Section 6 (Texas Traditional) Report Review

Form emailed to FWS S6 coordinator (mm/dd/yyyy): 3/6/2013

TPWD signature date on report: 2/19/2013

Project Title:

Final or Interim Report? Final

Grant #: TX E-130-R

Reviewer Station: Clearlake ESFO

Lead station concurs with the following comments: NA (reviewer from lead station)

Interim Report (check one):

- ☐ Acceptable (no comments)
- ☐ Needs revision prior to final report (see comments below)
- ☐ Incomplete (see comments below)

Final Report (check one):

- ☒ Acceptable (no comments)
- ☐ Needs revision (see comments below)
- ☐ Incomplete (see comments below)

Comments:

FINAL PERFORMANCE REPORT

As Required by

THE ENDANGERED SPECIES PROGRAM

TEXAS

Grant No. TX E-130-R

Endangered and Threatened Species Conservation

Surveys for Threatened and Endangered Mussels and Fishes in Rivers of Northeastern Texas

Prepared by:

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Carter Smith
Executive Director

Clayton Wolf
Director, Wildlife

31 January 2013

INTERIM REPORT

STATE: Texas GRANT NUMBER: TX E-130-R-1

GRANT TITLE: Surveys for Threatened and Endangered Mussels and Fishes in Rivers of Northeastern Texas

REPORTING PERIOD: 1 Sep 2010 to 31 Jan 2013

OBJECTIVE(S). To obtain a database of information on the occurrence of rare species of mussels and fish throughout the extent of the rivers of the northeast Texas region.

Segment Objectives:

Task 1. Oct -Dec 2010. Historical information will be compiled and examined for the occurrence of each species of threatened and endangered fish and mussel in each River Basin. Habitat preferences and other pertinent traits for each species will be determined.

Task 2. Jan – Mar 2011. Use GIS maps to find potential areas within the river that contain appropriate geomorphology and habitat conditions for the occurrence of each threatened or endangered species. Data used will include river width, sinuosity, geology, substrates, vegetation, historical hydrologic data from USGS gauges, etc.

Task 3. May – Nov. 2011 & 2012. Surveys will conducted within each River Basin for the rare fish and mussel species in areas that we predicted from the historical data and our previous collection information.

Task 4. Dec. – May 2011 and 2012. The presence of threatened and endangered species will be placed into ArcGIS.

Significant Deviations:

None.

Summary Of Progress:

Please see Attachment A.

Location: Northeastern Texas.

Cost: Costs were not available at time of this report, they will be available upon completion of the Final Report and conclusion of the project.

Prepared by: Craig Farquhar Date: 19 February 2013

Approved by: _____ Date: 19 February 2013
C. Craig Farquhar

ATTACHMENT A

Final Report

Surveys for Threatened and Endangered Mussels and Fishes in Rivers of Northeastern Texas

Texas Parks and Wildlife Department
United States Fish and Wildlife Service Section 6 Grant
TX E-130-R

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Reporting Period

September 1, 2010 – Jan. 31, 2013

Abstract

The goal of this project was to obtain a database of information on the threatened and rare species of mussels and fish in the northeast Texas region. Fishes and mussels were collected in the fall of 2010, spring and summer of 2011, and spring and summer of 2012 at 19 sites in the Angelina river, 10 sites in the Attoyac bayou, 65 sites in the Neches river, 40 sites in the Sabine River, 13 sites in the Cypress Creek basin, 13 sites in the Sulphur river, and 7 sites in the Trinity river. Sites were chosen based on habitat description from data from recent historical collections and our own surveys in 2009 and earlier. Overall, we collected 11,559 fish over the study. We found 5,896 fish from the Sabine River representing 59 species and 3,830 fish from the Neches River representing 56 species. We collected 342 fish in the Cypress River basin representing 32 species and 1,133 fish representing 23 species in the Sulphur River. We collected 353 fish in the Angelina River representing 22 species. We collected 20,134 individual mussels of 35 species of which 83% were live. We recorded 1853 live and 243 dead mussels of 22 species in the Angelina river and Attoyac bayou, 10,122 live and 972 dead mussels of 28 species from the Neches river, 460 live and 294 recently dead mussels of 19 species from the Cypress Creek basin, 2215 live and 1139 dead mussels of 19 species from the Sabine, 940 live and 95 dead mussels of 21 species from the Sulphur river, and 1124 live and 679 dead mussels of 16 species in the Trinity river. We found 2 species of fish state listed as species of concern (Western sand darter and Sabine shiner) and 3 species listed as threatened (creek chubsucker, blue sucker, and blackside darter) and 6 species of mussels listed as state threatened. Four of the mussel species collected as part of our survey have been petitioned for federal listing. The highest mussel diversity was 28 species and occurred within the upper Neches, which corresponds to the location of a new USFW refuge. The highest fish diversity occurred in the Sabine River. The Texas Pigtoe appears stable but is difficult to separate visually from the rare Triangle Pigtoe. The distribution of the Southern Hickorynut is restricted to only a very few sites on the Neches River. The Louisiana Pigtoe is also restricted to the Neches River. The Sandbank Pocketbook and the Texas Heelsplitter are rare everywhere and primarily found only in the Neches and Sabine Rivers.

Introduction

The United States contains an extremely diverse freshwater mussel fauna (Unionids) with approximately 300 historic species (Neves et al., 1997; Williams et al., 1993). However, anthropogenic effects on the nation's rivers have impacted both the number of species and their abundances and distributions (Vaughn, 1997; Vaughn and Taylor, 2000; Strayer, 1999). Currently, about 12 percent are considered extinct and 23 percent are threatened (Galbraith et al., 2008, Galbraith and Vaughn, 2010; Shannon, 1993). In Texas the same habitat destruction from impoundments, contaminants and invasive species have occured with the result that of the 51 described species of unionids, 15 species were designated as State Threatened (TPWD, 2009) and of those 9 are being considered for protection under the Endangered species Act (ESA). Of those 6 species are found in the larger rivers of eastern Texas. Similar to freshwater mussel species, the southern United States has the richest diversity and highest number of endemic fish species in North America, with 41% of these native fishes considered endangered, threatened, or vulnerable (Warren et al. 2000). Habitat alteration including channelization, impoundments, sedimentation, and other flow modifications are the primary reasons behind these declines (Warren et al. 2000). East Texas is a center for fish diversity in the state. For example, two of its largest rivers, the Neches and Sabine Rivers, have 93 and 108 species, respectively, out of the approximately 161 species known in the state (Thomas et al. 2007). The same impacts on fish occur in these rivers.

Northeast Texas has 5 river basins that have independent flow to either the Red River in Louisiana or to the Gulf of Mexico. Because of its water resources, this area has been a prime site for reservoir development and for commercial interests that require large quantities of water. Intensive ranching, poultry operations, timber harvesting, and oil drilling are significant industries in most northeast Texas counties. In addition, because of the dramatic increase in population in the nearby Dallas/Fort Worth area, intense pressure exists to build dams on all the rivers and large tributaries in the region. Populations within northeast Texas alone are expected to increase from 1 million to 1.5 million people increasing the demand for water (TPWD 2005). Alteration of the natural flow regime caused by reservoir construction is one of the most significant threats to riverine ecosystems (Dynesius and Nilsson 1994, Nilsson and Berggren 2000). The 2005-2010 Texas Comprehensive Wildlife Conservation Strategy plan (TPWD 2005) identified "evaluating how instream flows and water quality impact rare and endangered species" as an area of high priority. For both fishes and mussels, disruption of natural habitat has been reported as one of the most significant threats to their survival (Williams et al. 1993, Warren et al. 2000).

To list a species under the ESA requires “substantial information” using biological data to demonstrate destruction of habitat and range, overutilization, inadequate regulation, and factors impacting it continued existence (USFWS, 2009). For mussels in Texas, for both rare and common species, such information is lacking (Howells, 2010). Historically, unionids have received limited attention from the scientific and regulatory agencies. In 1992 Texas Parks and Wildlife Department began some studies throughout the state on mussel abundances and also harvesting pressures. In 2008 a petition to list eleven species was presented to the USFWS with 6 of those species found in eastern Texas. In a 90 day finding USFWS removed the Southern Hickorynut (*Obovaria jacksoniana*) from federal consideration although it is still state listed as threatened. The five remaining east Texas species being considered are the Louisiana Pigtoe, *Pleurobema riddellii*, the Texas Pigtoe, *Fusconaia askewi*, the Triangle Pigtoe, *Fusconaia lananensis*, the Sandbank Pocketbook, *Lampsilis satura*, and the Texas Heelsplitter, *Potamilus amphichaenus*.

To validate their threatened status more complete surveys for rare species of fish and mussels are needed throughout the extent of the rivers in the northeast Texas region. The historical survey data on the mussels and fishes in the region is limited in scope and much of it is dated. Five of the twelve unionid species considered for listing as Endangered by the U. S. Fish and Wildlife Service have been recorded within northeast Texas, as well as five state Threatened species of fish and six fish Species of Concern (TPWD 2005). Recently TPWD has increased funding for surveys of unionid mussels in east Texas (Karatayev and Burlakova, 2007; Williams et al., 2009). These surveys were largely conducted in reservoirs and at bridge crossings of rivers, which are **not** the optimal sites for these unionids. Reservoirs tend to support thin-shelled lentic species that can tolerate silting and our work on both the Sabine and Neches Rivers found Texas heelsplitters, Louisiana pigtoes and southern hickorynuts in sites quite distant from bridge crossings (Ford, et al, 2009; Williams et al., 2009). The rivers of east Texas have been occasionally sampled for fish diversity (e.g., Hubbs 1957, Capone and Kushlan 1991, Anderson et al. 1995, Burgess 2003, Hoeinghaus et al. 2007), however, these did not record the threatened species. Some state agencies have also sampled in rivers proposed for this study as part of monitoring efforts (e.g., TCEQ, TPWD). To our knowledge, no surveys have been undertaken to specifically document the distribution of the rare fish species.

This study specifically fills in records for areas in northeast Texas where freshwater mussels and fishes have not been recently surveyed with emphasis given to those sites where habitat characteristics are appropriate for the endangered or threatened species listed in the Texas Wildlife Action Plan. In 2010 N. Ford and L. Williams began surveys of the five major rivers in northeastern Texas under a grant from TPWD and continued that work in 2011 and 2012 with the current section 6 grant from USFWS. These surveys were designed to gain information about distribution and abundance of the 6 state threatened mussel species and 11 rare east Texas fish.

Objective

The overall objective was to obtain a database of information on the occurrence of rare species of mussels and fish throughout the extent of the rivers of northeast Texas region.

The mussel species are the Triangle pigtoe, *Fusconaia lananensis*; Texas pigtoe *F. askewi* and Louisiana pigtoe, *Pleurobema riddellii*; the Texas heelsplitter, *Potamilus amphichaenus*; the Sandbank Pocketbook, *Lampsilis satura* and the Southern Hickorynut, *Obovaria jacksoniana*. Fish species that are Threatened or Species of Concern include the paddlefish, *Polyodon spathula*; American eel, *Anguilla rostrata;* bluehead shiner, *Pteronotropis hubbsi;* blackspot shiner, *Notropis atrocaudalis*; ironcolor shiner, *N. chalybaeus*; Sabine shiner, *N. sabinae*; silverband shiner, *N. shumardi*; blue sucker, *Cycleptus elongates*; creek chubsucker, *Erimyson oblongus*; blackside darter (*Percina maculata*) and the Western sand darter, *Ammocrypta clara*. The project involved surveying on rivers and large tributaries in five specific river basins (Sulphur, Cypress Creek, Sabine, Neches and Trinity) that have different logistical problems and also somewhat different preliminary databases. Some have relatively good mussel data but not fish and others have fish information but no mussel data ((Hubbs 1957, Capone and Kushlan 1991, Anderson et al. 1995, Burgess 2003, Ford and Nicholson, 2006, Hoeinghaus et al. 2007, Ford et. al., 2009). However, none of the river basins have good information on endangered and threatened species particularly as their occurrence relates to the total extent of the rivers. By determining some of the habitat characteristics and landscape level geomorphic characteristics of the rivers associated with the particular species, we were able to sample in locations that were likely to have the threatened species. These sites were often some distance from bridge access. This allowed us to be more successful in finding these species than have previous researchers. By also limiting where we sampled to appropriate sites only, we were able to survey a greater extent of each basin.

Having five river basins within the same geographic area (impacted by the same rainfall, temperature and other stochastic factors) but having somewhat different impacts from humans (channelization, pollution, impoundments) allowed us to also examine whether specific anthropogenic impacts are likely factors in the declines of particular species. We also identified habitat and landscape characteristics for the rare species for use in choosing survey sites. This information should be useful in planning management strategies to improve conditions for these rare species. This information should also be important in developing recovery plans for these threatened fish and mussel species.

General Locations

Site name, or street address: North Eastern Texas

County, municipality, township: Delta, Fannin, Lamar, Red River, Bowie, Cass, Morris, Titus, Camp, Upshur, Franklin, Hopkins, Delta, Rains, Wood, Van Zandt, Smith, Henderson, Cherokee, Anderson, Houston, Trinity, Polk, Tyler, Angelina, Nacogdoches, Panola, Harrison, Gregg

State: Texas

Country: USA

For the Sulphur River Basin sites were chosen within reaches of the Upper South Sulphur River west of Cooper Lake Reservoir and another section on the North Sulphur River and South Sulphur west of Wright Patman Reservoir. For the Cypress Creek Drainage, sites on the Big Cypress Creek below Lake Bob Sandlin and below Lake o' the Pine west of Caddo were surveyed as was Little Cypress Bayou and Black Cypress Bayou. Both of these drainages join the Sabine River on the Louisiana border. Ford had previously surveyed the Sabine River (Ford and Nicholson, 2006; Ford et al., 2009) but additional sites southeast from Lake Tawakoni to Toledo Bend were sampled in the current study. Because of its importance as a more natural river, a large number of sites on the Neches River primarily in the upper reaches above B. A. Steinhagen dam were surveyed. We also had unpublished data from a 2009 survey on the Neches by Ford and Troia, which are included in the overall database (Troia and Ford, 2010). Sites on the large tributaries of the Neches; the Angelina River and Attoyac Bayou north of Sam Rayburn Reservoir were surveyed also but considered in this report together as the Angelina River basin. The specific sites of East Texas where the rivers surveyed are shown on the map in the attachments (Appendix A).

Methods

Task 1. *Historical information will be compiled and examined for the occurrence of each species of threatened and endangered fish and mussel in each River Basin. Habitat preferences and other pertinent traits for each species will be determined.*

Very little is known regarding the physical habitat necessary to maintain fish and mussel populations in Texas. For species whose habitat has been described in the literature, these characterizations tend to be informal impressions that are vague and not particularly useful in the field. For example, the habitat of the Texas Heelsplitter, *Potamilus amphichaenus*, was recently described as "from quiet waters on sand and mud" (Neck, 1986). Similarly, the Triangle Pigtoe, *Fusconaia lananensis*, from the lower Angelina River was reported to inhabit "sand, silt and gravel substrata at depths of 0.2-0.5 m" (Howells 2010). Although such descriptions are helpful in formulating initial ideas on habitat preferences for state-threatened species, they do little in terms of providing insight in terms of specific areas within lakes and streams where those species might be expected. This is primarily because these measures do not adequately describe the physical habitat that is relevant to fish mussels. Researchers are now defining and measuring variables based on what each aquatic species requires of its environment (D'Ambrosio et al., 2009; Strayer 2008; Newton et al. 2008). This approach entails identifying key properties of habitat (i.e., functional attributes) that influence ecological responses such as survival, growth, and reproduction and then translating these processes to environmental variables that can be measured in the field or acquired from existing datasets (Morales et al., 2006; Allen and Vaughn, 2010). This requires specific characterization of habitat for each mussel species.

