The effects of an urban area on water quality and benthic macroinvertebrate diversity in the Lumbee River

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Introduction

- Runoff from urban areas can pollute nearby rivers, decrease water quality, and be harmful to aquatic organisms[1].
  - High levels of nitrogen and phosphorus are often associated with decreased water quality.
- The diversity of benthic (bottom-dwelling) macroinvertebrates can indicate the water quality[3].
- Water quality and macroinvertebrate diversity can vary seasonally.
- The Lumbee river is a blackwater river with high levels of tannins.
- This project examined the effects of an urban area on the Lumbee River*, a culturally and ecologically important river[2] in North Carolina.
- Three sites were selected based on their proximity to an urban area (Lumberton, NC).

Methods and Materials

- Samples were taken at 3 different sites over the course of a year
  - 3 samples per site collected in summer
  - 1 sample per site collected in fall and winter
  - Spring samples could not be collected due to COVID-19 pandemic
- Benthic invertebrates were collected using a D-net and preserved in 70% ethanol.
- Benthic macroinvertebrates were identified and counted using a dissecting microscope.
- Physical water quality variables were recorded at each site
- Water samples were collected using a swing sampler, and water chemistry levels were analyzed using a Hach® DR3900 spectrophotometer.
- Several water chemistry variables had concentrations that were under the limit of detection for our tests.

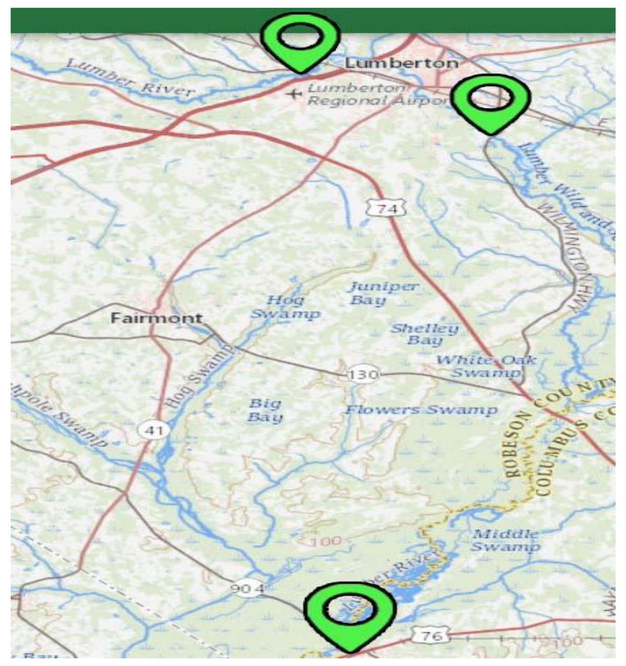


Figure 1. Location of the 3 sample sites used for this project. The first location at the top is the Before Lumberton site. The next site is the After Lumberton site, and the site farthest south is the Recovery Site. These sites were chosen to see any changes as the Lumbee River flows through Lumberton.

Predictions

- Water quality and benthic invertebrate diversity will be highest at the Recovery Site and lowest at the After Lumberton Site.
- DO will be lower in the summer, however large storms are likely to affect water quality more than seasonality.
- Benthic invertebrate diversity may be lower during spring/summer because the terrestrial adult stages emerge from the river.

