FINAL REPORT

As Required By

STATE WILDLIFE GRANTS PROGRAM

TEXAS

Federal Aid Project

STATEWIDE FRESHWATER MUSSEL SURVEY

Principal Investigator: Robert G. Howells

Philip P. Durocher
Director
Inland Fisheries Division

Robert L. Cook
Executive Director
Texas Parks and Wildlife Department

31 August 2006
[5 November 2009 edits]

Final Report

State: Texas **Grant Number:** T-15-P

Grant Title: Statewide Freshwater Mussel Survey

Reporting Period: from September 1, 2004 **through** 31 August 2006

Project Statement Objective(s):

DESCRIPTION OF PROJECT AND WORK TO BE DONE: A review of published Texas Parks & Wildlife Department mussel survey reports (1992-2003) identified water bodies statewide where significant unionid assemblages had been found or where rare, endemic species had been documented. This study reexamined these locations to determine current mussel abundance and species composition and compare current findings to previous TPWD and published data. Sampling employed a variety of collection and observation techniques as appropriate for each location and comparable to techniques used earlier by TPWD. Mussel identifications were confirmed by consultation with authorities on unionids. This work occurred over a period of two years with all sites being examined at least once during this time.

Accomplishments: Proposed study sites were surveyed by Stephen F. Austin State University and Laredo Community College. Survey data were analyzed and summarized by Texas Parks and Wildlife Department's Heart of the Hills Fisheries Science Center (HOH). The results of the project are presented in the attached report.

Significant Deviations: The only deviation from the initial proposal was that an examination of Falcon Reservoir was not completed. However, several additional sites were substituted.

Prepared by: Robert G. Howells **Date:** 31 August 2006

Approved by: _____ **Date:** _____

INTRODUCTION

In January 1992, Texas Parks and Wildlife Department's (TPWD) Heart of the Hills Fisheries Science Center (HOH) began surveying freshwater mussel populations in Texas to better understand and manage this resource. Since then, various surveys have been conducted each year and reported in: Howells 1994, 1995, 1996a, 1996b, 1997a, 1997b, 1998a, 1999, 2000, 2002a, 2003a, 2004, 2005. Other related reports include Howells 1993b, 1996 c, 1996 d, 1996 e, 1997 c, 1997 d, 1997 e, 1997 f, 1998b, 2000b, 2002b, 2003b and Howells et al. 1997, and Howells et al. 2003.

In 2004, State Wildlife Grant (SWG) funding was obtained to support mussel surveys (in 2005 and 2006) by personnel at Stephen F. Austin State University (SFASU) and Laredo Community College (LCC). As a partner in this grant, TPWD staff were able to synthesize these survey data and earlier work to develop a broad view of the status of freshwater mussel populations throughout a large part of Texas. This synthesis is crucial to the development of plans for the general conservation of freshwater mussels in the state. This report presents results of 2005-6 surveys and assesses status of mussel populations relative to earlier published surveys.

METHODS

A review of published Texas Parks & Wildlife Department mussel surveys identified sites statewide where significant unionid assemblages had been found in the past or where rare endemic species had been documented. These sites, initially designated for survey in the current project, are listed below:

Initial sites designated for mussel surveys.

Survey Site	County	Drainage	Date sampled
Lake Wichita	Wichita	Wichita R.	13 Jul 200
Lake Arrowhead	Archer	Little Wichita R.	14 Jul 2005
Pine Creek at FM 906	Lamar	Red R.	9 Jul 2005
Bob Sandlin Reservoir	Camp/Titus	Big Cypress Bayou	4-11 Nov 2005
Big Cypress Bayou below Ft. Sherman dam	Camp/Titus	Big Cypress Bayou	4 Jun 2006
B.A. Steinhagen Reservoir (Dam B)	Tyler/Jasper	Neches R.	24 Oct 2005
Neches R. below Town Bluff Dam	Tyler/Jasper	Neches R.	28 Oct 2005
Eagle Mountain Reservoir	Tarrant/Wise	Trinity R.	12 Jul 2005
Lake Lewisville	Denton	Trinity R.	11 Jul 2005
Cedar Creek Reservoir	Kaufman/Henderson	Trinity R.	23 Nov 2005
Lake Houston	Harris	San Jacinto R.	7 Oct 2005
Buffalo Bayou-Bear Creek below Addicks Dam	Harris	Buffalo Bayou	15 Aug 2005
Stillhouse Hollow Reservoir	Bell	Brazos R.	24 Nov 2005
Somerville Reservoir	Burleson/Washington	Brazos R.	25 Nov 2005
Lake Buchanan	Llano/Burnet	Colorado R.	21 Jul 2005
Elm Creek at FM 216	Runnels	Colorado R.	22 Jul 2005
Nasworthy Reservoir	Tom Green	Colorado R. (Concho)	20 Jul 2005
Brownwood Reservoir	Brown	Colorado (Pecan B.)	25 Jul 2005
Brady Lake	McCulloch	Colorado (Brady Cr.)	17 Jul 2005
Lake Gonzales	Gonzales	Guadalupe R.	29 Apr 2006
Lake Corpus Christi	Live Oak	Nueces R.	23 Jul 2005, 6 May 2006
Falcon Reservoir	Zapata	Rio Grande	*
Elm Creek north of Ballinger	Runnels	Colorado R.	22 Jul 2005
Concho R. at Paint Rock pictographs	Concho	Colorado R. (Concho)	17 Jul 2005
Spring Creek at Foster Park	Tom Green	Colorado R. (Concho)	20 Jul 2005
San Saba R.	Menard	Colorado R. (San Saba)	20 Jul 2005
Live Oak Cr.., Lady Bird Johnson Park	Gillespie	Colorado R. (Pedernales)	16 Jul 2005

Guadalupe R., Hayes Park, Kerrville	Kerr	Guadalupe R.	16 Jul 2005
Guadalupe R., below L. Gonzales	Gonzales	Guadalupe R.	28 Apr 2006
Guadalupe R., below L. Wood	Gonzales	Guadalupe R.	29 Apr 2006
San Marcos R., Palmetto State Park	Gonzales	Guadalupe R.	27 Jul 2005, 27 Apr 2006
Sabine R. at US 59	Harrison/Panola	Sabine R.	16 Aug 2005
Sabine R. at US 43	Harrison/Panola	Sabine R.	16 Aug 2005, 18 Sep 2005
Attoyac Bayou	San Augustine/Shelby	Neches R. (Angelina)	2 Sep 2005
Sandy Creek	Shelby	Neches R. (Angelina)	2 Sep 2005
Village Creek	Hardin	Neches R.	3 Sep 2005
Rio Grande (3 sites)	Webb	Rio Grande	various, 2005

* Not sampled.

Initially designated for survey, Falcon Reservoir was not surveyed. However, several nearby sites along the Rio Grande were surveyed in lieu of Falcon Reservoir. During the course of the project, opportunities arose to survey additional sites. These sites are listed below:

Additional sites designated for mussel surveys.

Survey Site	County	Drainage	Date
Wichita River (5 sites)	Wichita	Red	30 Sep 2005
Pat Mayse Reservoir	Lamar	Red	23 Oct 2005
Sanders Creek	Lamar	Red	9 Jul 2005, 23 Oct 2005
Cypress Springs Reservoir	Franklin	Big Cypress	05 Nov 2005
Lake Livingston	Polk-Trinity/San Jacinto	Trinity	6-7 Oct 2005
Concho R.	Concho	Colorado	17 Jul 2005
Inks Lake	Burnet/Llano	Colorado	21 Jul 2005
Lake LBJ	Burnet	Colorado	26 Jan 2005
Guadalupe River below UGRA dam	Kerr	Guadalupe	16 Jul 2005
Lake Wood	Gonzales	Guadalupe	29 Apr 2006
Rio Grande, at Roma*	Starr	Rio Grande	17 Mar 2005
Rio Grande, at Salinena*	Starr	Rio Grande	4 Feb 2006
Rio Grande, at Dolores Creek*	Zapata	Rio Grande	17 Dec 2005
Rio Grande, Dryden Crossing	Terrell	Rio Grande	07 Jan 2006
Rio Grande, near Los Moras Creek	Maverick	Rio Grande	08 Jan 2006
Lake Casa Blanca	Webb	Rio Grande	7 Mar 2006

* Sampled in lieu of the initially designated Falcon Lake site.

Most sites were surveyed by Stephen F. Austin University staff. Sites along the Rio Grande were surveyed by Laredo Community College staff. The Nature Conservancy, HOH, and volunteers contributed to the overall effort. Records from external sources (volunteers, etc.) are used occasionally in this report.

Various habitats were sampled at each collection site. Collection methods and sampling effort varied among sites depending, in part, upon field conditions at the time of sampling. Minimum sampling effort involved visual examination of shoreline and shallow-water habitat with hand collection. Greater effort was feasible at many sites and these were sampled by wading and snorkeling with hand collection. Previous published reports detail these methods (Howells 1994, 1995, 1996a, 1996b).

Results are presented as numbers of live and dead mussels, condition of shells and valves, and percent composition in the collection. Caution should be used in considering percentages calculated from small sample sizes. Where a species was represented only by fragments or numbers were not recorded, it was excluded from percent composition

calculations. Varying environmental conditions can confound attempts to define how long a given specimen has been dead; however, a number of terms have been used herein to convey an approximation of this. While inherently imprecise, these characterizations are useful in distinguishing mussels that have been dead for many years or decades from those that died days or weeks before collection. Terminology relating to condition of shells, as well as methodology for counting shells is summarized in Howells (1996a, 1996b) and Appendix I.

Mussels were identified to species when possible. Some subfossil or weathered specimens could not be identified to species. Ill-defined taxonomic status of some "species" also sometimes precluded specific identifications. Non-unionid bivalves (including Asian clams) were sometimes documented when encountered. Where no bivalves were found, this is indicated. Where unionids were absent, but no information was recorded for Asian clams, it was reported as "no unionids present." Common and scientific names used generally follow Turgeon et al. (1988), Williams et al. (1993), and Howells et al. (1996), and are presented in Howells (1995, 1996a, 1996b) and Appendix I. Terminology for calculations used includes:

Term	Meaning or calculation
L	Number live (also *N* live).
D	Number dead = shells (paired valves) and valves (unpaired individual valves)
%Lsp	The percentage of each individual species that was alive; example: 4 living and 1 dead threeridges is expressed as 'threeridges 80.0%Lsp.'
%L	The percentage of living specimens of a given species relative to all living mussels; example: in a collection with 5 living threeridges, 1 dead threeridge, 10 living giant floaters, and 5 living lilliputs, the %L for threeridges would be 25.0%L. Dead specimens are not considered in this calculation.
%T	The percentage of living and dead specimens of a given species relative to the total number of living and dead of all species.
*N*L/h	Number of living specimens collected per hour of effort.
*N*T/h	Total number of living and dead collected per hour of effort.
*N*L/m^2	Number of living specimens per m^2.
*N*T/m^2	Total number of living and dead per m^2
CPUE	Catch per unit effort
P	Present, but not counted

RESULTS AND DISCUSSION

Presentation of results within this report is organized first by calendar year in which sampling occurred. Within each of the two years of sampling, data for specific survey sites are grouped by major river basin. When historical data are available, site-specific records are followed by a comparison of current and past data and an assessment of the overall status of mussels at that site (or group of sites).

JANUARY – DECEMBER 2005

Red River Drainage

Wichita River

Wichita River, Site 1 at FM 369S and Arena Road, Wichita County, Texas, 30 September 2005.

TPWD staff and a Master Naturalist (MN) volunteer examined this site by wading and found the following:

Wichita R., Site 1, at FM 369S Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Pink papershell	0	0.5x1	relatively recently dead	100.0
Asian clam (present; 2 shells, long dead and recently dead)				

Total specimens	0	1	1(L+D)	0.0%L
Total species	0	1	1(L+D)	

Wichita River, Site 2, riffle area upstream of FM 1634, Wichita County, Texas, 30 September 2005.
TPWD staff and a MN volunteer examined this site by wading (2.25-minute time search); found no bivalves.

Wichita River, Site 3, downstream of FM 1634, Wichita County, Texas, 30 September 2005.
TPWD staff and a MN volunteer examined this site by wading (1.5 man-hours time search) and found the following specimen:

Wichita River, Site 3, downstream of FM 1634, 1.5 man-hours Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Pink papershell	0	0.5x1	very long dead		100.0
Total specimens	0	1	1(L+D)	0.0%L	
Total species	0	1	1(L+D)		

Wichita River, Site 4, access point off Ridgemont Drive, Wichita Falls, Wichita County, Texas, 30 September 2005.
TPWD staff and a MN volunteer examined this site by wading; found no bivalves.

Wichita River, at Burnet Park, Wichita Falls, Wichita County, Texas, 30 September 2005.
TPWD staff and a MN volunteer examined this site by wading and found the following:

Wichita River, at Burnet Park Species	*N* alive	*N* shells	Condition		Percent of total (L+D)
Pink papershell	0	0.5x5	long dead		100.0
Unidentifiable fragments	0	2	long dead		-
Total species	0	5	5(L+D)	0.0%L	
Total species	0	1	1(L+D)		

The five locations above were examined at the request of the TPWD Inland Fisheries Management personnel relative to the planned opening of a city water desalinization plant scheduled to begin operations in late 2005 including discharging brine into the Wichita River between sites 3 and 4. The 2005 findings were consistent with a previous survey in 1996 (Howells 1997a, b). In both surveys, no living unionid populations were found in the area downstream of the planned brine discharge site. No evidence of the presence of current freshwater mussel populations that could be impacted by brine releases was found.

Lake Wichita

Lake Wichita (Wichita River drainage), SFASU Site 1, east side of reservoir, city boat ramp at Clipper Lane, 33.82969^{o} N, 98.54872^{o} W, Wichita County, Texas, 13 July 2005.
SFASU personnel conducted timed (1.3 man-hours; no unionids found), distance searches (100 m at water depths of 0.2-1.5 m; no unionids found), wading and snorkeling produced the following specimens:

Lake Wichita, Site 1, city boat ramp Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Fragile papershell	0	0.5x1	relatively recently dead-subfossil	4.5

Mapleleaf	0	8.0+0.5x13		subfossil	95.5
Total specimens	0	22	22(L+D)	0.0%L	
Total species	0	2	2 (L+D)		

Lake Wichita (Wichita River drainage), SFASU Site 2, south shore, city park at Fairway Boulevard, Wichita County, Texas, 33.83508° N, 98.56331° W, 13 July 2005.
SFASU personnel conducted timed (2.3 man-hours; no unionids found), distance search (100 m at 0.2-1.5 m), wading and snorkeling produced the following specimens:

Lake Wichita, Site 2, south shore park Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Fragile papershell	0	0.5x3	long dead	16.7
Mapleleaf	0	4.0+0.5x10	long dead	77.8
Pink papershell	0	0.5x1	relatively long dead	5.6
Total specimens	0	18	18(L+D) 0.0%L	
Total species	0	3	3 (L+D)	

Lake Wichita (Wichita River drainage), SFASU Site 3, city access road near dam, Wichita County, Texas, 33.84061° N, 98.53883° W, 13 July 2005.
SFASU personnel conducted timed (1.5 man-hours; no unionids found), distance search (100m at 0.2-1.5 m; no unionids found), wading and snorkeling produced the following specimens:

Lake Wichita, Site 3, near dam Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Mapleleaf	0	14.0+0.5x3	relatively long dead	100.0
Total specimens	0	17	17(L+D) 0.0%L	
Total species	0	1	1(L+D)	

Lake Wichita was examined by TPWD in January 1994 and July 1994 (Howells 1996a) and September 1997 (Howells 1997a, b). In January 1994, two fishery management technicians picked up several representative specimens when the reservoir was down 1.4 m and sent them to HOH for identification (no formal survey). Staff from TPWD formally surveyed this reservoir in July 1994 (3 man-hours) and again in September 1997, but found abundance and diversity limited. When SFASU reexamined this impoundment in July 2005, water levels (that had been low for an extended period) had recently increased. This may have decreased abundance and diversity of unionids, and scattered survivors into deeper waters where they were more difficult to locate.

Lake Wichita Summary	Jan 1994				Jul 1994					Jun 1995					Jul 2005			
	L	D	%L	%T	L	D	%L	%T	T*N*/h	L	D	%L	%T	T*N*/h	L	D	%L	%T
Fragile papershell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	4	0.0	7.0
Pink papershell	0	3	0.0	30.0	-	-	-	-	-	0	15	0.0	19.2	5.0	0	1	0.0	1.8

Giant floater	0	2	0.0	20.0	2	3	5.3	8.2	1.7	1	3	6.3	5.1	1.3	-	-	-	-
Mapleleaf	0	4	0.0	40.0	34	9	89.5	70.5	14.3	15	44	93.8	75.6	19.7	0	52	0.0	91.2
Paper pond pondshell	0	1	0.0	10.0	2	11	5.3	21.3	4.3	-	-	-	-	-	-	-	-	-
Total specimens	0	10	0.0%L 10(L+D)		38	23	62.3%L 61(L+D)		20.3/h	16	62	20.5%L 78(L+D)		26.0/h	0	57	0.0%L 57(L+D)	
Total species	0	4	4(L+D)		3	3	3(L+D)			2	3	3(L+D)			0	3	3(L+D)	

Fluctuating levels and low-water conditions likely prevent Lake Wichita from developing large, diverse unionid populations. Mapleleaf species in this impoundment appear to be dominated by poorly sculptured 'common' mapleleafs (*Quadrula quadrula*). Elsewhere in this drainage, occasional specimens appear to be southern mapleleaf (*Q. apiculata*) and this species probably appears sporadically in Lake Wichita as well. Here mapleleaf was the dominant species on each of the survey dates. Pink papershell appears to be declining and fragile papershell may be increasing in abundance. Though giant floater and paper pondshell (thin-shelled species) were never abundant, absence from recent samples may reflect intolerance to dewatering and less ability to survive predator attacks at such times.