We compiled occurrence data for the 6 state-listed mussel species from combined datasets developed by Texas Parks and Wildlife Department (TPWD), Robert G. Howells (BioStudies), Lyuba Burlakova (Buffalo State), and surveys performed by UT-Tyler staff. This allowed us to create a thorough and accurate database from which to plot known species locations. For each record, we verified identifications and locality information by comparing the account with the species' known range, and noted date of collection and whether the specimen was alive or recently dead when collected. We also categorized whether a species account was historic or contemporary, using 1980 as the cutoff between the two; records that were categorized as historic were removed from the project database. We chose 1980 because this time period marks the end of major reservoir construction in Texas. In general, large reservoirs have a profound influence on downstream benthic communities, often eliminating rare species or those that are habitat specialists (Vaughn and Taylor 1999) so we feel restricting results to after that date would give a better representation of current conditions of the rivers.

After occurrence data were acquired for the 6 state-listed mussel species, we examined the records to get insight into where the current surveys for the specific species should occur. We also used geological maps to predict locations with the most appropriate habitats for mussels as the rare species seem to associate strongly with riffle areas. These sites were surveyed in 2010 and 2011 to produce a database that could be used in Task 2.

A search of the literature on the rivers of East Texas showed no records for the threatened fish species (Hubbs 1957, Capone and Kushlan 1991, Anderson et al. 1995, Burgess 2003, Hoeinghaus et al. 2007).

Task 2. *Use GIS maps to find potential areas within the river that contain appropriate geomorphology and habitat conditions for the occurrence of each threatened or endangered species. Data used will include river width, sinuosity, geology, substrates, vegetation, historical hydrologic data from USGS gauges, etc.*

Our data for each species from 2010 and 2011 was used with GIS layers to predict which conditions in stream systems (e.g. river width, geology, substrate, sinuosity, etc.) are important for a species. We created habitat suitability maps for each species identifying the sites with high suitability for each species. The results were used to prioritize sites to survey in each of the river basins although ground truthing has only been tested in the Neches drainage.

Task 3. *Surveys will be conducted within each River Basin for the rare fish and mussel species in areas that we predicted from the historical data and our previous collection information.*

For threaten mussels each river was in general surveyed from the upstream areas east of Dallas to downstream areas in northeast and eastern Texas. Surveys on the Sabine and Neches began in the late summer of 2010 and the other rivers were started in 2011. Some data from an earlier TPWD grant were available from 2009 and were also incorporated into our database.

We went to each designated site by kayak and did initial reconnaissance of areas along the shore for shells and in appropriate locations we sampled using a timed hand search, or with scuba gear in deeper areas (Vaughn, et al., 1997). Surveys were standardized on a per person-hour of searching (Strayer and Smith, 2003). Depending on the goals of the particular survey multiple samples varying from 50 to 300 m of the river at that site were made. All live unionids were collected, identified, counted and then returned to the river. Vouchers were retained in the University of Texas at Tyler collection in particular for any questionable specimens for later identification.

Fish were collected at chosen sites using electrofishing (Smith Root SR6 tote barge with generator) and seines. Fish were identified in the field and released at the site of capture or collected for later identification depending on the expertise of the survey crew. Representative vouchers were collected and maintained in the UT-Tyler collections in the Department of Biology.

Task 4. *The presence of threatened and endangered species will be placed into ArcGIS.*

The river at each site of surveying was mapped using ArcGIS with mesohabitats (e.g. riffle, run, pool) indicated and the presence of mussel beds and fish species of concern obtained from GPS delineated within the sites. A georeferenced database using historical data and data collected by our study was compiled in ArcGIS and made available to USFW.

Results

Task 1. Completed.

In total, we compiled 206 historical records for 6 state-threatened mussel species (Tables 1 – 6). *Fusconaia askewi* (Texas Pigtoe) was the most common species in the project database. The majority of these records are from the Sabine River. The least common species in the database is *Obovaria jacksoniana* (Southern Hickorynut). The remaining species are relatively poorly represented in the project database. As for major river basins, the Neches and Sabine basins are well represented; however, observations of threatened species within these basins are not well distributed. Instead, they appear to be aggregated within segments of these rivers correlated with access points such as bridges. The Cypress drainage, Sulphur River and Trinity River are very poorly surveyed.

Most historical data on rare fish came from museum records, and most of those were from 1950s collection by Clark Hubbs. Recent published fish surveys (Hubbs 1957, Capone and Kushlan 1991, Anderson et al. 1995, Burgess 2003, Hoeinghaus et al. 2007) did not report these species. Few records existed for most species, with the exception of the blackspot shiner (*Notropis atrocaudalis*), which has more than 75 records. Table summaries of historical records for all species except blackspot shiner are below (Tables 7-13).

Species Historical Records

Fusconaia lananensis (Triangle Pigtoe)

Fusconaia lananensis is endemic to the Neches drainage basin of east Texas and has been recorded in the Angelina River, Attoyac Bayou and southern tributaries of the Neches such as Village Creek (Howells 2006; Karatayev and Burlakova 2007a, b). It is a problematic species as it is difficult to distinguish between it and the Texas pigtoe, *F. askewi*. This makes the evaluation of the current 27 records difficult. In addition nearly half of the records are from Village Creek. Surveys collecting vouchers is critical with genetic analysis to determine that it is a distinct species.

TABLE 1. Records for *F. lananensis* prior to the current surveys.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
4	Neches	Angelina River	Angelina	2005, 2006	X	X
3	Neches	Attoyac Bayou	Nacogdoches	1994, 2005	X	-

2	Neches	Attoyac Bayou	Shelby	2006, 2007	X	-
1	Neches	Beech Creek	Hardin	2002	X	-
1	Neches	Big Sandy Creek	Polk	2004	X	-
1	Neches	Sandy Creek	Shelby	2005	X	X
1	Neches	Turkey Creek	Tyler	2002	X	-
13	Neches	Village Creek	Hardin	2002, 2004, 2005, 2007	X	-
1	Neches	Village Creek	Shelby	2006	X	-

***Fusconaia askewi* (Texas Pigtoe)**

Fusconaia askewi is endemic to east Texas Rivers but is not common in any except the Sabine where it sometimes is abundant. In the Neches, Angelina, Cypress creek drainages it is much less abundant and is often the least common species. Of the 75 recent records in our report the lower Neches and the upper Sabine rivers are by far where most occur. Therefore, we concentrated surveys on other drainages that have historic records for this species. In addition, specimens currently considered this species from the Trinity and the Sulphur Rivers were particularly surveyed for.

TABLE 2. Records for *F. askewi* prior to the current study.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
1	Cypress Creek	Big Cypress Creek	Marion	1992	X	-
2	Cypress Creek	Big Cypress Creek	Titus	2006	X	-
1	Neches	Beech Creek	San Jacinto	2002	X	-
1	Neches	Big Sandy Creek	Polk	2004	X	-
1	Neches	Hickory Creek	Tyler	2004	X	-
1	Neches	Turkey Creek	Tyler	2002	X	-
17	Neches	Village Creek	Hardin	1986, 2002, 2005	X	X
2	Neches	Angelina River	Angelina	1981	X	-
1	Neches	Angelina River	Cherokee	1984	X	-
1	Neches	Angelina River	Houston	2006	X	-
1	Neches	Angelina River	Leon	2005	X	-
3	Neches	Neches River	Anderson	2008, 2009	X	-
2	Neches	Neches River	Hardin	2006	X	-
7	Neches	Neches River	Houston	1980, 1982, 1984	X	-
1	Sabine	Lake Fork Creek	Wood	1994	X	-
3	Sabine	Sabine River	Gregg	1984	X	-
2	Sabine	Sabine River	Wood	2005, 2006	X	X
12	Sabine	Sabine River	Harrison	1981, 1984, 1992, 1994, 2005, 2006	X	X
5	Sabine	Sabine River	Newton	1993	X	X
8	Sabine	Sabine River	Panola	1995, 2005, 2006	X	-
3	Sabine	Sabine River	Rusk	1994, 2005	X	X

***Lampsilis satura* (Sandbank Pocketbook)**

Lampsilis satura is endemic to eastern Texas and western Louisiana (Vidrine, 1993). It is found in rivers in gravel or sand substrates. It occurs in the Neches and Sabine basins currently but only in scattered sites. They are often the species with the lowest abundance. Potentially *L. satura* could be found in the Sulphur River or other Red River drainages. The current database lists 41 sites but with disjunct occurrences. We did widespread surveys to determine the extent of its distribution.

TABLE 3. Records for *L satura* prior to the current surveys.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
1	Neches	Hickory Creek	Tyler	1982	X	-
3	Neches	Village Creek	Anderson	1986, 2004	X	-
1	Neches	Village Creek	Cherokee	2004	X	-
2	Neches	Village Creek	Houston	2004	X	-
3	Neches	Angelina River	Angelina	1981, 2004, 2006	X	-
1	Neches	Angelina River	Leon	2005	X	-
1	Neches	Neches River	Anderson	2008	X	-
1	Neches	Neches River	Angelina	1980	X	-
5	Neches	Neches River	Hardin	1993, 1996, 2005	X	X
4	Neches	Neches River	Houston	1982	X	-
3	Neches	Neches River	San Augustine	1980, 1993	X	-
1	Neches	Neches River	Smith	2000	X	-
2	Neches	Neches River	Tyler	2005	X	-
4	Sabine	Sabine River	Anderson	1981, 1994, 2005	X	X
5	Sabine	Sabine River	Gregg	1993	X	-
3	Sabine	Sabine River	Panola	2006	X	-
1	Sabine	Sabine River	Rusk	2006	X	-

***Obovaria jacksoniana* (Southern Hickorynut)**

Obovaria jacksoniana is a species of the southeastern United States that is rare throughout its range (Williams, et al., 2008). In Texas this species has never been abundant and was known from only two localities in the Neches river drainage, Village Creek (Bordelon and Harrel, 2004) and near highway 84 in the upper Neches (Troia and Ford, 2010). We found only 9 recent records and the only living specimens were all from those two sites. There are historic records from other east Texas Rivers and Troia found them in floodplain reaches of the Neches we surveyed in areas with lower banks and less shear stress.

TABLE 4. Records for *O. jacksoniana* prior to the current surveys.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
1	Neches	Hickory Creek	Houston	1982	-	X
1	Neches	Village Creek	Houston	2002	X	-
4	Neches	Neches River	Hardin	1980, 1982, 1984	X	-
2	Neches	Neches River	Houston	1982, 2007	X	X
1	Sabine	Sabine River	Anderson	1984	-	X

***Pleurobema riddellii* (Louisiana Pigtoe)**

Pleurobema riddelli occurs from drainages in eastern Texas (Howells et al., 1996) into Louisiana (Vidrine, 2008) and in the Red River tributaries in Arkansas. It is presently very uncommon in all drainages with only a few recent specimens recorded. In total, there are 38 records for the species most of which are from the Neches River basin. Some have been found in the Neches below Town Bluff Dam, Village Creek, a tributary of the Neches, in the Angelina River near Nacogdoches and only two in the Sabine River in recent times. However, the upper Neches may have the only numbers of the species (Troia, 2010) but in no cases have more than a few individuals been found. Because *P. riddellii* is so rare in all localities it may have been missed in passing surveys and so we performed more in depth sampling in areas where it could. Specifically, some in the Cypress creek and Sulphur river basin and throughout the upper Sabine.

TABLE 5. Location of records for *P. riddellii* prior to the current project.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
1	Neches	Big Sandy Creek	Polk	2004	X	-
2	Neches	Hickory Creek	Houston	1982	-	X
11	Neches	Village Creek	Hardin	1980, 1986, 2002, 2005, 2006	X	-
5	Neches	Angelina River	Angelina	1981, 2006	X	-
11	Neches	Neches River	Houston	1980, 1982, 1984, 2007	X	X
1	Neches	Neches River	San Augustine	1990	X	-
3	Neches	Neches River	Trinity	1980	X	-
2	Neches	Neches River	Tyler	1996, 2009	X	X
2	Sabine	Sabine River	Houston	1984	X	-

***Potamilus amphichaenus* (Texas Heelsplitter)**

The Texas Heelsplitter is endemic to Texas and Louisiana in bigger rivers such as the Sabine and Neches. It is also known from the Trinity but may hybridize with *P. ohienis* in impoundments of that drainage. Presently, it has small populations upstream of Sam Rayburn Reservoir (Karatayev and Burlakova, 2007) and the upper Neches River and below Town Bluff Dam. Its largest numbers are in the upper Sabine but it rarely has been seen in numbers at any single location. It's preferred habitat is poorly known but generally specimens are found in sand in slower reaches of the rivers. There are only 16 recent records in our database and most of those are only valves. It is a species that can adapt to reservoirs. We surveyed for it in larger rivers between bridges in larger pools.

TABLE 6. Records for *P. amphichaenus* prior to the current surveys.

# of records	Basin	Waterbody	County	Date of collection	Live	Shells
2	Neches	B.A. Steinhagen	Jasper	1993, 2005	X	X
1	Neches	B.A. Steinhagen	Newton	1997	X	-

2	Neches	B.A. Steinhagen	Tyler	2005	X	-
1	Neches	Neches River	Hunt	2000	X	-
1	Neches	Neches River	Rains	2000	X	-
2	Sabine	Sabine River	Harrison	2005	X	X
4	Sabine	Sabine River	Panola	2005, 2006	X	-
1	Sabine	Sabine River	Rusk	2005, 2009	X	-
1	Sabine	Sabine River	San Augustine	2006	X	-
1	Sabine	Sabine River	Van Zandt	2009	X	-

***Polyodon spathula* (Paddlefish)**

We could find no records for paddlefish in East Texas, despite past stocking efforts in Toledo Bend Reservoir. It is likely that rivers in East Texas may be too turbid today because of land use practices (e.g., reservoirs and agriculture, primarily) to support populations of paddlefish. It is listed as a threatened species by the state of Texas.

***Anguilla rostrata* (American Eel)**

We could find no records for American eel in East Texas. Downstream reservoirs prevent eels from occurring in East Texas rivers. It is listed as a species of concern in Texas.

***Pteronotropis hubbsi* (Bluehead Shiner)**

We found one record for this species in East Texas. Given the lack of historical collections we consider this an extremely rare species. It is listed as threatened by the state of Texas.

TABLE 7. Location of records for *P. hubbsi* prior to the current project.

Basin	Waterbody	County	Date of collection
Cypress	Haggerty Creek	Harrison	1951

***Notropis chalybaeus* (Ironcolor Shiner)**

Five records for the ironcolor shiner were found in East Texas Rivers, all in the Cypress. This species is noted as rare throughout its range (Williams and Echelle 1998). It is listed as a species of concern in Texas.

TABLE 8. Location of records for *N. chalybaeus* prior to the current project.

