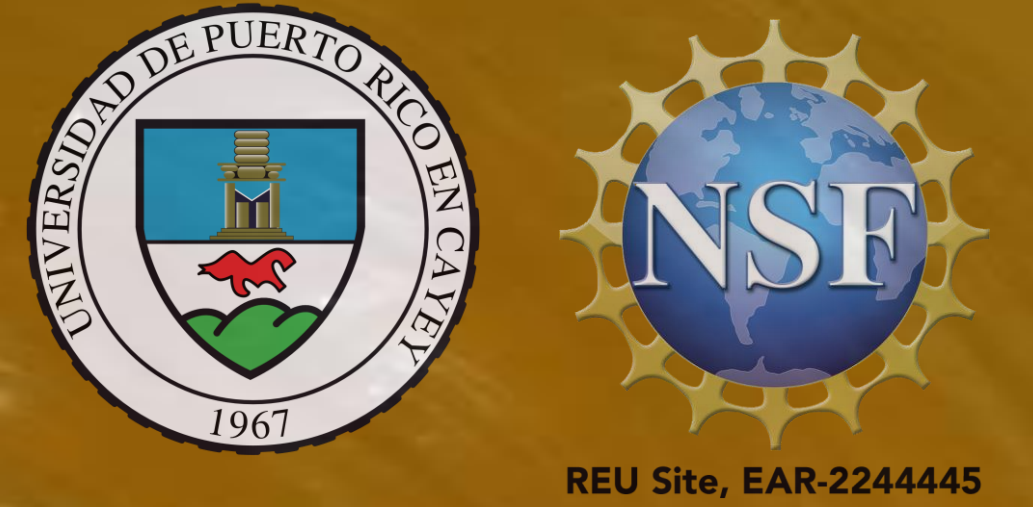# A fresh perspective on historical specimens: improving natural history collections data facilitates freshwater mussel conservation

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Background

Anthropogenic environmental disturbances have decimated freshwater mussel populations across the US, so much so that they are now considered one of the country's most endangered groups of animals. Preserved specimens located at the National Museum of Natural History (NMNH) are integral to understanding how US mussel diversity and distribution has changed across time and space, and thus are