Comparative Analysis of Fish Harvest over Time in the Upper Mississippi River System

Caille Paulsen[1] and Anthony J. DeFreece[2]
[1]University of Texas at San Antonio, Department of Environmental Science and Ecology, [2]University of North Texas, Department of Anthropology

Introduction:

For millennia, people living on the Upper Mississippi River System (UMRS) have relied on resources from the Mississippi River and its floodplain. Archaeological evidence indicates that fish routinely make up large percentages of the total fauna recovered from deposits in this region (Conner and Asch 1985, Stafford et al. 1985). Today, the Mississippi River is used in numerous ways, including recreational activities, commercial fishing, and transportation. Commercial fish harvest in the UMRS is an artisanal fishery of independent local fishers, in contrast to industrialized oceanic fisheries. The Long Term Resource Monitoring (LTRM) program of the UMRS tracks the status and trends of fishes in the UMRS. We can examine potential human impacts on river systems by comparing monitoring samples and archaeological data. We compared fish community data from the LTRM, commercial fishing, and archaeological collections.

Methods:

Archaeological data are derived from published zooarchaeological collections from sites in the UMRS with at least 500 fish bones. Modern monitoring data are from the LTRM element of US Army Corps of Engineers' Upper Mississippi River Restoration Program (Ratcliff et al. 2014). We analyzed fish communities from large and small hoop nets in the main and side channel habitats. Commercial harvest data from annual IDNR reports are self-reported by commercial harvesters and those who buy them (Maher 2019).

We examined taxa present in modern commercial harvest reports (Table 1) so the overlap of taxa would give an accurate comparison of fish communities across the three datasets. We grouped archaeological collections by time period and grouped modern data by monitoring versus commercial harvest.

Using Primer 7 statistical software, we transformed counts of fish bones to presence/absence. We produced a Bray-Curtis similarity matrix for use in all statistical analyses and did a cluster analysis to view similarities and groupings within our data. Using analysis of similarity (ANOSIM) we tested for differences among these groups and graphically displayed similarities across our data using non-metric multidimensional scaling (Figure 1). We used SIMPER to determine which taxa drove these differences.

Results:

Results indicate that both commercial data and monitoring data differed significantly from all archaeological collections ($P \leq 0.005$). Middle Woodland collections did not significantly differ from either Late Woodland or Mississippian periods ($P \geq 0.093$). All other time period pairings differed significantly from each other ($P \leq 0.011$). The modern commercial harvest data group with monitoring data more so than they do with archaeological collections. When locations of the commercial harvest data are considered, the lower reaches (Pool 25, Pool 26, and Open River) are more similar to monitoring, while seven sites from the upper reaches (Pool 13, La Grange) showed a similarity overlap with all archaeological data at 69% and with several Woodland collections at 85% (Figure 1).

Hypothesis:

We hypothesize that the frequency of occurrence of fish taxa from modern commercial harvest records will be more similar to archaeological collections than LTRM monitoring data. We expect that neither commercial harvest nor archaeological harvest data will be as similar to LTRM monitoring data as they are to each other.
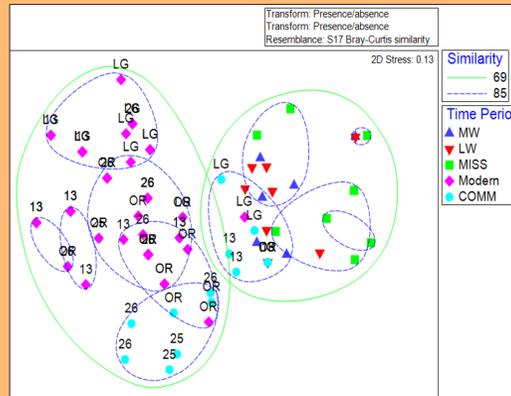

Figure 1. Presence/Absence NMDS as a factor of time period and commercial versus monitoring data.
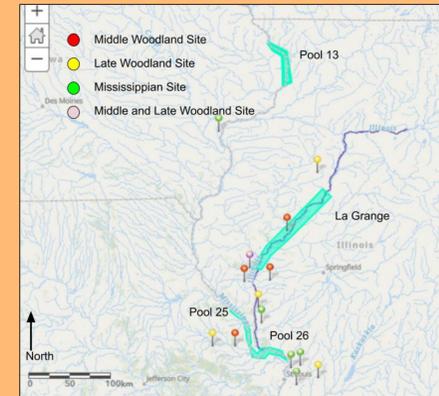

Figure 2. Map showing location of sites and pools. Two northern sites are not pictured.

Table 1. Fish Taxa Analyzed

Sturgeon (Acipenseridae)	Carpsuckers (*Carpiodes* spp.)
Paddlefish (*Polyodon spathula*)	Buffalo (*Ictiobus* spp.)
Gar (*Lepisosteus* spp.)	Bullhead Catfish (*Ameiurus* spp.)
Bowfin (*Amia calva*)	Blue Catfish (*Ictalurus furcatus*)
Shad (*Dorossoma* spp.)	Channel Catfish (*Ictalurus punctatus*)
Minnows (Cyprinidae)	Flathead Catfish (*Pylodictis olivaris*)
Freshwater Drum (*Aplodinotus grunniens*)	Other Suckers (Catistomidae)

Photo 1. Electrofishing on Carlyle Lake

Photo 2. Gehring archaeological site at Southern Illinois University Edwardsville

Discussion:

Commercial data differed significantly from all archaeological time periods. Seven commercial harvest records did group with archaeological collections at 69% and 85% similarity, partially supporting our hypothesis.

The Anthropocene is defined as a geological epoch where humans are the primary driver of environmental processes. This research allows us to explore how river use has changed over time. Archaeological data consistently had a higher frequency than monitoring data of bowfin, other suckers, bullhead catfishes, and gars, while the modern monitoring data held no species or groups that were more frequent than archaeological data.

There are currently no quantity limits on commercial harvest fish catches. River-caught fishes generally are not in high demand and as such, commercial fishers have a low incentive to pursue larger catches (Maher 2019). The Illinois Department of Natural Resources limits fishing licenses for taxa that may be at risk of overharvest, such as the shovelnose sturgeon (*Scaphirhynchus platorynchus*) (Maher 2019; Nepal et al. 2015).

In the upper reaches (Pool 13 and La Grange, Figure 2), the commercial records are more similar to the archaeological collections compared to the monitoring samples. This indicates that the same fish communities being harvested commercially in those areas today are similar to those that people harvest thousands and hundreds of years in the past. According to the data provided by the Illinois Department of Natural Resources, the management of commercial harvest has prevented commercial fishing from negatively impacting fish communities in the UMRS (Maher 2019).

Conclusion:

The data from archaeological collections, modern commercial harvesting, and modern monitoring samples give partial support to our hypothesis that commercial records are more similar to archaeological collections relative to monitoring samples. Commercial and monitoring data were significantly different, and both commercial and monitoring data differed significantly from archaeological data. Nevertheless, more archaeological collections group with commercial records in the upper reaches. Those fishes that make up the commercially harvested economy now have been consistently harvested by humans for the last 2,000 years. Based on prior research and our analyses, we suggest that any negative changes in the fish communities in the modern UMRS likely result from anthropogenic factors other than commercial harvest.

Contact Information:
DeFreece: anthonydefreece@my.unt.edu
Paulsen: caille.paulsen@gmail.com