Data Gap or Biodiversity Gap? Evaluating apparent spatial biases in community science observations of Odonata in the east-central United States.

C. M. Bullion and **C. A. Bahlai**
Department of Biological Sciences
Kent State University, Kent, OH 44240

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INTRODUCTION

Odonates (dragonflies and damselflies) are an ancient order of aquatic insects that shape food webs as predators during all life stages. Their life history has been extensively linked to external cues, especially temperature and photoperiod, making this taxon especially vulnerable to climate change. **The conservation of these insects requires a better understanding of this relationship, which can be challenging due to the lack of high-resolution data.**

Fortunately, a worldwide hobbyist following has emerged around these charismatic insects, with websites like iNaturalist hosting **over 1,500,000** open-sourced citizen science observation records. This has allowed for better insights into Odonata biodiversity trends and distributions in areas where traditional survey data is lacking. However, citizen science has not gone uncriticized. Inequalities in sampling effort, data storage, and mobilization create inherent bias through overrepresentation and data gaps.
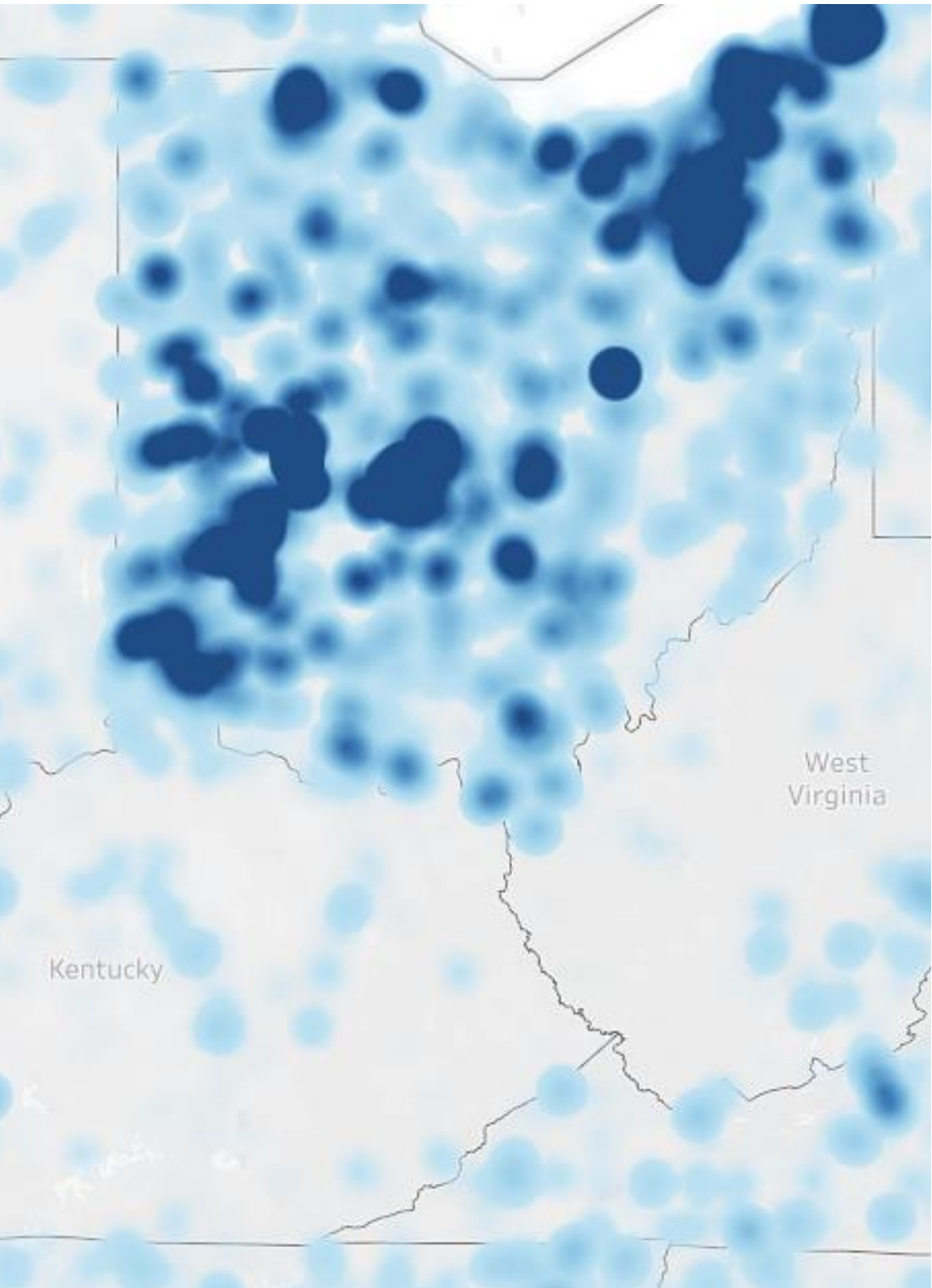
Figure 1. A map of iNaturalist Odonata observations in the eastern US, displaying both a prominent data gap over the central Appalachian Mountains and unusually high sampling density in Ohio, likely due to the efforts of the Ohio Odonate Survey.

