Archaeological Data Indicate a Broader Late Holocene Distribution of the Sandbank Pocketbook (Unionidae: *Lampsilis satura* Lea 1852) in Texas

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Source: American Malacological Bulletin, 34(2):133-137.
Published By: American Malacological Society
DOI: http://dx.doi.org/10.4003/006.034.0209
URL: http://www.bioone.org/doi/full/10.4003/006.034.0209

Amer. Malac. Bull. **34**(2): 133–137 (2016)

RESEARCH NOTE

Archaeological Data Indicate a Broader Late Holocene Distribution of the Sandbank Pocketbook (Unionidae: *Lampsilis satura* Lea 1852) in Texas

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Abstract: One way that archaeologists provide unique conservation datasets is through the establishment of pre-Euroamerican baselines for animal communities that were part of human-environment interactions during the last few millennia. Freshwater mussel remains from archaeological sites offer a rich data source for establishing this type of baseline. We establish a conservation baseline for the late Holocene sandbank pocketbook (*Lampsilis satura*, Lea 1852) in the upper Trinity River of central and north Texas. These data may 1) lead to greater confidence in existing contemporary data for unoinid biogeography; 2) lead to information on whether or not community composition differs between the late Holocene and today; and/or 3) provide a justification for more intensive contemporary surveys. Such data are relatively easily acquired, inexpensive to generate, and highly informative for environmental management.

Key words: applied zooarchaeology, paleobiogeography, archaeomalacology, Unionidae

Archaeological remains of mussel shell are increasingly studied for the purpose of understanding the late Holocene geographic ranges of unionids (e.g., Randklev *et al*. 2010a, Peacock *et al*. 2012, Randklev and Lundeen 2012). The use of archaeological data on animal remains in conservation biology is termed "applied zooarchaeology" as zooarchaeology is the study of whole and fragmented bones, shells, antlers, and other animal tissues recovered from archaeological sites (Lyman 1996, Wolverton and Lyman 2012). Such data provide a pre-Euroamerican baseline for biological conservation and ecological restoration (Lyman 2012a, Rick and Lockwood 2013, Wolverton *et al*. 2016a).

Knowledge of the distribution and status of threatened freshwater mussel species is one of the most important components for mussel conservation efforts (NNMCC 1998). Although studies on mussels are increasing, information on the geographic distribution and location of remaining mussel populations varies by species, location, and perceived rarity. For example, in Texas mussels have been largely ignored by the scientific and conservation community until the recent listing of 15 species as state-threatened, of which 12 are being considered for listing under the Endangered Species Act (TPWD 2010, USFWS 2001, 2011). Since then researchers have rediscovered several species thought to have been extinct (Randklev *et al*. 2010b, Randklev *et al.* 2012) and uncovered additional populations of rare species (Randklev *et al.* 2013, Ford *et al.* 2014, Tsakiris and Randklev 2016). Similarly, knowledge of the historical distribution of mussels varies from being well documented to poorly understood depending on geographic location. This is unfortunate, as these types of data are equally critical for evaluating a species' status; the absence of such information may hamper efforts to evaluate a species' viability or lead to erroneous conclusions about its range curtailment (Randklev and Lundeen 2012).

In the Upper Trinity River drainage, located in north central Texas, the late Holocene biogeography of unionids continues to be poorly understood; several species thought to be rare or absent have been identified in archaeological samples that date to the late Holocene (Randklev and Lundeen 2012). Shell remains for one of these species, the sandbank pocketbook (*Lampsilis satura*, Lea 1852), are particularly important, as until recently this species was thought to have never occurred in the Trinity River (Howells 2010). Unlike rivers in the American Midwest and Southeast, rivers in Texas and many other areas of the interior Southwest tend to be hydrologically and geographically isolated, generally winding north to south from their headwaters to their mouths in the Gulf of Mexico. As result, each river system comprises regionally isolated unionid and fish host communities. Establishing the biogeographic presence of one or more species in a river such as the Trinity represents an important range extension across drainages that are hydrologically independent. Such a range extension may be minor in terms of geographic distance, but is significant in terms of hydrology and unionid biogeography.

