Project Title: Surveys of freshwater mussels in 3 units of the Big Thicket Preserve

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Introduction:

Freshwater mussels have historically dominated riverine systems of the southeastern United States in terms of benthic biomass (Parmalee and Bogan, 1998) and can exceed all other bottom dwelling organisms by an order of magnitude (Strayer et al., 1994). They often occur in dense multispecies beds that perform significant functional roles such as removing suspended organic material, moving sediments and providing habitat for other animals (Christian and Berg, 2000; Strayer et al.,1997; Vaughn and Hakencamp, 2001). They are also sensitive to pollution and other environmental problems and so are widely recognized as indicator species for water quality (Shannon et al., 1993; Williams, et al., 1993). They are highly speciose with over 300 species in the family Unionidae in the United States alone (Neves, 1993; McMahon and Bogan, 2001). Riverine mussels are relatively sedentary, slow-growing and long-lived (> 25 years) and the larvae of most species must parasitize specific host fish (Watters 1994; Vaughn and Taylor 2000), all of which makes them extremely susceptible to anthropogenic effects.

North American mussel populations have been declining for over a century with 35 species now presumed extinct and nearly 50% imperiled to some degree (Neves et al., 1997; Vaughn, 1997). It is important to note that it is not only the rare species of mussels that are in trouble but nearly all are in decline in most rivers (Bogan, 1993; Vaughn and Taylor, 1999). In the southeastern United States where mussels are well studied, 42% of the unionid populations that had been abundant are now in poor condition and nearly 70% of the populations may not survive over the next 30 years (Neves et al., 1997). Other areas such as the major rivers of Illinois and Ohio have shown similar declines with nearly 40% of their original mussel fauna now eradicated (Shannon, et al., 1993). However, for many states, including Texas, the status of many mussel species is poorly known (Howells, et al., 1996; Neves, 1992). We do know that overharvesting, pollution, reservoirs and other human activities, that have been implicated in the decline of species elsewhere, are occurring in Texas as well (Ford and Nicholson, 2006; Ford et. al., 2009; Howells, 1997; Howells et al., 1997).

Texas has over fifty species of unionid mussels in multiple river basins that often have isolated drainage into the Gulf of Mexico (Howells, et al., 1996). The species composition in southeastern Texas differs significantly from that of central and western areas (Neck, 1982; Howells, 1997). Southeast Texas is also a region where the construction of reservoirs and smaller impoundments has been prevalent. The change in water flow downstream of dams has major impacts on mussel diversity and abundance (Vaughn and Taylor, 1999). The Neches River is the main water source for the upper units of the Big Thicket National Preserve and a hydroelectric dam (Dam B forming B. A. Steinhagen reservoir) is just upstream of these units. In addition to impacts from that dam, erosion from agricultural land and water pollution have likely been impacting the freshwater mussels of this area (Neck, 1986). However, the Neches and its tributaries above Beaumont receive some environmental protection from the lands of the Big Thicket National Preserve. Whether this has reduced the factors causing mussel declines elsewhere is unknown since mussel surveys in the area are limited and dated.

The historical survey data on the mussels for the Big Thicket area was reviewed in Howell, 1997 and since that time TPWD has conducted some additional surveys in the Neches in that area (Howells, pers. comm.). Thirty species have been recorded in the 3 counties (Jasper, Tyler and Hardin) that include the upper units (Beech Creek Unit, Canyonlands Unit, Neches Bottom and Jack Gore Baygall Unit and the Upper Neches River Corridor unit) of the Big Thicket (Table 1). Five of the Texas State threatened unionid species have been recorded within these units. However, the most recent

TPWD surveys were in 2006 (Howells, 2006) and most were in the 1990s. Upper units of the Big Thicket are just below the Town Bluff Dam B on B. A. Steinhagen reservoir. Reservoirs tend to support thin-shelled lentic species that can tolerate silting rather than the threatened riverine species. The Texas Heelsplitter is an exception in that it has adapted to reservoirs and has a significant population in Steinhagen (Howells, 1997). The rivers downstream of dams are subjected to instream flows that are occasionally extremely high and often variable, also producing isolated pools. This causes two impacts on mussels. The high flows scour the substrate and remove mussels entirely. The variable flows cause bank erosion and the movement of large amounts of sand downstream. Only mussel species that can move in these shifting sands can survive in this habitat. In addition, hydroelectric dams such as B. A. Steinhagen release cooler deep water in large amounts in the summer for electrical requirements, and this colder water can inhibit reproduction in some species.