Basin	Waterbody	County	Date of collection
Cypress	Eagle Creek	Harrison	1951
Cypress	Caddo Lake	Harrison	1951
Cypress	Haggerty Creek	Harrison	1951
Cypress	Black Bayou	Cass	1953
Cypress	Flat Creek	Cass	1953

***Notropis sabinae* (Sabine Shiner)**

Six records were found for the Sabine shiner in East Texas Rivers. The species was found in both the Neches and Sabine Rivers. It is listed as a species of concern in Texas and by the U.S. Forest Service.

TABLE 9. Location of records for *N. sabinae* prior to the current project.

Basin	Waterbody	County	Date of collection
Neches	Legg Creek	Nacogdoches	1949
Neches	Bonita Lake	Nacogdoches	2000
Sabine	Sabine River	Panola	1953
Sabine	Yellow Bayou	Newton	1953
Neches	Indian Creek	Nacogdoches	1953
Neches	Bernhardt Creek	Rusk	1953

***Notropis shumardi* (Silverband Shiner)**

Only two records were found for the silverband shiner in East Texas rivers. One record is from the Sabine and one, more recent, from the Angelina River. The species is listed as of concern in Texas. Given its rarity in collections, reconsideration of its status may be warranted.

TABLE 10. Location of records for *N. shumardi* prior to the current project.

Basin	Waterbody	County	Date of collection
Neches	Angelina River	Nacogdoches	1994
Sabine	Sabine River	Orange	1956

***Cycleptus elongatus* (Blue Sucker)**

No historical records were found for blue suckers in East Texas rivers. The species is listed at threatened in Texas. We know of records in the lower Sabine River (collected by consultants), but these records only appear in grey literature.

***Erimyzon oblongus* (Creek Chubsucker)**

Five historical records, all from the 1940s and 1950s, were found for creek chubsuckers. Historically they were found in the Neches, Sabine, Trinity, and Cypress watersheds. The species is listed as threatened in Texas.

TABLE 11. Location of records for *E. oblongus* prior to the current project.

Basin	Waterbody	County	Date of collection
Neches	Neches River	Nacogdoches	1949
Sabine	Sabine River	Harrison	1951
Sabine	Sabine River	Newton	1953

Cypress	Big Cypress Bayou	Upshur	1953
Trinity	Trinity River	Polk	1957

***Ammocrypta clara* (Western Sand Darter)**

Only one historical record was found in East Texas from the Sabine River. This species must be considered rare in Texas. It is listed as a species of concern, but its conservation status may warrant further consideration.

TABLE 12. Location of records for *A. clara* prior to the current project.

Basin	Waterbody	County	Date of collection
Sabine	Sabine River	Panola	1953

***Percina maculata* (Blackside Darter)**

Four historical records were found for the blackside darter. These records were from the 1950s in the Sulphur and Cypress watersheds. The species is listed as threatened in Texas. It is uncommon throughout the southeastern U.S.

TABLE 13. Location of records for *P. maculata* prior to the current project.

Basin	Waterbody	County	Date of collection
Cypress	Big Cypress Bayou	Harrison	1951
Cypress	Black Bayou	Cass	1953
Cypress	Jim's Bayou	Cass	1953
Sulphur	Sulphur River	Cass	1953

Task 2. Completed. *Use GIS maps to find potential areas within the river that contain appropriate geomorphology and habitat conditions for the occurrence of each threatened or endangered species. Data used will include river width, sinuosity, geology, substrates, vegetation, historical hydrologic data from USGS gauges, etc.*

Our GIS data were used to predict which conditions in east Texas stream systems are important for rare species of mussels and fish. The results were used to find sites in the all the rivers with the potential conditions where rare species should be found. Using Maxent modeling we were able to use our GIS layers to further predict where to sample for rare mussel species and this modeling was used in site selection for the 2012 sampling season in the Neches River.

Task 3. Completed. *Surveys have been conducted within each River Basin for the rare fish and mussel species in areas that we predicted from the historical data, our previous collection information, and our Maxent modeling results.*

Photos of collection sites.

Fig. 1. Site of mussel survey on the Neches River.

Fig. 2. Mussel collection on the Neches River.

Fig. 3. Site of mussel collection in the Angelina River

Fig. 4. Measuring a site on the Attoyac bayou.

Fig. 5. Counting mussels on the Sabine River

Fig. 6. Site for a mussel survey in the Sabine River.

Fig. 7. Survey site in the Trinity River.

Fig. 8. Surveying for mussels in the Trinity River.

Fig. 9. Counting mussels in the Sulphur River.

Fig. 10. Survey site in the Sulphur River.

In 2010--2012, five river basins were surveyed in sites we determined from the information on habitat preferences of the species from the historical data and our collection in the Neches in 2009. In addition, we used Maxent to model habitat preference for each endangered species and selected sites to sample in 2012 in the Neches River based on this information (U.S. Fish and Wildlife Service Section 6 Grant (USFWS); Williams et al., 2011; Phillips et al., 2006). We recorded a total of 20,134 mussels of 35 species, of which 16,714 were live (Table 14). All of the live except for a few vouchers were returned in the site from which they were collected. The percentage of recently dead (with two valves and little weathering) varied by species but averaged 17% (Table 14).

Table 14. Number of Live and Recently Dead (both valves and little weathering) of mussels in 5 drainages of east Texas. Threatened species are in red.

Species	Total Collected	Number Live	Number Dead	% dead
Bankclimber	1043	870	173	0.17
Bleufer	971	661	310	0.32
Creeper	35	17	18	0.51
Deertoe	1336	1095	241	0.18
Fawnsfoot	48	38	10	0.21
Fragile Papershell	462	188	274	0.59
Giant Floater	155	88	67	0.43
Gulf Mapleleaf	63	56	7	0.11
Lilliput	1	1	0	0.00
Little Spectaclecase	15	10	5	0.33
Louisiana Fatmucket	148	79	69	0.47
Louisiana Pigtoe	489	455	34	0.07
Mapleleaf	34	25	9	0.26
Paper Pondshell	5	1	4	0.80
Pimpleback	3	3	0	0.00
Pink Papershell	15	11	4	0.27
Pistolgrip	2878	2485	393	0.14
Pond Mussel	6	3	3	0.50
Pondhorn	37	23	14	0.38
Rock Pocketbook	98	86	12	0.12
Round Pearlshell	94	91	3	0.03
Sandbank Pocketbook	127	100	27	0.21
Southern Hickorynut	26	24	2	0.08
Southern Mapleleaf	799	676	123	0.15
Tapered Pondhorn	1	1	0	0.00
Texas Heelsplitter	34	13	21	0.62

Texas Lilliput	56	23	33	0.59
Texas Pigtoe	1510	1187	323	0.21
Threehorn Wartyback	1705	1563	142	0.08
Threeridge	949	621	328	0.35
Triangle Pigtoe	164	148	16	0.10
Washboard	1539	1379	160	0.10
Western Pimpleback	4148	3917	231	0.06
White Heelsplitter	1	1	0	0.00
Yellow Sandshell	1139	775	364	0.32
Total	20134	16714	3420	0.17

In the Angelina River including the Attoyac Bayou we found 1853 live mussels and 243 dead of 22 species. The Western Pimpleback was the most common with the washboard almost as abundant (Table 15, Fig. 11). Of the threatened species the Texas Pigtoe and Triangle Pigtoe were the most common with 141 and 54 recorded live. Sandbank pocketbooks were also recorded with 9 live.

In the Neches River of the 28 recorded species, the Western Pimpleback was clearly dominant with 3209 collected alive (Table 15, Fig. 12). All 6 threatened species were recorded with Texas pigtoes being most common with 745 recorded alive. Texas Heelsplitter was least common with only 6 recorded live. Twenty-six of the extremely rare Southern Hickorynut were recorded from 4 different sites on the Neches River.

In the three branches of the Cypress Creek drainage we recorded 21 species but none in large numbers (Table 15, Fig. 13). The bankclimber was the most abundant in these creeks and 18 Louisiana pigtoe and 2 Texas pigtoe were the only live threatened species. Several species that are typical of emphemeral waterbodies such as pondhorns, and Texas lilliputs were found. The rare Creeper was found in some sites also.

The Sulphur River showed significant alteration through canalization so required the most diving surveys. Of the 22 species there, the large-water species, the yellow sandshell and the bleufer were dominant (Fig. 14). The Texas Pigtoe was the only threatened species found and only 2 live were recorded. These however, where morphologically distinct from those of the other rivers and were retained for genetic analysis.

The Trinity River was sampled in conjunction with TxDot work in the Dallas Fort Worth area. A total of 1124 live and 679 dead of 16 species were recorded (Fig. 15). One dead Sandbank pocketbook and a number of Texas Pigtoes were recorded. The pigtoes were distinct from those of the other rivers so 1 specimen was retained for genetic analysis. Although not recorded in our database the Louisiana pigtoe was also recently found live in the Trinity River (pers. Comm. Jean Krejca).

Table 15. Number of mussels collected in each river basin.

	Angelina (+Attoyac)		Neches		Sabine		Cypress Creek		Sulphur		Trinity				
Species	# live	# Dead	# live	# Dead	# live	# Dead	# live	# Dead	# live	# Dead	# live	# Dead	Total	# live	# Dead
Bankclimber	46	17	461	87	57	28	257	36	49	5	0	0	1043	870	173
Bleufer	33	15	153	79	113	117	12	21	275	7	75	71	971	661	310
Creeper	3	0	8	1	0	0	6	17	0	0	0	0	35	17	18
Deertoe	170	30	505	72	329	123	10	0	2	1	79	15	1336	1095	241
Fawnsfoot	0	0	35	10	0	0	0	0	3	0	0	0	48	38	10
Fragile Papershell	8	13	57	59	52	109	3	5	28	5	40	83	462	188	274
Giant Floater	5	1	30	2	8	2	9	17	12	2	24	43	155	88	67
Gulf Mapleleaf	0	0	51	4	0	0	5	1	0	2	0	0	63	56	7
Lilliput	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
Little Spectaclecase	0	3	10	2	0	0	0	0	0	0	0	0	15	10	5
Louisiana Fatmucket	4	6	49	14	1	0	25	49	0	0	0	0	148	79	69
Louisiana Pigtoe	16	4	421	25	0	1	18	4	0	0	0	0	489	455	34
Mapleleaf	0	0	0	0	0	0	1	0	24	9	0	0	34	25	9
Paper Pondshell	0	0	0	0	0	1	1	2	0	0	0	1	5	1	4
Pimpleback	0	0	0	0	0	0	0	0	3	0	0	0	3	3	0
Pink Papershell	0	0	0	0	0	0	0	0	11	4	0	0	15	11	4
Pistolgrip	243	33	1234	142	720	160	22	26	17	5	249	27	2878	2485	393
Pond Mussel	0	0	0	0	0	0	2	3	1	0	0	0	6	3	3
Pondhorn	14	3	6	2	0	0	2	2	0	0	1	7	37	23	14
Rock Pocketbook	3	0	52	1	21	9	1	0	5	2	4	0	98	86	12
Round Pearlshell	0	0	91	3	0	0	0	0	0	0	0	0	94	91	3
Sandbank Pocketbook	9	1	77	12	14	13	0	0	0	0	0	1	127	100	27
Southern Hickorynut	0	0	24	2	0	0	0	0	0	0	0	0	26	24	2
Southern	56	4	178	11	212	89	0	0	7	0	223	19	799	676	123

Mapleleaf															
Tapered Pondhorn	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0
Texas Heelsplitter	0	0	6	5	7	16	0	0	0	0	0	0	34	13	21
Texas Lilliput	1	0	13	3	0	0	9	30	0	0	0	0	56	23	33
Texas Pigtoe	141	26	745	54	282	214	2	3	2	10	15	16	1510	1187	323
Threehorn Wartyback	79	14	1106	77	112	29	0	0	38	5	228	17	1705	1563	142
Threeridge	46	5	475	47	1	5	22	9	52	9	25	253	949	621	328
Triangle Pigtoe	54	10	94	6	0	0	0	0	0	0	0	0	164	148	16
Washboard	410	13	878	65	48	29	0	1	28	13	15	39	1539	1379	160
Western Pimpleback	494	33	3209	135	130	29	33	29	2	1	49	4	4148	3917	231
White Heelspitter	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0
Yellow Sandshell	18	12	153	52	108	165	20	37	379	15	97	83	1139	775	364
Total Collected	**1853**	**243**	**10122**	**972**	**2215**	**1139**	**460**	**292**	**940**	**95**	**1124**	**679**	**20134**	**16714**	**3420**

We sampled 31 sites on the Angelina River and Attoyac Bayou where we collected and identified 1853 live and 243 recently dead mussels. We also sampled 53 sites on the Neches River where we collected and identified 10,122 live and 972 dead mussels. We collected 3354 mussels from the Sabine River (2215 live and 1139 dead) in 42 sites. We recorded 752 mussels from the Cypress Creek basin (460 live and 292 dead) in 13 sites on the Black Cypress Bayou, Little Cypress Bayou and Big Cypress creek. We collected 1035 mussels from the Sulphur River (940 live and 95 dead) in 9 sites, and 1203 mussels from the Trinity river (1124 live and 679 dead) in 4 surveys (Table 14). The rivers differed in the percentage of dead with the Trinity River having the largest percentage dead and the Sulphur River having the lowest percentage of dead.

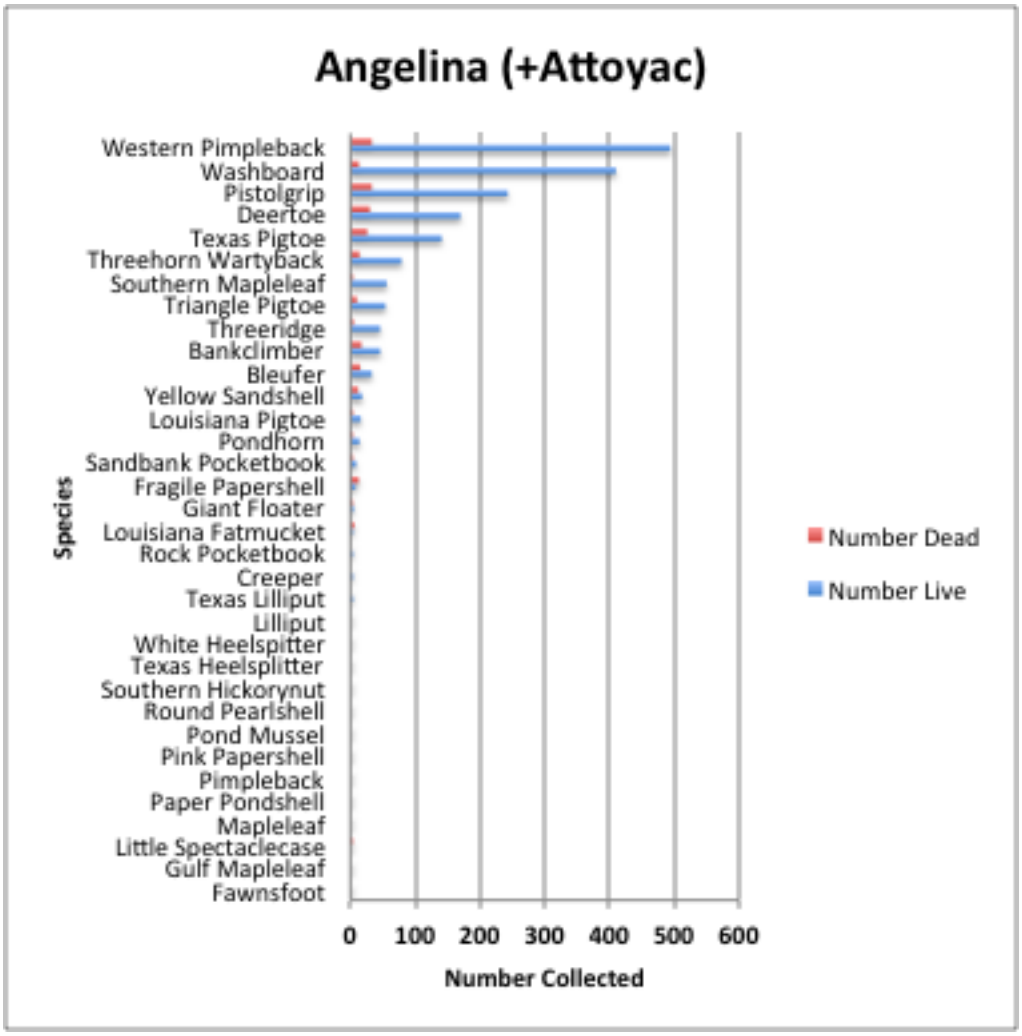

Fig. 11. Ranked abundance of mussels recorded from the Angelina River (+ Attoyac Bayou).