A single live individual and a weathered shell, both tentatively identified as *Lampsilis satura,* were recently reported from the upper Trinity River drainage (McDermid *et al.* 2013, Ford *et al.* 2014) Historically, *Lampsilis satura* occurred from the San Jacinto east into the Neches-Angelina and Sabine Rivers (Howells 2010a). *L. satura* inhabits small to large rivers with moderate flows on gravel, gravel-sand, and sand substrates (Howells 2010a). Multiple umbos with intact hinges and teeth of *L. satura* were recovered from archaeological site 41TR198 on the West Fork of the Upper Trinity. The site, dating between 2400 and 500 years before present, was excavated in the mid-2000s by GeoMarine, Inc. (now Versar) for which the authors analyzed unionid shell remains (Peter and Harrison 2011). In this paper we briefly review previous research on late Holocene unionids in the Upper Trinity, describe the *L. satura* remains that were identified, and discuss the conservation implications of zooarchaeological data for this species.

Previous research

Applied zooarchaeological research has increased in importance during the last two decades (Lyman 2012a, b). Such research on unionid remains has been important in the American Southeast, where zooarchaeological data have supported natural science or led to revisions of contemporary biogeography (e.g., Parmalee 1956, Gordon 1983, Lyons *et al.* 2007, Peacock *et al.* 2011, Peacock 2012, references cited in Peacock *et al.* 2012). In Texas, zooarchaeological data have been important for clarifying the geographic ranges of species in the Trinity River and the Leon River (Randklev *et al.* 2010a, Randklev and Lundeen 2012, Popejoy *et al.* 2016,). Species thought to have been rare or absent from these drainages (Neck 1982, 1990, Randklev *et al.* 2013) have been identified in late Holocene archaeological faunas. For example, Randklev et al. (2010a) showed that bankclimber (*Plectomerus dombeyanus*, Valenciennes 1827), a species thought to not be present in the Trinity River drainage, did in fact occur and appeared to be common during the late Holocene. In addition, remains of *Fusconaia* sp., previously thought to occur mainly in the Neches and Sabine drainages, was the dominant mussel in the West Fork of the Trinity, but taxonomic problems for this genus in Texas (Burlakova *et al.* 2012) precluded assignment of those individuals to species. Zooarchaeological remains of *Pleurobema riddellii* were also present at sites dating to the late Holocene in the Upper Trinity and are represented in the 41TR198 fauna (Randklev and Lundeen 2012).

METHODS

Unionid remains from 41TR198 were identified through comparison to modern reference specimens housed at the University of North Texas Laboratory of Zooarchaeology and Elm Fork Natural Heritage Museum in addition to the use of published guides (Howells *et al.* 1996, Parmalee and Bogan 1998). Specimens identified as *Lampsilis satura* are moderately thick-shelled and are characterized by beaks that are raised high above the hinge line with a posterior ridge that is broadly rounded. Also important is the presence of muscle scars along the upper portion of the anterior wall of the beak cavity. The presence of lateral teeth that are compressed, slightly curved and not especially long is also diagnostic. Shells of *L. satura* are morphologically similar to those of lentic forms of *Lampsilis hydiana* (Lea, 1838) (Louisiana fatmucket) and *Potamilus purpuratus* (Lamarck, 1819) (bluefer), two species that occur in the Upper Trinity River drainage. Numerous valves of *L. hydiana* were present in 41TR198 and all resembled the lotic form of this species, which is characterized as having a thin shell, a rhomboid shell shape, and teeth that are thin and compressed but similar to those seen in other lampsiliid species (see Howells *et al*. 1996, Howells 2010b for further details). Shells of *P. purpuratus* can be confused with those of *L. satura* due to their moderately thick shell, elevated beaks, and rounded posterior ridge, but *L. satura* differs from this species in that it has shorter and more compressed lateral teeth, and the dorsal margin of its shell forms a sigmoid curve.

RESULTS AND DISCUSSION

An initial analysis of 25 percent of the freshwater mussel assemblage from 41TR198 led to the taxonomic identification of 2915 shells and shell fragments (Randklev and Wolverton 2009). Since that time there has been ongoing analysis of the remaining 75 percent of the sample. Twelve umbo fragments have been identified as *Lampsilis satura*. One of these specimens is illustrated in Fig. 1. The identification places *L. satura* west of its accepted zoogeographic range (Howells 2010a) and provides evidence that *L. satura* historically occurred in the Trinity (Fig. 2).

