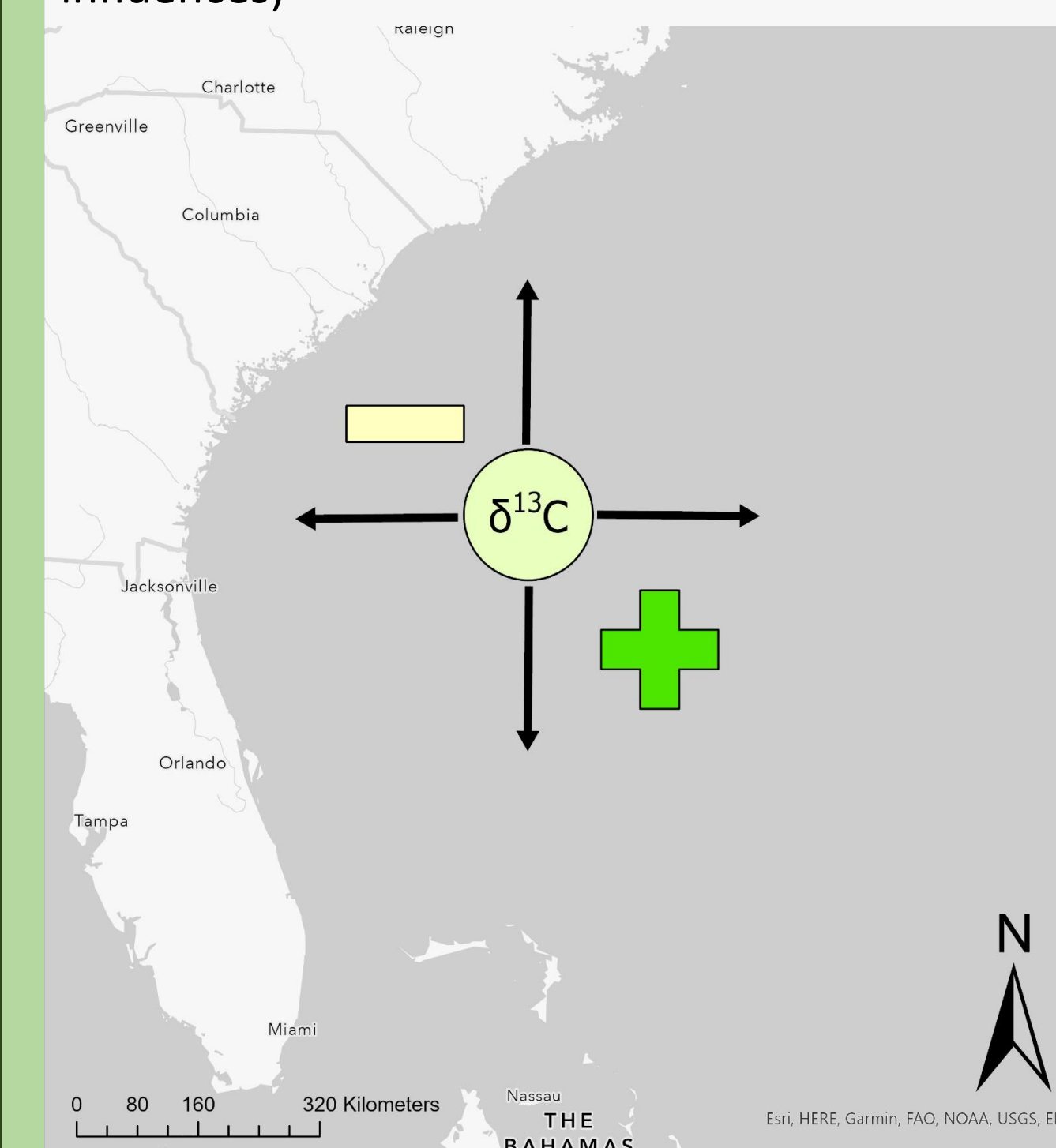
δ^{15}N will increase southward (as seen in trends of primary producers)
δ^{15}N will increase nearshore (due to terrestrial influences)
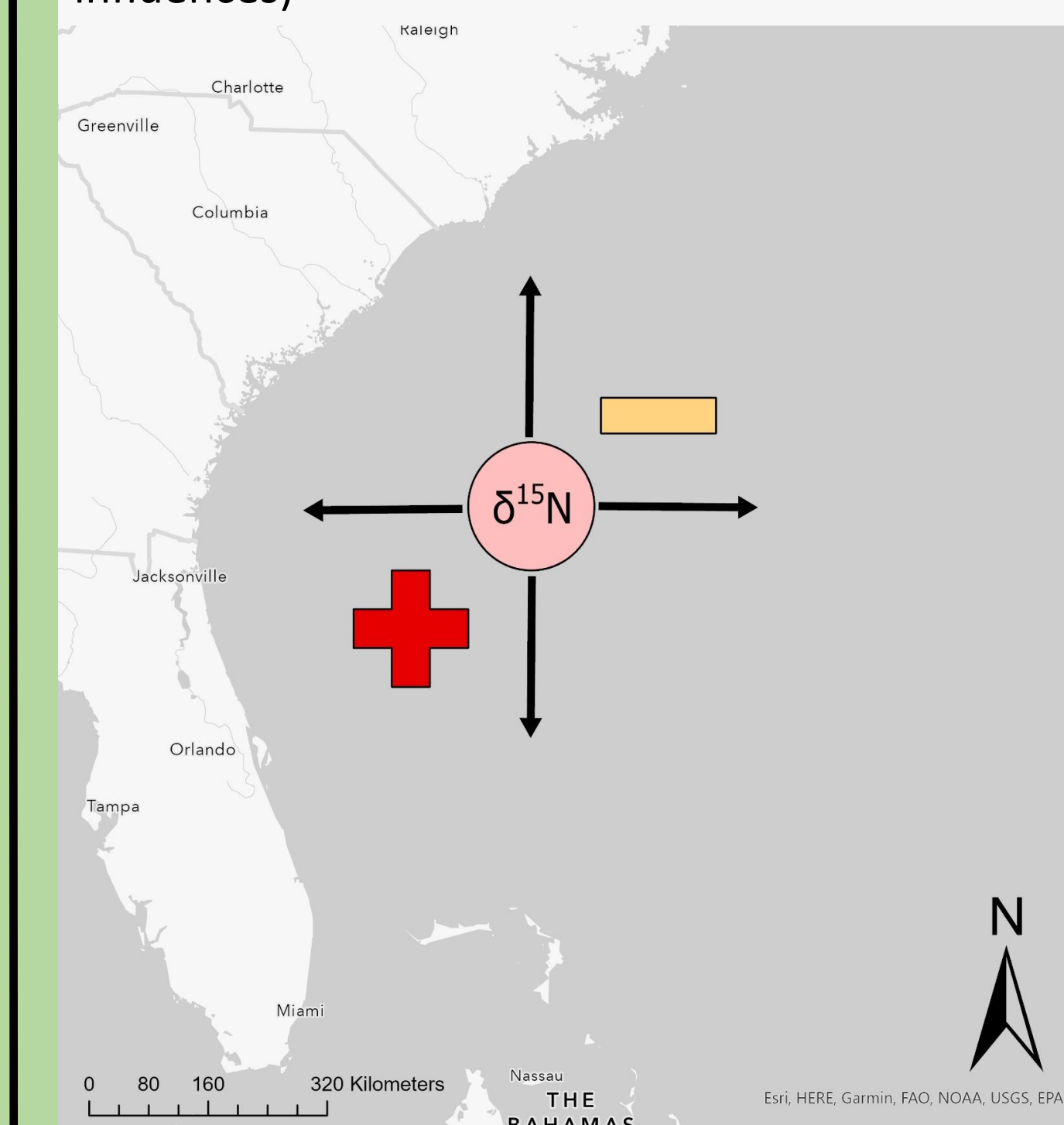
- **Establishing an Isoscape of the SEUSA** that can be utilized by isotopic studies of organisms in similar or higher trophic positions
- **Development of predictive models** to elucidate patterns in isotopic variation and reduce the sampling needs of isoscape maintenance

References

1. Graham, B. S., Koch, P. L., Newsome, S. D., McMahon, K. W., & Aurioles, D. (2010). Using isoscapes to trace the movements and foraging behavior of top predators in oceanic ecosystems. Isoscapes: Understanding Movement, Pattern, and Process on Earth through Isotope Mapping, 299–318. https://doi.org/10.1007/978-90-481-3354-3_14/FIGURES/6
2. Barnes, C., Jennings, S., & Barry, J. T. (2009). Environmental correlates of large-scale spatial variation in the δ^{13}C of marine animals. Estuarine, Coastal and Shelf Science, 81(3), 368–374. https://doi.org/10.1016/J.ECSS.2008.11.011
3. Hofmann, M., Wolf-Gladrow, D. A., Takahashi, T., Sutherland, S. C., Six, K. D., & Maier-Reimer, E. (2000). Stable carbon isotope distribution of particulate organic matter in the ocean: a model study. Marine Chemistry, 72(2–4), 131–150. https://doi.org/10.1016/S0304-4203(00)00078-5
4. Sedberry, G. R. (1985). Food and feeding of the tomtate, *Haemulon aurolineatum*. Fishery Bulletin, 83(3).
5. Vose, F. E., & Nelson, W. G. (1994). Gray triggerfish (*Balistes capriscus*, GMELIN) feeding from artificial and natural substrate in shallow Atlantic waters of Florida. Bulletin of Marine Science, 55(3), 1316–1323.