Previous research supported community science as an alternative to traditional, structured sampling, but showed differences that suggest that there may be external factors influencing the formation of data gaps.

WHAT ABOUT NATURAL HISTORY COLLECTIONS?

Natural history collections (NHCs) are extensive sources of biodiversity data, spanning **back at least 300 years and possessing approximately 3 billion records**. These collections offer comprehensive representations of biodiversity and have been utilized in various community-level studies, including those centered on climate change and conservation. However, like community science data, NHCs can include biased patterns, such as spatial and temporal biases, detectability biases, and information content bias, that can lead to misinterpretations of species observations. This leads us to the question of:

Do systematic differences occur between community science records and museum data in Ohio odonates?

Contact information: cbullion@kent.edu

Can community science data accurately monitor dragonfly and damselfly biodiversity?
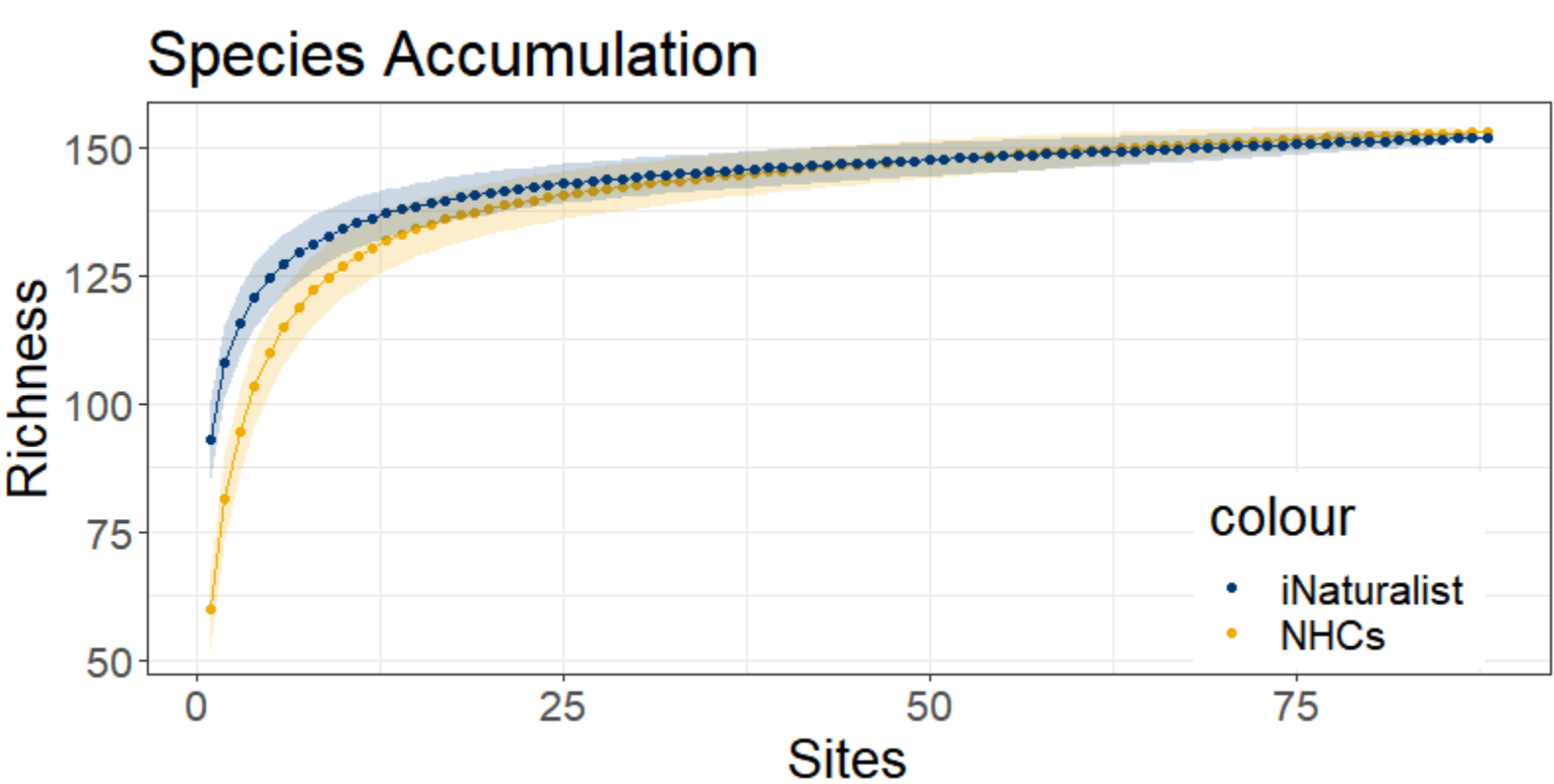
It depends!