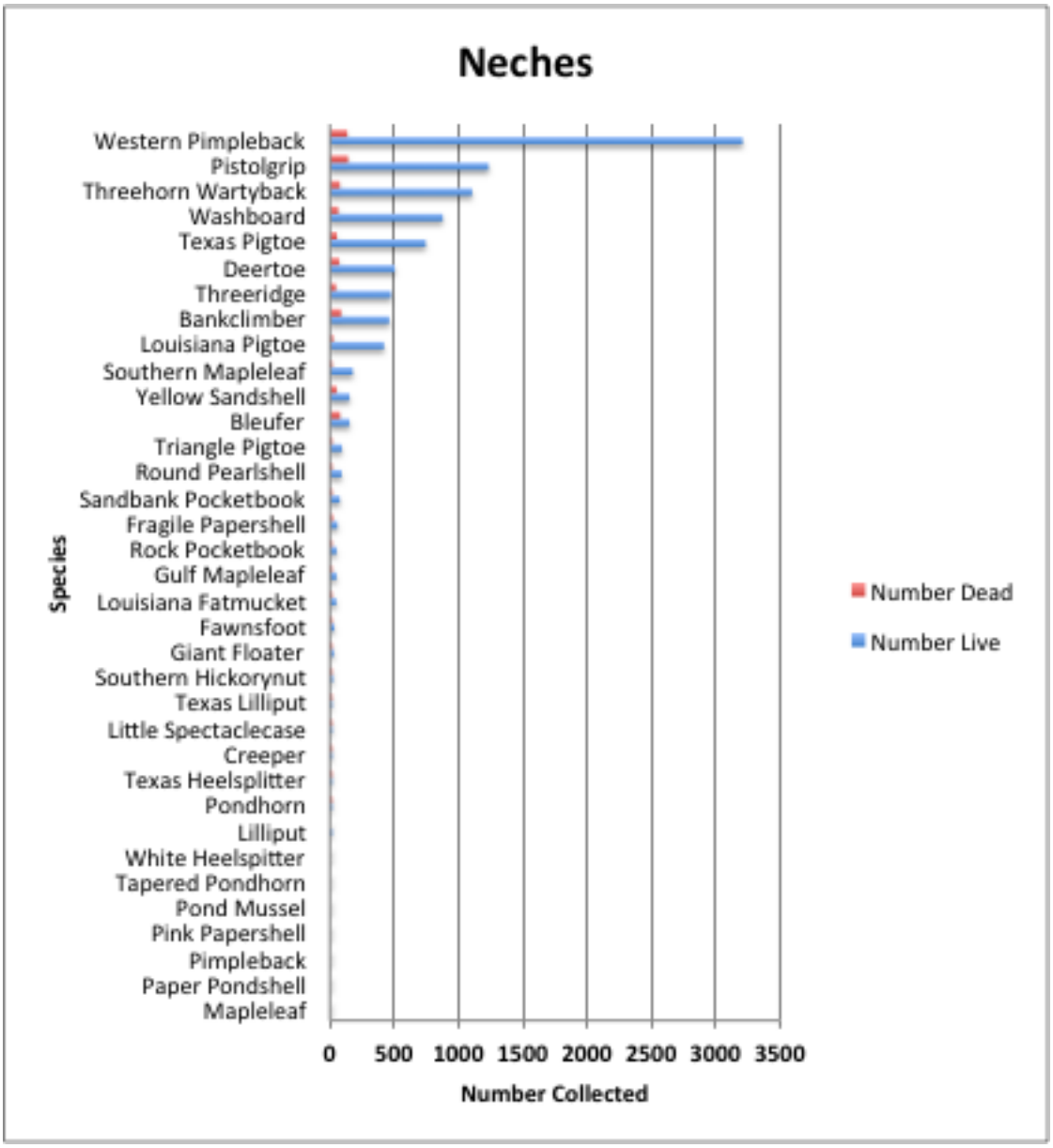

Fig. 12. Ranked abundance of mussels recorded from the Neches River.

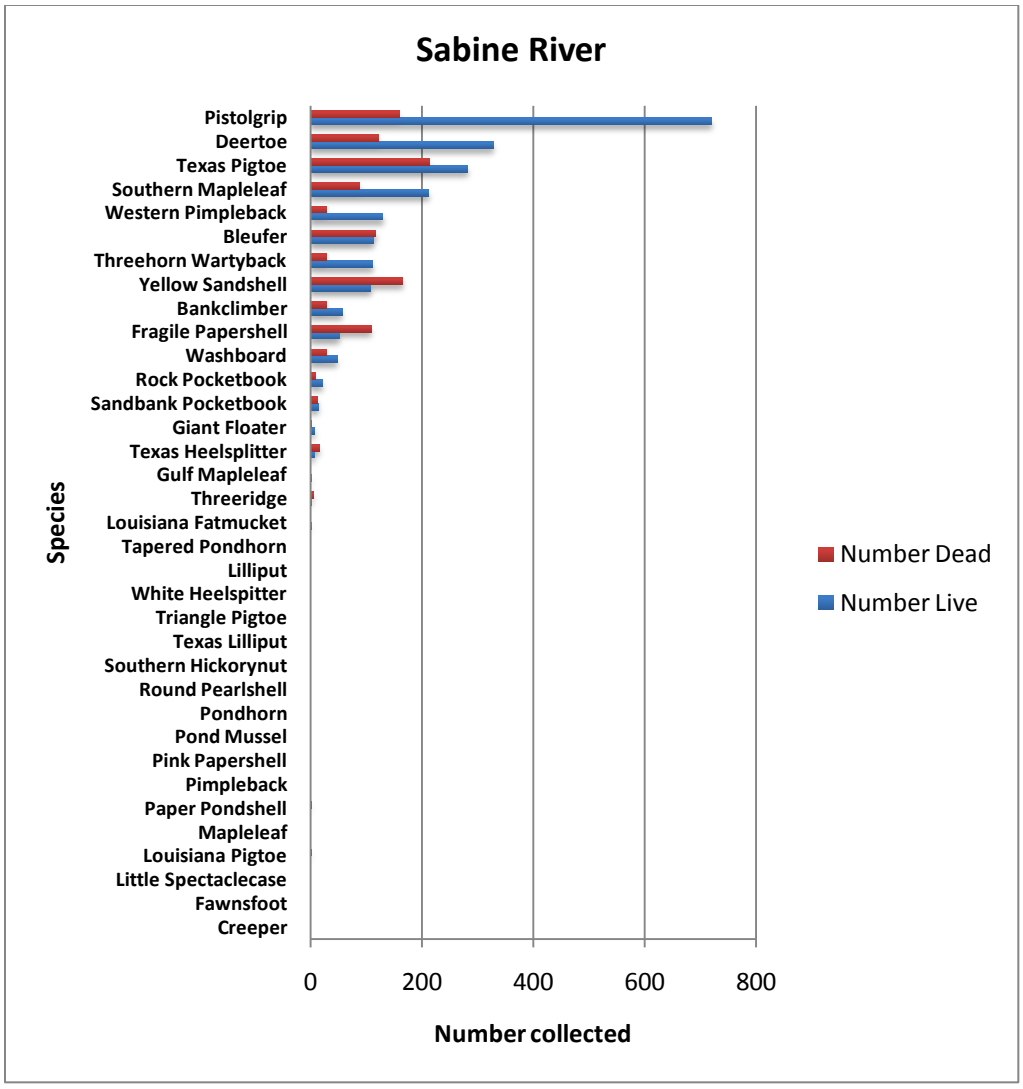

Fig. 13. Ranked abundance of mussels recorded from the Sabine River.

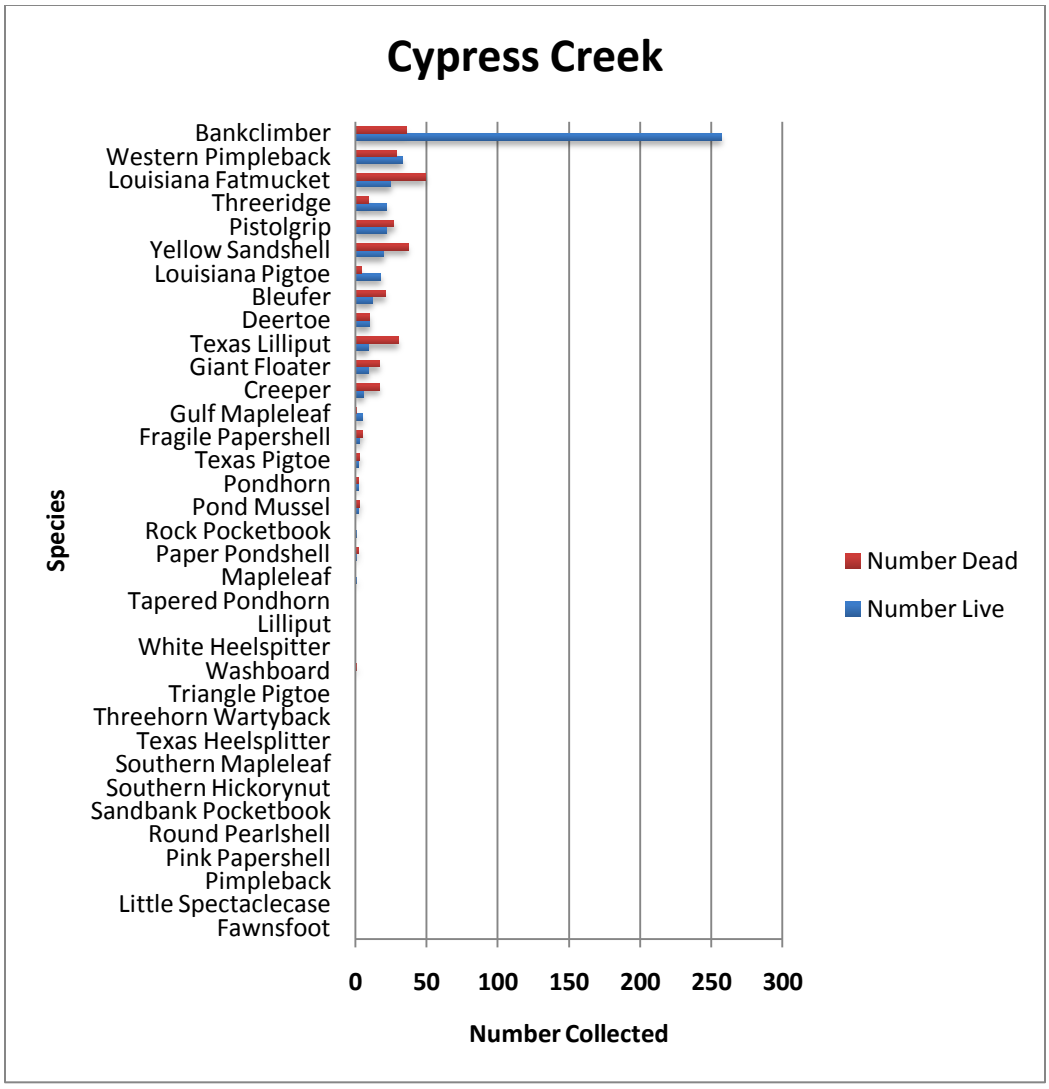

Fig. 14. Ranked abundance of mussels recorded from the Cypress Creek drainage (Black Cypress creek, Little Cypress bayou, Big Cypress Bayou).

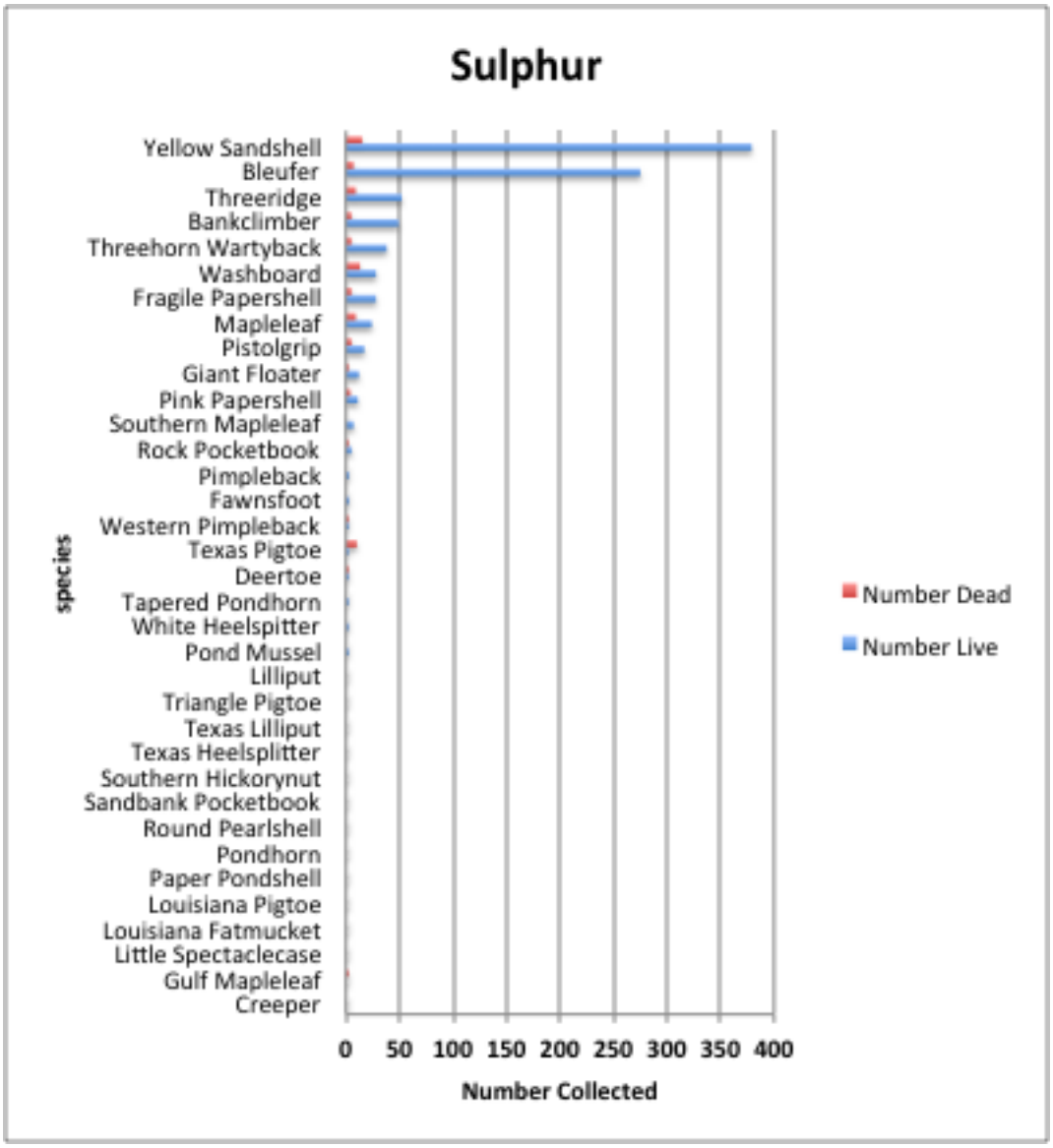

Fig. 15. Ranked abundance of mussels recorded from the Sulphur River.