Lake Arrowhead

Lake Arrowhead (Little Wichita River drainage), SFASU Site 1, northwest side of state park boat Ramp, Clay County, Texas, 33.74952° N, 98.39072° W, 14 July 2005.
SFASU personnel conducted timed searches (1 man-hour; no unionids found), a distance search (150 m; no unionids found), but did find a single, relatively long dead mapleleaf valve placed on a lakeside table.

Lake Arrowhead (Little Wichita River drainage), SFASU Site 2, east shore at the end of Pawnee Trail, Clay County, Texas, 33.73844° N, 98.3458° W, 14 July 2005.
SFASU personnel conducted timed searches (1.33 man-hours); no identifiable unionids were found; however, 1 unidentifiable shell fragment and Asian clams shells were documented.

Lake Arrowhead (Little Wichita River drainage), SFASU Site 3, southeast shore at bridge near Deer Creek, Clay County, Texas, 33.66859° N, 98.38725° W, 14 July 2005.
SFASU personnel conducted timed searches (1.8 man-hours; no unionids found), a distance search (150 m; produced a single valve, included below), wading and snorkeling also produced a single valve:

Lake Arrowhead, southeast shore near Deer Creek Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Mapleleaf	0	0.5x1	relatively long dead	50.0
Paper pondshell	0	0.5x1	relatively long dead	50.0
Total specimens	0	2	2(L+D) 0.0%L	
Total species	0	2	2(L+D)	

The freshwater mussel population in Lake Arrowhead was previously discussed by Neck (1989) based on a 1984 survey and was reexamined by HOH in 1994 (Howells 1996a), 1996 (Howells 1997a), and 1997 (Howells 1998a).

Lake Arrowhead Summary	Neck (1989)	Jul 1994				Oct 1996				Sep 1997	Jul 2005			
		L	D	%L	%T	*N*/h	L	D	%L	%T	*N*/h	L+D	L	D	%L	%T

Yellow sandshell	X	15	0	14.7	12.7	5.0	2	1	25.0	21.4	1.5	0	-	-	-	-
Fragile papershell	X	22	2	21.6	20.3	8.0	0	2	0.0	14.3	1.0	0	-	-	-	-
Pink papershell	X	28	10	27.5	32.2	12.7	1	3	12.5	28.6	2.0	0	-	-	-	-
Giant floater	X	6	3	5.9	7.6	3.0	-	-	-	-	-	-	-	-	-	-
Mapleleaf	X	26	1	25.5	22.9	9.0	5	0	62.5	35.7	2.5	0	0	1	0.0	50.0
Lilliput	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pondhorn	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper pondshell	X	5	0	4.9	4.2	1.7	0	0	0.0	0.0	0.0	0	0	1	0.0	50.0
Total	-	102	16	87.9%L		38.7/h	8	6	57.1%L		7.0/h	0	0	2	0.0%L	
specimens	-	118(L+D)					14(L+D)					0	2(L+D)			
Total species	8	6	4	6(L+D)			4	3	4(L+D)			0	0	2	2(L+D)	

These survey findings indicate that the Lake Arrowhead mussel population may be in decline, both in abundance and diversity. In 1997 and in 2005, this reservoir had low water levels for extended periods followed by increasing levels just prior to being surveyed. The number of species and specimens was likely reduced during dewatering and survivors scattered in deeper waters where they were more difficult to locate.

Pat Mayse Reservoir

Pat Mayse Reservoir, two sites (combined) west side of dam and east of SH 906, 33°51.10'N – 95°33.46' W and 33°50.53' N-95°32.24' W, Lamar County, Texas, 23 October 2005.

SFASU staff examined two sites on this impoundment (0.9 man-hour, combined) during a low-water period and reported the following specimens:

Pat Mayse Reservoir, 23 October 2005, 0.9 man-hour					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Fragile papershell	0	3.0	recently dead		5.5
Threehorn wartyback	0	15.0	recently dead		27.3
Pink papershell	0	13.0	recently dead		23.6
Bleufer	2	6.0	recently dead		14.5
Giant floater	0	10.0	recently dead		18.2
Mapleleaf	0	5.0	recently dead		9.1
Paper pondshell	0	1.0	recently dead		1.8
Total specimens	2	53	55(L+D)	3.6%L	
Total species	1	7	7(L+D)		

Pat Mayse Reservoir was previously examined by HOH in August 1993 (Howells 1995) and June 1994 (Howells 1996a). The 1993 survey was only a casual examination of a single cove on the northwest corner of the reservoir and the 1994 effort in this same area was confounded by extremely high water levels. Therefore, neither previous survey accurately represented the unionid assemblage in this impoundment.

Pat Mayes Reservoir	Aug 1993				Jun 1994				Oct 2005			
Summary	L	D	%L	%T	L	D	%L	%T	L	D	%L	%T

Yellow sandshell	-	-	-	-	0	1	0.0	14.3	-	-	-	-
Fragile papershell	-	-	-	-	0	1	0.0	14.3	0	3	0.0	5.5
Threehorn wartyback	-	-	-	-	-	-	-	-	0	15	0.0	27.3
Pink papershell	-	-	-	-	0	1	0.0	14.3	0	13	0.0	23.6
Bleufer	-	-	-	-	-	-	-	-	2	6	100.0	14.5
Giant floater	-	-	-	-	-	-	-	-	0	10	0.0	18.2
Mapleleaf	0	1	0.0	33.3	4	0	100.0	57.1	0	5	0.0	9.1
Lilliput	0	1	0.0	33.3	-	-	-	-	-	-	-	-
Paper pondshell	0	1	0.0	33.3	-	-	-	-	0	1	0.0	1.8
Total specimens	0	3	0.0%L		4	3	57.1%L		2	53	3.6%L	
	3(L+D)				7(L+D)				55(L+D)			
Total species	0	3	1(L+D)		1	3	4(L+D)		1	7	7(L+D)	

Sanders Creek

Sanders Creek, below Pat Mayse Reservoir dam, 33°51.19'N to 33°51.41'N, 95°33.13'W to 95°32.56'W, Lamar County, Texas, 09 July 2005.

SFASU staff conducted timed searches (12.0 man-hours) and reported the following specimens:

Sanders Creek, below Pat Mayse Reservoir, 09 July 2005, 12.0 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	2	1.0	long dead	1.0
Yellow sandshell	6	83.0+0.5x1	recently dead-very long dead	17.5
White heelsplitter	0	6.0	very long dead	1.2
Fragile papershell	11	81.0	relatively recently dead-subfossil	17.9
Threehorn wartyback	10	83.0+0.5x31	relatively recently dead- long dead	24.1
Bleufer	18	67.0+0.5x24	relatively long dead-very long dead	20.4
Giant floater	1	5.0+0.5x1	long dead-very long dead	1.4
Mapleleaf	1	33.0+0.5x38	relatively recently dead-long dead	14.0
Wartyback	0	1.0	relatively recently dead	0.2
Pimpleback	0	0.5x1	recently dead	0.2
Mapleleaf (sp.?)	0	3.0	relatively long dead	0.6
Deertoe	0	4.0+0.5x2	relatively recently dead	1.2
Total specimens	49	465	514(L+D) 9.5%L	
Total species	7	12	12(L+D)	

SFASU staff also took 3, 0.25-m ^{2} quadrat samples on 09 July 2005 and reported the following specimens:

Sanders Creek, below Pat Mayse Reservoir, total of 3, 0.25-m^2 quadrats				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Fragile papershell	1	0.0	-	50.0
Threehorn wartyback	1	0.0	-	50.0
Total specimens	2	0	2(L+D) 100.0%L	
Total species	2	0	2(L+D)	

Sanders Creek, below Pat Mayse Reservoir dam, 33°51.19'N, 95°33.13'W, Lamar County, Texas, 23 October 2005. SFASU staff conducted random shallow water searches (man-hours undocumented) and found:

Sanders Creek, below Pat Mayse Reservoir, 23 October 2005				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Yellow sandshell	0	P	not documented	-
White heelsplitter	4	P	not documented	-
Fragile papershell	0	16.0	not documented	-
Washboard	2	1.0	not documented	-
Threehorn wartyback	0	2.0	not documented	-
Bleufer	0	7.0	not documented	-
Mapleleaf	0	4.0	not documented	-
Wartyback	0	1.0	not documented	-
Pistolgrip	2	2.0	not documented	-
Giant floater	0	1.0	not documented	-
Deertoe	0	6.0	not documented	-
Total specimens	8	40+	40+(L+D)	
Total species	3	11	11(L+D)	

This location was examined by TPWD and volunteers in 1993 (Howells 1995) and by volunteers in 1996 (1997a); however, none of these efforts included timed searches or density estimates. No counts were taken in 1993 and only living specimens were documented in 1996 (except for single specimens of two species). Additionally, the second examination of this location by SFASU personnel in October did not count shells of two species and did not document condition of shells and valves. Unfortunately, these differences preclude most direct comparisons between years at this location.

Sanders Creek comparison	Aug 1993	Jun 1996				Jul 2005			
	L+D	L	D	%Lsp	%L	L	D	%Lsp	%L
Threeridge	-	0	1	0.0	0.0	2	1	67.0	4.1
Rock-pocketbook	-	-	-	-	-	-	-	-	-
Ouachita rock-pocketbook	P	-	-	-	-	-	-	-	-
Yellow sandshell	-	29	-	-	6.6	6	84	6.7	12.2
White heelsplitter	-	10	-	-	2.3	0	6	0.0	0.0
Fragile papershell	P	8	-	-	1.8	11	81	12.0	22.4
Washboard	-	-	-	-	-	-	-	-	-
Threehorn wartyback	P	148	-	-	33.9	10	114	8.1	20.4
Pink papershell	-	7	-	-	1.6	-	-	-	-
Bleufer	-	74	-	-	16.9	18	91	16.5	36.7
Giant floater	-	2	-	-	0.5	1	6	14.3	2.0
Mapleleaf	P	74	-	-	16.9	1	71	1.4	2.0
Wartyback	P	24	-	-	5.5	0	1	0.0	0.0
Pimpleback	P	60	-	-	13.7	0	1	0.0	0.0
Mapleleaf spp.	-	-	-	-	-	0	3	0.0	0.0
Deertoe	-	1	-	-	0.2	0	6	0.0	0.0
Lilliput spp.	-	0	1	0.0	0.0	-	-	-	-
Total specimens	not counted	437	2+		<99.5%L	49	465		9.5%L

		439+(L+D)			514(L+D)		
Total species	6	11	2	13(L+D)	7	12	12(L+D)

Sanders Creek, downstream of Pat Mayse Reservoir dam, is one of only two locations in Texas where recently dead shells of the federally endangered Ouachita rock-pocketbook have been found. Also, Sanders Creek and adjacent Pine Creek (below) support the only known populations of white heelsplitter and what may be pimpleback (*Quadrula pustulosa*) in Texas. Mapleleafs in these streams and associated waters appear to be dominated by atypically sculptured mapleleaf (*Q. quadrula*), but with some southern mapleleaf (*Q. apiculata*) and Gulf mapleleaf (*Q. nobilis*) present as well. Earlier reports often referred to mapleleaf mussels from this area as either mapleleaf or southern mapleleaf.

Pine Creek

Pine Creek, SFASU Site 1, upstream of FM 906 bridge, Lamar County, Texas, from 33.85132° N, 95.34495° W to 33.84813° N, 95.34695° W, 9 July 2005.
SFASU personnel conducted a timed search (6 man-hours) and documented:

Pine Creek, upstream of FM 906, 6 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Yellow sandshell	11	18.0+0.5x6	recently dead-subfossil	17.1
White heelsplitter	6	17.0	recently dead–relatively long dead	11.2
Fragile papershell	0	18.0	recently dead-long dead	8.8
Threehorn wartyback	14	24.0+0.5x26	relatively recently dead- long dead	31.2
Bleufer	6	15.0+0.5x3	relatively recently dead-long dead	11.7
Mapleleaf	6	21.0+0.5x9	relatively recently dead-very long dead	17.6
Pimpleback	3	0.0	-	1.5
Pistolgrip	1	1.0	relatively long dead	1.0
Total specimens	47	158	205(L+D) 22.9%L	
Total species	7	7	8(L+D)	

Pine Creek, SFASU Site 1, downstream of FM 906 bridge, Lamar County, Texas, from 33.85132° N, 95.34495° W to 33.85216° N, 95.34440° W, 9 July 2005.
SFASU personnel conducted a timed search (2 man-hours) and documented:

Pine Creek, downstream of FM 906, 2 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Yellow sandshell	2	1.0	relatively recently dead	10.0
White heelsplitter	0	2.0	long dead	6.7
Threehorn wartyback	6	4.0	relatively recently dead-relatively long dead	33.3
Bleufer	2	1.0	relatively recently dead	10.0
Mapleleaf	6	0.0	-	20.0
Pimpleback	1	0.0	-	3.3
Pistolgrip	4	0.0	-	13.3
Deertoe	0	1.0	relatively recently dead	3.3
Total specimens	21	9	30(L+D) 70.0%L	
Total species	6	5	8(L+D)	

Pine Creek at FM 906 is one of only two locations in Texas where recently dead shells of federally-endangered Ouachita rock-pocketbooks have been found (Howells 1993b). This site was surveyed in August 1993 when TPWD staff sampled the creek upstream from FM 906 and C.M. Mather and J.A.M. Bergmann sampled areas downstream of this crossing (Howells 1995); only the upstream data is presented below, but Mather and Bergmann found similar composition and abundance downstream as well. Both up- and downstream areas were examined again by TPWD staff in 1996, but only living specimens were recorded; heavy rain just prior to the survey confounded the efficiency of survey efforts.

Pine Creek Summary	Aug 1993 upstream only						Jun 1996 up- & downstream			Jul 2005 up- & downstream					
	L	D	%Lsp	%L	%T	*N*L/h	L	%L	*N*L/h	L	D	%Lsp	%L	%T	*N*L/h
Yellow sandshell	10	8	55.6	33.3	30.0	3.3	1	2.7	0.5	13	25	34.2	19.1	16.2	4.8
White heelsplitter	6	16	27.3	20.0	20.0	2.0	8	21.6	4.0	6	19	24.0	8.8	10.6	3.1
Fragile papershell	10	2	83.3	33.3	36.7	3.3	8	21.6	4.0	0	18	0.0	0.0	7.7	2.3
Threehorn wartyback	2	1	33.3	6.7	5.0	0.7	9	24.3	4.5	20	54	27.0	29.4	31.5	9.3
Pink papershell	0	2	0.0	0.0	3.3	0.0	-	-	-	-	-	-	-	-	-
Bleufer	0	1	0.0	0.0	1.7	0.0	1	2.7	0.5	8	19	29.6	11.8	11.5	3.3
Giant floater	0	frag	P	-	-	0.0	-	-	-	-	-	-	-	-	-
Mapleleaf spp.	2	0	100.0	6.7	3.3	0.7	9	24.3	4.5	12	30	28.6	17.6	17.9	4.0
Pimpleback	-	-	-	-	-	-	-	-	-	4	0	100.0	5.9	1.7	0.5
Pistolgrip	-	-	-	-	-	-	-	-	-	5	1	83.3	7.4	2.6	0.8
Deertoe	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	0.4	0.3
Paper pondshell	0	frag	P	-	-	0.0	1	2.7	0.5	-	-	-	-	-	-
Total specimens	30	30	60(L+D)	50.0%L			37			68	167	235(L+D)	28.9%L		
Total species	5	8	7(L+D)				7			7	8	9(L+D)			

At least 12 species were documented in Pine Creek in the vicinity of FM 906. Since the original collections, three species of mapleleaf mussels (mapleleaf *Q. quadrula*, southern mapleleaf *Q. apiculata*, and Gulf mapleleaf *Q. nobilis*) have been recognized in this area and it is possible all three were present during these surveys; however, mapleleaf is apparently the dominant species. Several species that were not located in 1993 or 1996 (pimpleback, pistolgrip, deertoe) were likely overlooked due to low density and less sampling effort prior to 2005. Pimpleback specimens found are assumed to be *Q. pustulosa*, but neither these specimens nor any mapleleaf species have been subject to biochemical genetic confirmation to date.

Big Cypress Bayou Drainage

Cypress Springs Reservoir

Cypress Springs Reservoir, southwest side near dam, SFASU Site 4, 33°03.129' N, 95°08.545'W, Franklin County, Texas, 5 November 2005.

SFASU staff conducted timed searches (0.75 man-hours) at this location.