important resources for conservation stakeholders. Nonetheless, many records in the NMNH freshwater mussel collection do not align with our current understanding of US freshwater mussel biodiversity because they occur outside the expected distribution of the species. These "out of range" records could be the result of misidentifications, incorrect spatial information, or represent novel records that extend the geographic range of the species. Of the >20,000 records in the NMNH freshwater mussel collection, 1,158 have been flagged as occurring outside the species expected range (**Figure 1**).
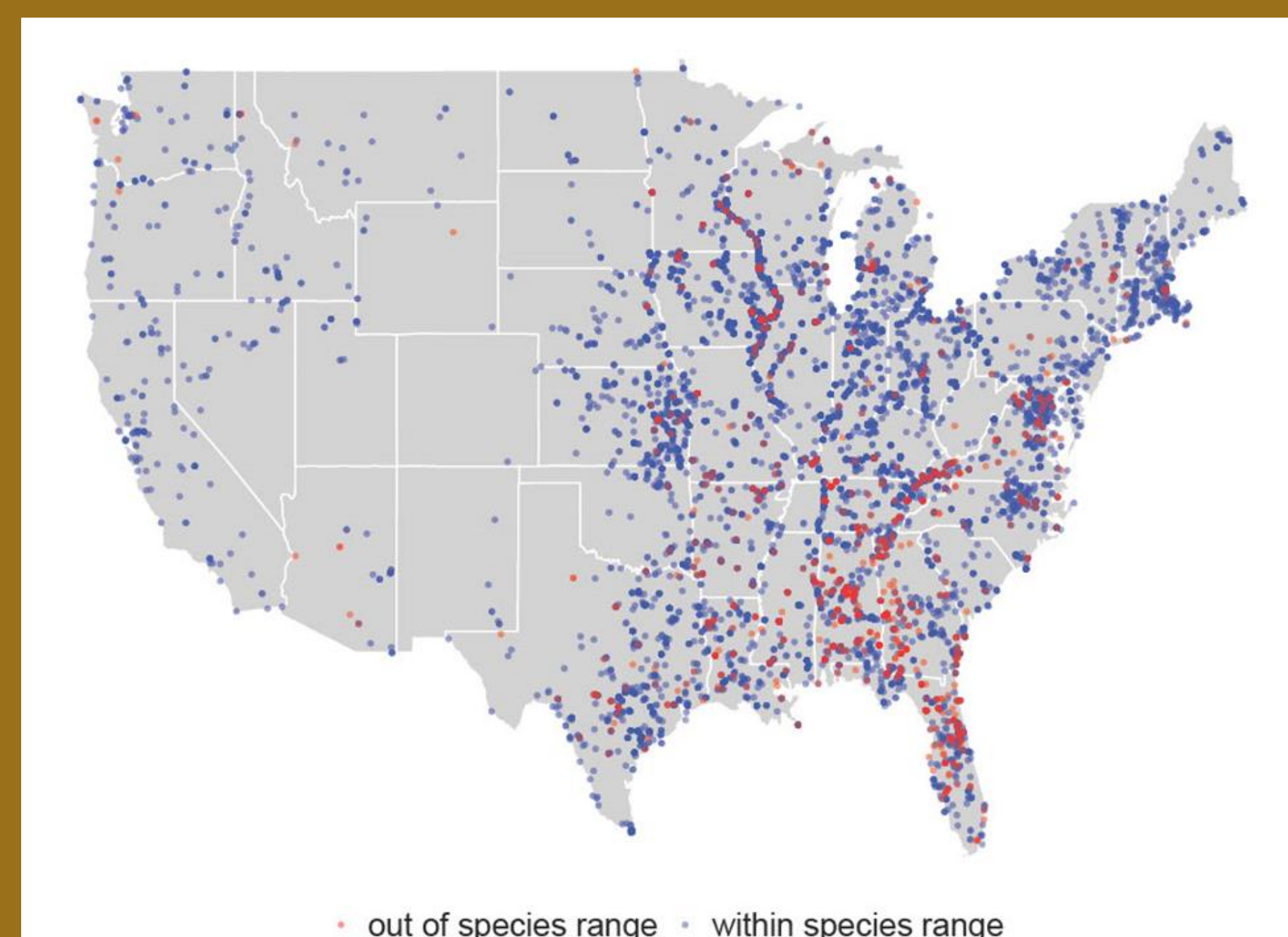

