Shifts in Relative Abundance of Backwater Fishes in the Lower Illinois River Valley through Millennia

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Introduction

The Illinois River provides food, water, and transportation for many species including humans (Styles 2011). The main channels and backwaters of this river are both important, as seasonal flooding connects them, allowing many organisms to use both habitats for spawning and feeding (Styles 2011). The archeological record shows that for thousands of years, people used backwaters of the Illinois River (Styles 2011). Anthropogenic changes including dams, levees, agricultural runoff, and management choices have modified the location, nature, and occurrence of backwaters (Sparks 2010). We hypothesize that these anthropogenic alterations have caused a decrease in backwater fish abundance from the ancient past to modern times. We investigate how modifications to the river and landscapes have impacted the abundance of backwater-dependent fishes by calculating the relative abundance of each group with time. We closely examined four groups of fishes based on their habitat preferences (Table 1).

Scientific Name	Common Name	Habitat
Amia Calva	Bowfin	Limnophilic-Backwater
Ictiobus spp.	Buffalo fish	Multi-habitation
Moxostoma spp.	Redhorse	Rheophilic-Main Channel
Centrarchidae	Centrarchids	Limnophilic-Backwater

Table 1. Habitat preferences of each group.

Methods

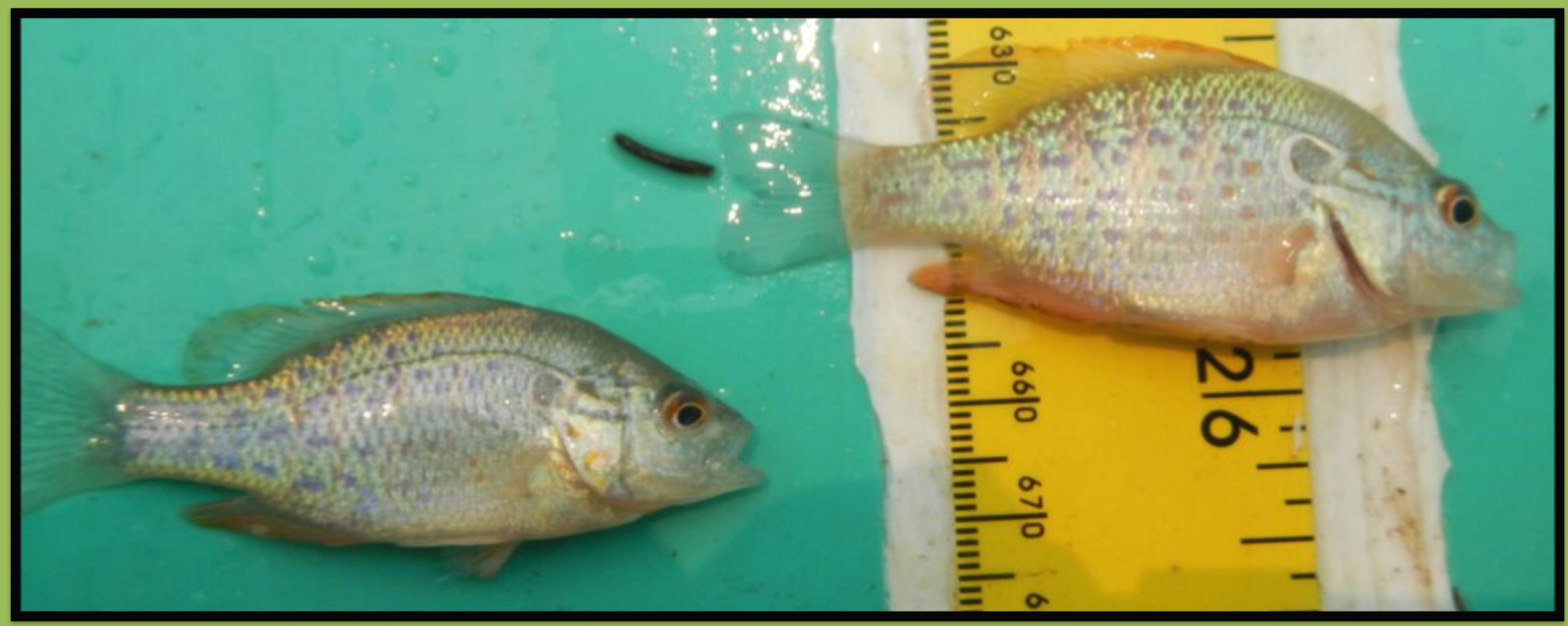
We compiled archeofaunal data from 10 collections across three temporal ranges in the Lower Illinois River Valley (Table 2). Where possible, radiocarbon dating was used to determine the temporal ranges of the sites; when that information was unavailable, relative dates were used. We examined the relative abundance of four fish groups. These groups were created based on their behavior in relation to backwaters. We grouped archeofaunal data into families with the exception of two, which were examined at the genus level because of their varied behavioral traits (Table 1).