Figure 3. Species accumulation curve comparing iNaturalist odonate observations (blue) against NHC odonate records (yellow) in Ohio.

Figure 4. Shannon diversity, comparing iNaturalist observations (blue) against NHC records (yellow). NHCs showed slightly higher Shannon diversity (3.7 vs 3.3).
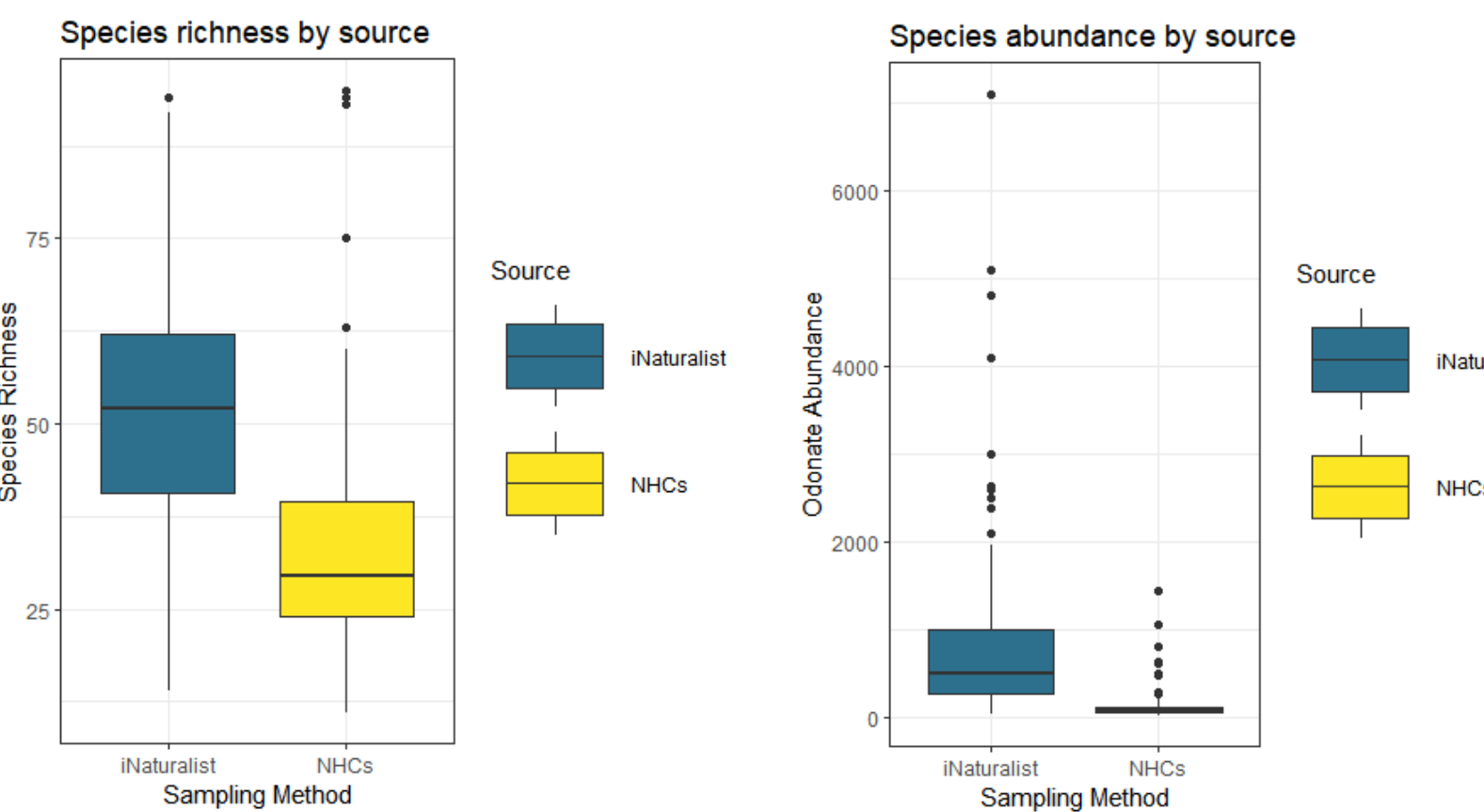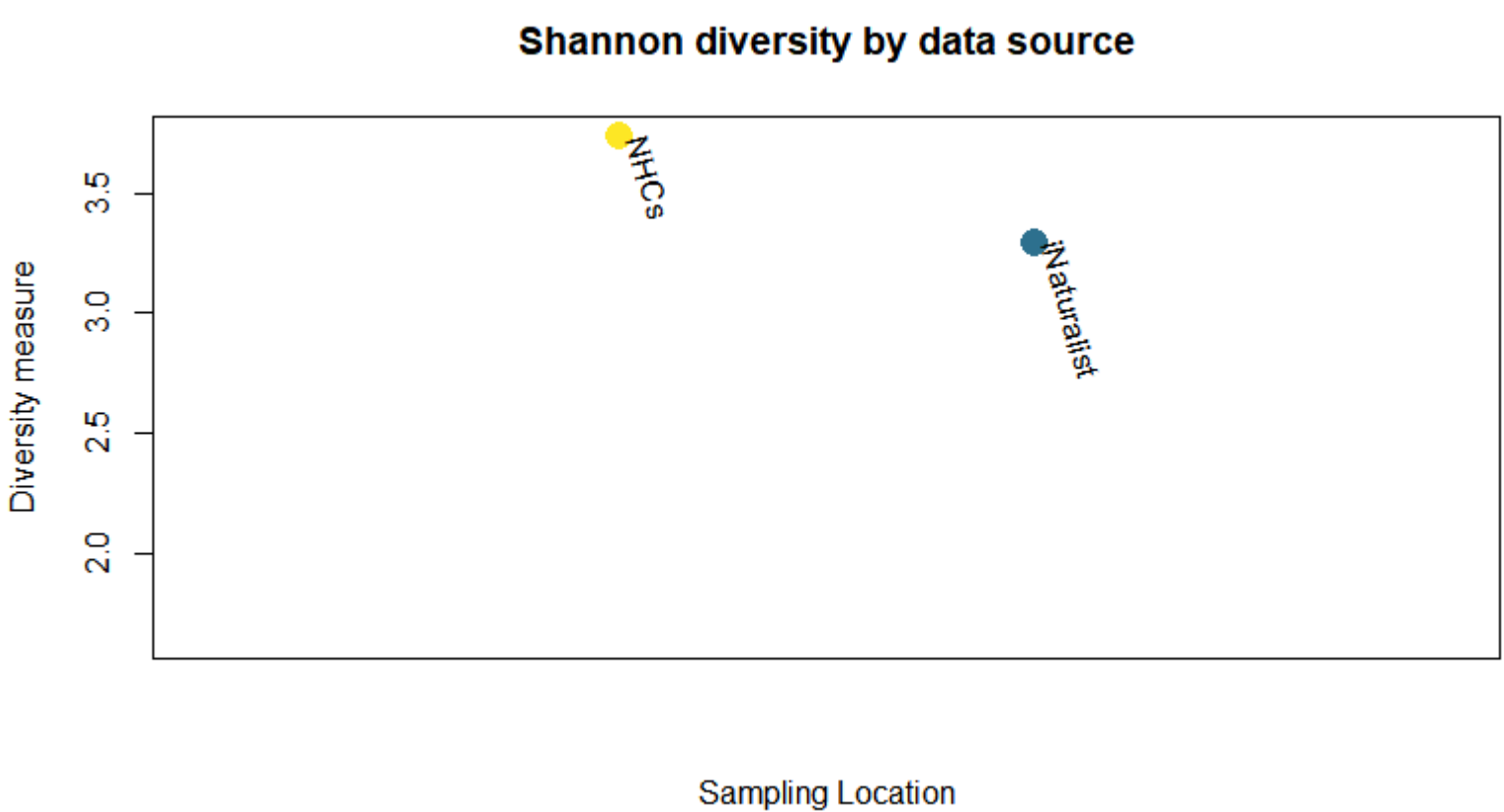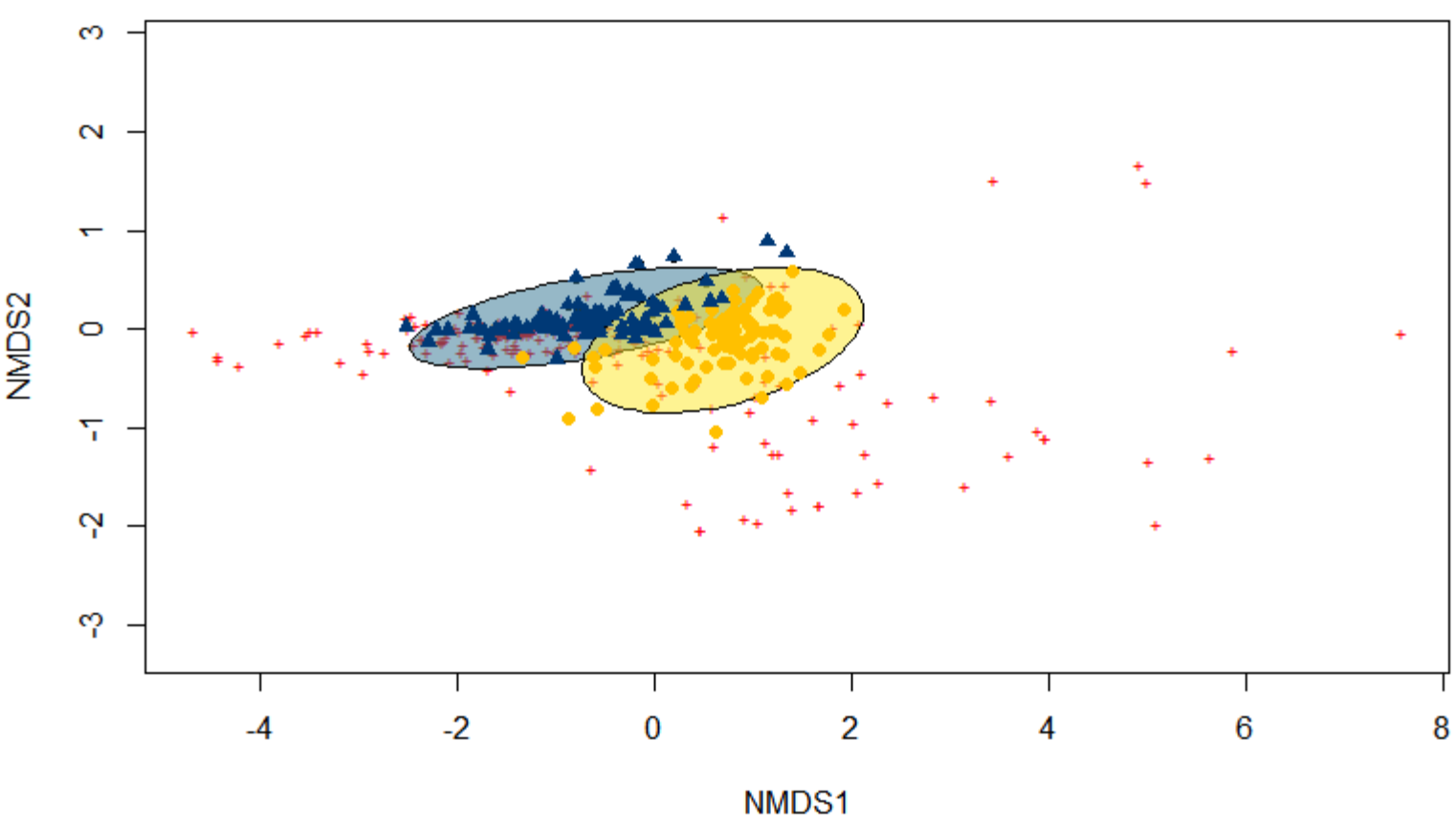
Figure 5. Box plots comparing species richness and abundance between reporting method. iNaturalist produced both significantly more records (p < 0.001) and reported significantly more species (p < 0.001) than NHC observations.

