Does Presence of Aquatic Vegetation Help Us Understand Variations in Fish Communities between the Archeological Record and Modern Samples?

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1 Introduction

The abundance and composition of fish communities vary with the density and type of aquatic vegetation in freshwater ecosystems (Chick & McIvor 1994, 1997; Lubber 1990). Archaeologists suggest that submersed aquatic vegetation (SAV) was present in the lower Illinois River Valley during archeological times as evidenced by the relative abundance of fish taxa represented among archaeological collections (Styles 1981). Today, SAV is common in the upper reaches of the Upper Mississippi River System (UMRS), but is rarely found downstream of Lock and Dam 19 (Moore 2010) (Figure 1). The absence of SAV in the lower reaches of the UMRS is likely caused by increased sedimentation which results in decreased light penetration and unfavorable rooting substrate (Sparks 2010). We hypothesize that fish communities in the archaeological record will be more similar to the upper reaches of the UMRS than the lower because SAV is present in both the modern upper reaches and throughout archaeological time periods. We expect modern fish taxa that rely on vegetation for spawning to more frequently occur in the upper reaches of the UMRS (Table 1).

Figure 1: Map of pools along the UMRS

2 Methods

We compared fish communities from the archeological record with modern monitoring data. For the modern data, we used electrofishing data collected from backwater lakes by the Long Term Resource Monitoring (LTRM) element of the US Army Corps of Engineers' Upper Mississippi River Restoration Program. These data included Pools 4, 8, 13, 26, and La Grange (Figure 1). The comparisons were limited to the fish taxa found in the archaeological record. Prior to analysis, we transformed all data, modern and archaeological, to presence/absence. We then generated a Bray-Curtis similarity matrix for use in all multivariate tests. We used analysis of similarity (ANOSIM) to test for differences between time periods and reaches. For the modern data, LTRM study pools were grouped as upper (Pools 4, 8, 13) or lower reaches (Pools 26, La Grange), whereas for the archaeological data, we grouped the collections based on temporally defined cultural periods (Middle Woodland, Late Woodland, Mississippian, and Oneota). The results were illustrated with non-metric multidimensional scaling (nMDS). Using SIMPER, we identified the fish taxa contributing to the differences among archaeological periods and the modern upper and lower reaches.

Species	Vegetation Use	Expectations	Results	Conclusion
Acipenseridae	**Spawning**	**Higher Frequency in Upper**	**Upper <7% Lower 0%**	**Rare or absent in both**
Polyodon spathula	Not dependent	Either	Upper <7% Lower 5%	Rare in both
Lepisosteus spp.	Not dependent	Either	Upper 90% Lower 100%	Common in both
Amia calva	**Spawning and protection**	**Higher Frequency in Upper**	**Upper 100% Lower 70%**	**Common in both**
Hiodontidae	Not dependent	Either	Upper 20% Lower 25%	Low occurrence in both
Dorossoma cepedianum	Not dependent	Either	Upper 100% Lower 100%	Common in both
***Esox* spp.**	**Spawning and habitat**	**Higher Frequency in Upper**	**Upper 97% Lower 0%**	**Limited to upper**
Cyprinidae	Not dependent	Either	Upper 100% Lower 100%	Common in both
Carpiodes spp.	Not dependent	Either	Upper 70% Lower 100%	Common in both
Catostomus commersoni	Not dependent	Either	Upper 53% Lower 0%	Limited to upper
Cycleptus elongatus	Not dependent	Either	Upper >7% Lower 0%	Absent in both
Erimyzon spp.	Not dependent	Either	Upper 0% Lower 0%	Absent in both
Hypentelium nigricans	Not dependent	Either	Upper 7% Lower 0%	Rare in both
***Ictiobus* spp.**	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper 77% Lower 100%**	**Common in both**
Minytrema melanops	Not dependent	Either	Upper 100% Lower 0%	Limited to upper
Moxostoma spp.	Not dependent	Either	Upper 97% Lower 60%	Higher occurrence in upper
Ameiurus melas	Not dependent	Either	Upper 23% Lower 40%	low occurrence in both
Ameiurus natalis	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper 43% Lower 35%**	**Low occurrence in both**
Ameiurus nebulosus	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper >7% Lower 50%**	**Limited to lower**
Ictalurus punctatus	Not dependent	Either	Upper 97% Lower 100%	Common in both
Ictalurus furcatus	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper 0% Lower 0%**	**Absent in both**
Pylodictus olivaris	Not dependent	Either	Upper 77% Lower 95%	Common in both
Noturus spp.	Not dependent	Either	Upper 33% Lower 25%	Low occurrence in both
Morone spp.	Not dependent	Higher Frequency in Upper	Upper 97% Lower 100%	Common in both
Perca flavescens	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper 100% Lower 0%**	**Limited to upper**
Ambloplites rupestris	Habitat	Higher Frequency in Upper	Upper 93% Lower 0%	Limited to upper
***Lepomis* spp.**	**Spawning and cover**	**Higher Frequency in Upper**	**Upper 100% Lower 100%**	**Common in both**
***Micropterus* spp.**	**Spawning and cover**	**Higher Frequency in Upper**	**Upper 100% Lower 100%**	**Common in both**
***Pomoxis* spp.**	**Spawning and cover**	**Higher Frequency in Upper**	**Upper 100% Lower 100%**	**Common in both**
***Sander* (*Stizostedion*) spp.**	**Spawning (preference)**	**Higher Frequency in Upper**	**Upper 97% Lower 90%**	**Common in both**
Aplodinotus grunniens	Not dependent	Either	Upper 100% Lower 100%	Common in both

