Investigating the Feeding Ecology of Blue Catfish (*Ictalurus furcatus*) in the Nanticoke River

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1 = Salisbury University, 2 = United States Geological Survey, 3 = Maryland Department of Natural Resources

Nanticoke River, Maryland & Delaware

- Interjurisdictional tributary on the Bay's eastern shore
- Largest and most biodiverse tributary on Delmarva peninsula (725,000-acre watershed)
- Blue Catfish introduction estimated around 2002

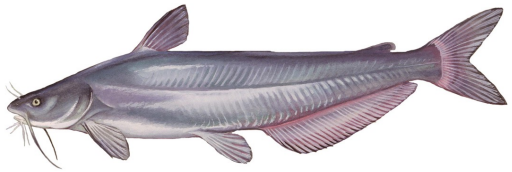

Illustration by Duane Raver

Nanticoke River

- No major barriers to fish passage
- Large quantities of surrounding intact wetlands
- Supports Blue Crab, Striped Bass, White & Yellow Perch, *Alosa spp*.
- Spawning population of Atlantic Sturgeon
- High agricultural nutrient inputs

Photo by Matt Rath, CBP

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Goals

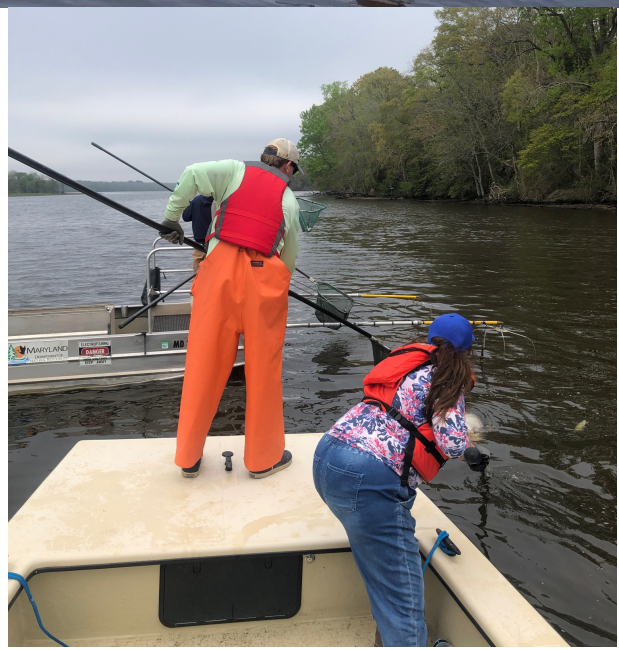
- Investigate the diet composition and trophic interactions of Blue Catfish in the Nanticoke River by analyzing stomach contents and stable isotopic ratios of N and C

- Investigate marine resource use by Blue Catfish in the Nanticoke River through the analysis of sulfur stable isotopic ratios found in bulk muscle and liver tissues

- Enhance outreach and awareness regarding invasive Blue Catfish on the Delmarva Peninsula