Ecological data are from the Long Term Research Monitoring (LTRM) element of the U.S. Army Corps of Engineers' Upper Mississippi River Restoration program (Ratcliff et al. 2014) and the Long Term Survey and Assessment of Large-River Fishes in Illinois (LTEF). We used electrofishing data from both programs, which use standardized non-destructive sampling methods (Ratcliff et al. 2014). We grouped the ecological data into the same taxonomic groups as the archeological data, transformed both data sets into relative abundance, and calculated a Bray-Curtis Similarity matrix for all samples with Primer 7 statistical software. We used ANOSIM to test for significant variation in fish families and genera among time periods, with all ecological samples considered the same (current) time period. Non-metric multidimensional scaling was used to illustrate the results of the ANOSIM analyses.

Site	Time Period	Dates	Analyst
Napoleon Hollow: 11PK500	Middle Woodland	164 cal BC- cal AD 388*	Styles and Purdue (1986)
Apple Creek: 11GE2	Middle and Late Woodland	cal AD134-805*	Parmalee et al. (1972)
Smiling Dan: 11ST123	Middle and Late Woodland	AD250-1000	Styles et al. (1985)
Carlin	Late Woodland	cal AD610-1210*	Styles (1981)
Newbridge: 11GE456	Late Woodland	cal AD605-885*	Styles (1981)
Koster East Early: 11GE4	Late Woodland	AD700-800	Enzerink (2015)
Koster East Late: 11GE4	Late Woodland	AD800-900	Ottenfeld (2015)
Worthy-Merrigan: 11C382	Mississippian	AD1000-1300	Dopson (2015)
Hill Creek: 11PK525	Mississippian	cal AD1190-1260*	Colburn (1985)
Mound House: 11GE7	Middle Woodland	48 BC-392 AD	Thornton (2014), Knutzen (2015)
Reach 7 Early	Modern	AD1957 -1993	LTEF
Reach 7 Late	Modern	AD1994-2014	LTEF
Reach 8 Early	Modern	AD1957-1993	LTEF
Reach 8 Late	Modern	AD1994-2014	LTEF
Pool 26	Modern	AD1994-2014	LTRM
La Grange	Modern	AD1994-2014	LTRM

Table 2. Source information for ecological and archeological sites.

*Calibrated dates for Napoleon Hollow, Apple Creek, Smiling Dan, (King et al. 2011), Carlin, Newbridge (Studenmund 2000), and Hill Creek (Conner 1985). Other dates were confirmed by relative dating in Smiling Dan (Stafford 1985), Koster East Early, Koster East Late (Farnsworth 1991), and Worthy-Merrigan (Wettersten 1983).



Orangespotted Sunfish (*Lepomis humilis*) , members of the family Centrarchidae

Results

The relative abundance of fishes differed significantly among time periods (R=0.716; P=.001) with modern ecological data differing from all archeological time periods (Figure 1; Table 3). We found no significant differences among the archeological periods. There was a higher relative abundance of bowfin in the archeological data than in the ecological data, whereas centrarchids showed higher relative abundance in the ecological data (Figures 2-4). Buffalo and redhorse, the genera chosen for their varied habitat preferences, showed no significant change through time (Figures 5 and 6). At 45 percent similarity archeological and ecological sites fell into groups respective to their temporal ranges, with the exception of the Mississippian sites (Figure 1).

	R Statistic	P Value	Similarity
MW to LW	0.270	0.047	37.29
MW to M	0.107	0.333	36.94
MW to C	0.948	0.005	25.11
LW to M	0.719	0.036	32.94
LW to C	0.913	0.002	34.57
M to C	0.927	0.036	26.88

Table 3. Similarity statistics between time periods.