The presence of *Lampsilis satura* in the West Fork of the Trinity during the late Holocene is important for several reasons. First, it demonstrates that there is still much to learn about the late Holocene unionid community in the Trinity River, a situation that extends to other rivers in Texas (e.g., Popejoy *et al.* 2016). Second, the absence of the species in the Upper Trinity today but its presence in the past is either an indication that its range has declined as result of anthropogenic impacts or that previous surveys have been inadequate, in terms of effort, to detect this species. If this species has been reduced in abundance or distribution in the Upper Trinity, then those reductions may relate to impacts stemming from river impoundment and changes in land use and water quality. If this species' absence today is due to sampling bias, which we think is the case, then mussel surveys by trained malacologists using a robust standardized sampling design that accounts for incomplete species detection (see Wisniewski *et al*. 2013) are needed throughout the Trinity River drainage.

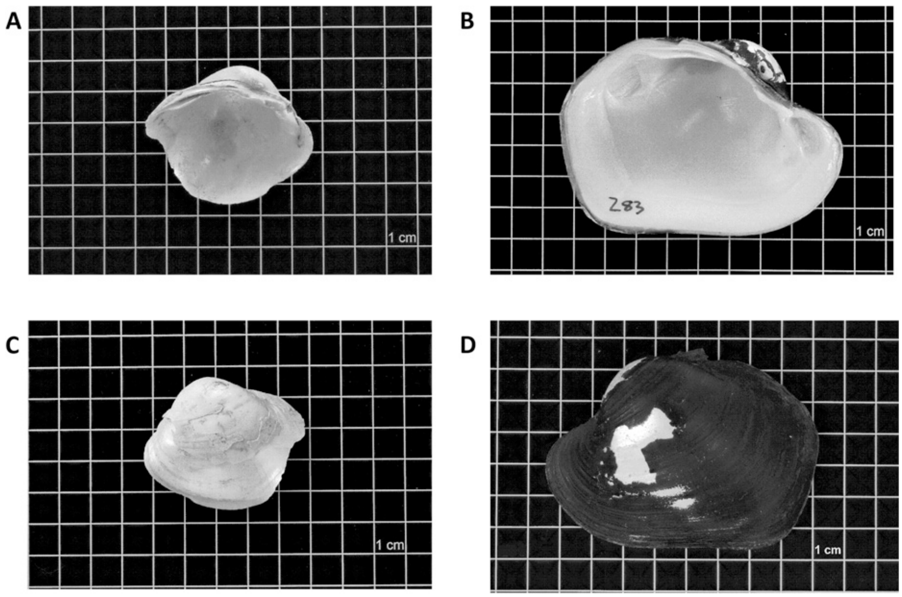

Figure 1. A) Interior, left valve of a late Holocene sandbank pocketbook shell from the West Fork of the upper Trinity River; B) interior left, valve of a modern sandbank pocketbook shell; C) the exterior view of the same specimen in A; and D) the exterior of the same specimen in B.

Third, the type of data presented here is foreign to many biologists and ecologists and therefore is rarely used in guiding conservation and restoration activities. There are two reasons for this: 1) these data are paleoecological instead of neoecological, which means that past mussel populations are sampled indirectly through deposition in, preservation within, and recovery from archaeological deposits; and 2) archaeological data are produced within the social sciences for the study of past cultures, not past ecology. Regarding the first concern, zooarchaeologists routinely assess the physical condition and attributes of faunal remains to assess whether differential destruction of shell (and other animal remains) has occurred within and between deposits (sensu Lyman 1994, also see Wolverton *et al.* 2010). Indeed, that faunal remains only preserve in some cases precludes many quantitative analyses of animal abundance (Grayson 1984, Lyman 2008, Wolverton *et al.* 2016b). As a result, many studies in applied zooarchaeology will be nominal-scale, biogeographic assessments of past species ranges. Wolverton *et al.* (2010) studied the robusticity of shells from different species that are common in the Trinity and Brazos rivers and concluded that species with relatively dense and spherical shells tend to have higher preservation potential. Shells of *Lampsilis satura* are moderate in terms of density but are relatively spherical compared to many species. Thus, if sandbank pocketbook individuals were collected by past hunter-gatherers, their remains are likely to preserve.

