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Exploring Impacts of Physical Stressors on Fish Diversity and Abundance in the Brazos River Estuary, Texas

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Introduction

Marine fish species spawned offshore have a strong connection with nearshore estuarine habitat. The larvae of a variety of species immigrate into estuarine nursery areas where they utilize abundant resources to grow and mature (Hettler and Chester 1990, Patterson and Whitfield 1997). Numerous factors influence immigration, survival, and growth of nekton including freshwater inflow, moon phase and tides, weather, currents, and biological interactions (Hettler and Chester 1990).

After recruiting, these nekton rely on the estuary for nourishment while growing; and interacting with a variety of abiotic stressors, which impact survival. The Brazos River Watershed covers 118,000 km^2 and has an average daily discharge of 7,400 cfs (Phillips 2006, NOAA 1990). Flow, along with salinity, dissolved oxygen, and temperatures are some primary abiotic factors that impact survivability and abundance of organisms in the Brazos River Estuary.

The current study evaluated the impacts of abiotic stressors on the abundance of the nekton community in the Brazos River Estuary over a spatial (lower 42 river km) and temporal (one year) scale.

Study Area

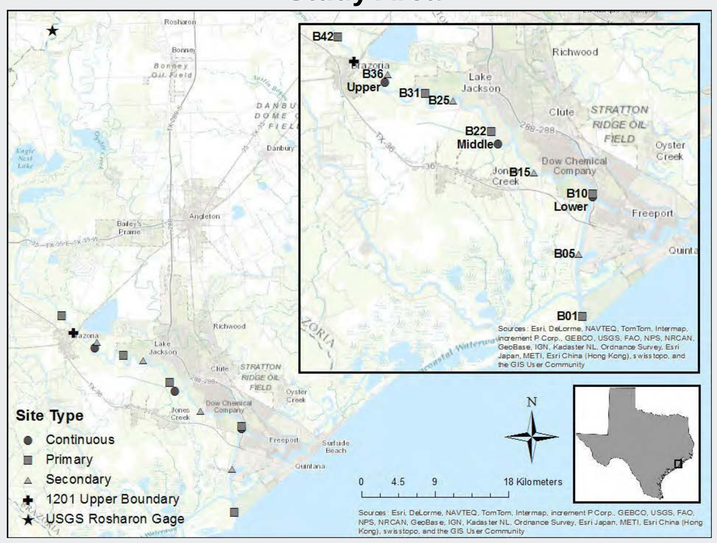

Figure 1: Study map of the Brazos River Estuary showing all trawl and water quality profile measurement sites. Primary sites sampled beam and otter trawls, along with water quality profiles, secondary sites sampled water quality profiles only, and continuous sites sampled conductivity and dissolved oxygen using HOBO loggers.

Methods

Monthly collections of nekton were sampled at five sampling sites in the Brazos River from December 2016 to October 2017. Sites ranged from 1.0 km (B01) to 42 km (B42) up river (Figure 1). All five sampling sites were previously sampled as part of past studies quantifying nekton diversity in the Brazos River (Johnson 1977, Miller 2014, Bonner et al 2015). Nekton were collected using a 6.4 mm mesh Renfro beam trawl and 3.1 m wide otter trawl equipped with 38.2mm stretch mesh (Figure 2). Otter and beam trawls were sampled in triplicate at each site, lasting five minutes and 50 feet respectively. Nekton were identified and measured in the field, or stored in 10% formalin/in-situ water and identified to species in the lab. Using a YSI ProDss system water quality profiles were taken at each sampling site. River discharge was also measured at B42 using a SonTek River Surveyor system.

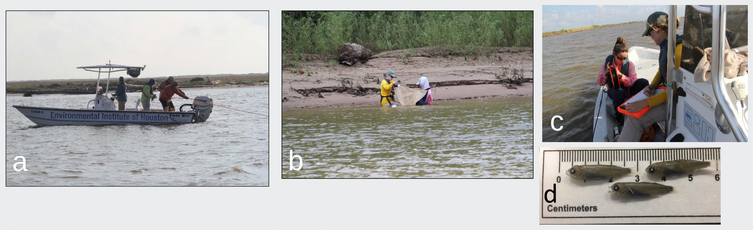

Figure 2: Nekton and water quality collection methods a) otter trawl, b) beam trawl, c) water quality d) lab processing.