Table 1: Information, expectations, results, and conclusions regarding the relationship between the fish studied and vegetation. Species reliant on vegetation for spawning are listed in bold.

3 Results

- The upper reaches and lower reaches of the UMRS differed significantly from all archeological periods ($p \leq 0.0002$)
- At 77% similarity, modern reaches grouped with some archeological collections (Figure 2)
  - Upper pools were similar to 13 archeological collections with all time periods represented
  - Lower pools were similar to four archeological sites from the Late Woodland
- We found no significant differences among the archaeological time periods ($p \geq 0.084$)
- The modern upper and lower reaches differed significantly ($p \leq 0.0001$)
- Of the 12 fish taxa expected to be limited to the upper reaches, six had higher frequencies of occurrence in the upper reaches, whereas two had higher frequencies in the lower reaches and four occurred equally in both reaches (Table 1)

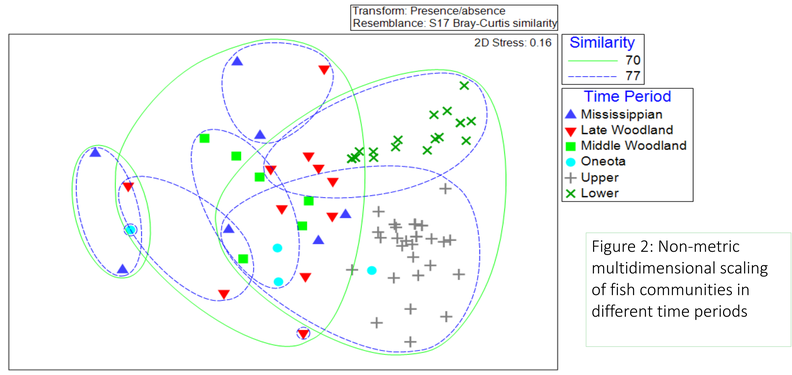

Figure 2: Non-metric multidimensional scaling of fish communities in different time periods

4 Discussion

Although all modern and archaeological groups differed significantly, at 77% similarity, there are a greater number of archeological collections grouping with the upper reaches compared to the lower. Additionally, collections from all four archaeological time periods are represented in the collections grouping with the upper reaches. This offers some support to our hypothesis and suggests that there is greater similarity between the frequency of occurrence of fish communities among archeological collections and the upper reaches. Overall, we examined 32 fish taxa: 12 of these taxa use SAV for spawning and we expected that these fishes would occur more frequently in the upper UMRS. Only six fish taxa met our expectations of having higher frequencies of occurrence in the upper UMRS. These taxa apparently use other substrate for spawning and are not exclusively dependent on SAV. Future studies should examine other factors that play a role in spawning habitat, such as water temperature and depth. Additionally, there are other groupings present with the archaeological collections at 77% similarity. Therefore, other unknown factors are structuring the archeological data. Future research could attempt to investigate what these factors might be.

A major limitation of our study is the differences in the two datasets we used for this comparison. The methods used to derive the archaeological collections we examined were collected through dissimilar means. This lack of standardization may allow multiple variables, such as the sampling methods used to collect fish bones, to affect the data. Additionally, the fish in the archeological collections were used by past Native Americans for food. Native Americans living in the UMRS may have had preferences regarding which fishes to harvest. These preferences introduce additional, although unknown, biases. These fishes, after being cooked and eaten, would be discarded, buried, and subsequently excavated further introducing additional sources of variation to these datasets. Lastly, the goals of ancient and present day people differ. People of the past fished for food, whereas the goal of the LTRM electrofishing monitoring is to catch the best representation of the fish communities that is logistically feasible. The combination of these limitations allows for multiple variables to drive the differences between the archaeological and modern data.

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