Figure 1. NMNH freshwater mussel specimen's distribution across continental United States. Blue dots are records plotted within the species expected distribution; red dots are records from outside their expected range.

Objective

Re-examine these out-of-range records to confirm or revise their taxonomic or spatial information as means to improve collections data and better understand how distributions have changed across time and space.

Methods and Materials

At first, we:
- Located each out-of-range records in the collections and examined them. The specimen identification was reevaluated using shell morphology and spatial information.

If we could not resolve it that way, we proceeded to:
- Use R programing and Microsoft Excel to filter the specimen records to make a candidate list of species typically found in the associated areas, and reidentify them if possible, using spatial information, hydrological metadata, literature, collections information, and specifically, morphological trait analysis.

Results

We examined and improved 244 out-of-range records in the NMNH freshwater mussel collection, which fell into 5 main categories (**Figure 2**). We came across:
- 25 that could not be reconciled given the available information.
- 2 records of specimens introduced to unnaturally occurring localities.
- 31 records where the spatial information was incorrect and properly changed to match their locality description.
- 170 records required taxonomic re-identifications, effecting the 71 species.
- 5 records represent novel populations that expand the expected distribution of species.

Taxonomic improvement revealed that:
- 1 specimen was from an extinct species.
- 73 records changed to an imperiled category.
- 93 records changed to non-imperiled categories.
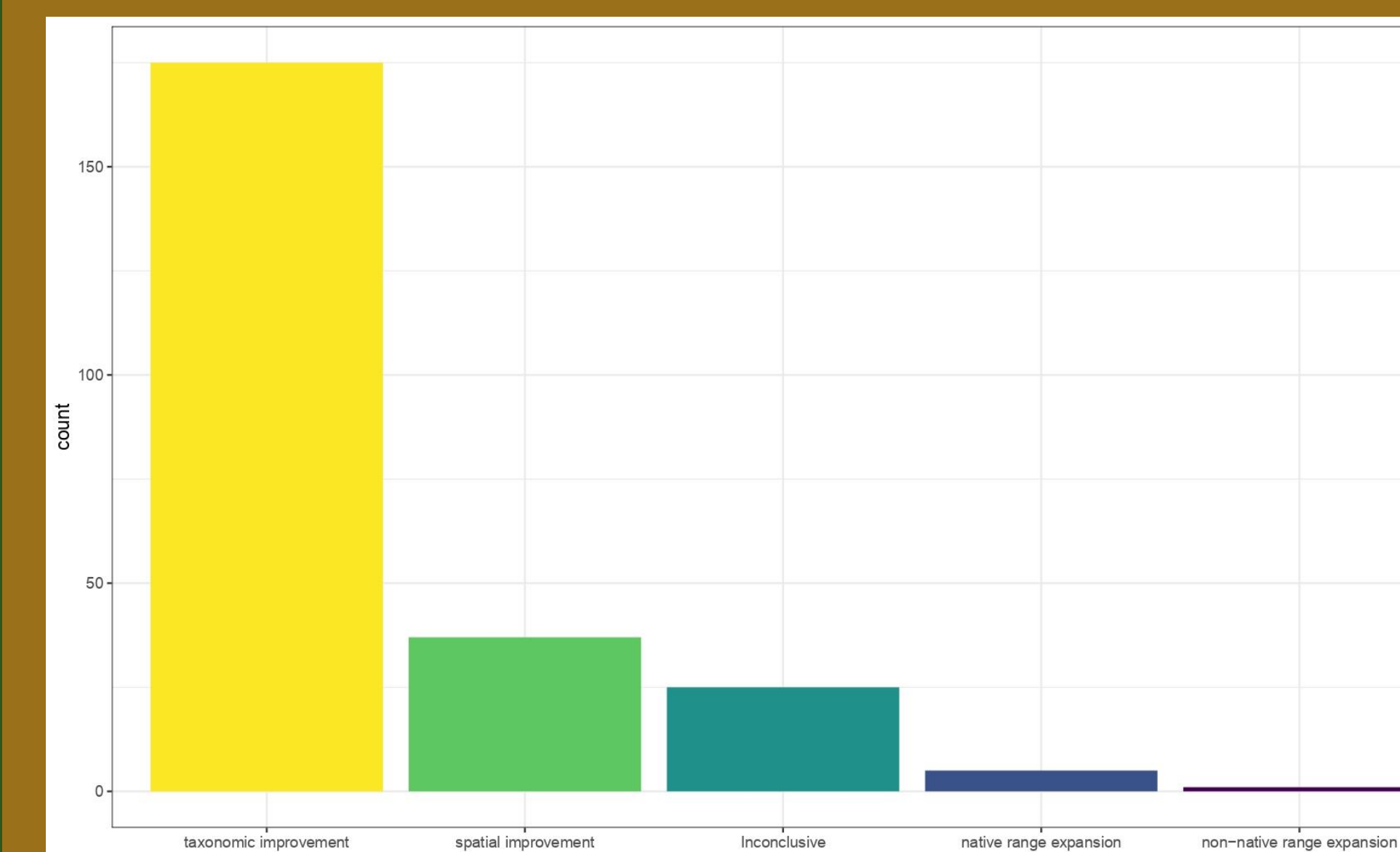- 3 records changed to species federally proposed endangered.

Methods and Materials

Figure 2. Analysis of NMNH freshwater mussel records of great concern. Overview of the corrections needed to resolve the problems associated to each record.

