Relationships between reservoir characteristics and fish species biomass in the USA

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Background

- Reservoirs are understudied fisheries resources. Little is known on how species biomass varies across reservoir types.
- Previously, we digitized a legacy paper database originally collated by the US Army Corps of Engineers containing community fish biomass values from 1127 poisoning surveys on 301 USA reservoirs, and created reservoir classification systems (see De Castro et al. *in review*).
- Here, we expand this work by digitizing and analyzing species biomass data in the same ecosystems.
- All data and reservoir classification systems will be published open access at the following data repository: https://github.com/caparisek/res_biomass_USA

Methods

- Digitized the National Reservoir Research Program rotenone fish biomass data, concentrating on species-specific resolution. Digitization is ongoing.
- Downloaded species functional feeding groups (FFGs) from the Fish Traits database (Frimpong and Angermeier 2011).
- Used Analysis of Variance (ANOVA) and Tukey's posthoc tests to evaluate significant differences in biomass of FFGs across reservoirs.
- Examined potential relationships between species biomass estimates and available limnological parameters. We initially assessed relationships using a Pearson correlation matrix and plot select relationships in Figure 5.

• Frimpong, E. A., and P. L. Angermeier. Fishtraits Database. 2011. http://www.fishtraits.info/

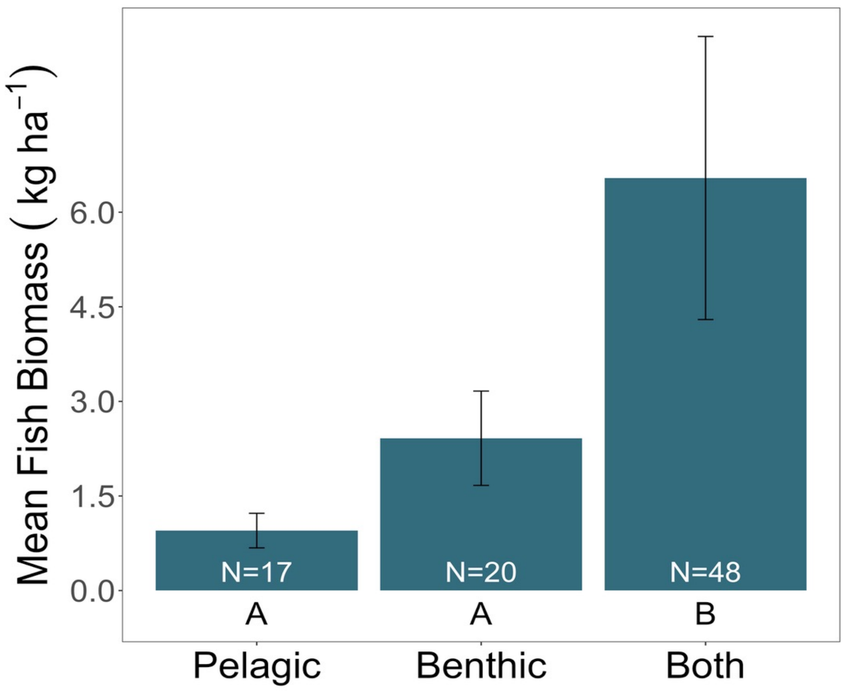

Figure 2: Reservoir fish biomass across three feeding ecologies. Sample size denotes number of species in each category.