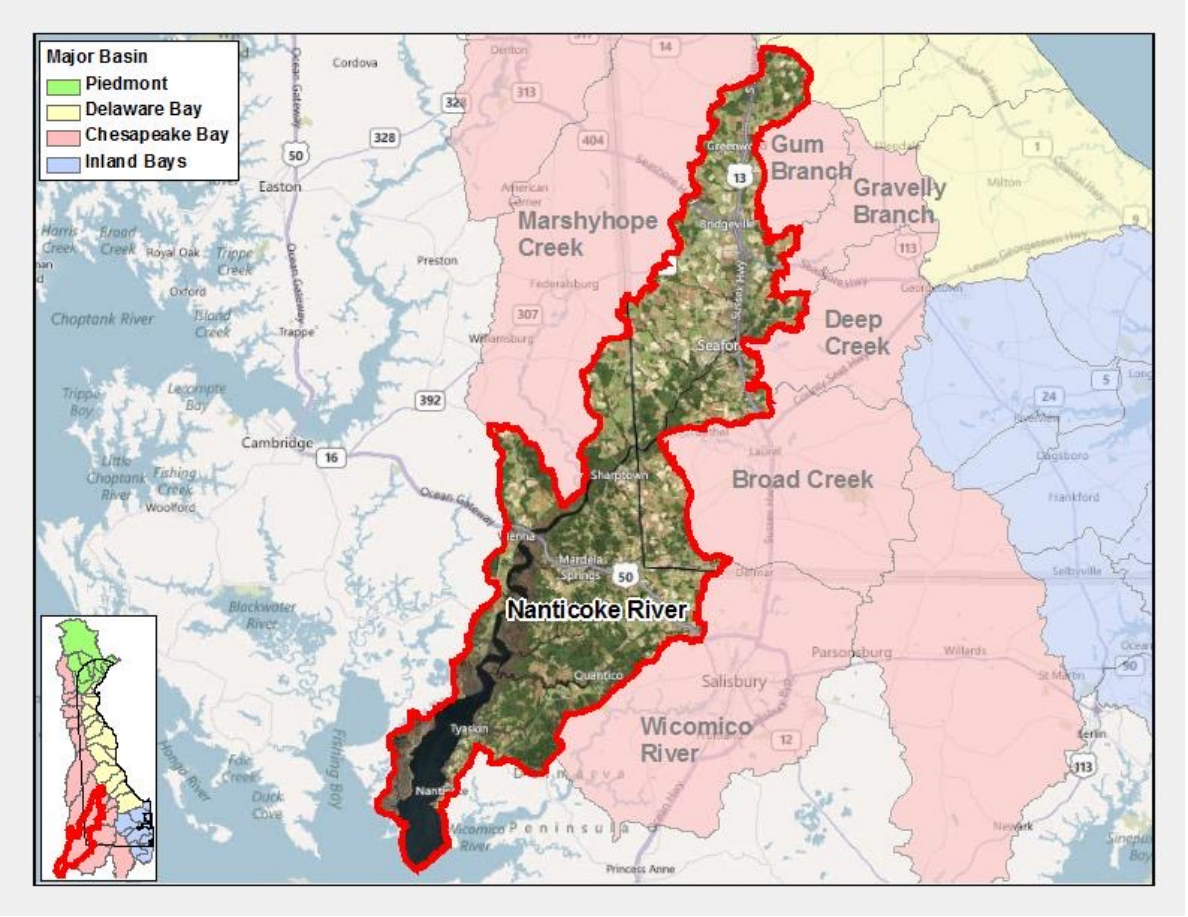
Fish Collection

- Monthly boat electrofishing with MD DNR and DE DNREC
- Chase boat to increase efficiency and fish storage space
- Tournaments – angler donations
- Trot lines and Trawl – supplementary



Fish Collection

- Most fish collected from Marshyhope Creek and Mainstem Nanticoke from MD state line to Vienna, MD
- Sampling constraints in Delaware portion and mesohaline section