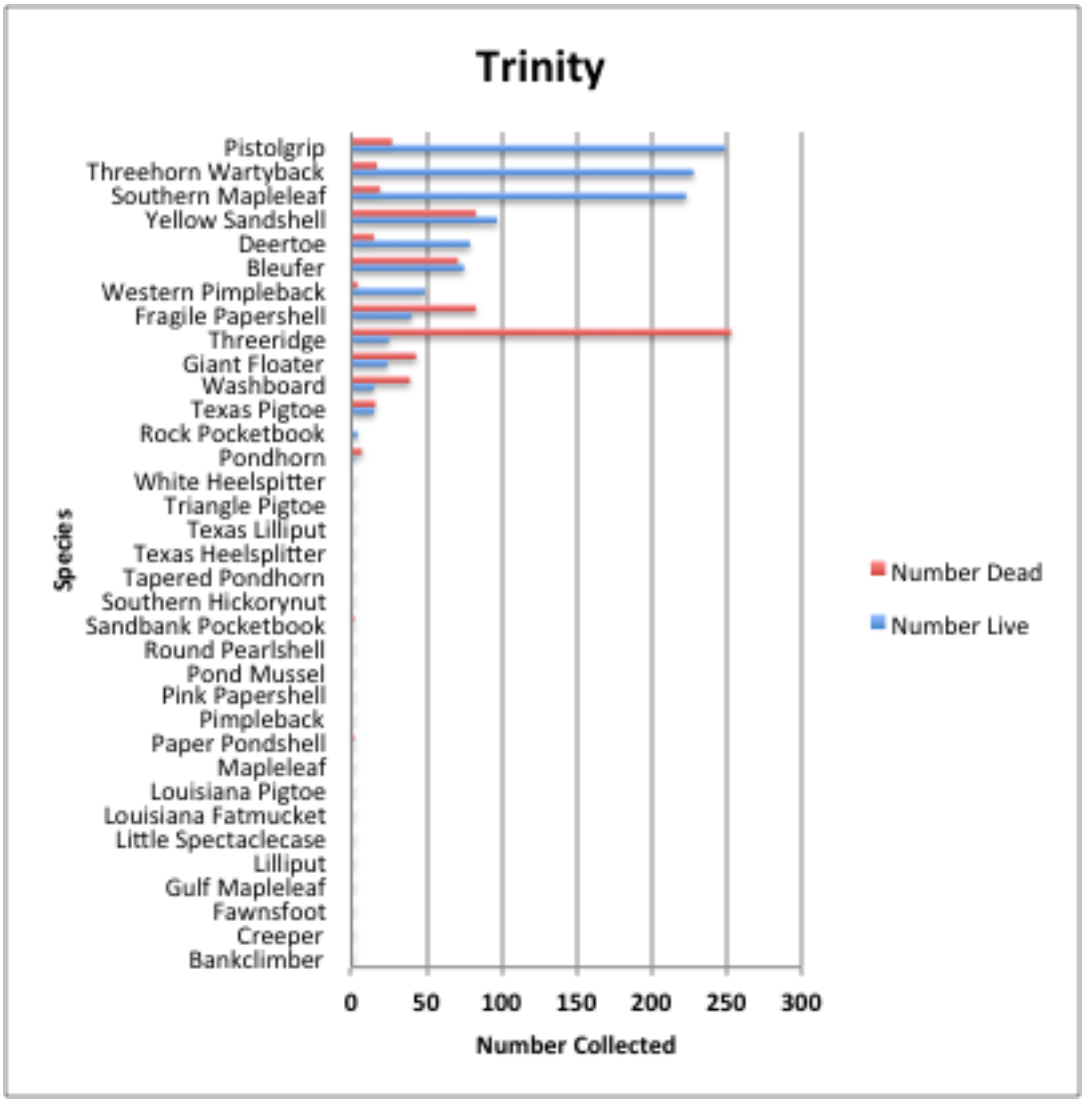

Fig. 16. Ranked abundance of mussels recorded from the Trinity River.

In 2011-2012, fish were collected on the Little Cypress, Angelina, and Sulphur Rivers to complement the fish data from the Sabine and Neches rivers collected in 2010 (Table 16). We sampled fish by electroshocking at each GIS predicted site for rare species. Equipment was brought to each site by a go-devil boat. Fish were identified in the field and released at the site of capture. We collected 347 fish on the Little Cypress River with one threatened species (blackside darter) collected in our samples. In the Sulphur River we sampled 1,133 fish with no threatened species collected. We collected 353 fish in the Angelina River with no endangered or species of concern collected in our samples. The Sabine River yielded 5,896 fish from 59 species with rare species including blue sucker and Sabine shiner. The Neches River had the most rare species (blue sucker, creek chubsucker, Sabine shiner, and Western sand darter), and we collected a total of 56 species (3,830 individuals) (Figs. 17 – 22).

Table 16. Fish abundances in rivers of East Texas.

Common Name	Angelina River	Cypress Creek	Neches River	Sabine River	Sulphur River	Total All Rivers
Bigscale Logperch			2	2		4
Black Crappie			8	1		9
Blackspotted Topminnow			1	6		7
Blackspotted/Blackstripe Topminnow Hybrid				1		1
Blackside Darter		1				1
Blackstripe Topminnow	7	4	24	7	1	43
Blacktail Redhorse	4		16	12		32
Blacktail Shiner	30	9	309	139		487
Blue Catfish				4	2	6
Blue Sucker			7	2		9
Bluntnose Darter			3			3
Bowfin		1	10	2		13
Brook Silverside		3	6	76		85
Bullhead Minnow	141	3	314	740	339	1537
Channel Catfish		1	41	296	80	418
Common Carp		3	12			15
Creek Chub				19		19
Creek Chubsucker			2			2
Dollar Sunfish		1	148	466	12	627
Dusky Darter	5		44	77		126
Fathead Minnow				15		15
Flathead Catfish			8	13		21
Freckled Madtom	7	1	23	143	1	175
Freshwater Drum		1	12	32	1	46
Ghost Shiner			12	18		30
Gizzard Shad		4	13	6	2	25
Golden Topminnow			5	1		6
Green Sunfish			21	55	41	117
Harlequin Darter	16		36	41		93
Lake Chubsucker		3	8	1		12
Largemouth Bass	2		83	12	3	100
Longear Sunfish	35	49	570	534	62	1250
Longear/Bluegill Sunfish Hybrid				7		7
Longear/Green Sunfish Hybrid				19		19
Longnose Gar			3	1		4

Mimic Shiner	3	6		2	24	35
Mississippi Silvery Minnow			568			568
Mud Darter	1	1	11	10		23
Orangespotted Sunfish			6	264		270
Pallid Shiner			101	2	4	107
Pirate Perch	1	126	32	5		164
Red Shiner	27	1	163	1817	347	2355
Redbreasted sunfish			1			1
Redear Sunfish	2	3	12	1	1	19
Redfin Shiner			7			7
Redspot Darter		14		1		15
Redspotted Sunfish	11	4	65	16	13	109
Ribbon Shiner	18	11	154	25		208
River Carpsucker				9		9
River Darter			1			1
Sabine River Shiner			3	28		31
Shortnose Gar		1		6	2	9
Slough Darter				8	6	14
Smallmouth Bass				1		1
Smallmouth Buffalo			15	19	14	48
Southern Brook Lamprey			2			2
Spotted Bass	10	8	150	89		257
Spotted Gar		4	22	13		39
Spotted Sucker	3		8	1		12
Starhead Topminnow			1			1
Suckermouth Minnow	5				2	7
Tadpole Madtom			3	17		20
Threadfin Shad			1	6		7
Warmouth	3	25	69	22	1	120
Weed Shiner	11	1	424	22		458
Western Mosquitofish		20	11	399	119	549
Western Sand Darter			1			1
White Bass				4		4
White Crappie		1	6	10		17
Bluegill Sunfish	11	29	249	347	56	692
Grass Pickerel		7				7
Yellow Bullhead Catfish		1	3	4		8
Grand Total Collected from 2009 - 2012	**353**	**347**	**3830**	**5896**	**1133**	**11559**
Species Richness	**22**	**32**	**56**	**59**	**23**	**72**

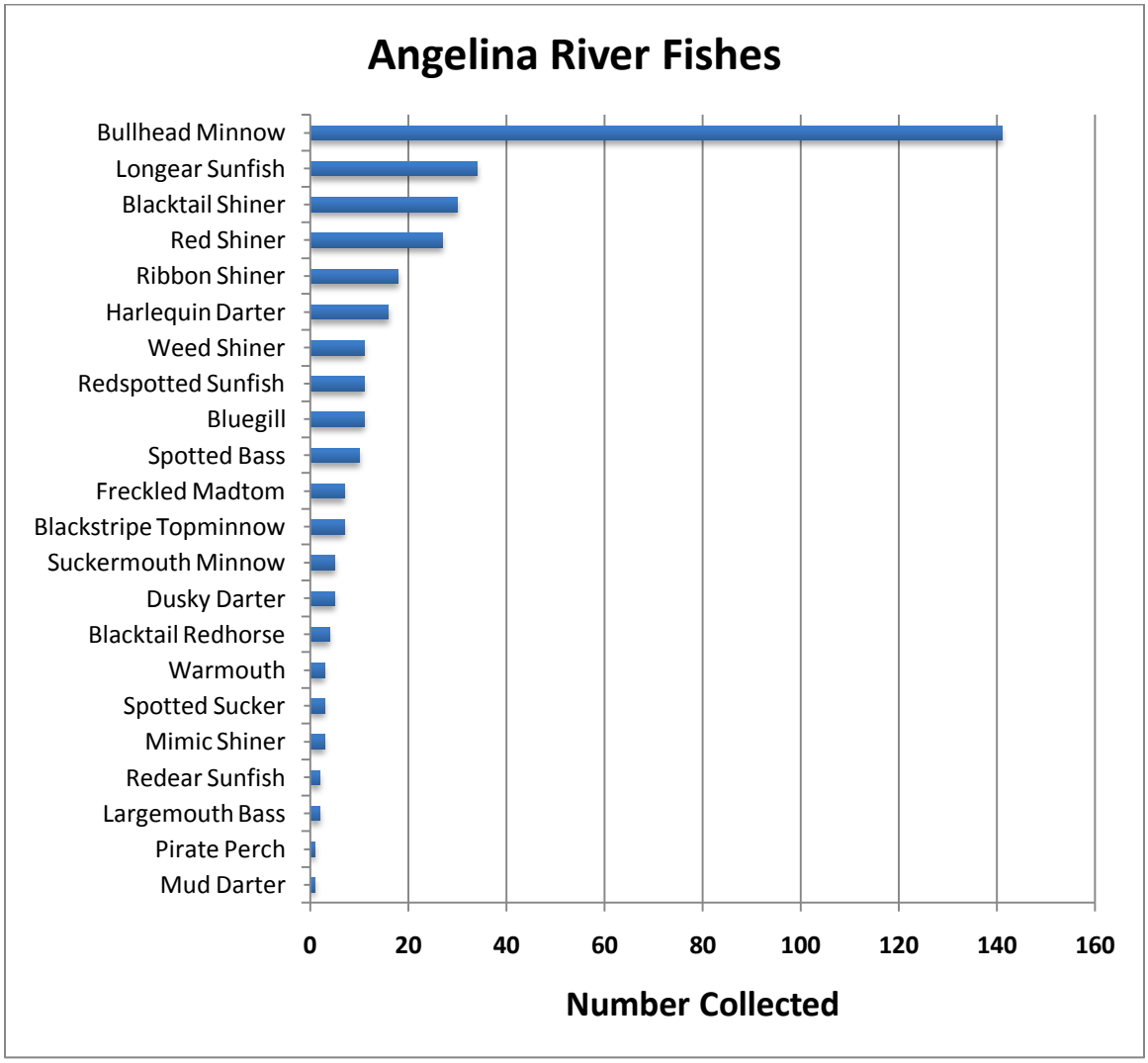

Fig. 17. Ranked abundance of fishes recorded from the Angelina River.

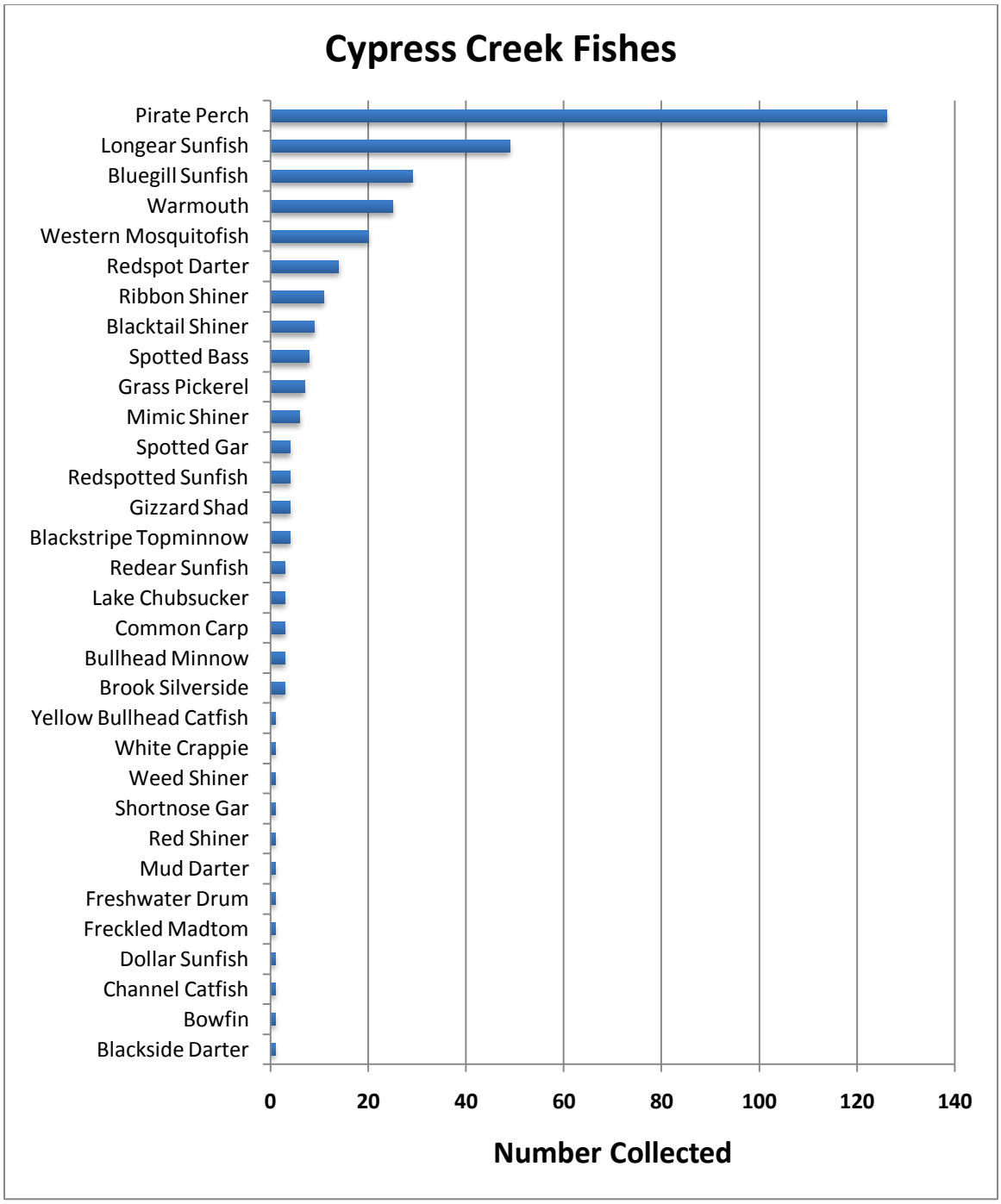

Fig. 18. Ranked abundance of fishes recorded from Cypress Creek.