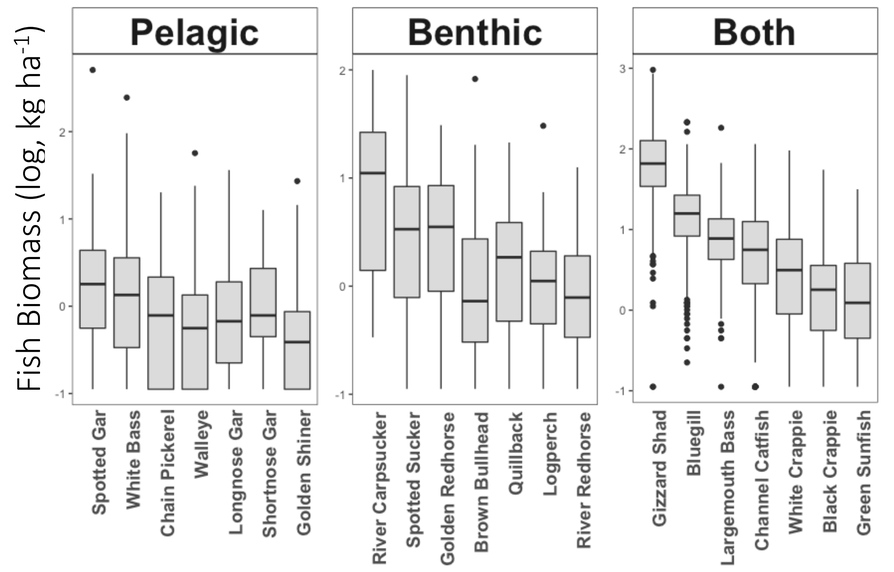

Figure 3: Boxplots of biomass values for the seven most common fish species in each functional feeding group. Boxes represent the mean and interquartile range and the whiskers represent 95% confidence intervals. Functional feeding groups classifications are based on the Fish Traits database (Frimpong and Angermeier 2011).

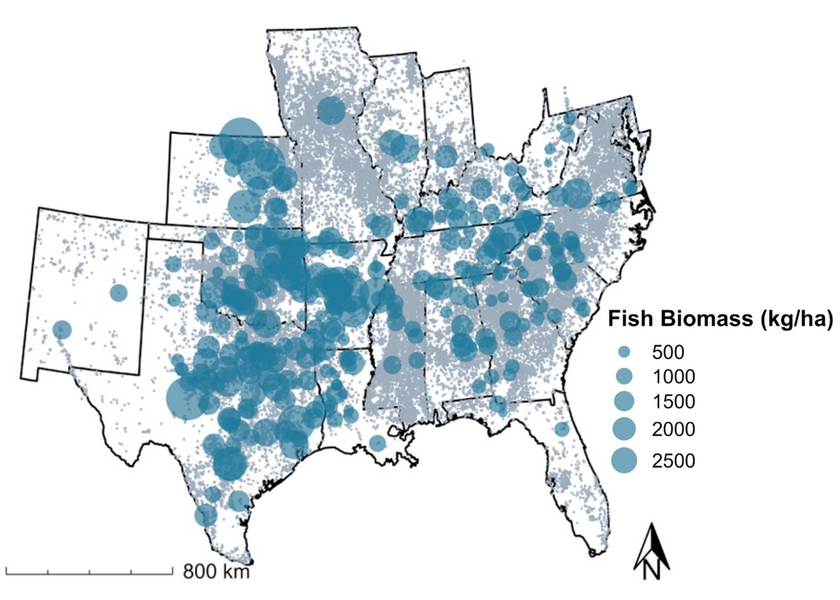

Figure 1: Map of contiguous USA depicting fish biomass of sampled reservoirs. Blue circles denote biomass estimates whereas gray dots show all reservoirs present in the USA National Inventory of Dams.