Results

Nekton Diversity

- Between the 5 sample locations nekton comprising 45 taxa totaling 11,862 individuals were caught.
- Pielous Evenness and total abundance measures not significantly different among all 5 sampling sites (Figure 3a).
- Sites B01 and B10 show significant grouping in Margalef Richness ($p < 0.01$) and total species caught ($p < 0.01$) (Tukey Pairwise comparisons) (Figure 4a, 3b).
- Samples at B22, B31, and B42 were similar in Shannon Diversity ($p < 0.01$) and Margalef Richness ($p < 0.01$) (Tukey Pairwise & Games-Howell comparisons) (Figure 4b, 4a).

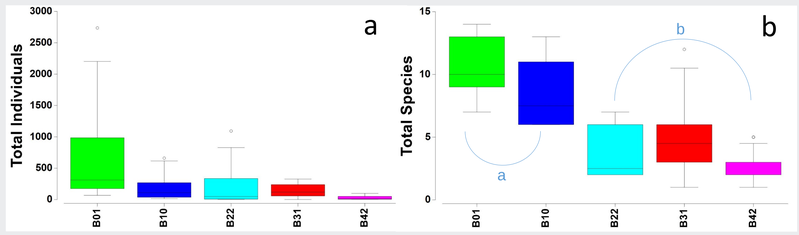

Figure 3: Total nekton abundance caught at each site (3a) and total number of nekton species caught at each site (3b). Blue groupings represent Tukey Comparison significant groupings (Minitab 17).

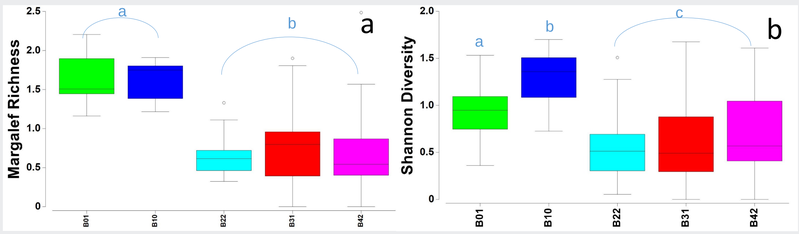

Figure 4: Margalef Richness index (4a) and Shannon Diversity Index (4b) of all nekton abundances between the 5 sampling sites. Blue groupings represent Games-Howell (4a) and Tukey Comparison (4b) significant groupings (Minitab 17).

Nekton Abundance

- Of the 11,862 individuals caught the most abundant species included Atlantic Croaker (41.2%) and Blue Catfish (9.6%) (Figure 5).
- Most abundant invertebrate constituents included River Shrimp (5.8%), and White Shrimp (2.6%) (Figure 6).
- Bottom salinity was the strongest individual factor predicting species abundance describing 69.3% of the variation (BEST Primer7).

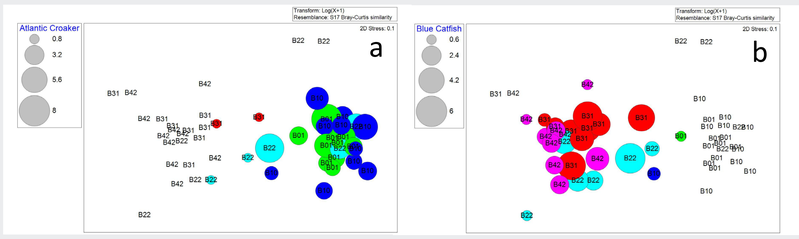

Figure 5: Non-metric MDS (nMDS) plots representing Log(X+1) abundances of Atlantic Croaker (5a) and Blue Catfish (5b) by sampling site.

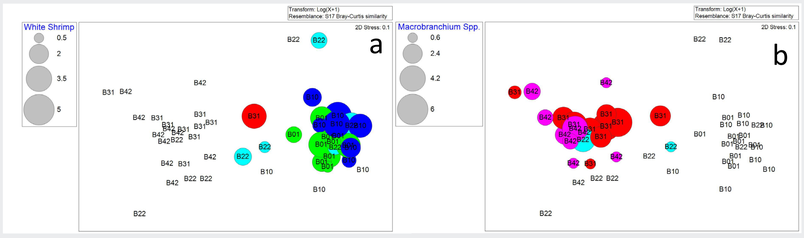

Figure 6: Non-metric MDS (nMDS) plots representing Log(X+1) abundances of White Shrimp (6a) and River Shrimp (6b).