Cypress Springs Reservoir, southwest corner near dam, 0.75 man-hours				Percent of
Species	*N* alive	*N* shells	Condition	total (L+D)
Yellow sandshell	4	2.0+0.5x2	relatively recently dead-relatively long dead	6.8
Pond mussel	45	13.0+0.5x2	relatively recently dead-relatively long dead	50.8
Giant floater	30	8.0	very recently dead-long dead	32.2

Texas lilliput	1	5.0+0.5x3	relatively recently dead-relatively long dead		7.6
Paper pondshell	2	1.0	recently dead		2.5
Total specimens	82	36	117(L+D)	69.5%L	
Total species	5	5	5(L+D)		

Cypress Springs Reservoir, northwest side off CR 3007 (1996 survey site), SFASU Site 6, 33°03.827' N, 95°08.485'W, Franklin County, Texas, 5 November 2005.
SFASU staff conducted timed searches (0.75 man-hours) at this location.

Cypress Springs Reservoir, northwest side, 0.75 man-hours Species	*N* alive	*N* shells	Condition		Percent of total (L+D)
Flat floater	0	6.0	recently dead-relatively recently dead		5.7
Yellow sandshell	0	5.0	very recently dead-long dead		4.7
Pond mussel	1	0.5x1	recently dead		1.9
Giant floater	5	82.0	very recently dead-long dead		82.1
Texas lilliput	0	1.0	relatively recently dead		0.9
Paper pondshell	0	5.0	recently dead-long dead		4.7
Total specimens	6	100	106(L+D)	5.7%L	
Total species	2	5	6(L+D)		

In July 1996, HOH staff and a local water district representative examined three locations on Cypress Springs Reservoir (Howells 1997a). Searches included wading and snorkeling and were largely restricted to shallow waters of 3 m or less.

Cypress Springs Reservoir, comparison	Jul 1996						Nov 2005					
	L	D	%Lsp	%L	%T	T*N*/h	L	D	%Lsp	%L	%T	T*N*/h
Flat floater	-	-	-	-	-	-	0	6	0.0	0.0	2.7	4.0
Louisiana fatmucket	1	0	100.0	3.2	2.8	0.3	-	-	-	-	-	-
Yellow sandshell	-	-	-	-	-	-	4	9	30.8	4.5	5.8	8.7
Pond mussel	0	3	0.0	0.0	8.3	1.0	46	16	88.5	52.3	27.4	41.3
Giant floater	-	-	-	-	-	-	35	90	28.0	39.8	55..8	83.3
Mapleleaf	30	2	93.8	96.8	88.9	10.7	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	1	9	10.0	1.1	4.5	0 .7
Paper pondshell	-	-	-	-	-	-	2	6	25.0	2.3	3.6	5.3
Total specimens	31	5	36(L+D)	86.1%L	12.0/h		88	136	224(L+D)	39.3%L	149.3/h	
Total species	2	2	3 L+D				5	6	6(L+D)			

When HOH first began surveys of the Big Cypress Bayou drainage in the early to mid-1990s, it appeared the system was becoming increasingly eutrophic (Howells 1996c). Indeed, based on the mussel species present, the upper reaches of Cypress Springs and Bob Sandlin reservoirs were least eutrophic, but with increasing eutrophication moving downstream to Caddo Lake. The above comparison of survey results in 1996 and again nine years later appears to support this premise. Here, mapleleaf (representative of somewhat less eutrophic conditions) dominated in 1996, but was completely absent in 2005. Instead, species associated with nutrient-rich systems with soft bottom

have become far more abundant and mapleleaf (even dead shell material) was not collected. Both species diversity and CPUE increased, but this increase was due largely to species like floaters and pond mussels.

Bob Sandlin Reservoir

Bob Sandlin Reservoir, southwest corner near dam, SFASU Site 1, 33°04.012'N, 95°00.099'W, Camp County, Texas, 4 November 2005, SWG.
SFASU staff conducted timed searches (0.75 man-hours) at this location.

Bob Sandlin Reservoir, southwest corner near dam, 0.75 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	1	0.0	-		0.6
Flat floater	0	1.0	relatively long dead		0.6
Yellow sandshell	31	36.0+0.5x2	very recently dead-long dead		41.1
Pond mussel	9	32.0	very recently dead-long dead		24.4
Giant floater	4	26.0+0.5x1	very recently dead-long dead		18.5
Mapleleaf	10	6.0+0.5x3	relatively long dead		11.3
Texas lilliput	2	4.0	very recently dead-long dead		3.6
Total specimens	57	111	168(L+D)	32.1%L	
Total species	6	6	7(L+D)		

Bob Sandlin Reservoir, northwest corner near dam, SFASU Site 2, 33°04.959'N, 95°00.366'W, Titus County, Texas,
4 November 2005.
SFASU staff conducted timed searches (2.0 man-hours) at this location.

Bob Sandlin Reservoir, northwest corner near dam, 2.0 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Flat floater	0	9.0	very recently dead-long dead		4.1
Yellow sandshell	78	45.0	recently dead-long dead		55.4
Pond mussel	0	40.0+0.5x1	very recently dead-recently dead		18.5
Giant floater	9	32.0+0.5x1	very recently dead-very long dead		18.9
Mapleleaf	0	3.0	very recently dead-long dead		1.4
Paper pondshell	0	3.0+0.5x1	very long dead		1.8
Total specimens	87	135	222(L+D)	39.2%L	
Total species	2	6	6(L+D)		

Bob Sandlin Reservoir, park boat ramp adjacent to power plant, SFASU Site 3, 33°05.524'N, 95°00.875'W, Titus County, Texas, 4 November 2005.
SFASU staff conducted timed searches (1.5 man-hours) at this location.

Bob Sandlin Reservoir, park boat ramp, 1.5 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Flat floater	3	1.0	recently dead	5.4
Yellow sandshell	28	5.0	very recently dead-long dead	44.6
Pond mussel	13	0.0	-	17.6
Giant floater	9	0.0	-	12.2

Mapleleaf	9	2.0+0.5x1	recently dead	16.2
Texas lilliput	1	0.0	-	1.4
Paper pondshell	0	2.0	recently dead	2.7
Total specimens	63	11	74(L+D) 85.1%L	
Total species	6	4	7(L+D)	

Bob Sandlin Reservoir, northwest corner near Cypress Springs dam off CR 3007, SFASU Site 5, no coordinates taken, Franklin County, Texas, 5 November 2005.
SFASU staff conducted timed searches (0.33 man-hours) at this location.

Bob Sandlin Reservoir, northwest corner near Cypress Springs dam, 0.33 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Flat floater	0	25.0	very recently dead-relatively recently dead	28.7
Yellow sandshell	10	4.0+0.5x1	very recently dead-relatively long dead	17.2
Pond mussel	13	0.0	-	14.9
Giant floater	5	12.0	very recently dead-relatively long dead	19.5
Mapleleaf	4	12.o	very recently-long dead	18.4
Texas lilliput	1	0.0	-	1.1
Total specimens	33	54	87(L+D) 37.9%L	
Total species	5	4	6(L+D)	

Bob Sandlin Reservoir, southwest of CR 1519, SFASU Site 7, 33°00.839' N, 95°09.215' W, Franklin County, Texas, 5 November 2005.
SFASU staff conducted timed searches (0.5 man-hours) at this location.

Bob Sandlin Reservoir, southwest of CR 1519, 0.5 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Flat floater	0	20.0	very recently dead-long dead	50.0
Pond mussel	0	6.0	very recently dead-long dead	15.0
Giant floater	0	6.0	very recently dead-long dead	15.0
Mapleleaf	2	4.0	recently dead	15.0
Texas lilliput	0	1.0	very recently dead	2.5
Paper pondshell	0	1.0	recently dead	2.5
Total specimens	2	38	40(L+D) 5.0%L	
Total species	1	6	6(L+D)	

Bob Sandlin Reservoir, at CR 2417, SFASU Site 8, 33°01.867' N, 95°07.307' W, Camp County, Texas, 11 November 2005.
SFASU staff conducted timed searches (0.5 man-hours) at this location.

Bob Sandlin Reservoir, at CR 2417, 0.5 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Flat floater	1	4.0	relatively recently dead-long dead	8.9
Yellow sandshell	5	1.0	recently dead	10.7

Pond mussel	21	19.0	very recently dead-relatively recently dead	71.4
Giant floater	0	4.0	very recently dead-relatively recently dead	7.1
Texas lilliput	0	0.5x1	long dead	1.8
Total specimens	27	29	56(L+D) 48.2%L	
Total species	3	5	5(L+D)	

In July 1996, HOH staff five locations on Bob Sandlin Reservoir (Howells 1997a). Searches included wading and snorkeling and were largely restricted to shallow waters of 3 m or less.

Bob Sandlin Reservoir, comparison	Jul 1996						Nov 2005					
	L	D	%Lsp	%L	%T	T*N*/h	L	D	%Lsp	%L	%T	T*N*/h
Threeridge	-	-	-	-	-	-	1	0	100.0	0.4	0.2	0.2
Flat floater	10	6	62.5	7.1	10.1	4.0	4	60	6.3	1.5	9.9	12.5
Louisiana fatmucket	1	0	100.0	0.7	0.6	0.3	-	-	-	-	-	-
Yellow sandshell	20	0	100.0	14.2	12.7	5.0	152	94	61.8	56.5	38.0	44.1
Pond mussel	78	4	95.1	55.3	51.9	20.5	56	98	36.4	20.8	23.8	27.6
Giant floater	12	5	70.6	8.5	10.8	4.3	27	82	24.8	10.0	16.8	19.5
Mapleleaf	16	0	100.0	11.3	10.1	4.0	25	31	44.6	9.3	8.7	10.0
Texas lilliput	3	1	75.0	2.1	2.5	1.0	4	6	40.0	1.5	1.5	1.8
Paper pondshell	1	1	50.0	0.7	1.3	0.5	0	7	0.0	0.0	0.1	1.3
Total specimens	141	17	89.2%L		52.7/h		269	378	41.6%L		117.0/h	
	158(L+D)						647(L+D)					
Total species	8	5	8(L+D)				7	7	8(L+D)			

In the nine years since the first TPWD survey of this reservoir, the mussel population appears to have increased. Pond mussel and giant floater, species associated with high-nutrient and soft bottom conditions were abundant during both surveys.

Sabine River Drainage

Sabine River

Sabine River, multiple sites between FM 1804 and FM 14, Smith and Wood counties, Texas 1-2 April 2006.
Staff from UT-Tyler (N. Ford, UT-Tyler; pers. comm.) used a canoe to access this stretch of river during a period when the river level was falling rapidly. They reported finding Texas pigtoe, yellow sandshell (ca 200), fragile papershell (ca 100), threehorn wartyback, Texas heelsplitter (2 recently dead), bleufer (ca 100), southern mapleleaf, pistolgrip, and deertoe. Most were recently dead.

Sabine River, at the Old Sabine Bottom Wildlife Management Area (8 km northeast of Lindale, TX; 109 km south of Lake Tawakoni), Smith County, Texas, June-September 2005.
Ford and Nicholson (In Press) surveyed this area in both the Sabine River and an adjacent old channel (10 sites combined below) and sent photos and specimens to HOH for identification. They reported the following:

Sabine River, Old Sabine Bottom Wildlife Management Area				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	0	4.0	-	2.4

Rock-pocketbook	1	0.0	-		0.6
Louisiana fatmucket	0	1.0	-		0.6
Yellow sandshell	5	9.0	-		8.2
Fragile papershell	4	18.0	-		12.9
Washboard	0	86.0	-		50.6
Threehorn wartyback	7	0.0	-		4.1
Bleufer	6	1.0	-		4.1
Giant floater	1	4.0	-		2.9
Southern mapleleaf	3	3.0	-		3.5
Western pimpleback	0	9.0	-		5.3
Pistolgrip	1	2.0	-		1.8
Deertoe	5	0.0	-		2.9
Total specimens	33	137	170(L+D)	19.4%L	
Total species	9	10	13(L+D)		

Old channel off the Sabine River, Old Sabine Bottom Wildlife Management Area

Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Rock-pocketbook	1	2.0	-	1.0
Louisiana fatmucket	12	6.0	-	5.9
Yellow sandshell	54	81.0	-	44.0
Fragile papershell	4	13.0	-	5.5
Washboard	0	2.0	-	0.7
Bankclimber	34	9.0	-	14.0
Bleufer	14	7.0	-	6.8
Giant floater	0	10.0	-	3.3
Southern mapleleaf	21	0.0	-	6.8
Western pimpleback	3	5.0	-	2.6
Texas lilliput	0	1.0	-	0.3
Pistolgrip	15	5.0	-	6.5
Pondhorn	1	2.0	-	1.0
Little spectaclecase	0	5.0	-	1.6
Total specimens	159	148	307(L+D)	51.8%L
Total species	10	13	14(L+D)	

Since mussel survey work began at HOH in 1992, sites upstream and downstream of Old Sabine Bottom Wildlife Management Area have been surveyed, but none focused specifically on this site.

Sabine River, at US 59 crossing, 32.32843° N, 94.35389° W, Panola County, Texas, 16 August 2005.
SFASU staff conducted timed searches (1.0 man-hours) at this location.

Sabine River, at US 59, 1.0 man-hour

Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Texas pigtoe	1	0.0	-	1.6
Louisiana fatmucket	1	0.0	-	1.6
Yellow sandshell	7	28.0+0.5x8	relatively recently dead-long dead	69.4
Fragile papershell	0	1.0+0.5x1	relatively long dead-long dead	3.2
Texas heelsplitter	0	7.0+0.5x1	relatively recently dead-long dead	12.9

Bleufer	2	0.0	-	3.2
Western pimpleback	3	0.0	-	4.8
Pistolgrip	1	0.0	-	1.6
Paper pondshell	1	0.0	-	1.6
Total specimens	16	46	62(L+D)	25.8%L
Total species	7	3	9(L+D)	

SFASU staff reported water levels low and indicated mussels were only found at depths less than 1 m. This site was examined by TPWD in 1994 (Howells 1996a) and from US 59 to Black Shoals in 1995 (Howells 1996b).

Sabine River, at US 59 comparison	Jul 1994				Jun 1995				Aug 2005			
	L	D	%L	%T	L	D	%L	%T	L	D	%L	%T
Threeridge	1	1	6.7	5.0	0	2	0.0	8.7	-	-	-	-
Texas pigtoe	6	7	40.0	32.5	2	4	33.3	26.1	1	0	6.3	1.6
Louisiana fatmucket	-	-	-	-	1	0	16.7	4.3	1	0	6.3	1.6
Sandbank pocketbook	1	1	6.7	5.0	0	1	0.0	4.3	-	-	-	-
Yellow sandshell	0	2	0.0	5.0	0	3	0.0	13.0	7	36	43.8	69.4
Fragile papershell	-	-	-	-	1	1	16.7	8.7	0	2	0.0	3.2
Bankclimber	0	2	0.0	5.0	0	2	0.0	8.7	-	-	-	-
Texas heelsplitter	1	1	6.7	5.0	-	-	-	-	0	8	0.0	12.9
Bleufer	0	2	0.0	5.0	0	1	0.0	4.3	2	0	12.5	3.2
Western pimpleback	0	2	0.0	5.0	0	1	0.0	4.3	3	0	18.8	4.8
Pistolgrip	6	4	40.0	25.0	2	2	33.3	17.4	1	0	6.3	1.6
Deertoe	0	3	0.0	7.5	-	-	-	-	-	-	-	-
Paper pondshell	-	-	-	-	-	-	-	-	1	-	6.3	1.6
Total specimens	15	25	37.5%L		6	17	26.1%L		16	46	25.8%L	
	40(L+D)				23(L+D)				62(L+D)			
Total species	5	10	10(L+D)		4	9	10(L+D)		7	3	9(L+D)	

In 1994 and 1995, TPWD staff collection rate was 7.5 and 11.5 specimens/hour, respectively, but in 2005, SFASU personnel took 22.4 specimens/hour. This increase in CPUE was largely due to an increase in yellow sandshell numbers found in 2005. The proportional number of living unionids appears to be decreasing over time. The only Texas heelsplitters, a rare local unionid, found in 2005 were dead shells.