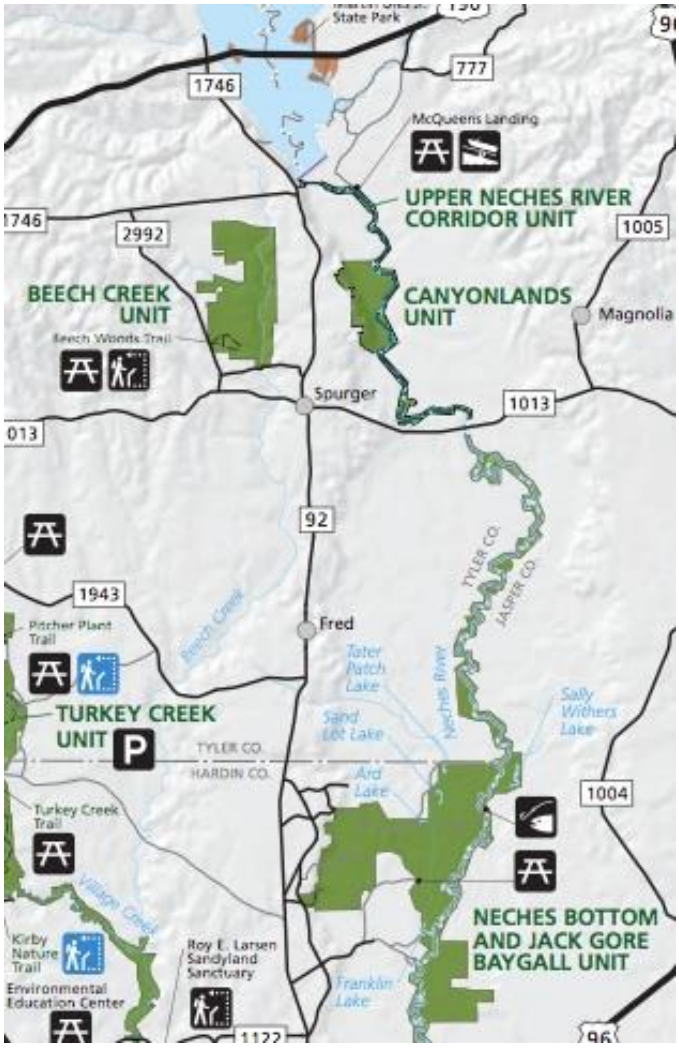

Figure 1. Upper Units of the Big Thicket National Preserve.

The current study specifically surveyed for mussels in the Neches River and some tributaries within 3 units of the Big Thicket Nature Preserve and another nearby unit that has a small stream. Specifically we surveyed for freshwater mussels in the Upper Neches River Corridor Unit just south of B. A. Steinhagen Dam B, and the Beech Creek Unit, Canyonlands Unit and the Neches Bottom and Jack Gore Baygall unit. We chose regions to survey that were spread throughout the extent of the river to get good coverage of all areas. We scouted the river first by boat for valves and suitable habitat, and then chose appropriate areas of 100 to 150 meters in which to conduct timed searches. Timed searches are the best method to obtain the most species and in particular to locate rare species. The surveyed sites were georeferenced to allow for future monitoring of these areas.

Table 1. Historical data for unionid mussels between B.A. Steinhagen Reservoir and Evadale. From Robert Howells, Biostudies. Note *Tritogonia* = *Quadrula* currently.

Amblema plicata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Amblema plicata	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Anodonta suborbiculata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Arcidens confragosus	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Arcidens confragosus	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Fusconaia askewi	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Fusconaia lananensis	Hardin	Neches River, US 96, W of Evadale, E of Silsbee (Evadale)
Glebula rotundata	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Lampsilis hydiana	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Lampsilis hydiana	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Lampsilis satura	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Lampsilis satura	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Lampsilis satura	Jasper	Neches River, FM 1013, 8.6 km ESE Spurger
Lampsilis teres	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Lampsilis teres	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Leptodea fragilis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Leptodea fragilis	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Ligumia subrostrata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Ligumia subrostrata	Tyler	Neches River, artificial lake 15 mi E of Woodville)
Megalonaias nervosa	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Megalonaias nervosa	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Megalonaias nervosa	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Obliquaria reflexa	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Obliquaria reflexa	Hardin	Neches River, US 96, W of Evadale, E of Silsbee (Evadale)
Plectomerus dombeyanus	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Plectomerus dombeyanus	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Pleurobema riddellii	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Pleurobema riddellii	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Potamilus amphichaenus	Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Potamilus amphichaenus	Jasper	Neches River, US 96, W of Evadale, E of Silsbee (Silsbee)
Potamilus purpuratus	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D