Results

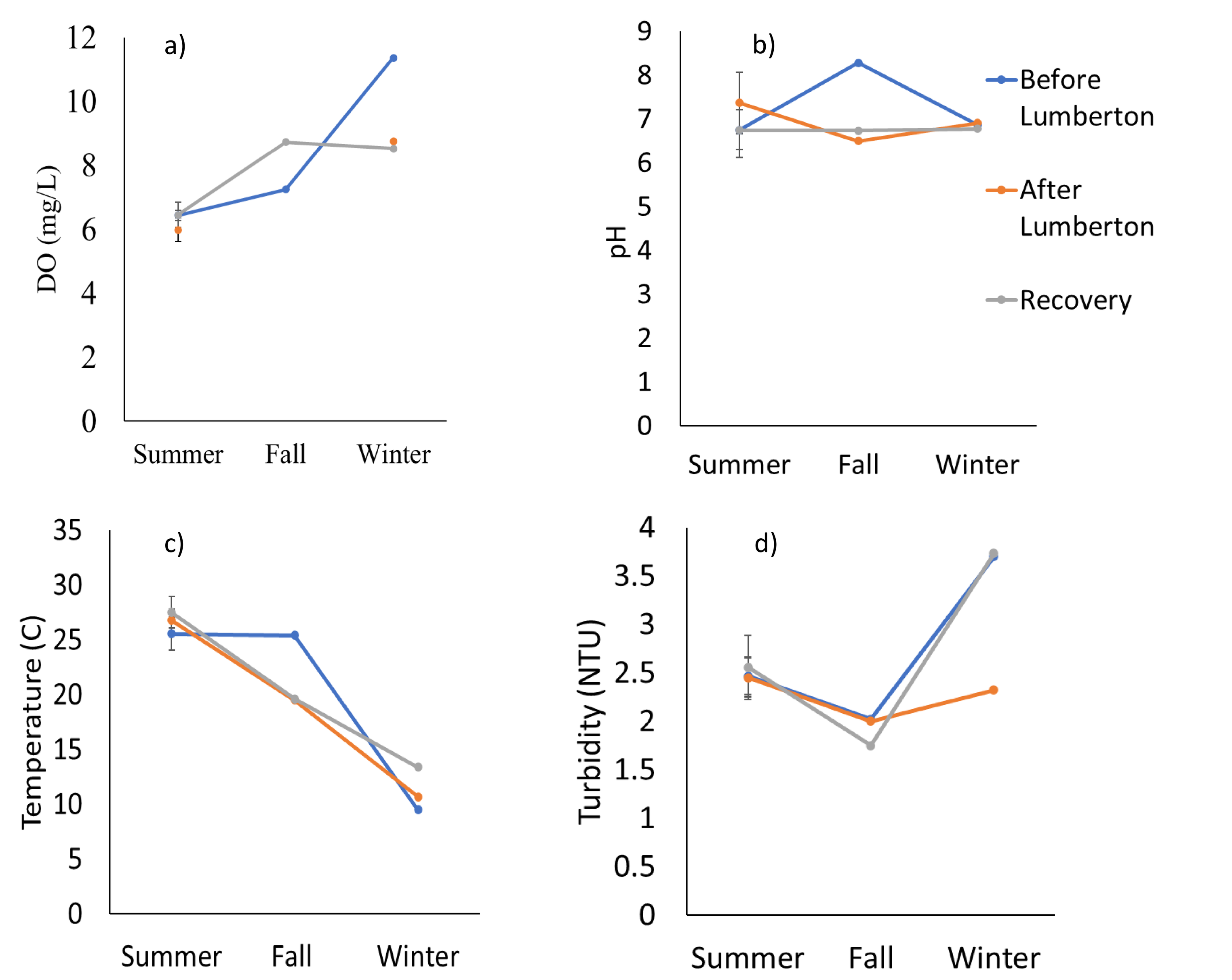


Figure 2. Physical variables that were recorded at each site. Error bars show standard deviation (summer samples). Sites were only sampled once in fall and winter. Kruskal-Wallis tests were used to evaluate differences in annual means between sites, and no significant differences were found. High turbidity in the winter samples was likely due to a large flooding event.