Figure 6. NMDS plot for iNaturalist records (blue) and NHC records (yellow). ANOSIM showed significant (p = 0.0001) difference in community composition between the two groups.
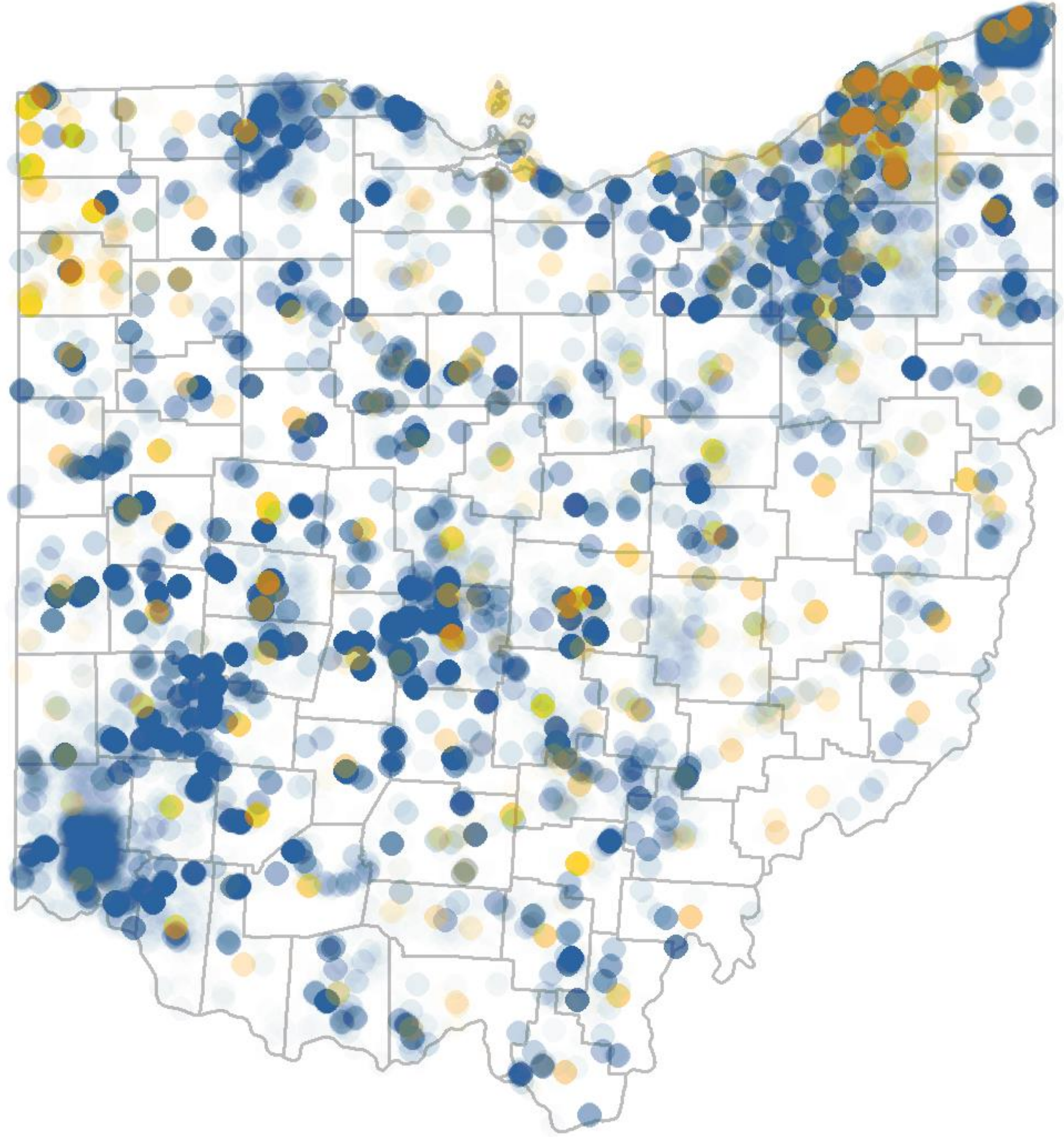
Figure 2. Map iNaturalist odonate observations (blue) against NHC odonate records (yellow) in Ohio.