Potamilus purpuratus	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Pyganodon grandis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Pyganodon grandis	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Quadrula apiculata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Quadrula apiculata	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Quadrula mortoni	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Quadrula mortoni	Hardin/JasperCo.	Neches R., US 96, W of Evadale, E of Silsbee
Quadrula nobilis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Quadrula nobilis	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Quadrula nodulata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Quadrula nodulata	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Toxolasma parvus	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Toxolasma texasiensis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Tritogonia verrucosa	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Tritogonia verrucosa	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Truncilla donaciformis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Truncilla donaciformis	Hardin	Neches River, US 96, W of Evadale, E of Silsbee
Truncilla truncata	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Uniomerus declivis	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Utterbackia imbecillis	Jasper/Tyler	Neches R., below B.A. Steinhagen Reservoir (Town Bluff D
Villosa lienosa	Hardin/Jasper	Neches R., US 96, W of Evadale, E of Silsbee
Villosa lienosa	Tyler	Neches River, Town Bluff

Methodology

Personnel from The University of Texas at Tyler (UT-Tyler) conducted 33 surveys in the 3 units of the Big Thicket that are just south of B. A. Steinhagen Dam and 1 unit further down the Neches River (Fig. 2). Thirty of these surveys were on the Neches River or tributaries or oxbows directly off of the mainstem. Of those 19 were from the mainstem and 9 were from oxbows. Three surveys were in Beech creek and its tributaries. For each survey of the mainstem and oxbows we located sites by boat starting from the nearest highway bridge crossings with a boat ramp and going both upstream and downstream. We used satellite maps to pick locations and then narrowed those down by chosing sites with valves on shore or appropriate mussel habitat, i.e. the presence of gravel or cobble. We marked off areas of 100 to 150 meters to sample and then used a timed hand search. This is known to be the most effective method to obtain rare species (Strayer et al., 1997; Strayer and Smith, 2003; Vaughn, et al., 1997). The hand search was accomplished by feeling for mussels in the sand or gravel down to 10 cm and also rinsing the substrate in our hands to look for small specimens. The time was determined by the number of surveyors present. Generally, we surveyed for 1 person/hour, i.e. if there were 4 persons present we surveyed for 15 minutes. Occasionally, when mussels were abundant we would survey for up to an additional ½ person hour. The only site in Beech Creek with water deep enough to support mussels was surveyed with the same method. All live and dead unionids were collected, identified and counted then live specimens were returned to the river. Valves were also returned as shells can be important habitat for other organisms. Some vouchers of recent dead specimens of threatened and other rare species were retained and catalogued into the University of Texas at Tyler collection. Each final survey location was delineated with GPS coordinates and a map of those produced (Fig. 2).