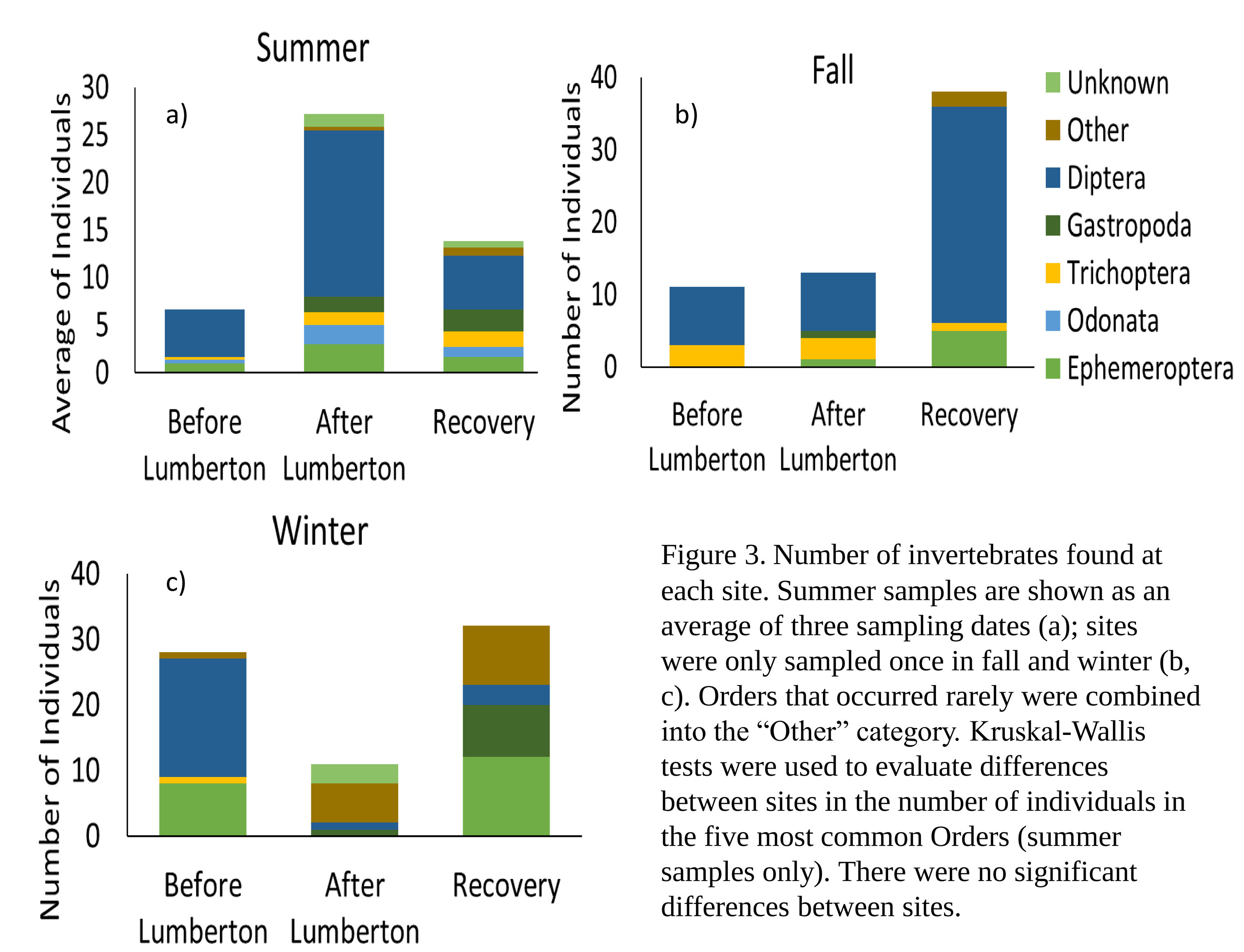
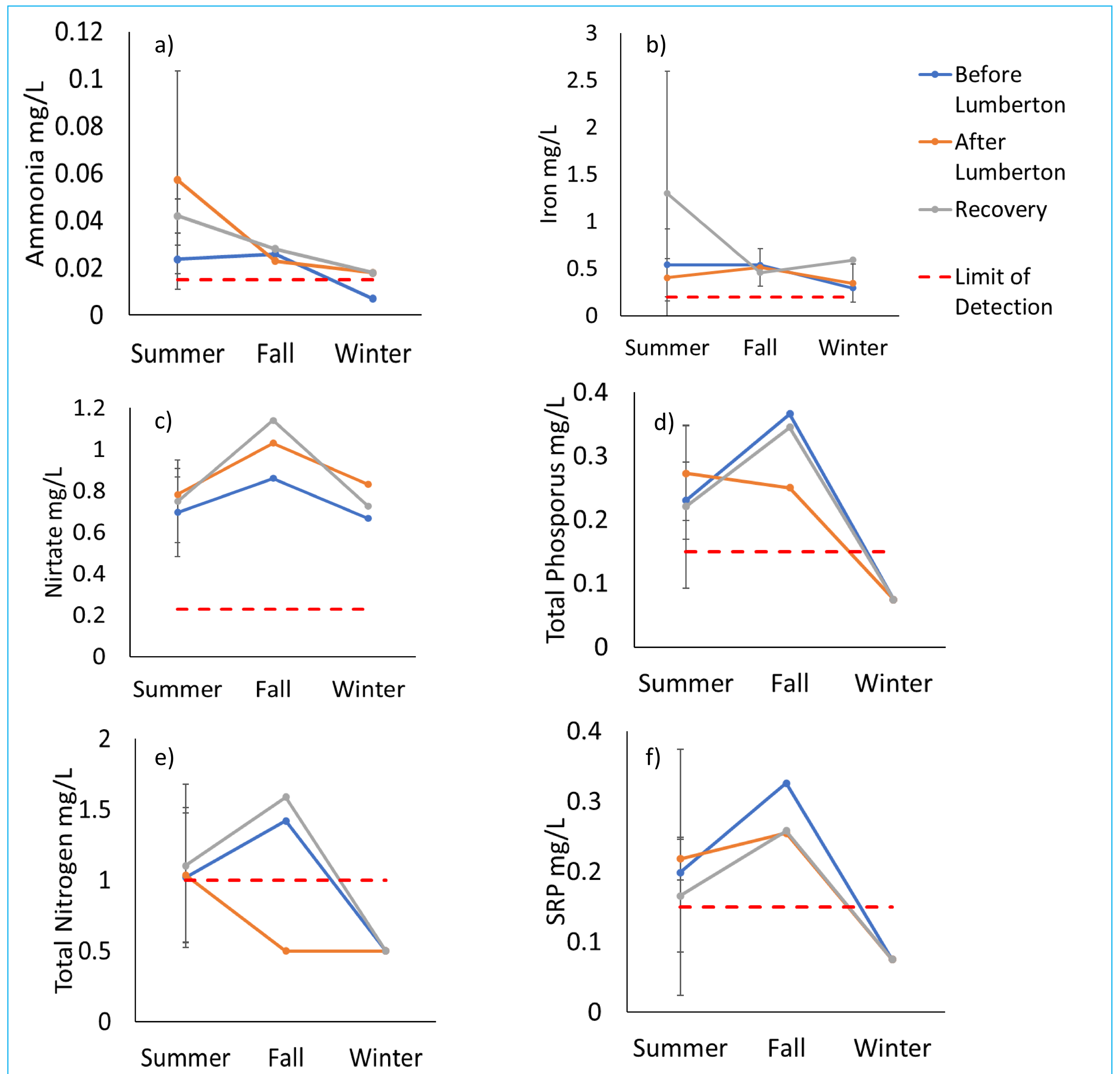


