Do Fish Communities Vary with Flooding across the Millennia in the Upper Mississippi River System?

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Introduction

Studies indicate that flooding can affect fish community structure (Chick et al., 2013; Junk et al., 1989). The flood pulse is a significant factor that contributes to productivity and interactions of flora and fauna throughout the river-floodplain system (Junk et al., 1989). In the last 40 years, humans have drastically modified the Upper Mississippi River System (UMRS) which in turn alters flooding (Sparks, 2010). Given these recent modifications, we expect that the frequency of occurrence of certain fish taxa may differ between years with and without flooding. We expect that fish communities represented in archaeological collections from wet periods would differ from those in archaeological collections from known dry periods. We hypothesize that fish communities from archaeological wet periods would be more similar to modern fish communities from years with flooding relative to years without. Our research tests for differences in fish communities between modern electrofishing data with known occurrences of flooding (i.e., no flood, normal flood, or late flood [after spring]) and archaeological data representing ancient fish communities from wet and dry periods.

Methods

- We used electrofishing data from the Long Term Resource Monitoring (LTRM) element of the US Army Corps of Engineers' Upper Mississippi River Restoration Program for our modern fish communities.
- Archaeological data are from published sources spanning the Middle Woodland to Mississippian time periods throughout the UMRS. We eliminated collections with less than 600 fish specimens.
- Modern samples and archaeological collections from reaches north of pool 13 are not included in this analysis to limit our comparisons to reaches with similar flooding magnitude and variation.
- Fishes in both the modern samples and archaeological collections were grouped to the lowest taxonomic levels possible from osteological identification.
- We compared modern and archaeological presence/absence data using the Primer statistical software with wet or dry time periods as a factor for archaeological samples and three categories of flooding (i.e. no flood, normal flood, late flood) for modern samples. We chose to discriminate between spring and early summer floods (normal floods) and floods in the summer or fall (late floods) because the floods in the latter category can influence the efficiency of modern sampling and do not coincide with the spawning period of most fishes in the UMRS.
- We used analysis of similarity (ANOSIM) to test for differences among wet or dry archaeological collections and the three flood categories in modern samples. We illustrated our results using non-metric multidimensional scaling (NMDS), and used SIMPER to examine the mean frequency of occurrence of taxa among our flood/wet and dry categories.

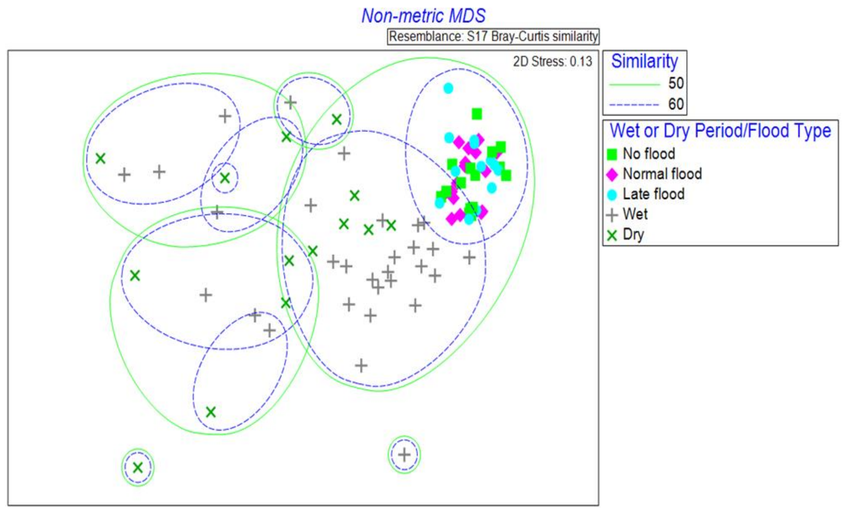

Figure 1: Non-metric multidimensional scaling (NMDS) of archaeological collections (wet, dry) and modern monitoring data (no flood, normal flood, late flood). Wet periods included Middle Woodland, Late Woodland, and Mississippian time periods. Dry periods included the Terminal Late Woodland, Emergent Mississippian, Mississippian time periods.

Results

We found no significant differences among the three flood categories in our modern data (ANOSIM $p \geq 0.625$). In contrast, the wet and dry periods in the archaeological collections differed significantly (ANOSIM $p \leq 0.022$). The differences in wet and dry periods of the archaeological data included: a greater frequency of occurrence of freshwater drum (*Aplodinotus grunniens*), channel catfish (*Ictalurus punctatus*), and redhorses (*Moxostoma* spp.) during wet periods, and a greater frequency of occurrence of chubsuckers (*Erimyzon* spp.), suckers (*Carpiodes* spp.), and minnows (Cyprinidae) during dry periods. All modern data differed significantly from all archaeological data (ANOSIM $p \leq 0.0003$). SIMPER showed a greater frequency of occurrence of orange spotted sunfish (*Lepomis humilis*), bluegill (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*) in the modern data than the archaeological collections. Further, it showed a greater frequency of occurrence of pike/pickerel (*Esox* spp.) and yellow (*Ameiurus natalis*), brown (*Ameiurus nebulosus*), and black (*Ameiurus melas*) bullhead catfishes in all archaeological collections than the modern data.

Hannah (left) and Emily (right) during an electrofishing run in Lake Carlyle.

Carol Colaninno (left) showing Hannah (middle) and Emily (right) Mississippian pottery found during an excavation of a feature.

Discussion

Our results indicate that the frequency of occurrence of fish communities did not significantly differ among the three flood categories in the modern data. Therefore, our hypothesis cannot be supported. Presence/absence may not be the best measure for detecting differences among flood types in our modern data because the LTRM monitoring is very intensive. Substantial reductions in abundance of a fish species could be occurring without reducing the likelihood that at least one individual would be captured each year.

We did find significant differences between archaeological collections from wet and dry periods. Freshwater drum, channel catfish, and redhorses all spawn during the spring. Normal flooding occurs during the spring months, so the occurrence of a wet period could have benefited spawning conditions and caused an increase in their overall presence. Chubsuckers, suckers, and minnows generally have spawning seasons during the late spring-early summer. During this time, temperatures are typically rising. The increase in temperatures and presumably low amounts of rainfall could have benefited spawning conditions and caused an increase in their overall occurrence in dry periods.

Largemouth bass and bluegill may have occurred more frequently in modern data because management efforts by state and federal agencies try to maintain or increase sport fish populations. Pikes, pickerels, and bullhead catfishes occurred more frequently in the archaeological data versus the modern data. This may be related to the different fishing technologies Native Americans used or their cultural preferences to select particular fishes for food over other taxa.

Our analysis is limited by the fact that archaeological data are not direct reflections of ancient environments, but rather, reflect the choices past peoples made regarding where and how to fish and which fish taxa to pursue. These data are further influenced by the culinary preference and disposal practices of people in the past and subsequent decisions archaeologists make. Future research could compare changes in commercial harvest data from years with differing flood levels. Commercial harvesting data may more closely resemble archaeological data and may reflect how fish communities and fishing practices change when people fish during floods.

Conclusion

The results did not support our hypothesis that the frequency of occurrence of fish communities from wet archaeological time periods would be more similar to modern data from years with flooding because we found no differences in the three flood categories in our modern data. We did find significant differences in the presence/absence of fishes between archaeological collections from wet periods and dry periods. Studies using other measures of fish community structure (e.g., catch per unit effort, relative abundance, etc.) may be more successful at elucidating how flooding affects fish communities in modern monitoring data.

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