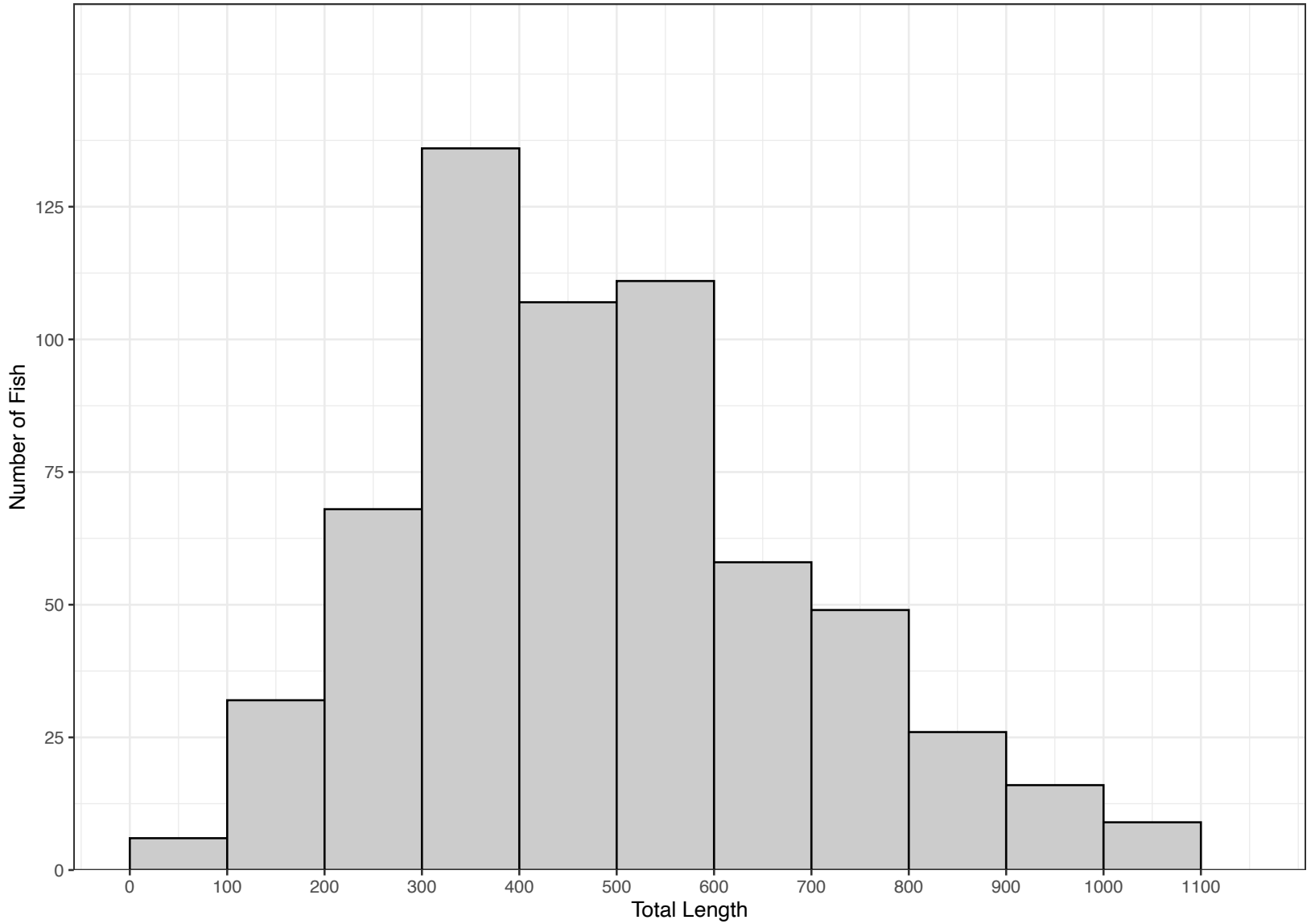


Map from delawarewatersheds.org

Methods

- Recording location, water quality, tide, length, weight, and sex
- Excising stomachs and analyzing contents
- Molecular analysis of unidentifiable fish prey (USGS)
- % Frequency of occurrence, % Weight, %PSIRI to characterize diet composition

Length Frequency – Preliminary* (n=620)