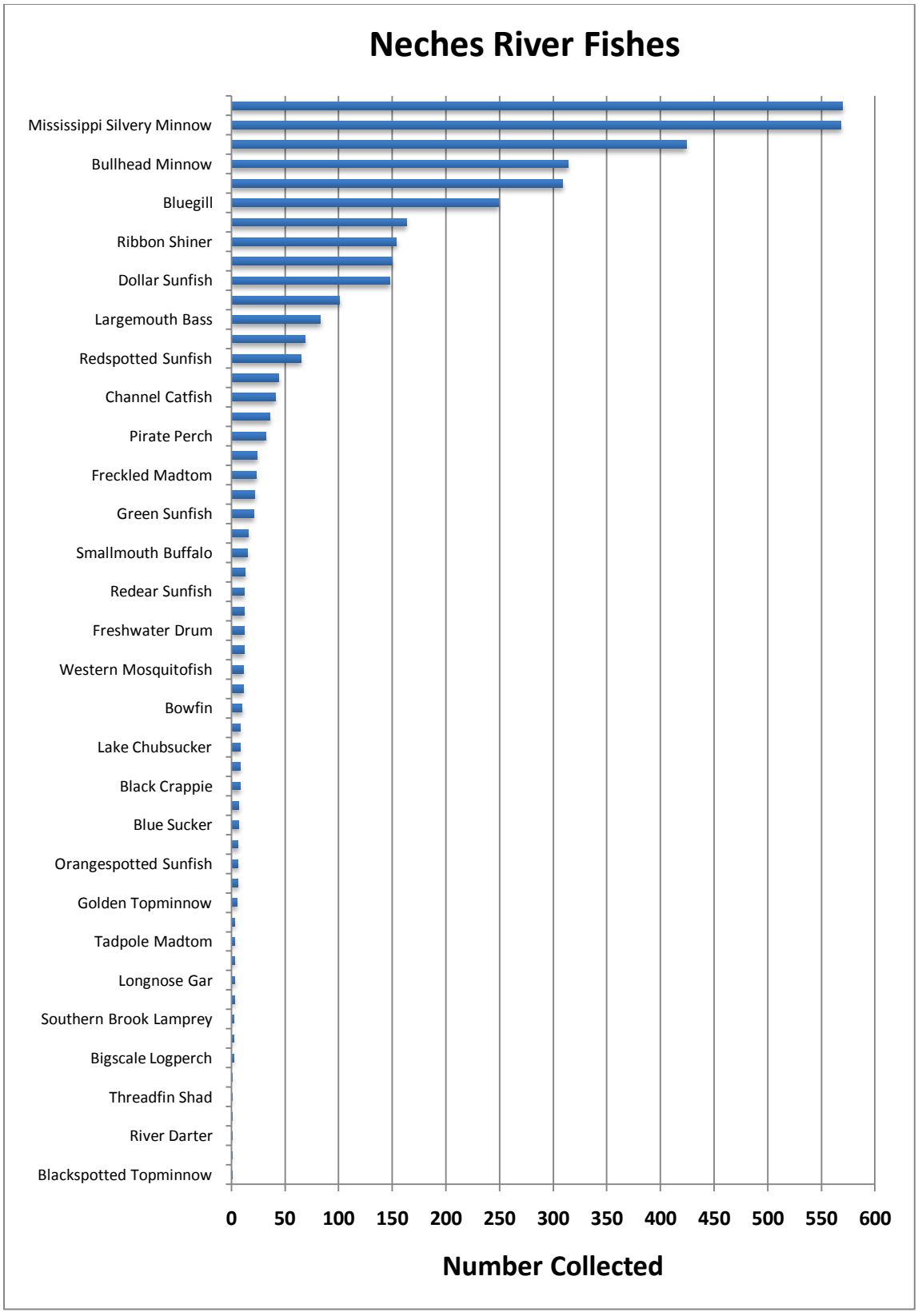

Fig. 20. Ranked abundance of fishes recorded from the Neches River.

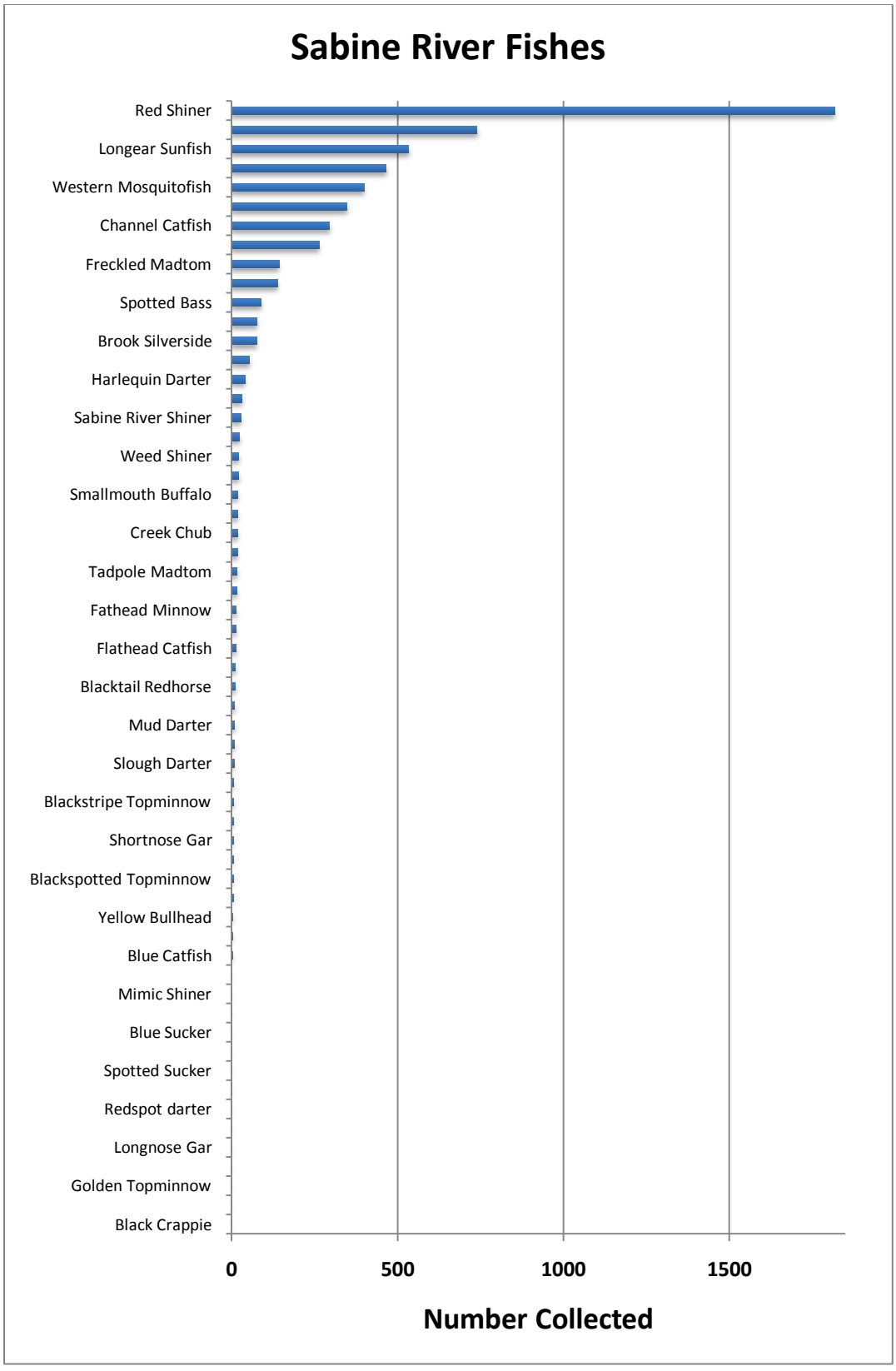

Fig. 21 Ranked abundance of fishes recorded from the Sabine River.

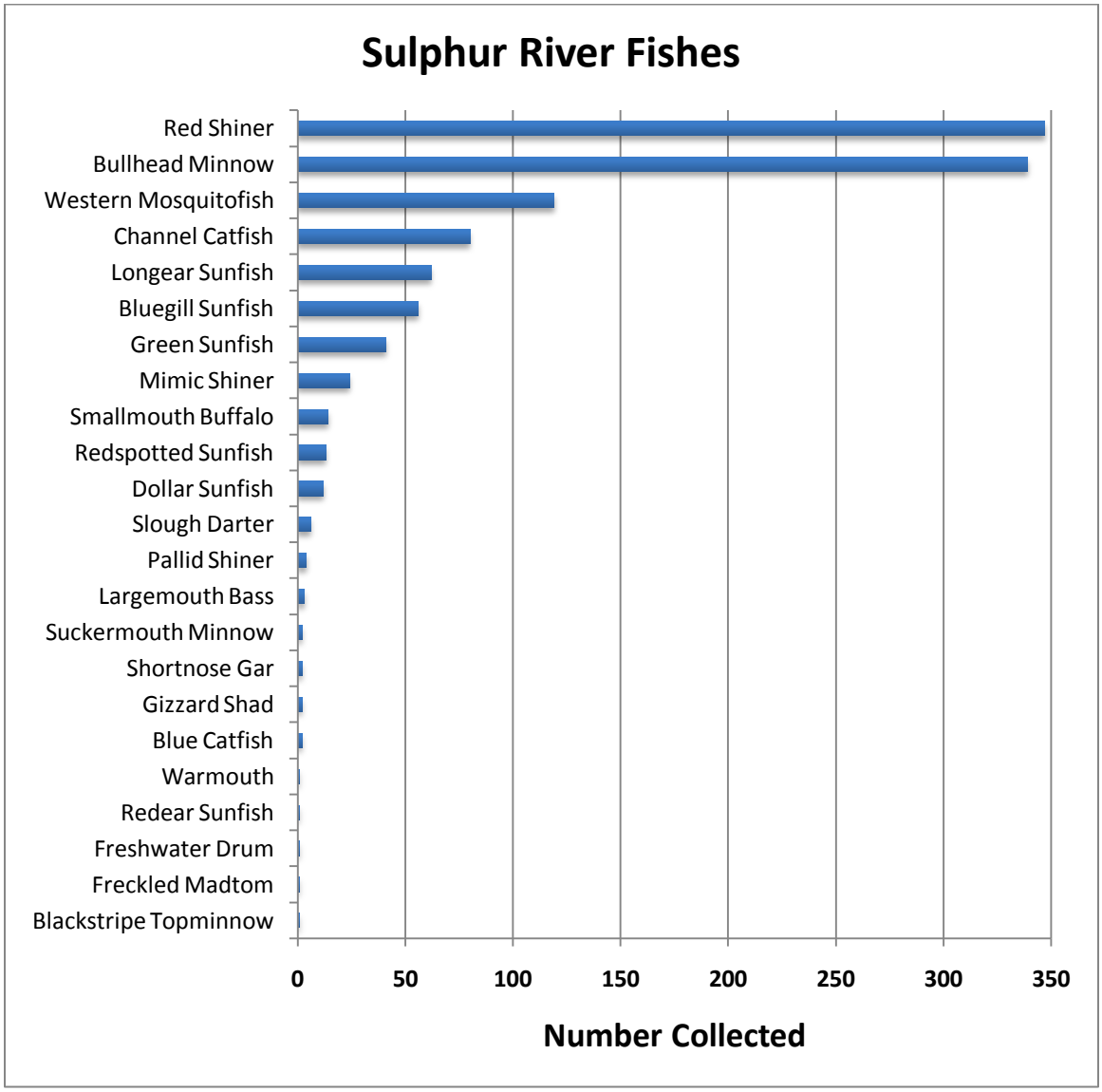

Fig. 22. Ranked abundance of fishes recorded from the Sulphur River.

Task 4. Completed. *The presence of threatened and endangered species will be placed into ArcGIS.*

Various physical and biotic layers for the maps using ArcGIS have been obtained. These GIS layers were used to determine the sites to sample in the Sabine and Neches rivers. Sampling in the Sulphur and Cypress rivers were limited to accessibility so these rivers were sampled where access was granted. In a separate but related grant (USFWS Section 6 Grant; Williams et al., 2011) we used these layers and some of our species data to validate the ability of our method to determine the presence of threatened mussel and fish species of concern within the sites using the software package Maxent

(Phillips et al., 2006). Final results of the Maxent modeling will be delivered to the USFWS in Fall 2013. A geo-referenced database of our current data has been compiled and included in a CD.

Discussion

Threatened mussels by river basin.

Texas Pigtoe

The Texas Pigtoe was the 6th most abundant species overall with 1510 collected alive. They were the 3rd most abundant species in the Sabine River and the 5th most abundant in the Neches and Angelina. They were much less common in the other three drainages and ranked much lower (9th to 16th). This species appears stable in the Sabine and Neches with a number of juveniles found in surveys there. However, because of the difficulty in distinguishing this species from other *Fusconaia* that are much rarer and its rarity in other rivers it would be advisable to continue its status as threatened.