◊MW=Middle Woodland; LW=Late Woodland; M=Mississippian; C=Current

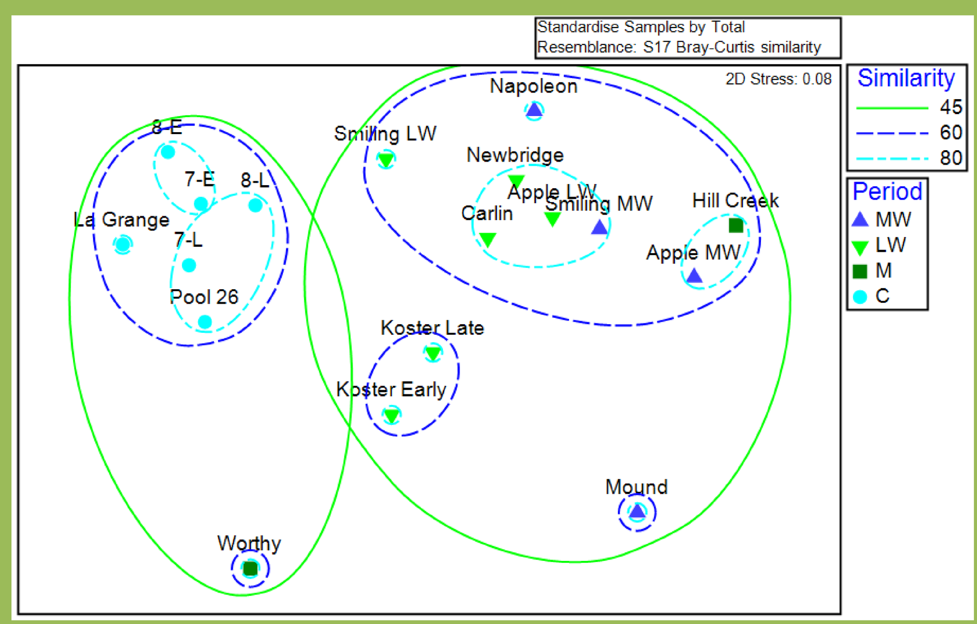


Figure 1. Groupings of archeological and ecological samples of fishes from the Lower Illinois River Valley.◊

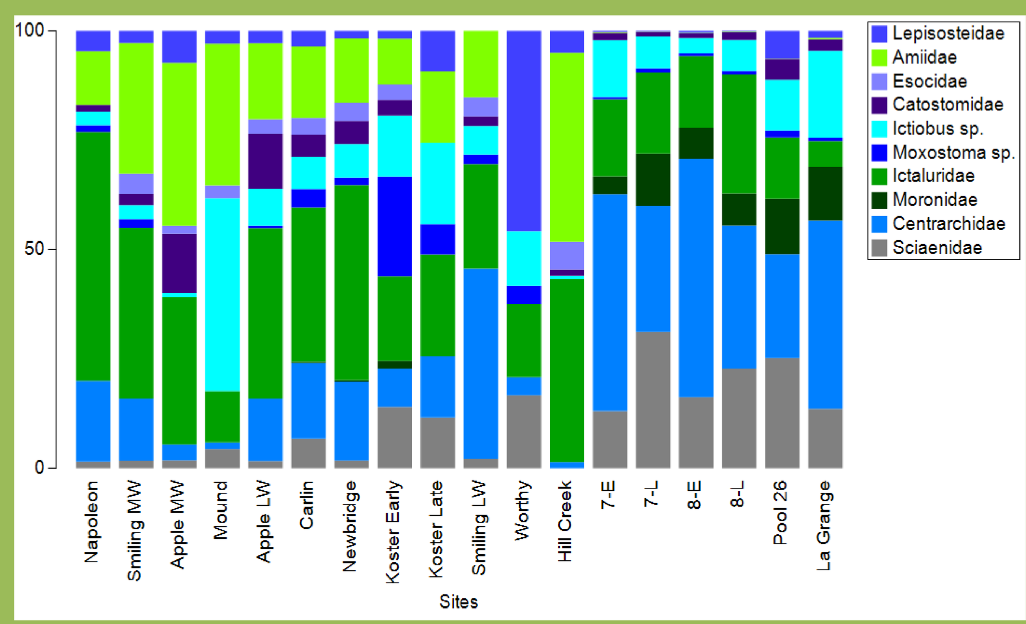


Figure 2. Relative abundance of fish taxa from archeological and ecological samples ordered chronologically, see Table 2.