Sabine River, at US 43 crossing, 32°22.184 N, 94°27.466 W, Panola County, Texas, 16 August 2005.
SFASU staff conducted timed searches (1.0 man-hour) at this location and found the following specimens:

Sabine River, at US 43, 16 August 2005, 1.0 man-hour Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	1.0+0.5x1	relatively long dead	2.2
Rock-pocketbook	1	0.0	-	1.1
Texas pigtoe	6	14.0+0.5x1	recently dead to relatively long dead	22.6
Louisiana fatmucket	0	1.0	relatively recently dead	1.1
Sandbank pocketbook	1	0.0	-	2.2
Yellow sandshell	0	2.0	relatively recently dead-relatively long dead	4.3

Fragile papershell	2	2.0	relatively recently dead-relatively long dead		1.1
Washboard	1	0.0	-		1.1
Threehorn wartyback	6	3.0+0.5x1	relatively recently dead-relatively long dead		10.8
Bankclimber	0	1.0	relatively long dead		1.1
Texas heelsplitter	0	1.0+0.5x1	long dead		2.2
Bleufer	0	4.0+0.5x1	relatively recently dead		5.4
Southern mapleleaf	5	3.0	relatively long dead		8.6
Western pimpleback	7	1.0	relatively recently dead		8.6
Pistolgrip	18	7.0	long dead		26.9
Paper pondshell	1	0.0	-		1.1
Total specimens	48	43	91(L+D)	52.7%L	
Total species	10	12	16(L+D)		

18 September 2005; SFASU examined this site again using timed searches (3.0 man-hours):

Sabine River, at US 43, 18 September 2005, 3.0 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	1	0.0	-		0.4
Texas pigtoe	40	21.0	relatively long dead to long dead		24.3
Louisiana fatmucket	1	0.0	-		0.4
Sandbank pocketbook	2	1.0	relatively long dead		1.2
Yellow sandshell	10	5.0+0.5x1	relatively recently dead to relatively long dead		6.4
Fragile papershell	12	4.0	relatively recently dead to long dead		6.4
Washboard	1	0.0	-		0.4
Threehorn wartyback	28	6.0	relatively recently dead to relatively long dead		13.5
Bankclimber	1	2.0	relatively recently dead to long dead		1.2
Texas heelsplitter	2	4.0	relatively long dead		2.4
Bleufer	0	1.0	relatively long dead		0.4
Southern mapleleaf	19	5.0	relatively recently dead to relatively long dead		9.6
Western pimpleback	25	2.0	relatively recently dead to relatively long dead		10.3
Pistolgrip	41	10.0	relatively recently dead to long dead		20.3
Deertoe	4	1.0	relatively long dead		2.0
Paper pondshell	1	0.0	-		0.4
Total specimens	188	63	251(L+D)	79.9%L	
Total species	15	12	16(L+D)		

18 September 2005; SFASU also examined this site using 11, 0.25-m^2 quadrats:

Sabine River, at US 43, 18 September 2005 – quadrat samples						
	Total/11 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	0.0	0.4	0.0	-	1.1
Texas pigtoe	5	11.0	1.8	4.0	relatively recently dead-relatively long dead	18.4
Sandbank pocketbook	1	0.0	0.4	0.0	-	1.1
Yellow sandshell	2	1.0	0.7	0.4	relatively long dead	3.4

Fragile papershell	4	2.0	1.5	0.7	relatively recently dead	6.9
Threehorn wartyback	9	1.0	3.3	0.4	relatively recently dead	11.5
Bankclimber	0	1.0	0.0	0.4	recently dead	1.1
Bleufer	1	0.0	0.4	0.0	-	1.1
Giant floater	1	0.0	0.4	0.0	-	1.1
Southern mapleleaf	13	2.0	4.7	0.7	relatively recently dead	17.2
Western pimpleback	17	2.0	6.2	0.7	relatively long dead	21.8
Pistolgrip	10	2.0	3.6	0.7	relatively long dead-o long dead	13.8
Deertoe	1	0.0	0.4	0.0	-	1.1
Total specimens	65 87(L+D)	22	23.6	8.0	31.6 T/m^2	
Total species	12	8	13(L+D)			

SFASU staff reported a "large mussel bed" downstream of the US 43 bridge. This area was surveyed by TPWD in 1994 (Howells 1996a) and in 1995 two specimens (1 yellow sandshell and 1 western pimpleback, both dead) were collected during other unrelated work in the area (Howells 1996b). However, the 1994 HOH survey focused on a slough near the bridge and did not extend into the higher-density bed area downstream.

Sabine River at US 43 comparison	July 1994					Aug 2005					Sep 2005				
	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h
Threeridge	3	2	14.3	11.4	1.5	0	2	0.0	2.2	0.0	1	0	0.5	0.4	0.3
Rock-pocketbook	0	1	0.0	2.3	0.0	1	0	2.1	1.1	1.0	-	-	-		-
Texas pigtoe	7	3	33.3	22.7	3.5	6	15	12.5	22.6	6.0	40	21	21.3	24.3	13.3
Louisiana fatmucket	0	1	0.0	2.3	0.0	0	1	0.0	1.1	0.0	1	0	0.5	0.4	0.3
Sandbank pocketbook	1	0	4.8	2.3	0.5	1	0	2.1	1.1	1.0	2	1	1.1	1.2	0.7
Yellow sandshell	0	6	0.0	13.6	0.0	0	2	0.0	2.2	0.0	10	6	5.3	6.4	3.3
Fragile papershell	0	1	0.0	2.3	0.0	2	2	4.2	4.3	2.0	12	4	6.4	6.4	6.4
Washboard	1	1	4.8	4.5	0.5	1	0	2.1	1.1	1.0	1	0	0.5	0.4	4.0
Threehorn wartyback	-	-	-	-	-	6	4	12.5	10.8	6.0	28	6	14.9	14.5	9.3
Bankclimber	3	4	14.3	15.9	1.5	0	1	0.0	1.1	0.0	1	2	0.5	1.2	0.3
Texas heelsplitter	-	-	-	-	-	0	2	0.0	2.2	0.0	2	4	1.1	2.4	0.7
Bleufer	0	2	0.0	4.5	0.0	0	5	0.0	5.4	0.0	0	1	0.0	0.4	0.0
Southern mapleleaf	-	-	-	-	-	5	3	10.4	8.6	5.0	19	5	10.1	9.6	6.3
Western pimpleback	6	2	28.6	18.2	3.0	7	1	14.6	8.6	7.0	25	2	13.3	11.2	8.3
Pistolgrip	-	-	-	-	-	18	7	37.5	26.9	18.0	41	10	21.8	20.3	13.7
Deertoe	-	-	-	-	-	-	-	-	-	-	4	1	2.1	2.0	1.3
Paper pondshell	-	-	-	-	-	1	0	2.1	1.1	1.0	1	0	0.5	0.4	0.3
Total specimens	21	23	47.7%L		10.5L/h	48	45	51.6%L		48.0L/h	188	63	74.9%L		62.7L/h
	44(L+D)					93(L+D)					251(L+D)				
Total species	6	10	11(L+D)			10	12	16(L+D)			15	12	16(L+D)		

Personnel conducting the survey in 1994 were somewhat less experienced than those in 2005, likely influencing numbers of specimens and species located. Water level and flow rate were higher in 1994. Additionally, 1994 efforts were directed at a slightly different area at this site and apparently failed to locate a mussel bed found downstream of the US 43 bridge in 2005. Some differences in the August and September SFASU survey efforts in 2005 presumably reflect locating or missing localized, high-density pockets of certain mussels.

The total number of specimens, living specimens, percentage alive, and percentage live collected per hour increased over time at this location. Threeridge and washboard, important commercial shell species, were found in limited numbers in all three surveys. This area was heavily harvested by commercial shell musselers in the early 1990s (Howells 1993); therefore, finding fewer animals of these species might be expected. Texas pigtoe, a rare species from eastern Texas and western Louisiana, was more abundant in 2005 than previous surveys indicated. Threehorn wartyback, southern mapleleaf, and pistolgrip were not taken in 1994, but were among the most abundant unionids in September 2005. In all three cases, this apparent increase in abundance is more likely explained by sampling of different microhabitats that reflect highly patchy and non-random distributions than by population increase. Other rare regional mussels, including sandbank pocketbook and Texas heelsplitter, were found in small numbers in each survey indicating these species persist in this stretch of river, but with no particular indication of population increase or decrease over time.

Neches River Drainage

Sandy Creek

Sandy Creek, at CR. 2913 crossing (31°41.213' N, 94°23.007' W) Shelby County, Texas, 2 September 2005. SFASU personnel used timed searches (3.5 man-hour total) and 0.25-m^2 quadrats (8) and found:

Sandy Creek, CR 2913, timed searches 3.5 man-hour					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	14	1.0	long dead		17.4
Triangle pigtoe	30	2.0	relatively recently-very long dead		37.2
Louisiana fatmucket	21	5.0	relatively recently-long dead		30.2
Yellow sandshell	1	0.0	-		1.1
Bleufer	1	0.0	-		1.1
Giant floater	3	0.0	-		3.5
Western pimpleback	4	1.0	long dead		5.8
Pistolgrip	2	1.0	long dead		3.5
Total specimens	76	10	86(L+D)	88.4%L	
Total species	8	5	8(L+D)		

Sandy Creek, CR 2913, 0.25-m^2 quadrats	Total/8 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Triangle pigtoe	1	0.0	0.5	0.0	-	16.7
Louisiana fatmucket	4	0.0	2.0	0.0	-	66.7
Western pimpleback	0	1.0.	0.0	0.5	long dead	16.7
Total specimens	5	1	2.5	0.5	3.0/m^2	
	6(L+D)					
Total species	2	1	3 (L+D)			

This site was examined by TPWD in July 1994 (Howells 1996a) and June 1995 (Howells 1996b). Shown below are number live (L), number dead (D, shells + valves), and percent of total.

Sandy Creek	Jul	Jun	Sept

at CR 2913 comparison	1994					1995					2005				
	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h
Threeridge	-	-	-	-	-	-	-	-	-	-	14	1	18.4	17.4	4.3
Triangle pigtoe	1	0	100.0	12.5	0.5	1	0	100.0	50.0	0.5	30	2	42.1	37.2	9.1
Louisiana fatmucket	0	1	0.0	12.5	0.5	1	0	100.0	50.0	0.5	21	5	34.2	30.2	7.4
Yellow sandshell	-	-	-	-	-	-	-	-	-	-	1	0	1.3	1.1	0.3
Bleufer	-	-	-	-	-	-	-	-	-	-	1	0	1.3	1.1	0.3
Giant floater	-	-	-	-	-	-	-	-	-	-	3	0	3.9	3.5	0.9
Western pimpleback	1	0	100.0	12.5	0.5	-	-	-	-	-	4	1	5.3	5.8	1.1
Pistolgrip	2	0	100.0	25.0	1.0	-	-	-	-	-	2	1	2.6	3.5	0.6
Little spectaclecase	3	0	100.0	37.5	1.5	-	-	-	-	-	-	-	-	-	-
Total specimens	7	1	87.5%L		4.0/h	2	0	100.0%L		1.0/h	76	10	88.4%L		24.6/h
	8(L+D)					2(L+D)					86(L+D)				
Total species	4	1	5(L+D)			2	0	2 (L+D)			7	5	8(L+D)		

When first examined in 1994, this site appeared to be limited in both abundance and diversity (Howells 1996a). It was one of only two locations at the time (now three) where endemic triangle pigtoe was found alive. When reexamined in 1995, it appeared some event upstream had resulted in extensive sand deposition that, in turn, eliminated most of the mussel assemblage here (Howells 1996b). The discovery of a larger, more diverse population here in 2005 indicates recovery from the losses found in 1995, except possibly for little spectaclecase that was not found during the SFASU survey in 2005.

Attoyac Bayou

Attoyac Bayou (> Angelina River > Neches River), CR 392-New Hope Road crossing upstream of SH 21, 31°32.597' N, 94°18.419' W, Nacogdoches and San Augustine counties, Texas, 2 September 2005. SFASU personnel examined this site using timed searches (1.5 man-hours) in shallow waters and 0.25-m^2 quadrates (N = 8) and reported the following specimens:

Attoyac Bayou, CR 392 crossing, timed search 1.5 man-hours					Percent of
Species	*N* alive	*N* shells	Condition		total (L+D)
Triangle pigtoe	17	0.0	-		41.5
Louisiana fatmucket	1	0.0	-		2.4
Bankclimber	10	1.0	very long dead		26.8
Bleufer	1	2.0	relatively recently dead		7.3
Pistolgrip	9	0.0	-		22.0
Total specimens	38	3	41(L+D)	92.7%L	
Total species	5	2	5(L+D)		

Attoyac Bayou at CR 392, 8, 0.25-m^2 quadrats	Total/8 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* shells	*N* alive	*N* shells	Condition	Percent of total (L+D)
Triangle pigtoe	8	0.0	4.0	0.0	-	66.7
Bankclimber	1	0.0	0.5	0.0	-	8.3
Pistolgrip	3	0.0	1.5	0.0	-	25.0

Total specimens	12	0	12(L+D)	100.0%L
Total species	3	0	3(L+D)	

The HOH staff examined Attoyac Bayou at six locations in 1994, but found unionids only at the SH 21 crossing (Howells 1996a) located 4.3 km south (downstream) of the CR 392 crossing examined by SFASU.

Attoyac Bayou comparison	1994 SH 21						2005 CR 392					
	L	D	%Lsp	%L	%T	T*N*/h	L	D	%Lsp	%L	%T	T*N*/h
Triangle pigtoe	1	0	100.0	14.3	12.5	0.5	17	0	100.0	44.7	41.5	11.3
Louisiana fatmucket	0	1	0.0	0.0	12.5	0.5	1	0	100.0	2.6	2.4	0.7
Bankclimber	-	-	-	-	-	-	10	1	90.9	26.3	26.8	7.3
Bleufer	-	-	-	-	-	-	1	2	33.3	7.3	2.4	2.0
Western pimpleback	1	0	100.0	14.3	12.5	0.5	-	-	-	-	-	-
Pistolgrip	2	0	100.0	28.6	25.0	1.0	9	0	100.0	23.7	18.2	6.0
Little spectaclecase	3	0	100.0	42.9	37.5	1.5	-	-	-	-	-	-
Total specimens	7	1	8(L+D)		4.0/h		38	3	41(L+D)		92.7%L	27.3/h
Total species	4	1	5 (L+D)				5	2	5(L+D)			

SFASU's sampling at CR 392 proved fortunate. No unionids were found at that site when surveyed by HOH in 1994. But, when surveyed by SFASU in 2005, additional triangle pigtoes were located. Lower Attoyac Bayou (at SH 21 and CR 392), in addition to Sandy Creek (an Attoyac Bayou tributary) and Village Creek (Hardin County) remain the only three locations where endemic triangle pigtoe is known to persist.

B.A. Steinhagen Reservoir

B.A. Steinhagen Reservoir (Neches River drainage), center of causeway at US 190, 30°51.193' N, 94°12.188' W, Tyler County, Texas, 24 October 2005.

SFASU personnel examined this site using a timed search (0.67 man-hours):

B.A. Steinhagen Reservoir, center of US 190 causeway Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	4.0	very recently dead	2.7
Flat floater	0	2.0	very recently dead	1.3
Louisiana fatmucket	0	2.0	very recently dead	1.3
Yellow sandshell	16	52.0	very recently dead	45.3
Fragile papershell	0	2.0	very recently dead	1.3
Threehorn wartyback	0	4.0	very recently dead	2.7
Bankclimber	2	18.0	very recently dead	13.3
Bleufer	2	20.0	very recently dead	14.7
Giant floater	0	14.0	very recently dead	9.3
Southern mapleleaf	0	3.0	very recently dead	2.0
Western pimpleback	0	5.0	very recently dead	3.3
Pistolgrip	1	0.0	-	0.7
Texas lilliput	1	1.0	very recently dead	0.7
Paper pondshell	0	1.0	very recently dead	0.7

Total specimens	22	128	150(L+D)	14.7%L
Total species	5	13	14(L+D)	

This location had not been previously examined by HOH.

B.A. Steinhagen Reservoir (Neches River drainage), southeast corner of causeway at US 190, 30°51.151' N, 94°10.411' W, Jasper County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.25 man-hours):

B.A. Steinhagen Reservoir, southeast corner of US 190 causeway					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Flat floater	0	1.0	very recently dead		2.9
Louisiana fatmucket	1	6.0	very recently dead		20.0
Yellow sandshell	0	4.0	very recently dead		11.4
Bankclimber	2	0.0	-		5.7
Texas heelsplitter	0	2.0	very recently dead		5.7
Bleufer	1	6.0	very recently dead		20.0
Giant floater	1	1.0	very recently dead		5.7
Southern mapleleaf	0	3.0	very recently dead		8.6
Western pimpleback	0	1.0	very recently dead		2.9
Gulf mapleleaf	0	3.0	very recently dead		8.6
Pistolgrip	0	2.0	very recently dead		5.7
Texas lilliput	0	1.0	very recently dead		2.9
Total specimens	5	30	35(L+D)	14.3%L	
Total species	4	11	12(L+D)		

This site was previously examined by a volunteer in 2000 (Howells 2001) during a mid-winter drawdown.

B.A. Steinhagen Reservoir, southeast corner of US 190 comparison	Feb 2000						Oct 2005					
	L	D	%L	%T	T*N*/h		L	D	%L	%T	T*N*/h	
Flat floater	0	1	0.0	1.2	2.0		0	1	0.0	2.9	4.0	
Rock-pocketbook	0	2	0.0	2.4	4.0		-	-	-	-	-	
Louisiana fatmucket	0	12	0.0	14.3	24.0		1	6	14.3	20.6	28.0	
Yellow sandshell	0	8	0.0	9.5	16.0		0	4	0.0	11.8	16.0	
Fragile papershell	0	11	0.0	13.1	22.0		-	-	-	-	-	
Threehorn wartyback	0	12	0.0	14.3	24.0		-	-	-	-	-	
Bankclimber	0	11	0.0	13.1	22.0		2	0	100.0	5.9	8.0	
Texas heelsplitter	-	-	-	-	-		0	2	0.0	5.9	8.0	
Bleufer	0	2	0.0	2.4	4.0		0	6	0.0	17.6	24.0	
Giant floater	0	8	0.0	9.5	16.0		1	1	50.0	5.9	8.0	
Southern mapleleaf	0	4	0.0	4.8	8.0		0	3	0.0	8.8	12.0	
Western pimpleback	0	11	0.0	13.1	22.0		1	0	100.0	2.9	4.0	
Gulf mapleleaf	-	-	-	-	-		0	3	0.0	8.8	12.0	
Pistolgrip	-	-	-	-	-		0	2	0.0	5.9	8.0	
Texas lilliput	-	1	0.0	1.2	2.0		0	1	0.0	2.9	4.0	
Paper pondshell	-	1	0.0	1.2	2.0		-	-	-	-	-	

Total specimens	0	84	0%L	168T/h				5	29	14.3%L	140T/h				
	84(L+D)							34(L+D)							
Total species	0	13						4	11						

When this site was examined in 2000, all unionids present were dead directly or indirectly due to low-water conditions. Despite this loss, mussels were apparently able to reinvade the area in the 5.6 years between surveys, but with slight reductions in abundance and diversity. CPUE was also slightly lower in 2005.