Environmental Factors

- Mean bottom salinities ranged from 0.312 – 25.61 psu (Figure 7a).
- Sites B01 and B10 had significantly greater salinities than the other 3 sites ($P < 0.01$) (Games-Howell Comparison).
- Flow severity negatively correlated to mean bottom salinity ($P = 0.048$, $r^2 = 0.0790$).

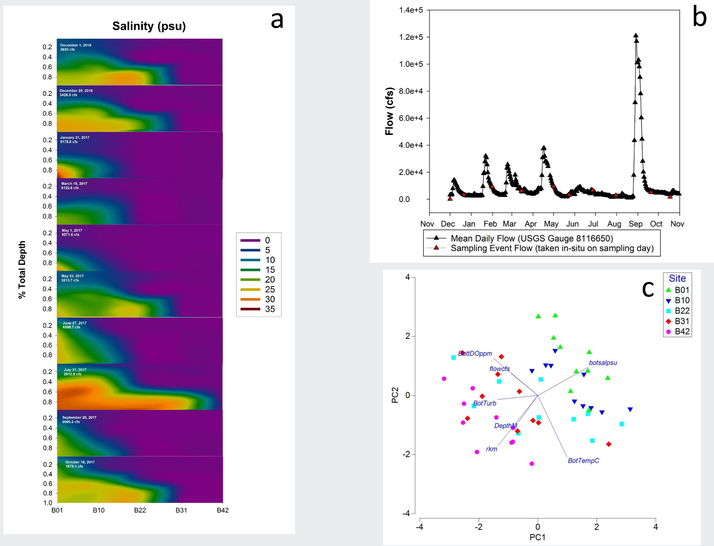

Figure 7: Contour plot showing salinity profile by site (7a), mean daily flow during project duration, Dec. 1, 2016 – Oct. 18, 2017 (7b), and PCA of environmental parameters by site (7c).

Conclusions

- The Brazos River Estuary is a highly dynamic system showing substantial variation in physical and biological composition.
- Numerous marine/estuarine species utilize the Brazos River Estuary as habitat for the majority of the calendar year.

Future Work

- Current study investigating the impacts of location and size on diet of juvenile estuarine fish species utilizing stable isotope analysis underway.
- Examine relationships between abundance/diversity/composition on diet of finfish within the Brazos River Estuary.
- Continued monitoring of flow severity and the impacts on the biota and appearance of the estuary.

Literature Cited

Bonner, T., J. Duke, G. Guillen, K. Winemiller and BIO-West (2015). Instream flows research and validation methodology framework and Brazos Estuary characterization. Texas Water Development Board: 202.

Hettler Jr, W. F., and A. J. Chester. 1990. Temporal distribution of ichthyoplankton near Beaufort Inlet, North Carolina. Marine Ecology Progress Series **68**:157-168.

NOAA. 1990. Estuaries of the United States: vital statistics of a national resource base. U.S. Department of Commerce. NOAA, NOS. Rockville, MD. 79 pp.

Johnson, R. 1977. Fishery survey of Cedar Lakes and the Brazos and San Bernard River Estuaries. Texas Parks and Wildlife Technical Series 28:175-183.

Miller, A. 2014. Characterization of the Brazos River Estuary. University of Houston-Clear Lake:126.

Paterson, A. W., and A. K. Whitfield. 1997. A Stable Carbon Isotope Study of the Food-web in a Freshwater-deprived South African Estuary, with Particular Emphasis on the Ichthyofauna. Estuarine, Coastal and Shelf Science 45:705-716.

Phillips, J. 2006. Geomorphic context, constraints, and changes in the lower Brazos and Navasota Rivers, Texas. Texas Water Development Board.

Acknowledgments

- Field and lab assistance: Cory Scanes, Nicole Morris, Natasha Zarnstorff, Kris Warner, Sherah Loe, Anna Vallery, Mandi Gordon
- Funding: Texas Water Development Board, Bio-West, Inc.

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Prepared for Texas Chapter of the American Fisheries Society; College Station, TX; January 25-27, 2018