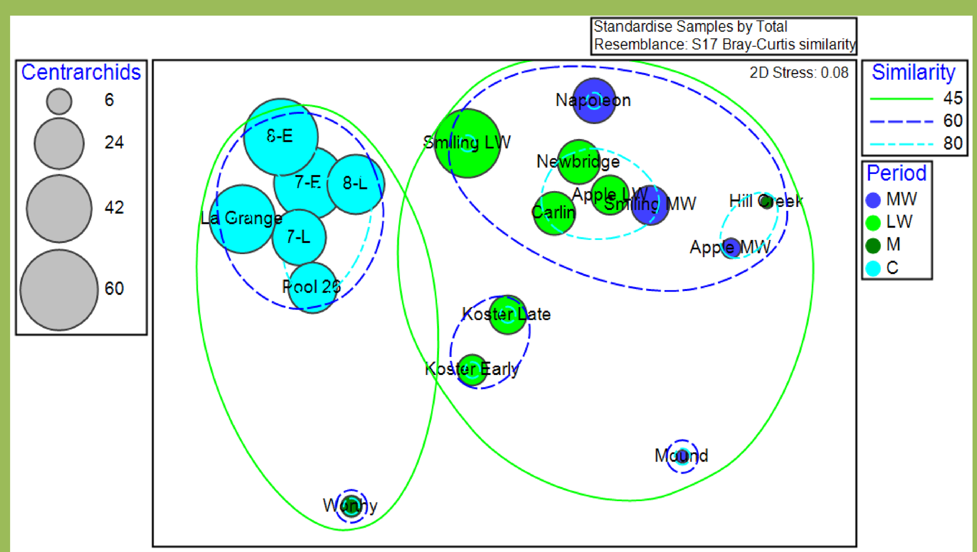


Figure 3. Relative abundance groupings of archeological and ecological samples of centrarchids from the Lower Illinois River Valley.◊

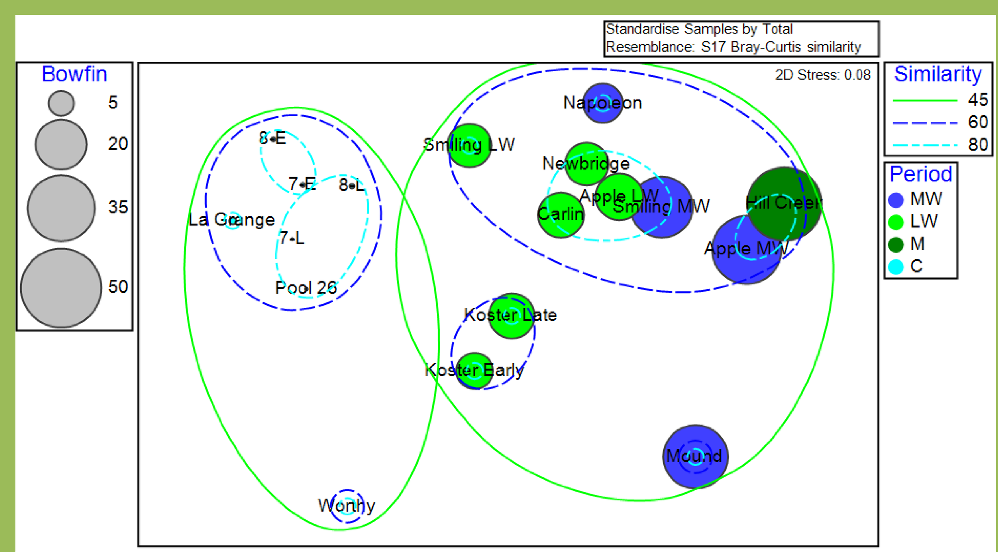


Figure 4. Relative abundance groupings of archeological and ecological samples of bowfin from the Lower Illinois River Valley.◊