B.A. Steinhagen Reservoir (Neches River drainage), northeast corner of causeway at US 190, 30°51.775' N, 94°10.968' W, Jasper County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.33 man-hours) and found:

B.A. Steinhagen Reservoir, northeast corner of US 190 causeway					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Flat floater	0	4.0		very recently dead	2.4
Louisiana fatmucket	0	24.0		very recently dead-relatively long dead	14.2
Yellow sandshell	0	79.0		very recently dead-long dead	46.7
Fragile papershell	0	1.0		relatively long dead	0.6
Texas heelsplitter	0	1.0		very recently dead	0.6
Bleufer	0	16.0		very recently dead-long dead	9.5
Giant floater	0	5.0		very recently dead-relatively long dead	3.0
Southern mapleleaf	0	3.0		very recently dead	1.8
Western pimpleback	0	7.0		very recently dead	4.1
Gulf mapleleaf	0	3.0		very recently dead	1.8
Pistolgrip	0	8.0		very recently dead-relatively long dead	4.7
Texas lilliput	0	18.0		very recently dead	10.7
Total specimens	0	169	169(L+D)	0.0%L	
Total species	0	12	12(L+D)		

This site was previously examined by HOH in 1993 (Howells 1995), by a volunteer in 2000 (Howells), and on several other dates when data from this site was pooled with other sites on this impoundment.

B.A. Steinhagen Reservoir, northeast corner of US 190 comparison	May 1993					Feb 2000					Oct 2005				
	L	D	%Lsp	%T	T*N*/h	L	D	%Lsp	%T	T*N*/h	L	D	%Lsp	%T	T*N*/h
Threeridge	-	-	-	-	-	0	2	0.0	2.0	4.0	-	-	-	-	-
Flat floater	-	-	-	-	-	0	2	0.0	2.0	4.0	0	4	0.0	2.4	3.0
Louisiana fatmucket	4	0	100.0	23.5	8.0	0	18	0.0	18.2	36.0	0	24	0.0	14.2	72.0
Yellow sandshell	5	1	83.3	35.3	12.0	0	14	0.0	14.1	28.0	0	79	0.0	46.7	237.0
Fragile papershell	-	-	-	-	-	0	6	0.0	6.1	12.0	0	1	0.0	0.6	3.0
Bankclimber	-	-	-	-	-	0	10	0.0	10.1	20.0	-	-	-	-	-
Texas heelsplitter	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.6	3.0
Bleufer	1	1	50.0	11.8	4.0	0	7	0.0	7.1	14.0	0	16	0.0	9.5	48.0
Giant floater	4	0	100.0	23.5	8.0	0	11	0.0	11.1	22.0	0	5	0.0	3.0	15.0
Southern mapleleaf	-	-	-	-	-	0	1	0.0	1.0	2.0	0	3	0.0	1.8	9.0
Western pimpleback	-	-	-	-	-	0	18	0.0	18.2	36.0	0	7	0.0	4.1	21.0

Gulf mapleleaf	-	-	-	-	-	0	2	0.0	2.0	4.0	0	3	0.0	1.8	9.0
Pistolgrip	-	-	-	-	-						0	8	0.0	4.7	24.0
Texas lilliput	0	1	0.0	5.9	2.0	0	2	0.0	2.0	4.0	0	18	0.0	10.7	54.0
Fawnsfoot	-	-	-	-	-	0	1	0.0	1.0	2.0	-	-	-	-	-
Pondhorn	-	-	-	-	-	0	2	0.0	2.0	2.0	-	-	-	-	-
Paper pondshell	-	-	-	-	-	0	3	0.0	3.0	6.0	-	-	-	-	-
Total specimens	14	3	82.4%L	34/h		0	99	0.0%L	198T/h		0	169	0.0%L	507T/h	
	17(L+D)					99(L+D)					169(L+D)				
Total species	4	3	5(L+D)			0	15	15(L+D)			0	12	12(L+D)		

The May 1993 collection was made during a normal pool level at this reservoir using wading and snorkeling. However, the 2000 and 2005 samples were taken during drawdowns when mussels were stranded on exposed bottoms or located in shallow waters where they were more easily documented. Despite losses in 2000, unionids were able to reoccupy this site prior to the 2005 dewatering, but diversity may be declining over time. Some of the most abundant species in 2000 were again abundant in 2005 (Louisiana fatmucket, yellow sandshell, and bleufer); however, yellow sandshell increased in abundance over this period.

B.A. Steinhagen Reservoir (Neches River drainage), south shore of Martin Dies State Park main unit at the end of Park Road 48 and north of Sandy Creek Park (reported as Site 5 close to Martin Dies State Park, end of Park Road 48), 30°50.403' N, 94°10.110' W, Jasper County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.5 man-hours):

B.A. Steinhagen Reservoir, south shore of Martin Dies State Park, 0.5 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Rock-pocketbook	0	1.0	very recently dead	0.6
Louisiana fatmucket	0	1.0	very recently dead	0.6
Yellow sandshell	0	14.0+0.5x1	very recently dead- long dead	9.6
Fragile papershell	0	14.0	very recently dead	9.0
Threehorn wartyback	0	47.0+0.5x3	very recently dead-relatively recently dead	32.1
Bankclimber	1	5.0	very recently dead	3.8
Texas heelsplitter	0	4.0	very recently dead	2.6
Bleufer	2	15.0	very recently dead	10.9
Giant floater	0	6.0	very recently dead	3.8
Western pimpleback	0	38.0+0.5x3	very recently dead-relatively long dead	26.3
Gulf mapleleaf	0	1.0	very recently dead	0.6
Total specimens	3	153	156(L+D) 1.9%L	
Total species	2	11	11(L+D)	

This site was previously examined by HOH 1996 (Howells 1997a) and 1999 (Howells 2000) and summarized by Howells et al. (2000).

B.A. Steinhagen Reservoir, Martin Dies State Park comparison	Jan 1996		Jan 1999							Oct 2005						
	L+ D	%T	L	D	L+D	%Lsp	%L	%T	T*N*/h	L	D	L+D	%Lsp	%L	%T	T*N*/h
Threeridge	19	3.6	0	1	1	0.0	0.0	0.7	1.0	-	-	-	-	-	-	-
Rock-pocketbook	3	0.6	2	0	2	100.0	2.1	1.4	2.0	0	1	1	0.0	0.0	0.6	2

Louisiana fatmucket	133	25.1	4	2	6	66.7	4.2	4.1	6.0	0	1	1	0.0	0.0	0.6	2
Yellow sandshell	14	2.6	10	15	25	40.0	10.5	17.1	25.0	0	15	15	0.0	0.0	9.6	30
Fragile papershell	28	5.3	8	3	11	72.7	8.4	7.5	11.0	0	14	14	0.0	0.0	9.0	28
Washboard	2	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Threehorn wartyback	39	7.4	12	4	16	75.0	12.6	11.0	16.0	0	50	50	0.0	0.0	32.1	100
Bankclimber	65	12.3	6	4	10	6.8	6.3	6.8	10.0	1	5	6	16.7	33.3	3.8	12
Texas heelsplitter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bluefer	25	4.7	10	8	18	55.6	10.5	12.3	18.0	2	4	6	33.3	66.7	3.8	12
Giant floater	12	2.3	5	5	10	50.0	5.3	6.8	10.0	0	15	15	0.0	0.0	9.6	30
Southern mapleleaf	3	0.6	5	0	5	100.0	5.3	3.4	5.0	0	6	6	0.0	0.0	3.8	12
Western pimpleback	101	19.1	15	8	23	65.2	15.8	15.8	23.0	0	41	41	0.0	0.0	26.3	82
Gulf mapleleaf	5	0.9	18	0	18	100.0	18.9	12.3	18.0	0	1	1	0.0	0.0	0.6	2
Pistolgrip	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Texas lilliput	40	7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	
Fawnsfoot	29	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-	
Paper pondshell	12	2.3	0	1	1	0.0	0.0	0.7	1.0	-	-	-	-	-	-	
Total specimens	530		95	51	146	65.1%L		146T/h		3	153	156	1.9%L		312T/h	
Total species	16		11	10	13					2	11	11				

In 1996, the COE that operates this reservoir conducted a 2-m drawdown in winter to kill noxious aquatic macrophytes. The HOH survey took place just as the 2-m level was reached. Some specimens had followed the declining water line, others dug into the substrate or buried under stranded macrophyte mats. Shortly after this survey, extreme freezing temperatures caused mortality among virtually all mussels present above the water line (Howells et al. 2000). The 1999 survey was also conducted just as the 2.0-m drawdown level was reached during a second attempt to winter-kill macrophytes. Other similar drawdowns occurred in this impoundment and mussels were exposed to dewatering for an extended period prior to the 2005 survey. Over time, species diversity appears to be declining and while several species remained somewhat abundant, mortality has increased. The apparent increase in CPUE in 2005 largely reflects low water level that facilitated easier collection of specimens.

B.A. Steinhagen Reservoir (Neches River drainage), Sandy Creek Park at CR 155, 30º49.840' N, 94º09.653' W, Jasper County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.5 man-hours):

B.A. Steinhagen Reservoir, Sandy Creek Park, 0.5 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	0	3.0	very recently dead to long dead	2.1
Flat floater	0	7.0	very recently dead	4.8
Louisiana fatmucket	0	9.0	very recently dead	6.2
Yellow sandshell	0	18.0	very recently dead	12.4
Fragile papershell	0	6.0	very recently dead	4.1
Threehorn wartyback	0	5.0	very recently dead	3.4
Bankclimber	1	8.0	very recently dead	6.2
Bleufer	0	7.0	very recently dead	4.8
Giant floater	0	33.0	very recently dead	22.8
Southern mapleleaf	0	3.0	very recently dead	2.1
Western pimpleback	0	44.0	very recently dead	30.3
Texas lilliput	1	0.0	-	0.7

Total specimens	2	143	145(L+D)	1.4%L
Total species	2	11	12(L+D)	

Sandy Creek Park was examined by HOH in 1996 (Howells 1997a) and again in 1999 (Howells 2000a) and is summarized in Howells et al. (2000). In 1999, both random area and timed (0.25 h) searches were used. Only the timed search data are presented below:

B.A. Steinhagen Reservoir, Sandy Creek Park comparison	Jan 1996		Jan 1999							Oct 2005						
	L+ D	%T	L	D	L+D	%Lsp	%L	%T	T*N*/h	L	D	L+D	%Lsp	%L	%T	T*N*/h
Threeridge	15	5.5	1	0	1	100.0	2.3	1.3	2.0	0	3	3	0.0	0.0	2.1	6.0
Flat floater	-	-	-	-	-	-	-	-	-	0	7	7	0.0	0.0	4.8	14.0
Rock-pocketbook	2	0.7	0	1	1	0.0	0.0	1.3	2.0	-	-	-	-	-	-	-
Louisiana fatmucket	17	6.3	2	2	4	50.0	4.9	5.1	8.0	0	9	9	0.0	0.0	6.2	18.0
Yellow sandshell	61	22.4	10	24	34	29.4	24.4	43.6	51.0	0	18	18	0.0	0.0	12.4	36.0
Fragile papershell	13	4.8	3	0	3	100.0	7.3	3.8	6.0	0	6	6	0.0	0.0	4.1	12.0
Pond mussel	-	-	1	0	1	100.0	2.3	1.3	2.0	-	-	-	-	-	-	-
Washboard	2	0.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Threehorn wartyback	52	19.1	3	0	3	100.0	7.3	3.8	6.0	0	5	5	0.0	0.0	3.4	10.0
Bankclimber	16	5.9	2	5	7	28.6	4.9	9.0	14.0	1	8	9	11.0	50.0	6.2	18.0
Texas heelsplitter	2	0.7	0	1	1	0.0	0.0	1.3	2.0	-	-	-	-	-	-	-
Bluefer	20	7.4	5	2	7	71.4	12.2	9.0	14.0	0	7	7	0.0	0.0	4.8	14.0
Giant floater	11	4.0	2	0	2	100.0	4.9	2.6	4.0	0	33	33	0.0	0.0	22.8	66.0
Southern mapleleaf	2	0.7	6	0	6	100.0	14.6	7.7	12.0	0	3	3	0.0	0.0	2.1	6.0
Western pimpleback	45	16.5	5	2	7	71.4	12.2	9.0	14.0	0	44	44	0.0	0.0	30.3	88.0
Gulf mapleleaf	14	5.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	-	-	-		1	0	1	100.0	50.0	0.7
2.0																
Paper pondshell	-	-	1	0	1	100.0	2.3	1.3	2.0	-	-	-	-	-	-	-
Total specimens	272		41	37	78	52.6%L		156T/h		2	143	145		1.4%L		290T/h
Total species	14		12	7	14					2	11	12				

As with other locations on B.A. Steinhagen Reservoir, the Sandy Creek Park area on the southeastern corner of the reservoir appears to be losing mussel diversity associated with repeated dewatering. Further, mortality associated with each drawdown appears to be substantial.

B.A. Steinhagen Reservoir (Neches River drainage), embayment on northwest corner of US 190 causeway, 30°51.266' N, 94°12.833' W, Tyler County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.33 man-hours):

B.A. Steinhagen Reservoir, northwest corner of US 190, 0.33 man-hours Species	*N* alive	*N* shells	Condition	Percent of total (L+D)
Giant floater	0	1.0	relatively recently dead	33.3
Texas lilliput	1	1.0	relatively long dead	66.7
Total specimens	1	2	3(L+D) 33.3%L	

Total species	1	2	2(L+D)

This site was previously examined by HOH in 1993 (Howells 1995), 1996 (Howells 1997a), and 1999 (Howells 2000), and by HOH and SFASU in 2004 (Howells 2005). The 1993 examination occurred during normal pool levels and employed snorkeling (4 man-hours); in 1996 and 1999, surveys were conducted on exposed bottom or in very shallow waters during drawdown and the 1996 data were combined with other reservoir sites and reported as a total for the impoundment.

B.A. Steinhagen Reservoir, cove NW of US 190	May 1993						Jan 1999						Sep 2005					
comparison	L	D	%Lsp	%L	%T	NT/h	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	NT/h
Flat floater	2	2	50.0	2.0	1.7	1.0	-	-	-	-	-	-	-	-	-	-	-	-
Rock-pocketbook	0	1	0.0	0.0	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Louisiana fatmucket	31	1	96.9	31.6	27.4	8.0	0	1	0.0	0.0	16.7	2.0	-	-	-	-	-	-
Yellow sandshell	12	1	93.3	12.2	11.1	3.3	-	-	-	-	-	-	-	-	-	-	-	-
Bankclimber	2	0	100.0	2.0	1.7	0.5	0	3	0.0	0.0	50.0	6.0	-	-	-	-	-	-
Giant floater	44	9	83.0	44.9	45.3	13.3	0	2	0.0	0.0	33.3	4.0	0	1	0.0	0.0	33.3	3.0
Southern mapleleaf	1	1	50.0	1.0	1.7	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Western pimpleback	1	0	100.0	1.0	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Texas lilliput	4	4	50.0	4.1	6.8	2.0	-	-	-	-	-	-	1	1	100.0	100.0	66.7	6.0
Paper pondshell	1	0	100.0	1.0	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Total specimens	98	19	117(L+D)		29.3T/h		0	6	6(L+D)		12.0T/h		1	2	3(L+D)	33.3%L		9.0/h
Total species	9	7	10				0	3	3(L+D)				1	2	2(L+D)			

This cove supported a moderately diverse and abundant assemblage of unionids dominated by soft-bottom and shallow-water taxa. Many of these species are less resistant to desiccation and predation during dewatering. The impact of repeated drawdown is marked by significant reductions in both abundance and diversity.

B.A. Steinhagen Reservoir (Neches River drainage), west side of Town Bluff dam (southwest corner of the reservoir), 30°47.734' N, 94°10.866' W, Tyler County, Texas, 24 October 2005.
SFASU personnel examined this site using a timed search (0.5 man-hours):

B.A. Steinhagen Reservoir, west side of Town Bluff dam, 0.5 man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Louisiana fatmucket	0	3.0		very recently dead	3.8
Yellow sandshell	2	22.0		very recently dead	30.0
Fragile papershell	0	8.0		very recently dead	10.0
Threehorn wartyback	0	4.0		very recently dead	5.0
Texas heelsplitter	0	5.0		very recently dead	6.3
Bleufer	0	5.0		very recently dead	6.3
Western pimpleback	3	0.0		-	3.8
Pistolgrip	0	19.0		very recently dead	23.8
Fawnsfoot	0	9.0		very recently dead	11.3
Total specimens	5	75	80(L+D)	6.3%L	
Total species	2	8	9(L+D)		

This location was examined by HOH in 1996 (Howells 1997a) and 1999 (Howells 2000). In 1999, both random and timed searches were conducted, but only timed search (0.08 man-hour) results are presented below.