Figure 3. Number of invertebrates found at each site. Summer samples are shown as an average of three sampling dates (a); sites were only sampled once in fall and winter (b, c). Orders that occurred rarely were combined into the "Other" category. Kruskal-Wallis tests were used to evaluate differences between sites in the number of individuals in the five most common Orders (summer samples only). There were no significant differences between sites.



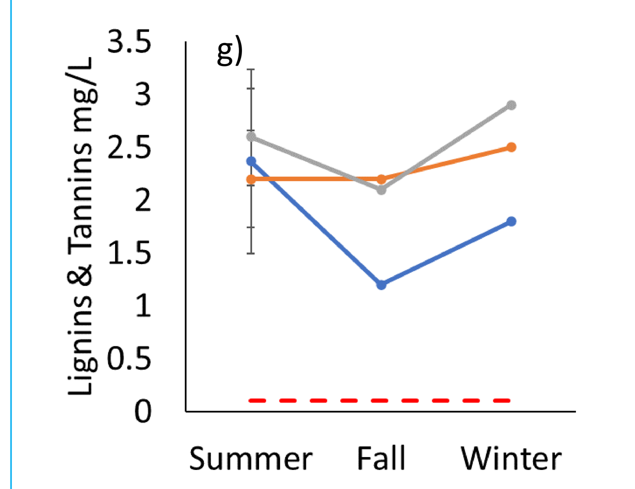


Figure 4. Water chemistry variables that were recorded at each site (SRP = soluble reactive phosphorus). Error bars show standard deviation (summer samples). Concentrations below measuring range are shown as half of the limit of detection. Kruskal-Wallis tests were used to evaluate differences in annual means between sites, and no significant differences were found.

Conclusions

- Predictions were not supported by results.
- There were no significant differences in measured variables between sites.
  - Wetlands surrounding the Lumbee River may filter out or otherwise process pollutants
- Our data suggest that urban runoff may not strongly influence the Lumbee River.

Acknowledgements

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References

1. Mallin, M. A. (2000). Impacts of industrial animal production on rivers and estuaries. *American Scientist*, 88(1), 26-37.
2. Mandaville, S.M. (2002). Benthic macroinvertebrates in freshwaters- taxa tolerance values, metrics, and protocols.
3. Emanuel, R.E. (2018). Climate change in the Lumbee River watershed and potential impacts on the Lumbee Tribe of North Carolina. *Journal of Contemporary Water Research & Education*, *163*, 79-93.

* The name "Lumber" is used for this river by governmental agencies; however we have elected to use the name "Lumbee" in accordance with a 2009 Lumbee Tribal Council Ordinance (lumbeetribe.com/tribal-ordinances).