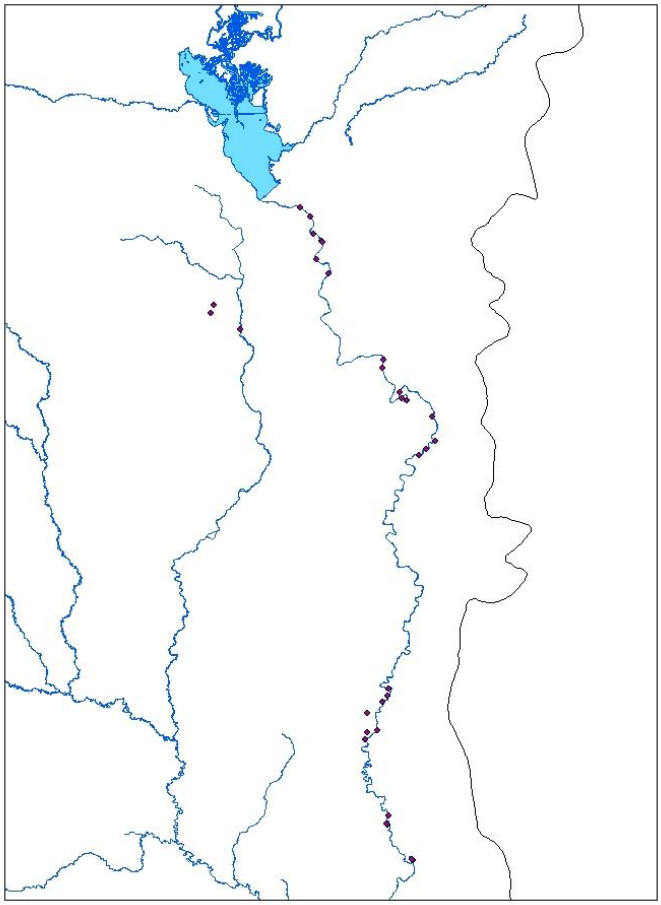

Fig. 2. Locations where surveys for mussels were conducted.

Objectives.

The overall goal of this project was to survey for mussels in the upper units of the Big Thicket National Preserve. In addition, information on abundance of the 6 mussels species that are State Threatened were gathered (Williams et al., 1993; Howells et al., 1996). These data will help determine locations of mussels within areas of the Big Thicket, which will provide important information for future conservation work.

Results.

564 live and 313 recent dead mussels of 23 species were found in the 30 surveys on the Neches River and several oxbows and tributaries connecting to it (Fig. 3). No mussels were found in Beech Creek and two small streams within the Beech Creek unit.

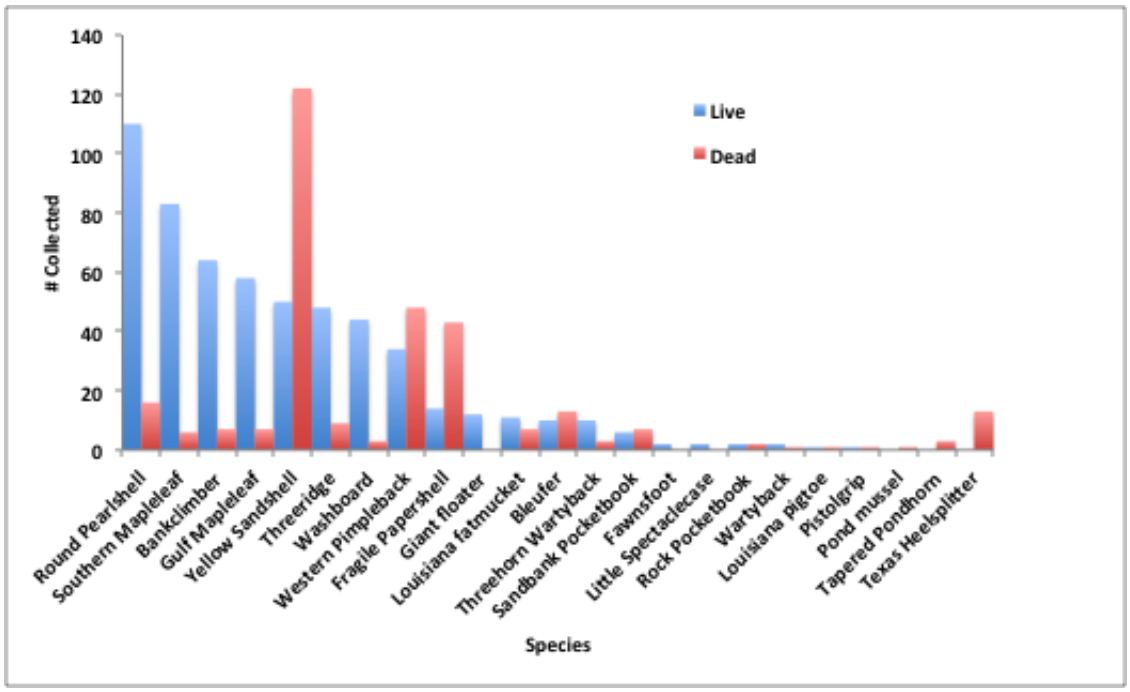

Fig. 3. Abundance for unionid mussels collect in 2013 in the upper units of the Big Thicket National Preserve ranked by number found live for each species from the most to least abundant.