B.A. Steinhagen Reservoir, west side at Town Bluff Dam comparison	Jan 1996		Jan 1999						Oct 2005					
	L+D	%T	L	D	%Lsp	%L	%T	NT/h	L	D	%Lsp	%L	%T	*N*L/h
Threeridge	14	3.6	3	1	75.0	3.9	4.9	48.0	-	-	-	-	-	-
Rock-pocketbook	5	1.3	-	-	-	-	-	-	-	-	-	-	-	-
Louisiana fatmucket	23	6.0	4	0	100.0	5.2	4.9	48.0	0	3	0.0	0.0	3.8	6.0
Yellow sandshell	33	8.6	5	2	71.4	6.5	8.5	84.0	2	22	8.3	40.0	30.0	48.0
Fragile papershell	15	3.9	3	0	100.0	3.9	3.7	36.0	0	8	0.0	0.0	10.0	16.0
Washboard	4	1.0	2	0	100.0	2.6	2.4	24.0	-	-	-	-	-	-
Threehorn wartyback	45	11.7	10	1	90.9	13.0	13.4	132.0	0	4	0.0	0.0	5.0	8.0
Bankclimber	55	14.3	32	0	100.0	41.6	39.0	384.0	-	-	-	-	-	-
Texas heelsplitter	-	-	-	-	-	-	-	-	0	5	0.0	0.0	6.3	10.0
Bleufer	38	9.9	6	0	100.0	7.9	7.3	72.0	0	5	0.0	0.0	6.3	10.0
Giant floater	47	12.2	-	-	-	-	-	-	-	-	-	-	-	-
Southern mapleleaf	9	2.3	-	-	-	-	-	-	-	-	-	-	-	-
Western pimpleback	67	17.4	11	1	91.7	14.3	14.6	144.0	3	0	100.0	60.0	3.8	6.0
Gulf mapleleaf	20	5.2	-	-	-	-	-	-	-	-	-	-	-	-
Pistolgrip	1	0.3	-	-	-	-	-	-	0	19	0.0	0.0	23.8	38.0
Texas lilliput	6	1.6	-	-	-	-	-	-	-	-	-	-	-	-
Fawnsfoot	-	-	-	-	-	-	-	-	0	9	0.0	0.0	11.3	19.0
Deertoe	-	-	1	0	100.0	1.3	1.2	12.0	-	-	-	-	-	-
Paper pondshell	2	0.5	-	-	-	-	-	-	-	-	-	-	-	-
Total specimens	384		77	5		93.9%L		984T/h	5	75		6.3%L		160T/h
			82(L+D)						80(L+D)					
Total species	16		10	4	10(L+D)				2	8	9(L+D)			

This site contained a high-density bed of heavy-shelled mussels when examined in 1996 and 1999 (e.g., threeridge, washboard). In addition to losses related to recurrent dewatering, it is possible this site was harvested by commercial musselers. In particular, washboards in this reservoir have especially good-quality shells valued by commercial musselers. Had drawdown-related losses been the only source of mortality, SFASU surveys would have been expected to find dead shells from heavy-shelled species.

Presented below are selected pooled samples by year that provide an indication of species composition, percent found alive, and percent of the total mussel assemblage reservoir-wide in B.A. Steinhagen Reservoir.

B.A. Steinhagen Reservoir – pooled data comparison	May 1993				Jan 1996				Jan 1999				Oct 2005			
	T*N*	%Lsp	%L	%T	T*N*	%Lsp	%L	%T	T*N*	%Lsp	%L	%T	T*N*	%Lsp	%L	%T
Threeridge	-	-	-	-	94	50.0	7.2	6.5	50	28.0	3.9	7.8	7	0.0	0.0	0.9
Flat floater	4	50.0	2.1	1.7	4	50.0	0.3	0.3	-	-	-	-	14	0.0	0.0	1.9
Rock-pocketbook	2	100.0	1.7	1.7	41	46.3	2.9	2.8	6	83.3	1.4	0.9	1	0.0	0.0	0.1
Louisiana fatmucket	52	94.2	41.9	27.8	141	49.7	10.8	9.8	40	60.0	6.6	6.3	46	2.2	2.6	6.3
Sandbank	-	-	-	-	-	-	-	-	1	0.0	0.0	0.2	-	-	-	-

pocketbook																
Yellow sandshell	39	71.8	23.9	20.9	173	39.7	10.5	12.0	165	52.1	23.8	25.9	208	8.7	47.4	28.1
Fragile papershell	2	100.0	1.1	1.7	97	50.5	7.6	9.2	37	37.8	3.9	5.8	31	0.0	0.0	4.2
Washboard	-	-	-	-	7	57.1	0.6	0.5	8	100.0	2.2	1.3	-	-	-	-
Threehorn wartyback	-	-	-	-	141	42.0	9.1	9.8	37	73.0	7.5	5.8	63	0.0	0.0	8.5
Bankclimber	1	100.0	0.9	0.5	98	60.2	9.1	6.8	67	67.2	12.5	10.5	37	16.2	15.8	5.0
Texas heelsplitter	1	0.0	0.0	0.5	31	35.5	1.7	2.1	11	45.5	1.4	1.7	12	0.0	0.0	1.6
Bleufer	4	75.0	2.6	2.1	162	39.5	9.9	11.2	51	51.0	7.2	8.0	74	6.8	13.2	10.2
Giant floater	67	87.0	20.5	35.8	81	65.6	6.9	5.6	43	20.9	2.5	6.8	61	1.7	2.6	8.3
Southern mapleleaf	2	50.0	0.9	1.1	52	38.5	3.1	3.6	17	100.0	4.7	2.7	12	0.0	0.0	1.6
Western pimpleback	3	0.0	0.0	1.6	217	43.3	14.5	15.0	77	76.7	16.3	12.1	57	5.3	7.9	7.7
Gulf mapleleaf	-	-	-	-	38	62.5	3.1	2.6	22	86.4	5.3	3.5	51	0.0	0.0	6.9
Pistolgrip	-	-	-	-	1	100.0	0.2	0.1	1	100.0	0.2	0.2	30	3.3	2.6	4.1
Lilliput	-	-	-	-	1	0.0	0.0	0.1	-	-	-	-	-	-	-	-
Texas lilliput	9	44.4	3.4	4.8	8	37.5	0.5	0.6	1	0.0	0.0	0.2	24	14.3	7.9	3.3
Fawnsfoot	-	-	-	-	15	73.3	1.7	1.0	-	-	-	-	9	0.0	0.0	1.2
Deertoe	-	-	-	-	1	0.0	0.0	0.1	1	100.0	0.2	0.2	-	-	-	-
Paper pondshell	1	100.0	0.9	0.2	5	60.0	0.5	0.3	2	50.0	0.2	0.5	1	0.0	0.0	0.1
Total specimens	187		81.6%L		1408		46.1%L		637		51.3%L		738		5.1%L	
Total species	13				21				19				18			

B.A. Steinhagen Reservoir and the Neches River immediately down stream of Town Bluff Dam has supported the most abundant and diverse unionid assemblage found to date by HOH in Texas. Some 25 species have been documented in the reservoir, with two more species found below the dam; seven others occur up- or downstream in the Neches and Angelina rivers or in the general area. This impoundment has noxious growths of floating waterhyacinth (*Eichhornia crassipes*) and hydrilla (*Hydrilla verticillata*) and more recently, common salvinia (*Salvinia minima*). Excessive macrophyte growth can exclude unionids from many areas if left unmanaged. Weed management techniques that would apply to all three species typically have negative effects on mussels. Since the early 1990s, TPWD and the COE (reservoir operator) have employed mid-winter drawdowns to reduce macrophyte density through desiccation and cold kills. Typically, every two years, the COE slowly drop water levels 2 m during January and February. Drop rate is moderately slow and drawdown duration as short as possible. This allows unionids to follow the declining water line, dig into substrate, or bury under stranded macrophyte mats. Although this should minimize mussel mortality, repeated drawdowns may be decreasing abundance and diversity as well as causing shifts in composition of the mussel assemblage.

Neches River

Neches River, below Town Bluff Dam, 30°47.567 N, 94°10.079 W, Tyler County, Texas, 28 October 2005. SFASU staff conducted timed searches (1.0 man-hour) at this location and found the following specimens:

Neches River, below Town Bluff Dam, 28 October 2005, 1.0 man-hour				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	20	2.0+0.5x1	recently dead to long dead	8.2
Rock-pocketbook	0	2.0	relatively recently dead	0.7
Sandbank pocketbook	0	6.0	relatively recently dead-relatively long dead	2.2
Yellow sandshell	0	4.0	relatively recently dead-relatively long dead	1.5
Fragile papershell	0	8.0	relatively recently dead-relatively long dead	3.0

Washboard	3	1.0	recently dead	1.5
Threehorn wartyback	33	18	recently dead-relatively long dead	19.1
Bankclimber	9	4.0	relatively recently dead-very long dead	4.9
Texas heelsplitter	0	1.0	relatively long dead	0.3
Bleufer	0	4.0	relatively recently dead-long dead	1.5
Southern mapleleaf	10	7.0	relatively recently dead-relatively long dead	6.4
Western pimpleback	65	14	relatively recently dead-long dead	29.6
Gulf mapleleaf	4	3.0	relatively recently dead-relatively long dead	2.6
Pistolgrip	18	6.0	relatively recently dead-relatively long dead	9.0
Fawnsfoot	0	2.0	relatively recently dead	0.7
Deertoe	4	9.0	relatively recently dead-relatively long dead	4.9
Wartyback	5	4.0	recently dead-long dead	3.4
Total specimens	171	96	267(L+D) 64.0%L	
Total species	10	17	17 (L+D)	

28 October 2005; SFASU also examined this site using 12, 0.25-m^2 quadrats:

Neches River, below Town Bluff Dam, 28 October 2005 – quadrat samples

	Total/12 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threehorn wartyback	11	0.0	3.7	0.0	-	26.8
Bankclimber	2	0.0	0.7	0.0	-	4.9
Southern mapleleaf	2	0.0	0.7	0.0	-	4.9
Western pimpleback	21	0.0	7.0	0.0	-	51.2
Gulf mapleleaf	3	0.0	1.0	0.0	-	7.3
Pistolgrip	1	0.0	0.3	0.0	-	2.4
Deertoe	1	0.0	0.3	0.0	-	2.4
Total specimens	41	0	41(L+D)		13.7/m^2	
Total species	7	0	7(L+D)			

This site was first surveyed by HOH in May 1993 when a brail was used under high-water conditions Howells 1995). A local biologist reported species found during a brief collection in July 1994 (Howells 1995). It was examined again in January 1996 during a mid-winter drawdown of B.A. Steinhagen Reservoir and with the assistance of a group of biologists gathered for a mussel workshop; brail, dredge, and hand collection were employed. The HOH staff surveyed this site in September 1996 during very low water; hand collections were made by snorkeling, wading, and on an exposed gravel bar (Howells 1997a). A volunteer attempted to survey this area during very high water conditions in March 2002, but located only a small number of specimens due to difficult conditions. In August 2004, HOH and SFASU staff visited this site to familiarize SFASU personnel with the area prior to their formal SWG-funded survey work (shown above and summarized below), but no detailed species counts were conducted (Howells 2005).

Neches River below Town Bluff Dam	May 1993				Jan 1996					Sep 1996					
comparison	L	D	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	3	0	2.9	2.9	1	18	5.3	1.0	5.2	35	4	89.7	8.6	7.3	6.5

Flat floater	-	-	-	-	1	0	100.0	1.0	0.3	-	-	-	-	-	-
Rock–pocketbook	1	0	1.0	1.0	0	frags	0.0	-	-	1	0	100.0	0.2	0.2	0.2
Louisiana fatmucket	-	-	-	-	0	7	0.0	0.0	1.9	1	2	33.3	0.2	0.6	0.5
Sandbank pocketbook	1	0	1.0	1.0	1	15	6.3	1.0	4.4	4	42	8.7	1.0	8.6	7.7
Yellow sandshell	-	-	-	-	0	19	0.0	0.0	5.2	15	0	100.0	3.7	2.8	2.5
Fragile papershell	1	0	1.0	1.0	0	12	0.0	0.0	3.3	1	1	50.0	0.2	0.4	0.3
Pond mussel	-	-	-	-	0	1	0.0	0.0	0.3	-	-	-	-	-	-
Washboard	-	-	-	-	3	1	25.0	3.1	1.1	2	2	50.0	0.5	0.7	0.7
Threehorn wartyback	6	0	5.8	5.7	15	30	33.3	15.6	12.5	111	6	94.9	27.3	21.9	19.5
Bankclimber	-	-	-	-	3	16	15.8	3.1	1.1	25	1	96.2	6.2	4.9	4.3
Louisiana pigtoe	-	-	-	-	-	-	-	-	-	2	1	66.7	0.5	0.6	0.5
Texas heelsplitter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bleufer	0	2	0.0	1.9	3	20	13.0	3.1	6.3	13	2	86.7	3.2	2.8	2.5
Giant floater	-	-	-	-	0	1	0.0	0.0	0.3	-	-	-	-	-	-
Southern mapleleaf	2	0	1.9	1.9	0	11	0.0	0.0	3.0	39	9	81.3	9.6	9.0	8.0
Western pimpleback	78	0	75.7	74.3	44	54	44.9	45.8	26.9	49	4	92.5	12.1	9.9	8.8
Gulf mapleleaf	4	0	3.9	3.8	7	4	63.6	7.3	3.0	30	17	63.8	7.4	8.8	7.8
Wartyback	6	0	5.8	5.7	3	1	75.0	3.1	1.1	5	4	55.6	0.7	1.7	1.5
Texas lilliput	-	-	-	-	0	1	0.0	0.0	0.3	-	-	-	-	-	-
Pistolgrip	-	-	-	-	7	25	21.9	7.3	8.8	21	21	50.0	5.2	7.9	7.0
Fawnsfoot	1	0	1.0	1.0	2	11	15.4	2.1	3.6	3	1	75.0	0.7	0.7	0.7
Deertoe	-	-	-	-	6	21	22.2	6.3	7.4	49	16	75.4	12.1	12.1	10.7
Paper pondshell	-	-	-	-	0	frags	-	-	-	-	-	-	-	-	-
Total specimens	103	2	98.1%L		96	268	26.4%L			406	133	75.3%L			
	105(L+D)				364(L+D)					539(L+D)					
Total species	10	1	11(L+D)		13	21	22(L+D)			18	16	18(L+D)			

continued

continued	Aug 2004						Oct 2005					
	L	D	%Lsp	%L	%T	*N*L/h	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	P	P	-	-	-	-	20	3	86.9	11.7	8.2	23.0
Rock-pocketbook	0	1	0.0	-	2.4	1.0	0	2	0.0	0.0	0.7	2.0
Sandbank pocketbook	1	12	7.7	-	31.7	13.0	0	6	0.0	0.0	2.2	6.0
Yellow sandshell	0	2	0.0	-	4.9	2.0	0	4	0.0	0.0	1.5	4.0
Fragile papershell	-	-	-	-	-	-	0	8	0.0	0.0	3.0	8.0
Washboard	P	P	-	-	-	-	3	1	75.0	1.8	1.5	4.0
Threehorn wartyback	P	P	-	-	-	-	33	18	64.7	19.3	19.1	51.0
Bankclimber	P	P	-	-	-	-	9	4	69.2	5.3	4.9	13.0
Texas heelsplitter	0	5	0.0	-	12.2	5.0	0	1	0.0	0.0	0.4	1.0
Bleufer	P	P	-	-	-	-	0	4	0.0	0.0	1.5	4.0
Giant floater	-	-	-	-	-	-	-	-	-	-	-	-
Southern mapleleaf	1	1	50.0	-	4.9	2.0	10	7	58.8	5.8	6.4	17.0
Western pimpleback	1	0	100.0	-	2.4	1.0	65	14	82.3	38.0	29.6	79.0
Gulf mapleleaf	0	4	0.0	-	9.8	4.0	4	3	57.1	2.3	2.6	7.0
Wartyback	1	1	50.0	-	4.9	2.0	5	4	55.5	2.9	3.4	9.0
Texas lilliput	-	-	-	-	-	-	-	-	-	-	-	
Pistolgrip	0	4	0.0	-	9.8	4.0	18	6	75.0	10.5	9.0	24.0
Fawnsfoot	0	5	0.0	-	12.2	5.0	0	2	0.0	0.0	0.7	2.0
Deertoe	2	0	100.0	-	4.9	2.0	4	9	30.8	2.3	4.9	13.0

Paper pondshell	-	-	-	-	-	-			-	-	-	-	-	-		
Total specimens	-	-	-	-	-	-			171	96	267(L+D)		64.0%L			
Total species	10	15	16(L+D)						10	17	17(L+D)					

Each of the major sampling efforts in the Neches River downstream from B.A. Steinhagen Reservoir (from Town Bluff Dam downstream ca 1.5 km) was conducted with different water levels and flow rates, varying numbers of people, and several sampling techniques. Subsequently, direct comparisons are difficult. Nonetheless, the mussel assemblage here can be characterized as having among the highest diversity and densities found by HOH in Texas. This assemblage has been dominated by western pimpleback and threehorn wartyback, with southern mapleleaf, Gulf mapleleaf, threeridge, and washboards in good numbers. Several species appear to be more abundant here that at any other site documented in Texas including fawnsfoot and wartyback. Both occur elsewhere in Texas, but not in significant numbers. Fawnsfoot has been found on each visit. Similarly, wartyback was also present on each examining, at least until the SFASU survey in 2005 when none were found. More sandbank pocketbooks appear present here than anywhere else in the state. Another interesting shift over time was the absence of Texas heelsplitter in earlier samples. This rare endemic species had been found in the reservoir upstream, but was not documented below Town Bluff Dam until 1996 when J.A.M. Bergmann reported a specimen some distance downstream (Howells 1997a). However, when HOH and SFASU examined this site in 2004, not only were there a substantial number of Texas heelsplitters, but the different sizes of juveniles suggested a reproducing population. Extremely rare Louisiana pigtoes have been found alive here. Direct threats from exotic macrophytes that are problematic in B.A. Steinhagen Reservoir are not significant issues in the river below Town Bluff Dam. Maintaining acceptable flow rates appears to be among the most important elements needed to keep this assemblage secure.