METHODOLOGY

To compare the data reported between citizen science and museum data, a statewide dataframe of Odonata museum data was compiled from Ohio museums via the Global Biodiversity Information Facility (GBIF). Selected observations encompassed all odonate sightings within the state of Ohio from 2011 to 2021, that contained spatial coordinates.

Latitude and longitude of observations were used to pair each record with their corresponding county. Observations were then aggregated to form a matrix containing the number of observations per odonate species for each county. Census data from 2019 was used to prepare a second matrix, containing population, population density, and size (in square miles) of each county.

From this, Shannon diversity, species richness and abundance were compared between counties and record source. Non-metric multidimensional scaling was used to compare the community composition of observed species between sources.

Future Directions – Future studies will compare the novelty of reports, to analyze how effective each method is at capturing the biodiversity of a region. Observations will be distributed over a series of grid cells. An accumulation plot will be made from this, representing the number of new grid cells contributed per source as years progress and allowing for comparisons regarding the novelty/redundancy of reports. Further models will made to compare where mismatches occur— for example, those recorded by NHCs and not citizen science, and vice versa.

CONCLUSIONS

Our research found that, at least for the area and scale mentioned, that the community science initiative, iNaturalist, outperformed NHCs in capturing biodiversity. However, Ohio is an unusual case and community science efforts in this state benefit greatly from the Ohio Odonate Survey. In regions with poor community science participation, NHCs may prove to be a more reliable source of community monitoring. Future studies will look at the physical traits of the odonates and how they influence an individual's choice the report to platforms like iNaturalist.