The salt tolerant Round Pearlshell was the most abundant species with several riverine species showing high numbers also. The mussel community was relatively even for the first 8 species' abundances (Fig. 3) and a large number of rare species also occur. Of the threatened species only the Sandbank Pocketbook was found live in more than very few locations. It was found in several of the sandbars along the main stem of the river. The Sandbank Pocketbook was not found in the backwaters. These areas were where the highest diversity of species was found and appeared to be refuges from the high shear stresses of the river. Although a number of Texas Heelsplitters were also found in the sandbars of the mainstem, they were always dead. Yellow sandshells were the only species common in the main stem of the river and they also were often found dead. Of the other threatened species, only a very few dead Louisiana pigtoes were found and no Triangle or Texas pigtoes.

Conclusions

Three of the Upper Units of the Big Thicket National Preserve are contiguous with or have oxbows from the Neches River, which has some of the highest diversity of mussels in eastern Texas (Howells, 1997). Although 23 of the potential 42 species were found the distribution of the locations with high abundance was disturbing. The main stem of the river has a high abundance of mussels above B. A. Steinhagen (Ford, pers. obs.). A large bed of mussels existed just below B. A. Steinhagen but was covered by shifting sands and is now gone (Howells, pers. comm.). The main stem of the river currently had nearly no mussels all the way down to highway 96. The dramatic fluctuations in water releases has eroded the banks and all good habitat is covered in shifting sand which most species of mussels can not tolerate. Therefore, the upper Neches River Corridor unit is now poor

habitat for mussels. In the Canyonlands unit and the Neches Bottom and Jack Gore Baygall unit the Neches River has numerous oxbows and tributaries into the river. These backwaters are refuges from the high shear stresses during water releases from B. A. Steinhagen. All of these sites had high abundances and often a high diversity of mussels. Further surveys should therefore concentrate on the oxbows and inlets into the river as they should exhibit higher diversity. In addition, some discussions with the river authority to mitigate the dramatic high flows would be important to improve conditions for mussels on the upper Neches River Corridor unit. Without that reduction in shear stress the situation will remain poor for this fauna.

The Beech Creek unit appeared to have enough water in the main stream to support some of the species tolerant of ephemeral conditions but none were found. It is possible that past droughts would have extirpated any mussels that might have occurred there. It is not appropriate habitat for any of the threatened species so the lack of mussels is not a major concern. With better rainfall the pondhorn and other small stream species should return.

In conclusion the diversity of mussels in the Big Thicket National Preserve was evaluated and found to have mixed results. The main stem of the upper Neches River had low abundances but did have two threatened species. The greatest diversity and abundance of mussels were found in the backwater areas of Canyonlands and the Neches Bottom and Jack Gore Baygall unit. The protection these areas provide for this declining fauna is therefore quite important and further monitoring is warranted.

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Appendix: Threatened East Texas Unionid Mussels in the Big Thicket National Preserve

Texas Pigtoe (*Fusconaia askewi*)
Listed as threatened by Texas Parks and Wildlife and under evaluation by U. S. Fish and Wildlife for potential listing as endangered. Only found in very small numbers in limited sites in the Neches River drainage. I have found a few individuals in sites in the upper Neches River. Bordelon and Harrel (2004) reported finding this species surviving in Village Creek, Hardin County, in 2002, and others were found in this stream in 2005 by SFASU personnel (Howells 2006). None were found in the current survey.

Triangle pigtoe, (*Fusconaia lananensis)*
Since 1992 only a few living specimens have been recorded from the Neches-Angelina drainage in Nacogdoches and San Augustine Counties. Bordelon and Harrel (2004) reported specimens from Village Creek, Hardin County that may be this species, as did SFASU personnel in 2005 (Howells 2006). SFASU personnel also confirmed the species persisting in Attoyac Bayou and Sandy Creek (a tributary of Attoyac Bayou) (Howells 2006). Populations are almost certainly eliminated from the type localities (Lanana and Bonita creeks (Howells, pers. comm.). None were found in the current surveys.

Louisiana pigtoe (*Pleurobema riddellii*)
Bordelon and Harrel (2004) reported specimens from Village Creek, Hardin County, as did SFASU personnel in 2005 (Howells 2006). The only confirmed living specimens in Texas waters in recent decades have been below Town Bluff dam and in Village Creek. None of the other previously reported population sites have produced living or recently dead specimens in many years. One valve of a recent dead individual was found in the Canyonlands unit.