Village Creek

Village Creek, at FM 418, 30°17.567' N, 94°10.079' W, Hardin County, Texas, 3 September 2005.

SFASU staff examined this site using timed searches (3.0 man-hours total) and reported the following:

Village Creek, at FM 418, 3.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	8	0.0		5.9
Texas pigtoe	64	1.0	long dead	47.8
Triangle pigtoe	18	0.0	-	13.2
Louisiana fatmucket	2	0.0	-	1.5
Yellow sandshell	1	1.0	long dead	1.5
Fragile papershell	0	1.0	long dead	0.7
Threehorn wartyback	1	0.0	-	0.7
Louisiana pigtoe	6	1.0	relatively long dead	5.1
Bankclimber	4	1.0	long dead	3.7
Bleufer	1	2.0	relatively recently dead	2.2
Western pimpleback	22	0.0	-	16.2
Unidentified unionids*	0	2.0	very long dead	1.5
Total specimens	127	9	136(L+D) 93.4%L	
Total species	10	7	12(L+D)	

*Unidentified unionids were suspected of being either Texas lilliput or little spectaclecase.

SFASU also examined this site using 10, 0.25-m^2 quadrats:

Village Creek	Total/10 quadrats	Mean *N*/m^2

at FM 418 Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	1	0.0	0.4	relatively long dead	5.9
Louisiana fatmucket	1	0	0.4	0.0	-	5.9
Texas pigtoe	6	0	2.4	0.0	-	35.3
Triangle pigtoe	2	0	0.8	0.0	-	11.8
Western pimpleback	5	1	2.0	0.0	relatively long dead	35.3
Louisiana pigtoe	1	0	0.4	0.0	-	5.9
Total specimens	15	2	17(L+D)		88.2%L	
Total species	5	2	6(L+D)			

Personnel from Lamar University surveyed this site on 20 May 2002 (Howells 2003); however, only living specimens were documented.

Village Creek at FM 418 comparison	May 2002			Sep 2005				
Species	L	%L	%T	L	D	%L	%T	
Threeridge	1	2.2	-	8	0	6.3	5.9	
Texas pigtoe	11	23.9	-	64	1	50.4	47.8	
Triangle pigtoe	5	10.9	-	18	0	14.2	13.2	
Louisiana fatmucket	7	15.2	-	2	0	1.6	1.5	
Yellow sandshell	-	-	-	1	1	0.8	1.5	
Fragile papershell	-	-	-	0	1	0.0	0.7	
Threehorn wartyback	-	-	-	1	0	0.8	0.7	
Louisiana pigtoe	-	-	-	6	1	4.7	5.1	
Bankclimber	-	-	-	4	1	3.1	3.7	
Bleufer	-	-	-	1	2	0.8	2.2	
Western pimpleback	12	26.1	-	22	0	17.3	16.2	
Wartyback	4	8.7	-	-	-	-	-	
Texas lilliput	3	6.5	-	-	-	-	-	
Little spectaclecase	3	6.5	-	-	-	-	-	
Unidentified unionids	-	-	-	0	2	-	1.5	
Total specimens	46			127	9	136(L+D)		93.4%L
Total species	8			10	7	12(L+D)		

Village Creek, at SH 327, 30°20.816’ N, 94°14.353’ W, Hardin County, Texas, 3 September 2006.
SFASU staff examined this site using timed searches (3.0 man-hours total) and reported the following:

Village Creek, at SH 327, 3.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	14	0.0	-	12.8
Louisiana fatmucket	28	0.0	-	25.7
Yellow sandshell	1	0.0	-	0.9
Threehorn wartyback	1	0.0	-	0.9
Louisiana pigtoe	13	0.0	-	11.9
Bankclimber	6	0.0	-	5.5

Bleufer	3	0.0	-		2.8
Southern mapleleaf	1	0.0	-		0.9
Western pimpleback	42	0.0	-		38.5
Total specimens	109	0	109(L+D)	100.0%L	
Total species	9	0	9(L+D)		

Personnel from Lamar University surveyed this site on 14 May 2002 (Howells 2003); however, only living specimens were documented.

Village Creek, at SH 327 comparison	May 2002			Sep 2005				
Species	L	%L	%T	L	D	%L	%T	
Threeridge	14	15.5	-	14	0	12.8	12.8	
Texas pigtoe	1	1.1	-	-	-	-	-	
Louisiana fatmucket	34	37.8	-	28	0	25.7	25.7	
Yellow sandshell	4	4.4	-	1	0	0.9	0.9	
Threehorn wartyback	-	-	-	1	0	0.9	0.9	
Louisiana pigtoe	-	-	-	13	0	11.9	11.9	
Bankclimber	2	2.2	-	6	0	5.5	5.5	
Bleufer	1	1.1	-	3	0	2.8	2.8	
Southern mapleleaf	-	-	-	1	0	0.9	0.9	
Western pimpleback	3	3.3	-	42	0	38.5	38.5	
Wartyback	1	1.1	-	-	-	-	-	
Texas lilliput	16	17.8	-	-	-	-	-	
Little spectaclecase	14	15.5	-	-	-	-	-	
Total specimens	90			109	0	109(L+D)	100.0%L	
Total species	10			9	0	9(L+D)		

Village Creek, at US 96, 30°17.105' N, 94°11.488' W, Hardin County, Texas, 3 September 2005.
SFASU staff examined this site using timed searches (1.0 man-hour total) and reported the following:

Village Creek, at US 96, 1.0 man-hour Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Threeridge	20	0.0	-		11.4
Texas pigtoe	32	0.0	-		18.3
Triangle pigtoe	51	1.0	relatively long dead		29.1
Louisiana fatmucket	3	0.0	-		1.7
Yellow sandshell	3	0.0	-		1.7
Threehorn wartyback	4	0.0	-		2.3
Bankclimber	4	0.0	-		2.3
Bleufer	1	0.0	-		1.7
Louisiana pigtoe	6	0.0	-		3.4
Western pimpleback	38	10.0	relatively recently dead-relatively long dead		27.4
Pistolgrip	2	0.0	-		1.1
Total specimens	164	11	175(L+D)	93.7%L	
Total species	11	2	11(L+D)		

SFASU also examined this site using 11, 0.25-m^2 quadrats:

Village Creek, at US 96	Total/11 quadrats		Mean N/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	9	0	3.3	0.0	-	9.9
Texas pigtoe	7	0	2.5	0.0	-	7.7
Triangle pigtoe	6	0	2.2	0.0	-	6.6
Pigtoe *Fusconaia* sp.?	27	0	9.8	0.0	-	29.7
Louisiana fatmucket	2	0	0.7	0.0	-	2.2
Threehorn wartyback	3	0	1.1	0.0	-	3.3
Bankclimber	11	0	4.0	0.0	-	12.1
Louisiana pigtoe	7	0	2.5	0.0	-	7.7
Western pimpleback	19	0	6.9	0.0	-	20.9
Total specimens	91	0	91(L+D)		100.0%L	
Total species	9	0	9(L+D)			

This location was examined six times from 1977 through 1980 by Vidrine (1990) and the taxa below were reported. Personnel from Lamar University surveyed this site on 6 and 8 May 2002 (dates combined) (Howells 2003; Bordelon and Harrel 2004)); however, only living specimens were documented.

Village Creek, at US 96 comparison	Vidrine 1990		Lamar 2002		Sep 2005			
	L	%L	L	%L	L	D	%L	%T
Threeridge	253	27.2	31	4.9	20	0	12.2	11.4
Texas pigtoe	-	-	216	33.9	32	0	19.5	18.3
Triangle pigtoe	82	8.8	14	2.2	51	1	31.1	20.1
Fusconaia total	"82"	"8.8"	"230"	"36.1"	"83"	"1"	"50.6"	"48.0"
Louisiana fatmucket	112	12.0	27	4.2	3	0	1.8	1.7
Sandbank pocketbook	30	3.2	-	-	-	-	-	-
Yellow sandshell	18	1.9	24	3.8	3	0	1.8	1.7
Pond mussel	1	0.1	-	-	-	-	-	-
Washboard	1	0.1	-	-	-	-	-	-
Threehorn wartyback	18	1.9	4	0.6	4	0	2.4	2.3
Southern hickorynut	1	0.1	5	0.8	-	-	-	-
Bankclimber	50	5.4	29	4.6	4	0	2.4	2.3
Bleufer	2	0.2	2	0.3	1	0	1.8	1.7
Louisiana pigtoe	165	17.7	1	0.2	6	0	3.7	3.4
Southern mapleleaf	2	0.2	-	-	-	-	-	-
Gulf mapleleaf	1	0.1	-	-	-	-	-	-
Western pimpleback	152	16.3	257	40.3	38	10	23.1	27.4
Wartyback	-	-	20	3.1	-	-	-	-
Pistolgrip	9	1.0	1	0.2	2	0	1.2	1.1
Lilliput	1	0.1	-	-	-	-	-	-
Texas lilliput	1	0.1	5	0.8	-	-	-	-
Fawnsfoot	1	0.1	-	-	-	-	-	-

Pondhorn	1	0.1	-	-	-	-	-	-
Little spectaclecase	29	3.1	1	0.2	-	-	-	-
Total specimens	1030		637		164			
Total species	21		15		11			

The mussel assemblage at this site may have experienced a significant decline in abundance and diversity since the 1977-1980 collections by Vidrine (1990). However, differences in sampling effort make it difficult to draw conclusions. The fusconaid pigtoes (Texas and triangle pigtoe) were, and continue to be, taxonomically problematic. Specimens taken by Lamar University and SFASU, appear to include both species as well as some intermediate forms. Strecker (1931) also reported Wabash pigtoe (*Fusconaia flava*, listed as *F. undata*), an extremely variable species, in the Neches River as well. Unless and until genetic analysis clarifies the taxonomic status of the various fusconaids in Village Creek (and elsewhere in Texas) the disposition of these pigtoes will remain clouded. An additional point of interest is the dramatic decline in threeridges. Although both the Vidrine and Lamar collections only reported living specimens, the SFASU survey documented dead shell material as well. If the decline in threeridge abundance was due solely to mortality, SFASU would have found shells, but did not. This suggests that harvest (of both living and good-condition shells) may have been a cause of the reduction in threeridge abundance. It should be noted that Village Creek is a no-harvest mussel sanctuary, but the commercial shell mussels (including threeridges) in the lower Neches River are of a particularly high quality and Village Creek is not marked as a sanctuary anywhere along its course.

Village Creek was historically recognized for its abundant and diverse mussel assemblage. However, when HOH first surveyed this stream in April 1994, only two long-dead western pimpleback were found among several sites visited (Howells 1996a). The HOH staff returned with video tape showing deep-shifting sand bottoms and oil on the water surface at the sites they examined, and concluded that unionids in this stream appeared to have been lost [Howells, R.G. 1994. Losing the Old Shell Game. Info-Mussel Newsletter 2(4):5.]. However, shortly thereafter, R.C. Harrel (Lamar University, Beaumont, Texas) contacted HOH to report finding several species of living unionids still present in Village Creek. This ultimately led to work by Bordelon and Harrel (2004) contradicting the 1994 information and confirming that a significant mussel assemblage still persisted in Village Creek. Indeed, in addition to rare *Fusconaia* and *Pleurobema* pigtoes, this creek is the only location where southern hickorynut has been found alive in Texas in several decades.

Trinity River Drainage

Lake Lewisville

Lake Lewisville, SFASU Site 1, Oakland Park (33.09167° N, 97.00752°W), Denton County, Texas, 11 July 2005.

SFASU staff conducted timed searches (1.5 man-hours), an area search (30 x 100 m), and a random shoreline search, collectively yielding the following specimens:

Lake Lewisville, Oakland Park Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Threeridge	1	0.0	-		5.3
Louisiana fatmucket	0	1.0	recently dead		5.3
Pink papershell	1	0.0	-		5.3
Western pimpleback	2	4.0	relatively recently dead		35.3
Lilliput	0	3.0	recently dead		15.8
Paper pondshell	3	3.0+0.5x1	recently dead		36.8
Total specimens	7	12	19(L+D)	36.8%L	
Total species	4	4	6(L+D)		

Lake Lewisville, SFASU Site 2, Willow Grove Park (33.11767° N, 97.01687° W), Denton County, Texas, 11 July 2005.
SFASU staff conducted timed searches (1.0 man-hour), a random shoreline search (ca 200 m), and snorkeled shallow waters collectively yielding the following specimens:

Lake Lewisville, Willow Grove Park, 1.0 man-hour					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Threeridge	0	1.0		relatively recently dead	2.3
Flat floater	0	4.0		fragments-relatively long dead	9.1
Louisiana fatmucket	1	0.0		-	2.3
Giant floater	0	0.5x2		relatively long dead-long dead	4.5
Southern mapleleaf	0	0.5x4		relatively long dead	9.1
Western pimpleback	0	2.0		very recently dead	4.5
Lilliput	5	0.5x3		relatively long dead	18.2
Paper pondshell	2	14.0+0.5x6		recently dead-relatively recently dead	50.0
Total specimens	8	36	44(L+D)	18.2%L	
Total species	3	7	8(L+D)		

Lake Lewisville, SFASU Site 3, Hickory Hill Park (from 33.10122° N, 97.04745° W to 33.10341° N, 97.05131° W), Denton County, Texas, 11 July 2005.
SFASU staff conducted timed searches (0.67 man-hours), a random shoreline and shallow water, and norkeling searches collectively yielding the following specimens:

Lake Lewisville, Hickory Hill Park, 0.67 man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Threeridge	0	0.5x1		long dead	9.1
Lilliput	0	2.0		recently dead –relatively recently dead	18.2
Paper pondshell	0	7.0+0.5x1		very recently dead –recently dead	72.7
Total specimens	0	11	11(L+D)	0.0%L	
Total species	0	3	3(L+D)		

Lake Lewisville, SFASU Site 4, Sycamore Bend Park (33.10498 N, 97.06520° W), Denton County, Texas, 11 July 2005.
SFASU staff conducted timed searches (0.5 man-hours), a random shoreline search (ca 200 m), and snorkeled shallow waters collectively yielding the following specimens:

Lake Lewisville, Sycamore Bend Park, man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Lilliput	1	4.0	recently dead		100.00
Total specimens	1	4	5(L+D)	20.0%L	
Total species	1	1	1(L+D)		

Lake Lewisville, SFASU Site 5, Stewart Creek Park (no coordinates reported), Denton County, Texas, 11 July 2005.
SFASU staff conducted timed searches (0.5 man-hours), a random shoreline search (ca 250 m), and snorkeled shallow waters collectively yielding the following specimens:

Lake Lewisville, Stewart Creek Park Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Fragile papershell	0	1.0	relatively recently dead	6.3
Giant floater	0	1.0+0.5x1	relatively long dead	12.5
Lilliput	0	6.0	relatively recently dead	37.5
Paper pondshell	1	6.0	recently dead- relatively recently dead	43.8
Total specimens	1	15	16(L+D) 6.3%L	
Total species	1	4	4(L+D)	

Lake Lewisville, SFASU Site 6, Hidden Cove Park (33.12503° N, 96.93926° W), Denton County, Texas, 11 July 2005.
SFASU staff conducted timed searches (0.5 man-hours), a random shoreline search (ca 200 m), and snorkeled shallow waters collectively yielding the following specimens:

Lake Lewisville, Hidden Cove Park Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Lilliput	0	9.0+0.5x1	recently dead	76.9
Paper pondshell	0	3.0	very recently dead-recently dead	23.1
Total specimens	0	13	13(L+D) 0.0%L	
Total species	0	2	2(L+D)	

Lake Lewisville, site reported as 'Dallas Mapco p. 550 Section B, between lake and RR track', Denton County, Texas, 7 September 2005.
A volunteer examined this area (30 m and 0.25 man-hours) and reported the following specimens:

Lake Lewisville, Hidden Cove Park, 0.25 man-hours Species	*N* alive	*N* shells	Condition	Percent of total (L+D)
Threeridge	0	0.5x1	unstated	8.3
Deertoe	0	0.5x1	unstated	8.3
Lilliput	0	10.0	unstated	83.3
Asian clam – present				
Total specimens	0	12	12(L+D) 0.0%L	
Total species	0	3	3(L+D)	

Neck (1990) provided a previous characterization of the unionid fauna in Lake Lewisville from collections made in 1977 and 1978 and TPWD reported additional survey efforts over several of the following years. Ten of Neck's 11 sites were examined by HOH staff using wading and brailing in June 1994 during high waters, but few unionids were taken (Howells 1996a). In September 1998, a volunteer documented specimens in shallows and exposed bottoms during a low-water period (Howells 1999). In August and September 1999, volunteer efforts continued and several sites were examined or reexamined as water levels continue to remain low

(Howells 2000). In October 1999, HOH staff and a volunteer surveyed exposed bottoms at several sites and documented 13 unionid taxa (Howells 2000). Additional volunteer surveys were conducted during several months in 2000 at several locations (combined below) (Howells 2001a) and at one site in August 2002 (Howells 2003a).