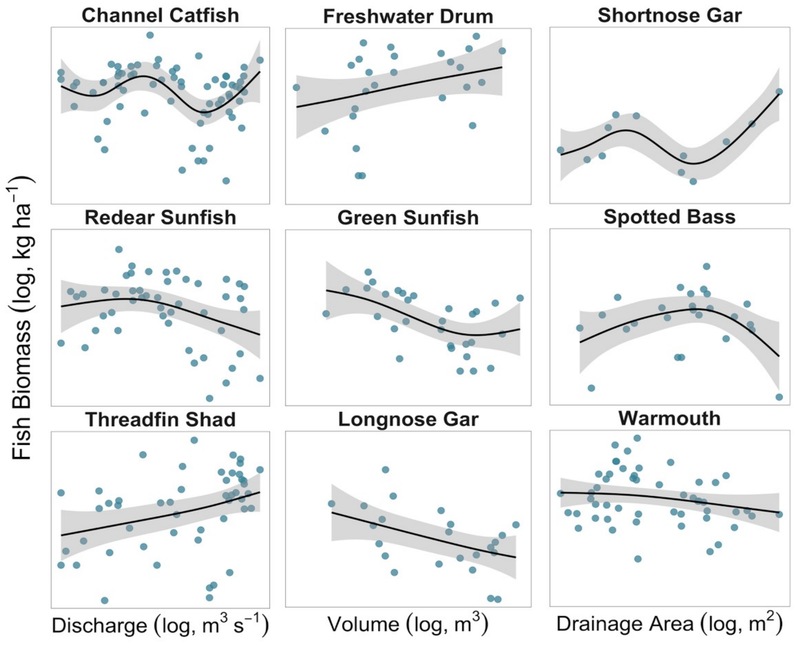

Figure 4: Scatterplots related species biomass and limnological variables (e.g., reservoir maximum discharge, volume, drainage area). Smoothed lines were constructed using a Generalized Additive Model (GAM). Future work will develop similar regressions subset by reservoir class once database digitization is complete.

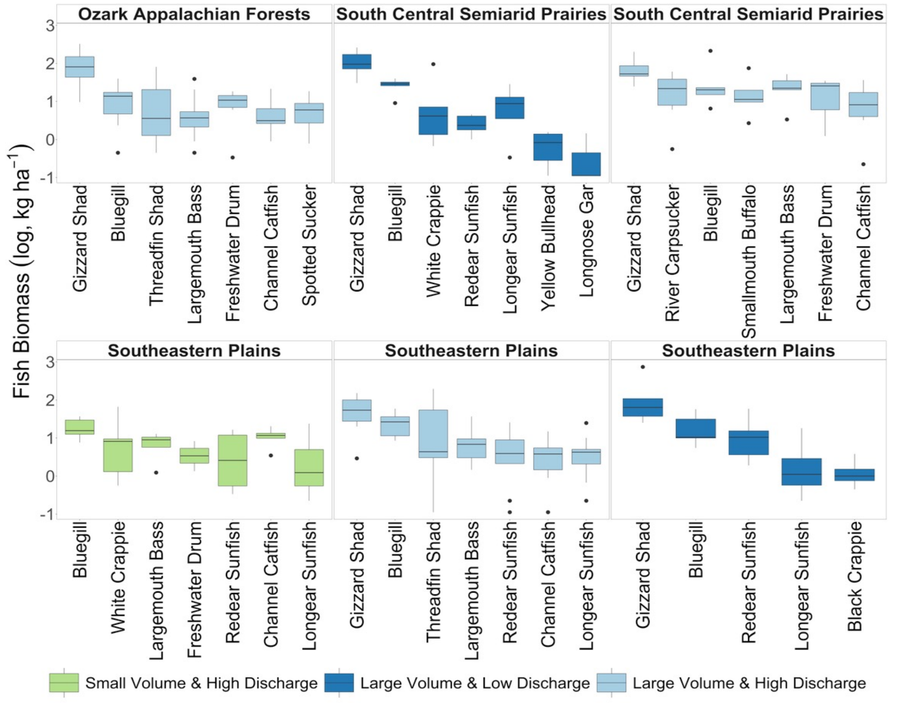

Figure 5: Boxplot of species' biomass (kg ha $^{-1}$) within each reservoir class for the top seven species with highest biomass. Only reservoir classes where a species' N have >4 data points are shown.

Figure 6: Species with the highest recorded mean biomass values. Top row (from left to right) Gizzard Shad (135.46 kg ha^{-1}), Grass Carp (44.5 kg ha^{-1}), Rio Grande Cichlid (116.0 kg ha^{-1}). Bottom row (from left to right) Smallmouth Buffalo (34.1 kg ha^{-1}), Bluegill (24.4 kg ha^{-1}) and Freshwater Drum (22.1 kg ha^{-1}). All photos from Wikimedia Commons, except for bluegill from Andrew Rypel.

Acknowledgements

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Summary

- The most common species by occurrence in sampled reservoirs are Bluegill (98% occurrence), Largemouth Bass (97%), Gizzard Shad (91%), and Channel Catfish (91%).
- Overall, benthic feeders have higher and more than 2x mean biomass (2.4 kg ha^{-1}) compared to pelagic feeders (0.9 kg ha^{-1}). This suggests that littoral habitats and production may be more important to reservoir ecosystems than previously thought.
- Some species demonstrated contrasting and potentially non-linear relationships with limnological variables.
- Conservation management of reservoir fisheries will require increased understanding of these patterns including how reservoir ecosystems have shifted in structure and function over time.