*Fish captured so far, from 11/21-7/22

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Stomach Contents

White Perch

Blueback Herring

Alewife

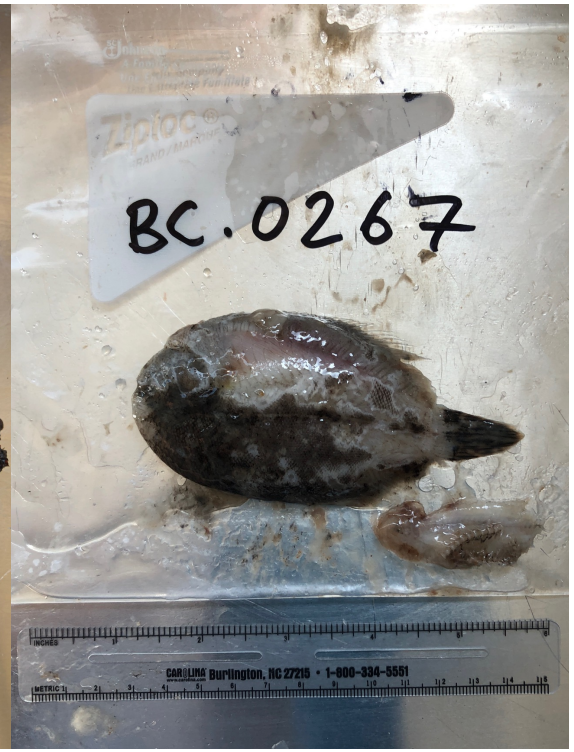
Gizzard Shad

Stomach Contents

Blue Crab

Striped Bass

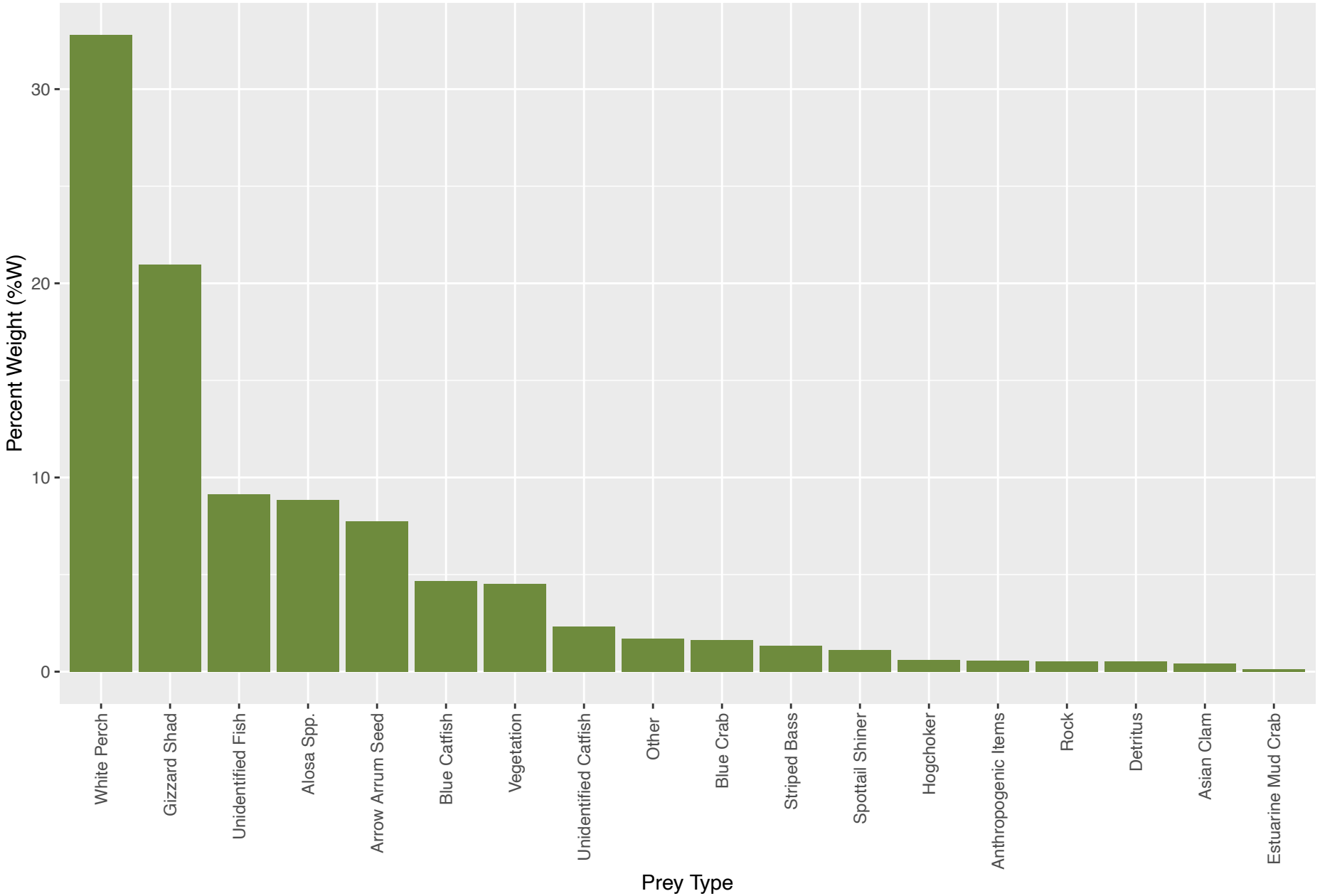
Vegetation



Hogchoker

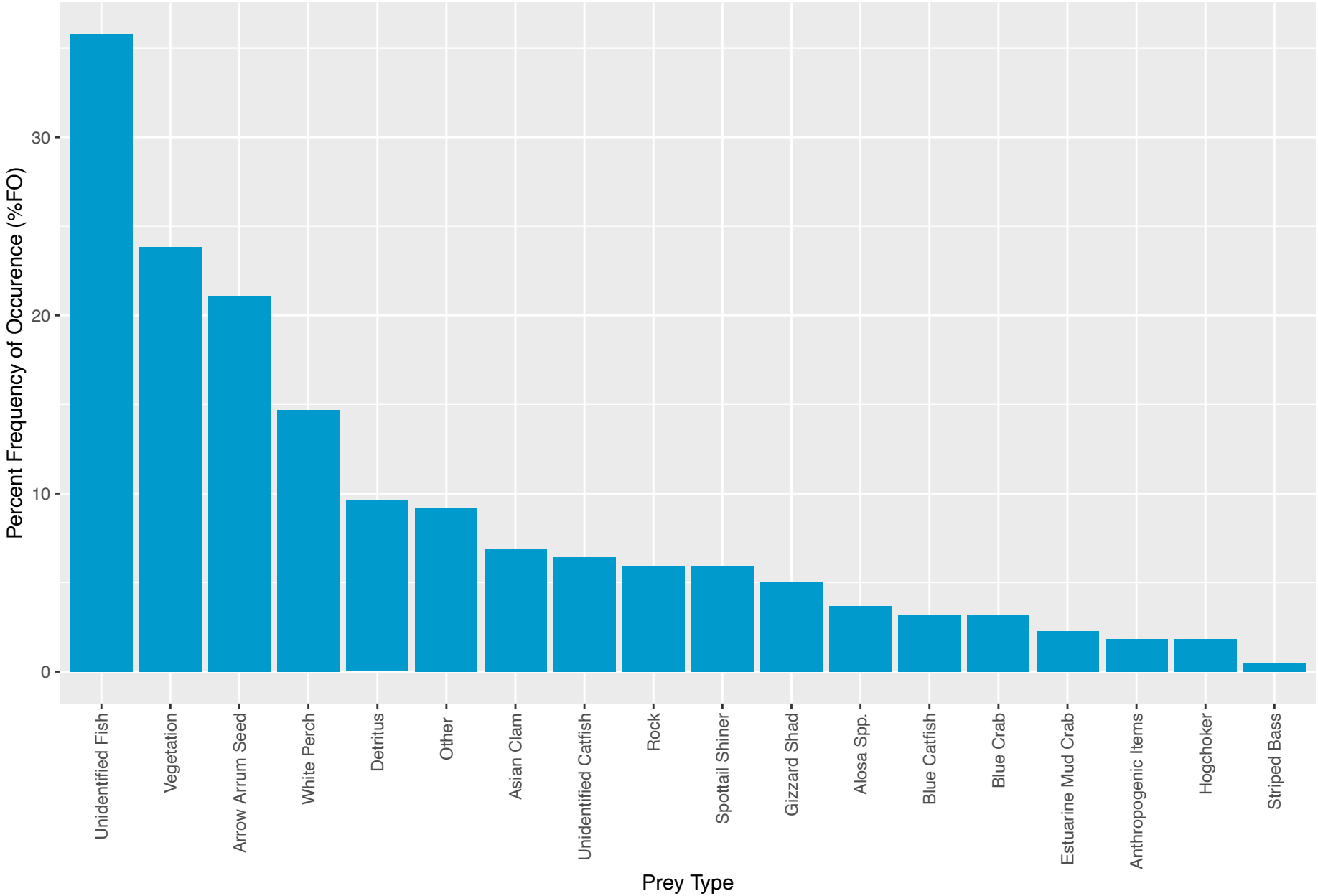
And the most surprising item so far, a Wood Duck…

Preliminary % Weight



- n = 218 stomachs containing prey items
- 11/2021-5/2022
- *Molecular analysis for UnID fish prey not yet complete*

Preliminary % Frequency of Occurrence



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Stable Isotope Analysis

- Removing small ($1cm^3$) dorsal white muscle tissue from BCF and diet items

- Freeze-drying, homogenizing, and packaging tissue samples
- Analysis of C/N isotopic ratios at UMCES CASIF
- Investigating Sulfur isotopic ratios in muscle + liver

- Expected products: C/N biplots, C/N/S vs. total length, mixing model, trophic relationships

Additional Collaborative Research with USGS

Health & Disease Research

- Cystic lesions
- *Y. ruckeri* – Barren Creek
- Sequencing bacterial isolates
- Molecular diagnostics