Discussion

By focusing on NMNH records flagged outside their expected range we have made impactful improvements to the collection, including several that improve our understanding of freshwater mussel distribution more generally. This includes:
- Four records of *Plethobasus cyphyus*, a federally endangered species that was previously unknown from much of the Missouri river subbasin, but these revised records confirm its historical presence in Elkhorn, Little Sioux and Little Blue rivers, further west than previously reported (**Figure 3 and 4**).
- One record of *Epioblasma florentina*, an extinct species. This correction makes an addition of an extinct specimen to a historical collection, only possible through collection revisions like this one.
- One record of *Utterbackia imbecillis* collected in Arizona (1996); this becomes the first known record of an introduced species to a non-native range in the collection.
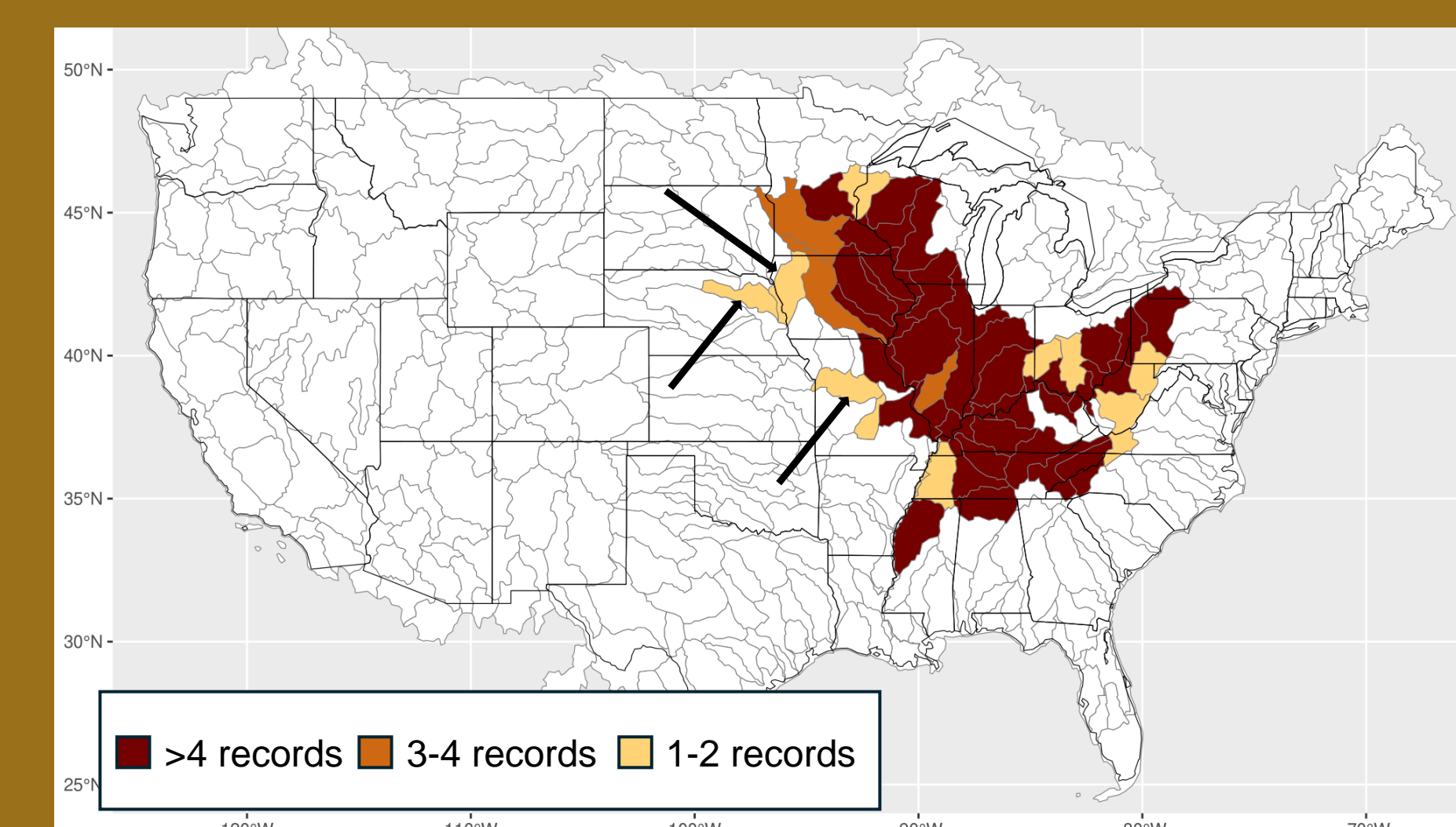

Figure 3. Native range expansion of *Plethobasus cyphyus*. Updated HUC 8 distribution of *P. cyphus*.

Figure 4. Representation of studied *Plethobasus cyphyus*. Two examples of *P. cyphus* records, with their specific collections data associated, from previously unknown populations in Nebraska and Little blue river in Missouri. Photo by Phillip Lee and James Tiller, Smithsonian Institution.

Conclusion and Future Directions

As a group of animals with a high conservation concern, these corrected records are foundational to understanding how distributions have changed across time and space and are critical to implementing effective taxon-based conservation efforts like the Endangered Species Act. Nevertheless, the work is far from done. There should be collective efforts to correct problematic records across all Institutions with mussel collections to make them more centralized, resourceful and updated assemblages.

For future endeavors, we will be preparing a manuscript documenting these *P. cyphus* populations for conservation stakeholders.

Acknowledgements and References

- Pfeiffer J, Dubose TP, Keogh SM. 2024 Feb 1. Synthesis of natural history collections data reveals patterns of US freshwater mussel diversity and decline. Biological conservation.:110462–110462. doi:https://doi.org/10.1016/j.biocon.2024.110462.
- Williams JD, Bogan AE, Garner JT. 2008. Freshwater mussels of Alabama and the mobile basin in Georgia, Mississippi and Tennessee. Tuscaloosa, Al: University Of Alabama Press, Cop.
- USGS Water Resources: About USGS Water Resources. waterusgsgov. [accessed 2024 Jul 23]. https://water.usgs.gov/GIS/huc_name.html#Region21.
- R Core Team (2024). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
- Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4. URL http://ggplot2.org.
- Photo credit: Tim Menard / USFWS. USFWS Mountain-Prairie - Flickr: Mussel Species Survey Marais des Cygnes National Wildlife Refuge 2011, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=18395443