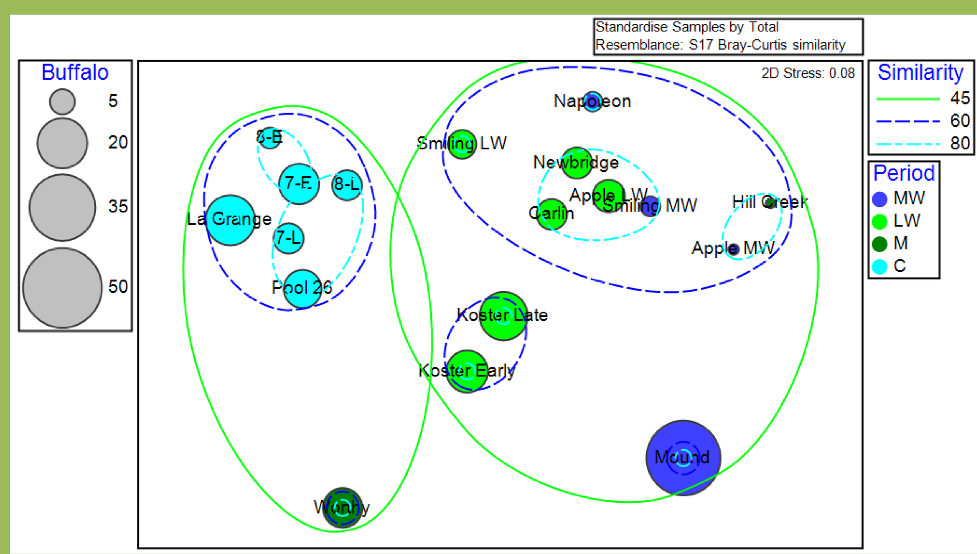


Figure 5. Relative abundance groupings of archeological and ecological samples of buffalo fish from the Lower Illinois River Valley.◊

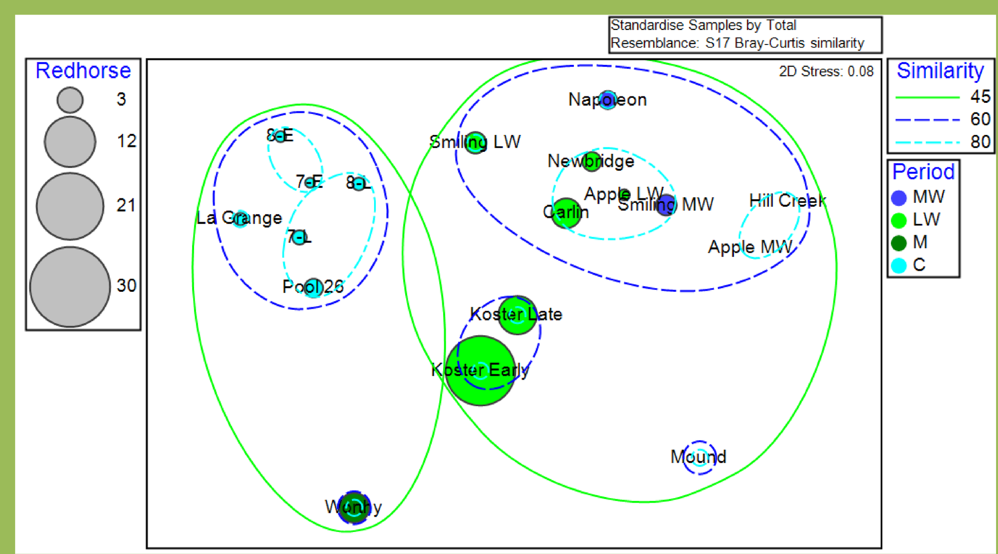


Figure 6. Relative abundance groupings of archeological and ecological samples of redhorse from the Lower Illinois River Valley. ◊

Discussion

We found significant differences in the relative abundance of backwater fishes in the archeological and ecological datasets. Bowfin abundance has declined largely in the modern collections, whereas centrarchids have increased. In contrast, the main channel fishes lack such drastic changes in abundance. The trend in bowfin supports our hypothesis that there is a decline in abundance of species preferring backwaters. The similarities between archeological and modern relative abundance of centrarchids is not consistent with our hypothesis. The categorization of centrarchids as a sport fish may account for this discrepancy. Sport fishes are highly managed and promoted by state and federal agencies due to the economic benefits of recreational fishing (Robinson and Buchanan 1984). Additionally, archeological data represents fishes harvested by humans, likely from a variety of habitats. We acknowledge the possible biases of fishing technology and selection by past peoples, as this may not accurately depict past river conditions.

Although this examination provides valuable information, data may be biased. Archeological data were restricted to sites in the Lower Illinois River Valley. Expanding beyond this river system might help to understand spatial patterns in these data. Discerning causality given the complexity of anthropogenic and non-anthropogenic variables represented in these data is difficult. Recent human modifications to rivers and landscapes are one of the causes represented in these data. Despite these limitations, this analysis provides a basis for future research on human-environmental interactions over millennia, rather than just decades.

Conclusions

Changes in the abundance of fishes preferring backwaters rather than the main channel may be related to recent modifications to our rivers and landscapes. Dams, levees, and agricultural practices have altered backwaters, and through time there is a decline in the abundance of some common backwater species. Centrarchids show an increase in abundance, however. This may reflect management practices and other potential biases in both archeological and ecological data.

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