Reproductive Endocrinology

- Collecting blood and gonad samples from individuals each month
- Testing hormones in blood plasma
- Gonadal histology comparisons

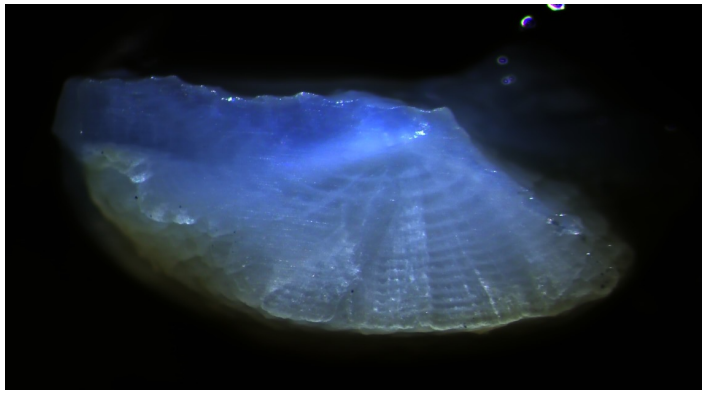
Additional Future Projects at Salisbury University

Fecundity

- Estimating gonadosomatic index, relative fecundity of BCF in Nanticoke

Age and Growth

- Removing otoliths from a portion of individuals from diet study
- Preparing and aging structures this Fall



Outreach

- Nanticoke River Invasive Fishing Tournament (7/30/2022)
- Sharptown Catfish Tournament (4/9/2022)
- “Third Friday” events in downtown Salisbury
- Angler Facebook group ”ask a scientist” events

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References

Aguilar, R., M. B. Ogburn, A. C. Driskell, L. A. Weigt, M. C. Groves, and A. H. Hines. 2017. Gutsy genetics: Identification of digested piscine prey items in the stomach contents of sympatric native and introduced warmwater catfishes via DNA barcoding. Environmental Biology of Fishes 100(4):325-336.

Amundsen, P., H. Gabler, and F. J. Staldvik. 1996. A new approach to graphical analysis of feeding strategy from stomach contents data -- modification of the costello (1990) method. Journal of Fish Biology 48(4):607-614.

Ator, S. W., & Denver, J. M. (2015). *Understanding the nutrients in the Chesapeake Bay watershed and implications for management and restoration: The eastern shore* (p. 84). US Department of the Interior, US Geological Survey.

Belkoski, D. J., M. Drzewicki, and F. S. Scharf. 2021. Specialized feeding patterns and marine resource use by nonnative catfishes in a coastal river ecosystem revealed by dietary and stable isotopic analyses. Marine and Coastal Fisheries 13(5):564-582.

Bigg, M. A., and H. A. Perez. 1985. Modified volume: A frequency-volume method to assess marine mammal food habits.

Bodine, K. A., and D. E. Shoup. 2010. Capture efficiency of blue catfish electrofishing and the effects of temperature, habitat, and reservoir location on electrofishing-derived length structure indices and relative abundance. North American Journal of Fisheries Management 30(2):613-621.

Chipps, S .R., and J .E. Garvey. 2007. Assessment of diets and feeding patterns. Pages 473–514 in C.S. Guy and M.L. Brown, editors. Analysis and interpretation of freshwater fisheries data. American Fisheries Society, Bethesda, Maryland.

Connolly, R. M., M. A. Guest, A. J. Melville, and J. M. Oakes. 2004. Sulfur stable isotopes separate producers in marine food-web analysis. Oecologia 138(2):161.

Cortés E. 1997. A critical review of methods of studying fish feeding based on analysis of stomach contents: application to elasmobranch fishes. Canada Journal of Fish and Aquatic Science 54(3):726–738.

Cucherousset, J., S. Bouletreau, A. Martino, J-M Roussel, and F. Santoul. 2012. Using stable isotope analyses to determine the ecological effects of non-native fishes. Fisheries Management and Ecology 19(2):111-119.

DeNiro, M. J., and S. Epstein. 1978. Influence of diet on the distribution of carbon isotopes in animals. Geochimica et cosmochimica acta *42*(5), 495-506.

Fabrizio, M. C., T. D. Tuckey, R. J. Latour, G. C. White, and A. J. Norris. 2018. Tidal habitats support large numbers of invasive blue catfish in a chesapeake bay subestuary. Estuaries and Coasts 41(3):827-840.