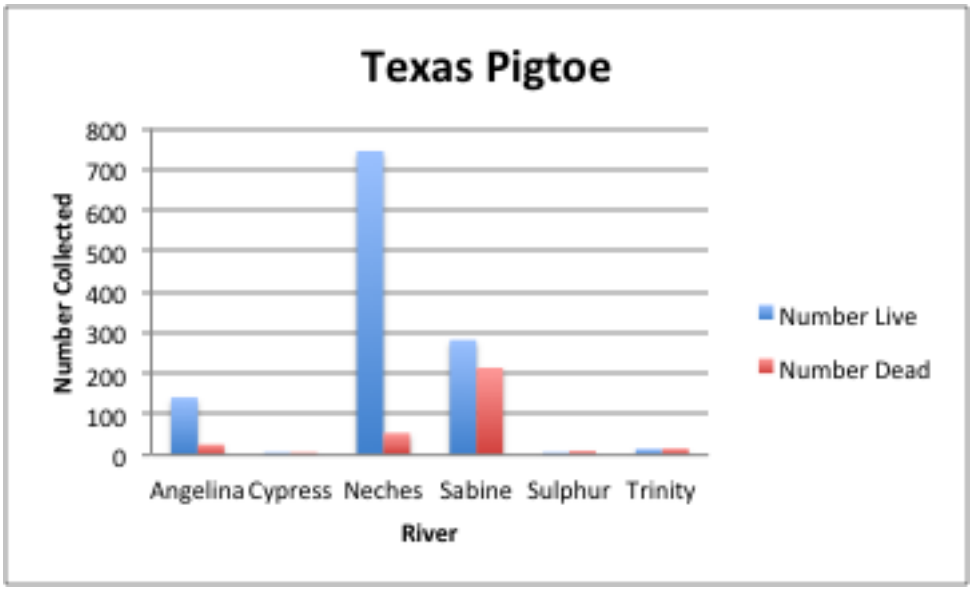

Fig. 23. Number of live and dead Texas Pigtoes collected in the 6 river basins.

The Triangle pigtoe ranks 14th overall in those collected alive. However, it only occurs in the Neches drainage (Angelina and Attoyac included). It ranked 8th in number in the Angelina and was abundant in some sites. However, it was very difficult to distinguish from the Texas pigtoe in the field and our belief is that many earlier records could be in error. A genetic assay for identification is critical for this species.

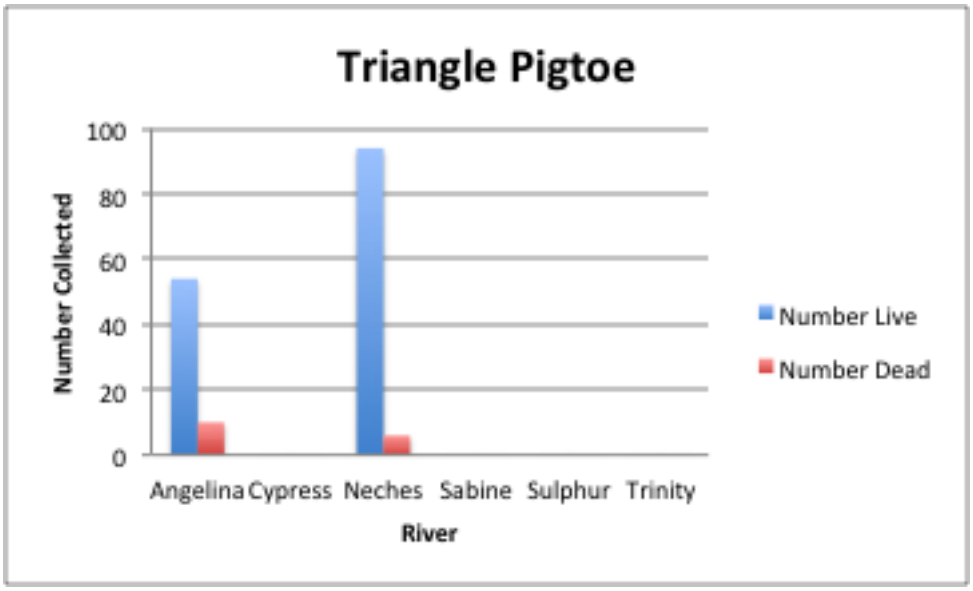

Fig. 24. Number of live and dead Triangle Pigtoes collected in the 6 river basins.

The Southern Hickorynut is one of the rarest of the riverine species ranking 25th overall and only occurring in 4 sites on the Neches River. Most species that were found less frequently than the southern Hickorynut were lake or ephemeral water species that were not normal residents in these rivers. No juveniles were found but this species is small and those may have been missed. However, we strongly suggest that this species receive additional protection.

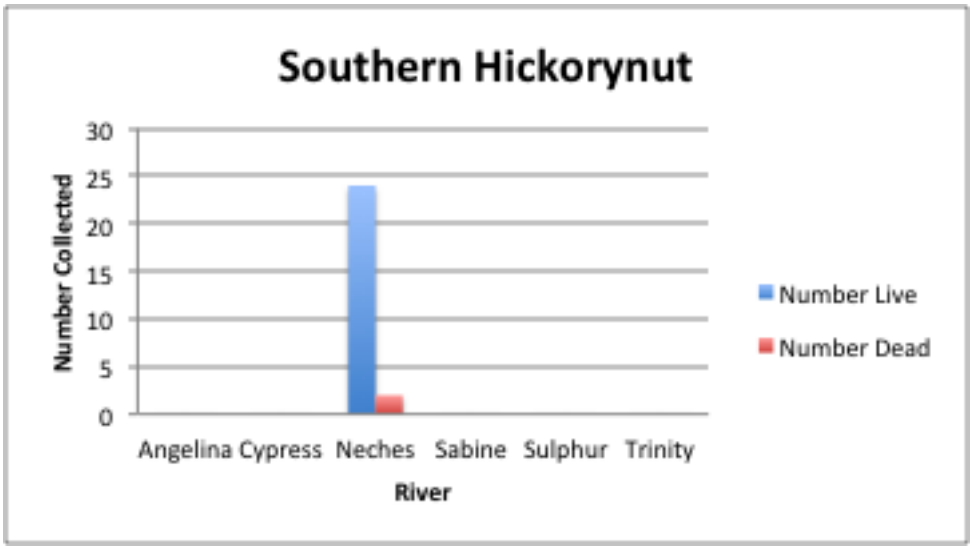

Fig. 25. Number of live and dead Southern Hickorynuts collected in the 6 river basins.

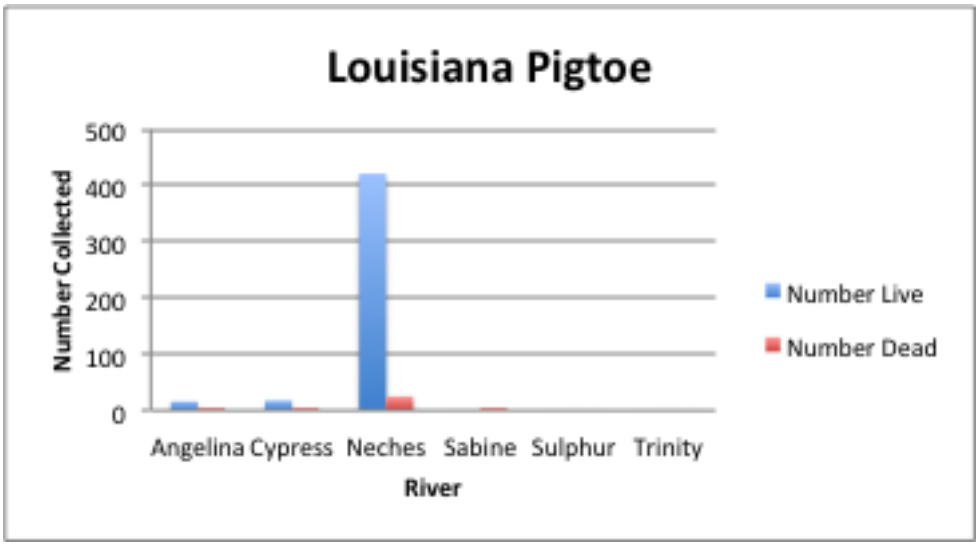

Fig. 26. Number of live and dead Louisiana Pigtoes collected in the 6 river basins.

The Louisiana pigtoe ranked 12th overall with 489 live individuals recorded including some juveniles. However, note that 421 of those came from the Neches River. The species was extremely rare in all other rivers with usually less than a dozen recorded. The sites in the Neches in which it was found were somewhat scattered but it seemed to required stable substrate in the form of gravel and cobble. This species should benefit by the protection the Neches River is receiving as a potential "Wild and Scenic" river.

The Sandbank Pocketbook was not common anywhere with a ranking of 16th and 127 live collected. Some recruitment was evident as juveniles were found. It was only located in the Neches drainage (Angelina and Attoyac also). One dead was recorded in the Trinity. This species needs to be monitored as it is appears to have no significant populations.

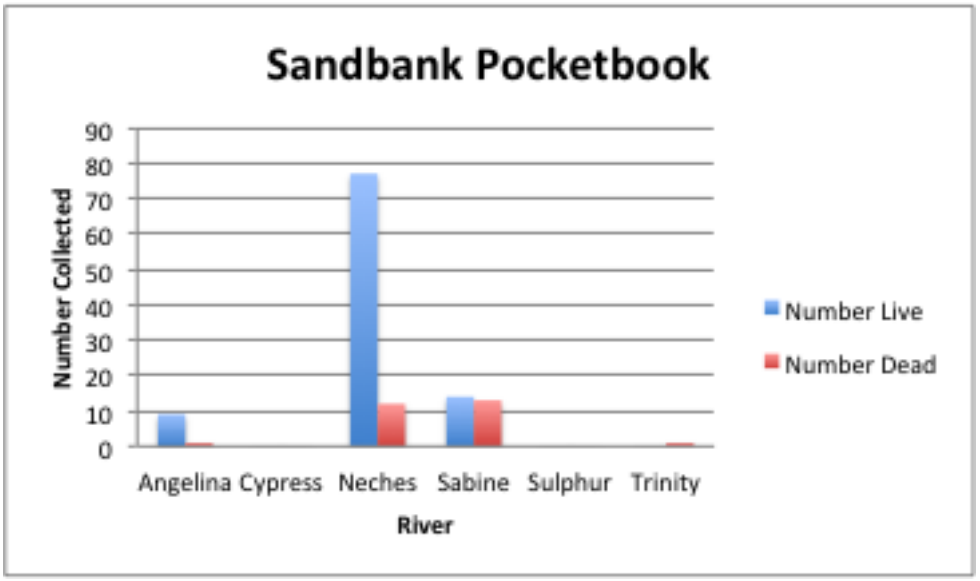

Fig. 27. Number of live and dead Sandbank Pocketbooks collected in the 6 river basins.

Of the threatened species the Texas Heelsplitter was the least abundant and rarer even than the Southern Hickorynut. It appears to have a different habitat preference and was found in sandy areas more than in riffles with cobble. This habitat is widespread in all the rivers so the lack of numbers of this species is troublesome. Juveniles were recorded so some recruitment is taking place. However, it may be subjected to higher levels of predation as it is a thin shelled species (Dunithan and Ford, in press).

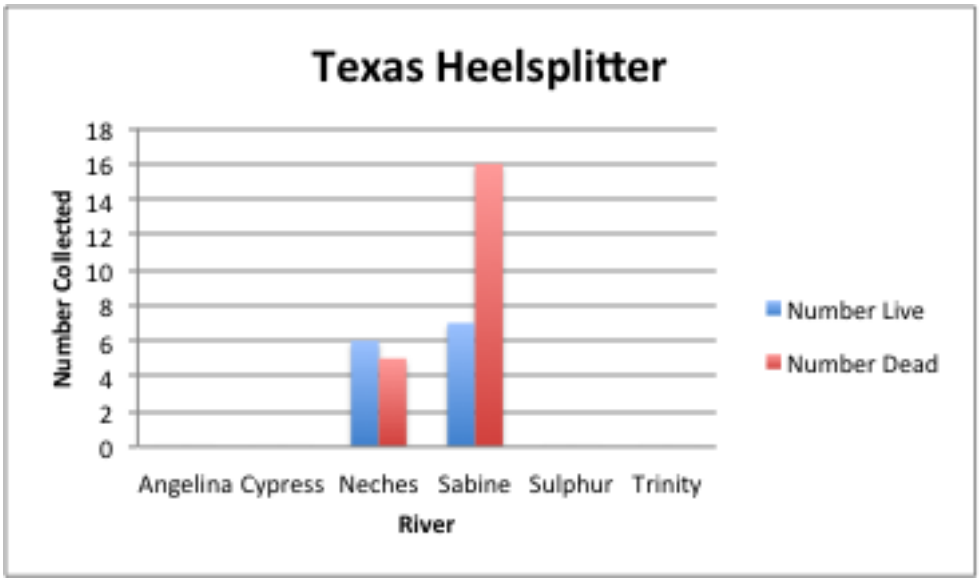

Fig. 28. Number of live and dead Texas Heelsplitters collected in the 6 river basins.

Other Rare Mussel Species

Some of the rarest species in this survey were not common because they are not riverine denisons. I.e. the pond mussel, pondhorn and Texas lilliput are found in lakes and ephemeral habitats. Some species were rare because these rivers are on the periphery of their ranges (i.e. pimpleback and white heelsplitter). However, a few that should have been present in some numbers were not abundant and merit some additional evaluation. These are the rock pocketbook, the fawnsfoot, the little spectaclecase and the creeper. These in our view should receive some protection at this time.

Fishes

We collected three creek chubsuckers in the Neches River. The species is listed as state threatened. At site at they were collected the river is highly connected to its floodplain. A number of side channels and small tributaries connect to the river nearby. This type of habitat is rare in East Texas rivers from our observation.

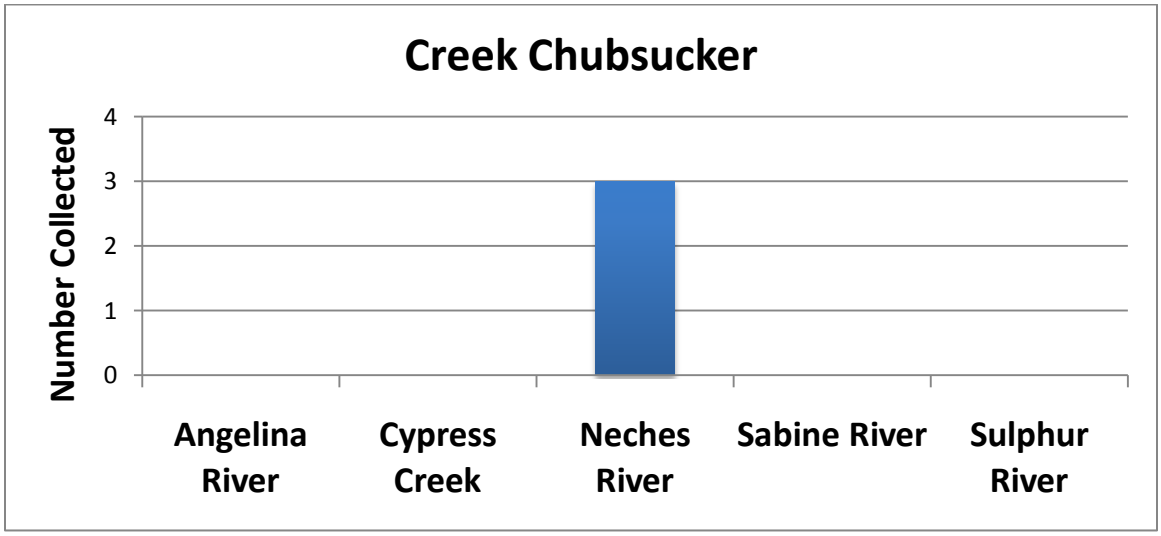

Fig. 29. Number of Creek Chubsuckers, *Erimyzon oblongus*, collected in the 5 river basins sampled.