Texas Heelsplitter (*Potamilus amphichaenus*)
Only about 150 specimens have ever been recorded and only a few living individuals within the last 15 years (Howells et al., 1996). This species appears to have been reduced to a small number of survivors in the upper Sabine River, a population in B.A. Steinhagen Reservoir and the Neches River immediately downstream of Town Bluff Dam (Howells et al. 2000; Howells 2006), and a stretch of the Trinity River upstream of Lake Livingston (Howells 1997 MDS 144, collections by Mather and Bergmann in 1996). However, B.A. Steinhagen Reservoir has been periodically dewatered to kill exotic macrophytes and stranded many mussels (Howells, et al., 2000). When refilled rotting terrestrial plants created anoxic conditions that likely eliminated much of the unionid assemblage in this reservoir. We found several dead individuals along sandbanks of the Upper Neches River corridor unit.

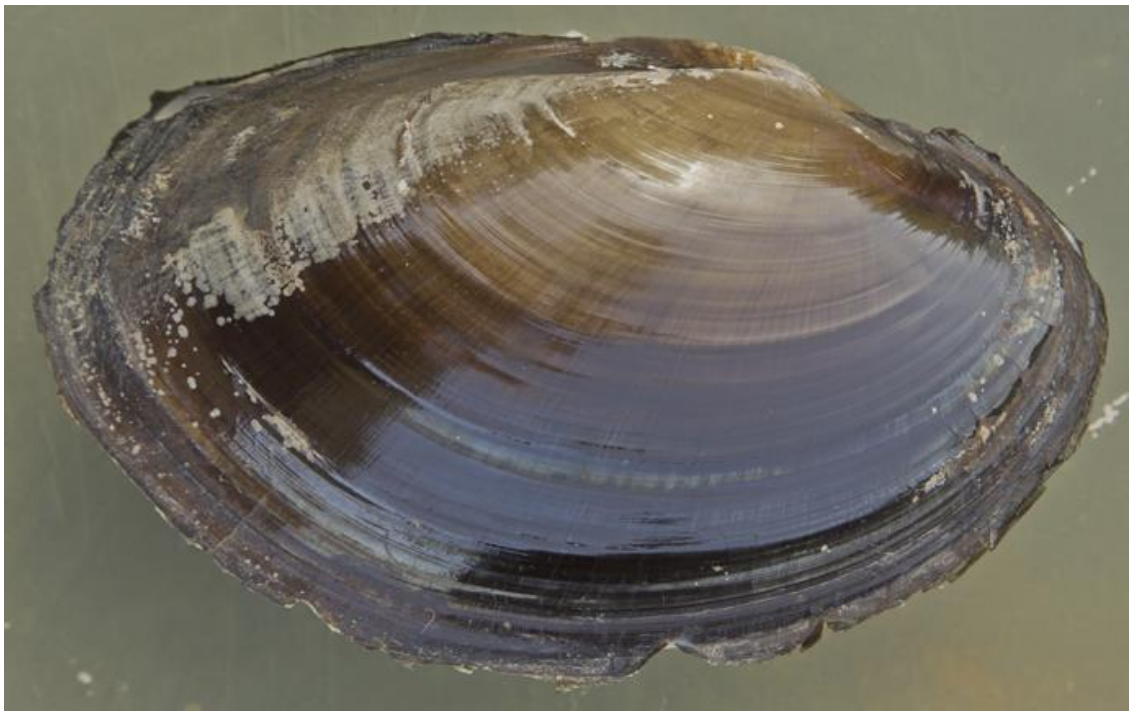
Sandbank pocketbook, (*Lampsilis satura*)

Although recently found as a small population in the Village Creek drainage basin of the Neches (Bordelon and Harrel, 2004) this species is still poorly known in Texas (Howells pers. comm.). I have found populationa in the upper Neches and Angelina. The only other significant population in Texas waters is present in the Neches River below Town Bluff Dam, with limited numbers living or recently dead individuals documented in Village Creek (Hardin County; Howells 2006). We found a number of live individuals in sandbars in the Upper Neches River corridor unit.

Southern Hickorynut (*Obovaria jacksoniana*)
The only known population was found in the village creek drainage of the lower Neches river (Bordelon and Harrel, 2004) however, it is a difficult species to identify. Extensive statewide mussel surveys have only located one other population in the upper Neches (Troia and Ford, 2010).

Pictures from the 2013 surveys (courtesy of Adrian Van Dellen)

Survey on Upper Neches River Corridor



Valve of Texas Heelsplitter

Valve of Louisiana Pigtoe and a Threehorn Wartyback

Musseling in an oxbow off the Neches