In regards to crossing from the social to the biological sciences, it is important that detailed morphological criteria upon which mussel-shell identifications are based be published in this type of study (e.g., Dombrosky *et al.* 2016, see discussion by Gobalet 2001). In some cases, it may be possible to verify morphological identifications through biomolecular analysis of tissue (e.g., ancient DNA or ancient proteins), but this particular line of evidence has received little scientific attention, so identifications continue to be based solely on shell morphology. In addition to concerns over misidentification, ecologists might question whether or not the presence of shells from a particular species represents a past local ecological community or is the product of people transporting shells from place to place (see Lyman 2012a). Zooarchaeologists refer to this as "the cultural filter" (Daly 1969, Peacock *et al.* 2012). This concern is generally unfounded as there is no benefit to humans transporting mussels long distances due to the perishability of edible parts and the low ratio of meat mass to shell mass in unionids (Parmalee and Klippel 1974, Lyman 1984). There is, however, the possibility that shells were used as tools. In the assemblages we have identified from the Upper Trinity River, evidence of tool manufacture from shells is non-existent. A more likely scenario for this assemblage is that observed by Peacock *et al.* (2012) for late Holocene archaeological mussel faunas from the Tombigbee River in Mississippi. For those faunas, nestedness analysis, assessment of species area curves, and study of the isotopic chemistry of shells indicated that prehistoric humans gathered shells from local beds near their camp sites and villages. A similar isotopic study of late Holocene unionid remains from the Upper Trinity would provide an empirical means to test our hypothesis that shells from 41TR198 are local in origin. Our conclusion based on the available evidence is that these remains of *Lampsilis. satura* represent a local record of occurrence in the West Fork during the late Holocene, west of the currently accepted contemporary range (Howells 2010a). The implications of this find is that *L. satura* appears to have been more widely distributed in the past, though its perceived absence today from the Trinity River drainage could stem from inadequate sampling.

Conclusion

This study represents a growing body of conservation data stemming from zooarchaeological analyses (e.g., Dombrosky *et al.* 2016, Rick and Lockwood 2013, references in Lyman 2012a). Such data represent deeper temporal information on

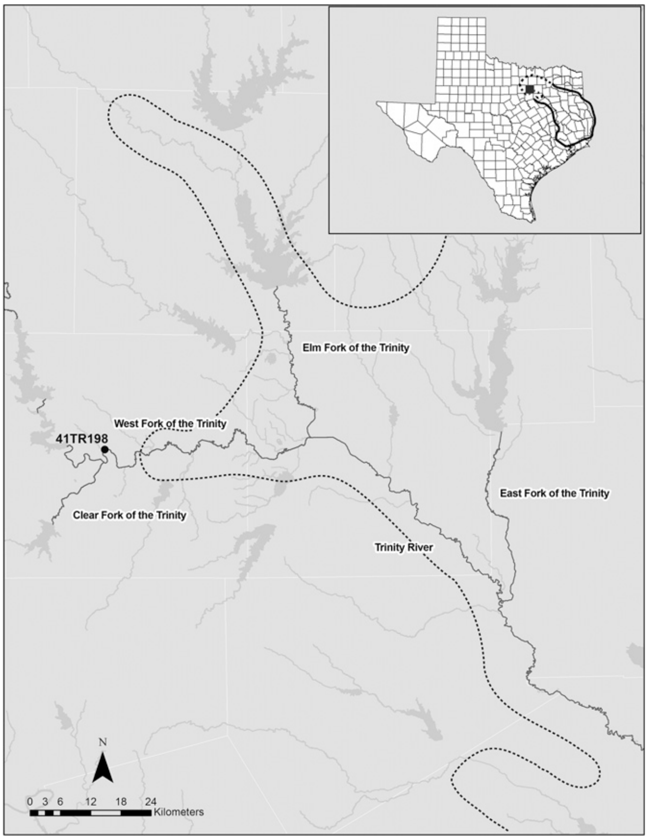

Figure 2. Map of the upper Trinity River; dashed line represents the presumptive range for the sandbank pocketbook based on reports by McDermid *et al.* (2013) and Ford *et al.* (2014).

human-environmental interactions than those provided by historic records. In this study, remains of *Lampsilis satura* provide biogeographic data indicating that the late Holocene range for the species was more extensive in the past, including the Trinity River. Archaeological collections of mussel remains exist for many river drainages in North America but are rarely if ever considered by conservationists and natural resource managers. This is unfortunate because late Holocene biogeographic data from archaeological faunas are relatively inexpensive to produce and easy to acquire. Such studies provide a unique and complementary source of data to support conservation biology, historical ecology, and environmental management.

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Submitted: 02 May 2016; **accepted:** 23 June 2016; **final revisions received:** 29 August 2016