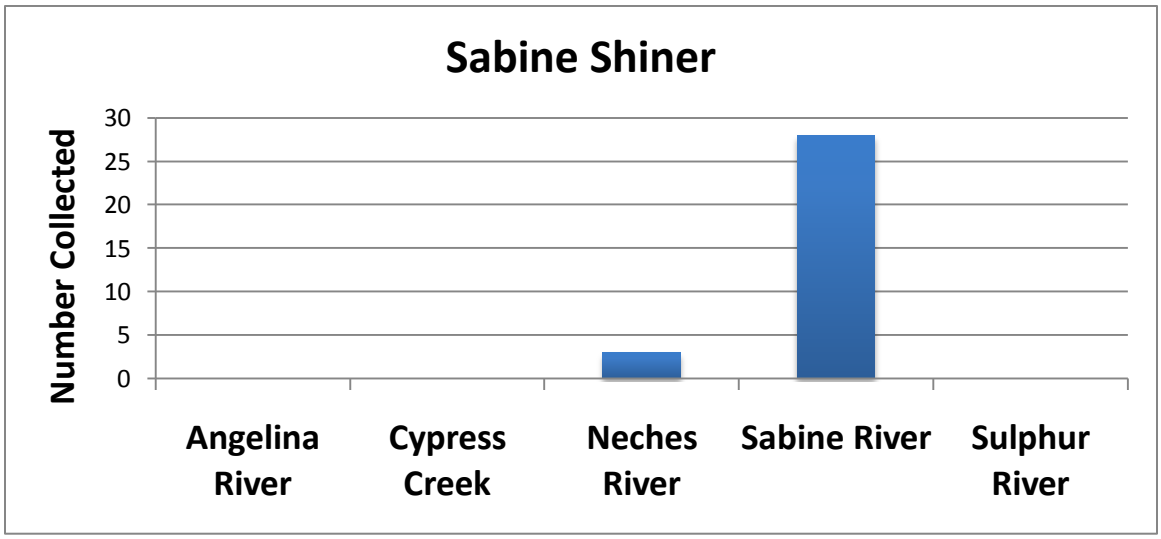

Fig. 30. Number of Sabine Shiners, *Notropis sabinae*, collected in the 5 river basins sampled.

The Sabine shiner is a species of concern in Texas, but we collected adequate numbers in the Sabine River. Only a few specimens were collected in the Neches River, and they were absent from the other rivers. They were collected over clean sandy run habitat.

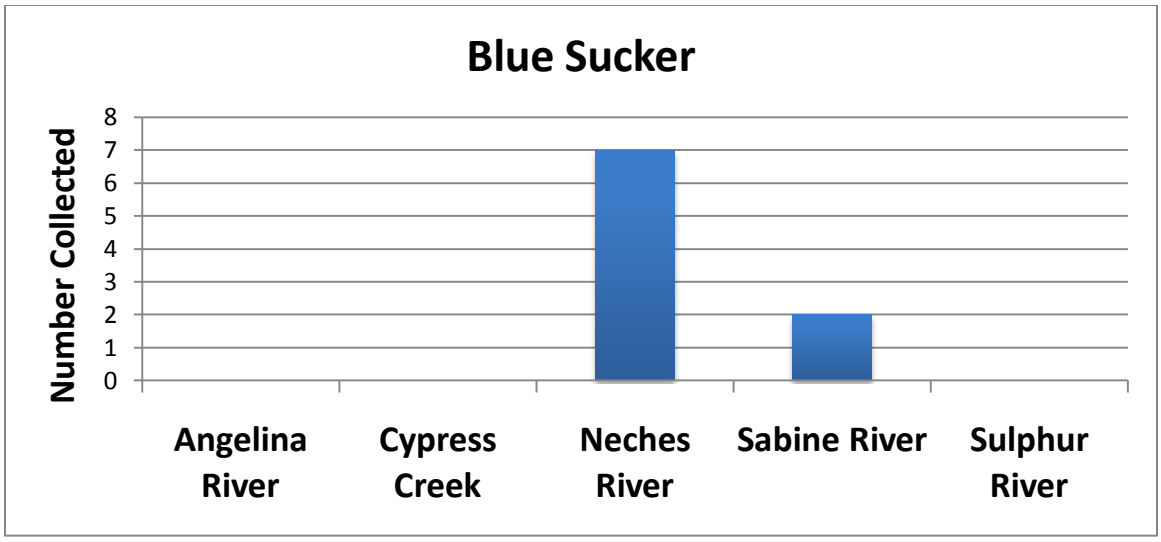

Fig. 31. Number of Blue Suckers, *Cycleptus elongatus*, collected in the 5 river basins sampled.

Blue suckers were collected in the Neches and Sabine Rivers, but were more abundant in the Neches River. We collected blue suckers in habitats associated with rocky outcrops or large logjams, both of which produce swift eddy-type flow conditions. One juvenile blue sucker was collected, and it was associated with large wood dams. Blue suckers are listed as threatened in Texas.

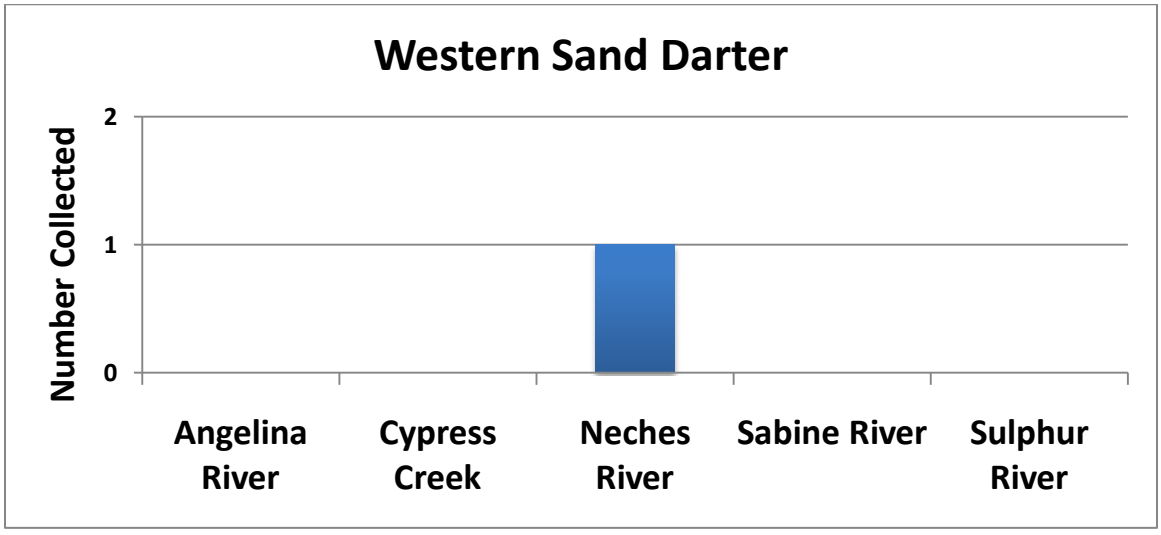

Fig. 32. The number of Western Sand Darters, *Ammocrypta clara*, collected in the 5 river basins sampled.

The Western sand darter was only collected in the Neches River, and only one specimen was collected. It is listed as a species of concern in Texas. Nothing can be said about it at this time.

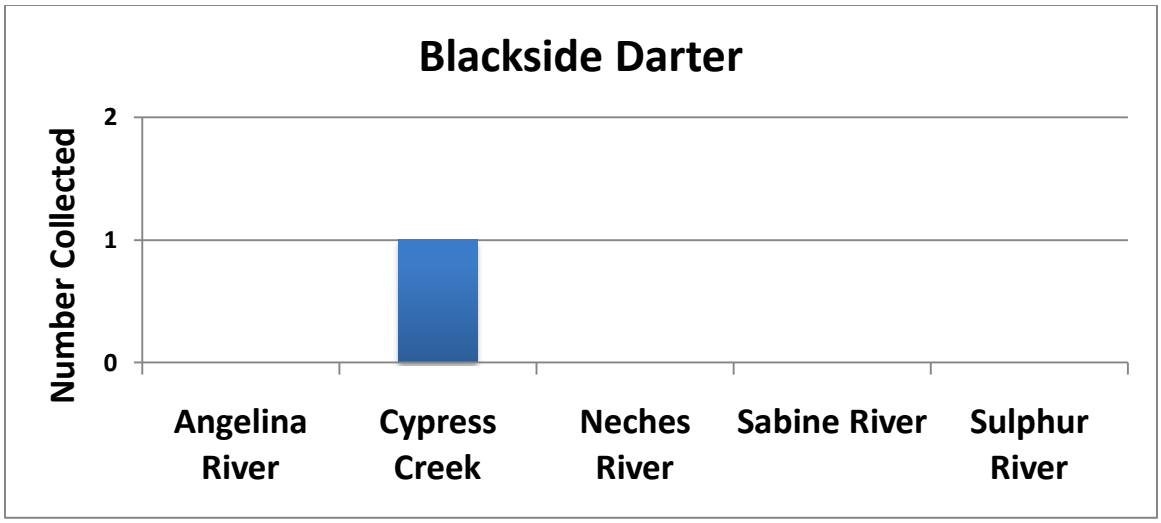

Fig. 33. Number of Blackside Darters, *Percina maculata*, collected in the 5 river basins sampled.

The blackside darter is listed as threatened in Texas. We only collected one individual in Little Cypress Creek so no conclusions as to its habitat can be made.

Conclusions

The Neches and the Sabine Rivers had the highest species richness and highest relative numbers of mussel species and also the most threatened species. The Texas pigtoe was abundant in several rivers but because of the difficulty of distinguishing it from the Triangle pigtoe it should remain protected. Additional the Texas pigtoes in the Sulphur and Trinity Rivers may in actuality be other species. The Texas heelsplitter is rare everywhere at least as living specimens. It has the greatest abundance in the Sabine River. It seems to suffer high raccoon predation. The Southern Hickorynut was only found in 4 sites that are relatively close together. If that area was impounded as has been proposed in the past it would likely become extinct in Texas. Other species that should be protected include the Little specklecase, Fawnsfoot and the Creeper.

The Neches and Sabine Rivers had the highest species richness and the highest number of rare fish species. None of the fish species of concern or threatened species were collected in high numbers in any river. As such, the conservation status of these species cannot be determined. More sampling needs to be conducted to determine with certainty their status. Additional conservation measures may be warranted for some species. It is likely that the American eel and paddlefish are extirpated from East Texas rivers. All other species were exceedingly rare (only a handful of specimens collected).

Acknowledgements

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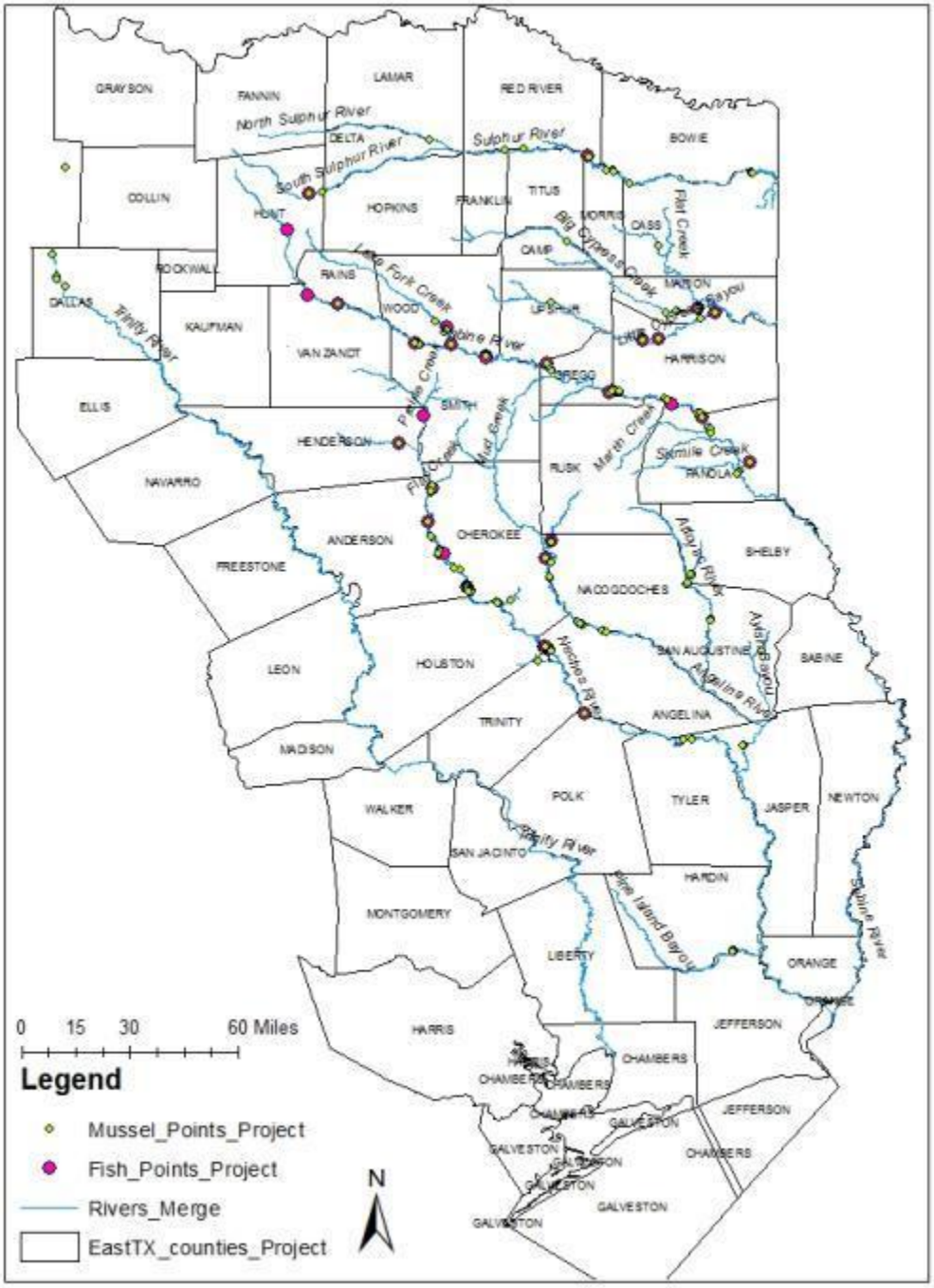
Appendix A


GRAYSON
FANNIN
LAMAR
RED RIVER
BOWIE
North Sulphur River
DELTA
Sulphur River
South Sulphur River
COLLIN
HOPKINS
FRANKLIN
TITUS
MORRIS
CASS
HUNT
Big Cypress Creek
Flat Creek
CAMP
ROCKWALL
RAINS
Little Fork Creek
MARION
DALLAS
Trinity River
KAUFMAN
WOOD
UPSHUR
VAN ZANDT
Sabine River
HARRISON
ELLIS
SMITH
PANOLA
HENDERSON
Prairie Creek
Mud Creek
RUSK
Martin Creek
Sammie Creek
NAVARRO
Flat Creek
ANDERSON
CHEROKEE
SHELBY
FREESTONE
NACOGDOCHES
Attoyac River
Ayish Bayou
SAN AUGUSTINE
SABINE
LEON
HOUSTON
Angelina River
Neches River
TRINITY
ANGELINA
MADISON
POLK
TYLER
JASPER
NEWTON
WALKER
Trinity River
SAN JACINTO
HARDIN
Pine Island Bayou
Sabine River
MONTGOMERY
LIBERTY
ORANGE
HARRIS
JEFFERSON
CHAMBERS
GALVESTON
0 15 30 60 Miles
Legend
Mussel_Points_Project
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N