Ferry LA, Cailliet GM. 1996. Sample size sufficiency and data analysis: are we characterizing and comparing diet properly? In: MacKinlay D, Shearer K (eds) Feeding ecology and nutrition in fish: proceedings of the symposium on the feeding ecology and nutrition in fish. International congress on the biology of fishes, San Francisco, CA, 14–18 July 1996, pp 71–80.

Hyslop, E. J. 1980. Stomach contents analysis–a review of methods and their application. Journal of Fish Biology 17:411–429.

Jacobs, K., M. Navarez, A. Homsey, G. J. Kauffman. 2020. Economic Value of the Nanticoke Watershed. University of Delaware, Newark, Delaware. https://nanticokeriver.org/wp-content/uploads/2020/05/Final-Economic-Survey.pdf

Kadye, W. T., and A. J. Booth. 2012. Integrating stomach content and stable isotope analyses to elucidate the feeding habits of non-native sharptooth catfish *Clarias gariepinus*. Biological Invasions 14(4):779-795.

Limburg, K. E., and J. R. Waldman. 2009. Dramatic declines in north atlantic diadromous fishes. Bioscience 59(11):955-965.

Macavoy, S. E., S. A. Macko, and G. C. Garman. 2001. Isotopic turnover in aquatic predators: Quantifying the exploitation of migratory prey. Canadian Journal of Fisheries and Aquatic Sciences 58(5):923-932.

Maryland Department of Natural Resources. 2014. Lower Eastern Shore water quality and habitat assessment overall condition 2012–2014. Maryland Department of Natural Resources, Annapolis, Maryland, USA.

Minagawa, M., and E. Wada. 1984.. Stepwise enrichment of 15N along food chains: further evidence and the relation between δ15N and animal age. Geochimica et cosmochimica acta *48*(5), 1135-1140.

Moran, Z., D. J. Orth, J. D. Schmitt, E. Hallerman, and R. Aguilar. 2015. Effectiveness of DNA barcoding for identifying piscine prey items in stomach contents of piscivorous catfishes. Environmental Biology of Fishes 99(1):161-167.

Moran, Z. S., & Stoeckel, J. N. (2021). Effects of chase boat use, electrofishing duration, and water velocity on sample efficiency and size structure of Blue Catfish. *North American Journal of Fisheries Management*, *41*, S388-S399.

Nepal, V., and M. C. Fabrizio. 2019. High salinity tolerance of invasive blue catfish suggests potential for further range expansion in the chesapeake bay region. PLoS One 14(11):e0224770.

Peterson, B. J., and B Fry. 1987. Stable isotopes in ecosystem studies. Annual review of ecology and systematics 18(1), 293-320.

Schloesser, R. W., M. C. Fabrizio, R. J. Latour, G. C. Garman, B. Greenlee, M. Groves, and J. Gartland. 2011. Ecological role of blue catfish in chesapeake bay communities and implications for management.

Schmitt, J. D., E. M. Hallerman, A. Bunch, Z. Moran, J. A. Emmel, and D. J. Orth. 2017. Predation and prey selectivity by nonnative catfish on migrating alosines in an atlantic slope estuary. Marine and Coastal Fisheries 9(1):108-125.

Schmitt, J. D., B. K. Peoples, L. Castello, and D. J. Orth. 2019. Feeding ecology of generalist consumers: A case study of invasive blue catfish *Ictalurus furcatus* in Chesapeake Bay, Virginia, USA. Environmental Biology of Fishes 102(3):443-465.

Secor, D. H., O'Brien, M. H. P., Coleman, N., Horne, A., Park, I., Kazyak, D. C., ... & Stence, C. (2021). Atlantic Sturgeon Status and Movement Ecology in an Extremely Small Spawning Habitat: The Nanticoke River-Marshyhope Creek, Chesapeake Bay. Reviews in Fisheries Science & Aquaculture, 1-20.

The Nature Consercvancy. 1998. Nanticoke River bioreserve strategic plan. The Nature Conservancy, Bethesda, MD, USA.

Zanden, M. J. V., and J. B. Rasmussen. 2001. Variation in δ15N and δ13C trophic fractionation: implications for aquatic food web studies. Limnology and oceanography 46(8), 2061-2066.

Questions?

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