Lake Lewisville combined sites comparison	Neck (1990) 1977-78		Jun 1994			Sep 1998					Aug-Sep 1999				
	T*N*	%T	L	D	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	624	37.5	2	1	42.9	2	23	8.0	5.9	17.7	30	30	50.0	8.0	11.1
Rock-pocketbook	16	1.0	-	-	-	-	-	-	-	-	0	2	0.0	0.0	0.4
Louisiana fatmucket	214	12.9	-	-	-	2	4	33.3	5.9	4.3	52+	30+	63.4	13.9	15.2
Sandbank pocketbook	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellow sandshell	76	4.6	-	-	-	3	4	42.9	8.8	5.0	18	4	81.8	4.8	4.1
Fragile papershell	63	3.9	-	-	-	1	7	12.5	2.9	5.7	37	25	59.7	9.9	11.5
Texas heelsplitter	40	2.4	-	-	-	-	-	-	-	-	1?	0	100.0	0.2	0.2
Pink papershell	-	-	-	-	-	0	1	0.0	0.0	0.7	18	2	90.0	4.8	3.7
Bleufer	88	5.3	-	-	-	4	4	50.0	11.8	5.7	18	2	90.0	4.8	3.7
Giant floater	160	9.6	-	-	-	10	12	45.5	29.4	15.6	60+	30+	66.7	16.0	16.7
Southern mapleleaf	281	16.9	3	1	57.1	0	35	0.0	0.0	24.8	58+	30+	65.9	15.5	16.3
Western pimpleback	13	0.8	-	-	-	0	7	0.0	0.0	5.0	13	7	65.0	3.5	3.7
Pistolgrip	*	*	-	-	-	-	-	-	-	-	-	-	-	-	-
Lilliput	1	>0.1	-	-	-	8	0	100.0	23.5	5.7	70+	2	97.2	18.7	13.4
Deertoe	69	4.1	-	-	-	0	1	0.0	0.0	0.7	-	-	-	-	-
Paper pondshell	18	1.1	-	-	-	4	9	30.8	11.8	9.2	-	-	-	-	-
Total specimens	1663		5	2	71.4%L	34	107	34.1%L			375	164	69.6%L		
			7(L+D)			141(L+D)					539(L+D)				
Total species	15		2	2		8	11				11	11			
			2(L+D)			12(L+D)					12(L+D)				

Lake Lewisville combined site comparison	Aug 2002					Jul 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeeridge	-	-	-	-	-	1	2	33.3	6.3	3.1
Louisiana fatmucket	0	1	0.0	0.0	8.3	1	1	50.0	6.3	2.1
Fragile papershell	0	2	0.0	0.0	16.7	0	1	0.0	0.0	1.0
Pink papershell	-	-	-	-	-	1	0	100.0	6.3	1.0
Bleufer	0	1	0.0	0.0	8.3	-	-	-	-	-
Giant floater	0	4	0.0	0.0	33.3	0	4	0.0	0.0	4.1
Southern mapleleaf	0	2	0.0	0.0	16.7	0	4	0.0	0.0	4.1
Western pimpleback	-	-	-	-	-	2	6	25.0	12.5	8.2
Lilliput	-	-	-	-	-	6	28	17.6	37.5	35.1
Paper pondshell	0	2	0.0	0.0	16.7	5	35	12.5	31.3	41.2
Total specimens	0	12	12(L+D)		0.0%L	16	81	97(L+D)		16.5%L
Total species	0	6	6(L+D)			6	8	9(L+D)		

Neck (1990) documented 15 unionid species in Lake Lewisville, including two not taken at his formal sampling sites. Unlike the low-water collections of Neck that documented a noteworthy abundance and diversity of unionids, the HOH sampling in 1994, done under high-water conditions, produced far fewer specimens. In 2000, water level began to decline and reached very low levels several times over the next few years. Low-water conditions and related factors (predators, increased ease of harvest, reduction in fish host availability) reduced abundance and diversity of the mussel assemblage. An additional element that may have contributed to mussel losses in Lake Lewisville related to shell collectors who attended at TPWD Mussel Watch program and obtained unionids at this reservoir. They also placed photographs of these mussels on a web site and called attention to the low water levels that would facilitate harvest by shell collectors. HOH examined this reservoir several times in 2000 (Howells 2001) and surveys late in the year found footprints and other evidence that large numbers of individuals had examined the exposed bottom areas where mussels were stranded or were still attempting to follow the declining water level. Certainly, low-water conditions were responsible for major declines in unionid abundance and diversity in Lake Lewisville. The effect of harvest by shell collectors is unknown. By 2002, numbers of species and numbers of individuals had declined significantly as had the proportion of living specimens. Prior to the SFASU sampling efforts in 2005, increased precipitation resulted in a major increase in pool elevation in Lake Lewisville. When the SFASU staff examined this reservoir, mussel populations that had been reduced (in numbers and diversity) had also moved to locations that were now in deeper waters. Such conditions made accurate surveys of mussel populations difficult.

In Lake Lewisville, as well as Lake Grapevine (below) and other Dallas-Fort Worth area waters in the upper Trinity River basin, endemic heelsplitter populations appear to have been impacted by "invading" pink papershell. Early reports (summarized in Neck and Howells 1994) exclusively reported Texas heelsplitter in this area. However, pink papershell was found by HOH in Eagle Mountain Reservoir in May 1992 (Howells 1994). Since then, populations in upper Trinity River impoundments have appeared more like pink papershell and less like Texas heelsplitter. Whether, pink papershell is displacing Texas heelsplitter or hybridizing with it is unknown. Tissue from these upper Trinity potamilids has not yet been subjected to genetic analysis.

Eagle Mountain Reservoir

Eagle Mountain Reservoir, SFASU Site 1, near dock at Peden Street (32.94294° N, 97.93926° W), Tarrant County, Texas, 12 July 2005.

SFASU staff conducted timed searches (2.0 man-hours; produced 2 live specimens) and snorkeled shallow waters collectively yielding the following specimens:

Eagle Mountain Reservoir, at Peden Street					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	0	14.0+0.5x35	long dead-very long dead		86.0
Yellow sandshell	1	0.0	-		1.8
Bleufer	0	1.0+0.5x1	long dead		3.5
Giant floater	1	0.0	-		1.8
Western pimpleback	0	0.5x3	long dead		5.3
Deertoe	0	0.5x1	relatively long dead		1.8
Total specimens	2	55	57(L+D)	3.5%L	
Total species	2	4	6(L+D)		

Eagle Mountain Reservoir, SFASU Site 2, east shore at Boat Club Street (32.88950° N, 97.49159° W), Tarrant County, Texas, 12 July 2005.

SFASU staff conducted a timed search (1.0 man-hour) in shallow water with snorkeling and a random shoreline search of ca 200 m yielding the following specimens:

Eagle Mountain Reservoir, at Boat Club Street, 1.0 man-hour	Percent of

Species	*N* alive	*N* shells	Condition	total (L+D)
Threeridge	0	0.5x3	very long dead-subfossil	20.0
Yellow sandshell	0	0.5x2	long dead – subfossil	13.3
Bleufer	0	0.5x1	very long dead	6.7
Western pimpleback	0	0.5x7	long dead – subfossil	46.7
Paper pondshell	0	0.5x1	relatively long dead	6.7
Fragile papershell	0	1	relatively recently dead	6.7
Total specimens	0	15	15(L+D) 0.0%L	
Total species	0	6	6(L+D)	

Eagle Mountain Reservoir, SFASU Site 3, east shore landing area (32.88943° N, 97.45338° W), Tarrant County, Texas, 12 July 2005.
SFASU staff conducted timed searches (0.5 man-hour) and searched ca 90 m of shoreline, but found no unionids or their shells; Asian clams were abundant.

Eagle Mountain Reservoir, SFASU Site 4, west side Ashwood City Park (32.87299° N, 97.51791° W), Tarrant County, Texas, 12 July 2005.
SFASU staff conducted timed searches (2.0 man-hours; produced 8 live specimens) and examined shallow waters for ca 200 m, collectively yielding the following specimens:

Eagle Mountain Reservoir, Ashwood City Park, 2.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	0.5x2	relatively recently dead	15.0
Yellow sandshell	0	0.5x2	very long dead	10.0
Giant floater	0	1.0	relatively recently dead	5.0
Western pimpleback	7	3.0+0.5x1	relatively long dead	55.0
Lilliput	0	0.5x1	relatively recently dead	5.0
Paper pondshell	0	0.5x2	relatively recently dead	10.0
Total specimens	8	12	20(L+D) 40.0%L	
Total species	2	6	6(L+D)	

Staff from HOH first sampled Eagle Mountain Reservoir in 1992; three dredge hauls produced one live threeridge and one recently dead pink papershell (Howells 1994). In 1993, HOH used a series of brail hauls to collect unionids here (Howells 1995) and in 1994, HOH surveyed this reservoir with both brail and shallow water hand collecting (Howells 1996a). In 1996, three sites were examined (combined) (Howells 1999).

Eagle Mountain Reservoir combined site comparison	Jun 1993					Jun 1994					Sep 1996					Jul 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	8	2	80.0	66.7	66.7	7	14	33.3	77.8	56.8	0	29	0.0	0.0	44.6	1	54	1.8	10.0	60.4
Yellow sandshell	-	-	-	-	-	0	4	0.0	0.0	10.8	0	16	0.0	0.0	24.6	1	4	20.0	10.0	5.5
Fragile papershell	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	1.5	-	1	0.0	0.0	1.1
Bleufer	-	-	-	-	-	0	1	0.0	0.0	2.7	0	3	0.0	0.0	4.6	0	3	0.0	0.0	3.3
Giant floater	1	1	50.0	8.3	13.3	0	2	0.0	0.0	5.4	0	6	0.0	0.0	9.2	1	0	100.0	10.0	1.1

Western pimpleback	3	0	100.0	25.0	20.0	2	5	28.6	22.2	18.9	0	8	0.0	0.0	12.3	7	14	33.3	70.0	23.1
Lilliput	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	1.1
Deertoe	-	-	-	-	-	0	2	0.0	0.0	5.4	0	1	0.0	0.0	1.5	0	1	0.0	0.0	1.1
Paper pondshell	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	1.5	0	3	0.0	0.0	3.3
Total specimens	12	3	80.0%L			9	28	24.3%L			0	65	0.0%L			10	81	12.3%L		
	15(L+D)					37(L+D)					65(L+D)					91(L+D)				
Total species	3	2				2	6				0	8				4	8			
	3(L+D)					6(L+D)					8(L+D)					9(L+D)				

Largely due to differences in water levels, equipment used, and personnel involved on each sampling attempt at Eagle Mountain Reservoir, in conjunction with limited mussel abundance and diversity, major trends over time are difficult to characterize in this impoundment. Interestingly, pink papershell was first found here by HOH in 1992, and although it appears to have invaded other upper Trinity River sites, seems not to have survived here.

Lake Lavon

Lake Lavon, south of FM 3286, exposed bottom during low water, Collin County, Texas, 12 December 2005.

A volunteer examined this area during a low water period and reported the following specimens:

Lake Lavon Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Louisiana fatmucket	0	4.0	very recently dead	6.1
Pink papershell	0	8.0	very recently dead-recently dead	12.1
Bleufer	0	2.0	recently dead	3.0
Giant floater	0	14.0	very recently dead-recently dead	21.2
Southern mapleleaf	12	25.0	unstated	56.1
Pondhorn	0	1.0	long dead	1.5
Total specimens	12	54	66(L+D) 18.2%L	
Total species	1	6	6(L+D)	

Unlike most other Dallas-Fort Worth reservoirs, this impoundment had not previously been surveyed by HOH.

Cedar Creek Reservoir

Cedar Creek Reservoir, at Caney City, CR 3054 at the end of Lagoon Street (SFASU Site 1), 32°13.539' N, 95°59.837' W, Henderson County, Texas, 23 November 2005.

SFASU staff used a timed search (0.75 man-hours) over 100 m of shoreline and reported the following:

Cedar Creek Reservoir, Caney City at CR 3054-Lagoon Street, 0.75 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	0	1.0+0.5x1	relatively long dead-very long dead	7.1
Giant floater	0	18.0+0.5x3	relatively recently dead-long dead	75.0
Southern mapleleaf	0	5.0	relatively recently dead-relatively long dead	17.9
Total specimens	0	28	28(L+D) 0.0%L	
Total species	0	3	3(L+D)	

Cedar Creek Reservoir, at Vista Village, Lakeview Drive (SFASU Site 2), 32°15.330' N, 96°00.267' W, Henderson County, Texas, 23 November 2005.
SFASU staff examined this site using a timed search (1.0 man-hour) and reported the following specimens:

Cedar Creek Reservoir, Vista Village, Lakeview Drive, 1.0 man-hour					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Yellow sandshell	0	1.0	relatively long dead		1.4
Giant floater	6	18.0	long dead-very long dead		32.9
Southern mapleleaf	9	36.0	long dead		61.6
Texas lilliput	0	2.0	long dead		2.7
Pondhorn (sp.?)	0	0.5x1	very long dead		1.4
Total specimens	15	58	73(L+D)	20.5%L	
Total species	2	5	5(L+D)		

Cedar Creek Reservoir, at Payne Springs, CR 2530 and Timber Trail (SFASU Site 3), 32°15.467' N, 96°04.565' W, Henderson County, Texas, 23 November 2005.
SFASU staff examined this site using a timed search (0.32 man-hours) and reported the following specimens:

Cedar Creek Reservoir, Payne Springs, CR 2530 and Timber Trail, 0.32 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Giant floater	2	2.0	very long dead		80.0
Texas lilliput	1	0.0	-		20.0
Total specimens	3	2	5(L+D)	60.0%L	
Total species	2	1	2(L+D)		

Cedar Creek Reservoir, south of Mabank at SH 198 bridge (SFASU Site 4), 31°19.856' N, 96°05.370' W, Henderson County, Texas, 23 November 2005.
SFASU staff examined this site using a timed search (0.99 man-hours) over 100 m of shoreline and reported the following specimens:

Cedar Creek Reservoir, south of Mabank at SH 198, 0.99 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Yellow sandshell	1	0.5x1	long dead		5.1
Fragile papershell	0	1.0+0.5x1	relatively recently dead-long dead		5.1
Giant floater	1	25.0	relatively recently dead-relatively long dead		66.7
Southern mapleleaf	0	6.0	relatively recently dead		15.4
Texas lilliput	1	2.0	relatively long dead		7.7
Total specimens	3	36	39(L+D)	7.7%L	
Total species	3	5	5(L+D)		

Cedar Creek Reservoir, boat ramp at SH 334 southeast corner of reservoir (SFASU Site 5), 32°19.844' N, 96°09.637' W, Henderson County, Texas, 23 November 2005.
SFASU staff examined this site, but did not document distance, time, or number of specimens under the belief

that shells found were discarded by anglers (not a natural distribution). They reported the following specimens:

Cedar Creek Reservoir, boat ramp at SH 334				Percent of
Species	*N* alive	*N* shells	Condition	total (L+D)
Louisiana fatmucket	0	2.0	long dead	-
Yellow sandshell	0	P	relatively recently dead-long dead	-
Giant floater	0	P	relatively recently dead-long dead	-
Southern mapleleaf	0	P	relatively recently dead	-
Total specimens	0	-		
Total species	0	4		

Cedar Creek Reservoir, northwest corner at SH 334 (SFASU Site 6), 32°19.754' N, 96°10.619' W, Henderson County, Texas, 23 November 2005.
SFASU staff examined this site using a timed search (0.48 man-hours) and reported the following specimens:

Cedar Creek Reservoir, northwest corner at SH 334, 0.48 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Giant floater	0	1.0	recently dead		33.3
Southern mapleleaf	0	0.5x2	long dead		66.7
Total specimens	0	3	3(L+D)	0.0%L	
Total species	0	2	2(L+D)		

When TPWD freshwater mussel work first began in 1992, a questionnaire survey of resident and non-resident mussel license holders indicated that Cedar Creek Reservoir was the most heavily harvested reservoir in Texas, visited nearly three times more often by shellers than the next most popular reservoir (Howells 1993a). Cedar Creek Reservoir was sampled by HOH in June 1993 with 18 brail hauls, 6 diver-assisted 0.25-m^2 quadrats, and 4 shoreline area searches (Howells 1993b, 1995). It was revisited in October 1997, when shallow-water and brail hauls were omitted (due to the limited number of mussels taken by these techniques in 1993) and the number of quadrat samples and timed searches was increased (Howells 1997b, 1998a).

Cedar Creek Reservoir combined site	Jun 1993					Oct 1997					Nov 2005				
comparison	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	0	1	0.0	0.0	0.4	-	-	-	-	-	-	-	-	-	-
Louisiana fatmucket	0	1	0.0	0.0	0.4	-	-	-	-	-	0	2	0.0	0.0	2.2
Yellow sandshell	1	0	100.0	0.5	0.4	2	1	66.7	0.9	1.1	1	4	20.0	8.3	5.4
Fragile papershell	-	-	-	-	-	-	-	-	-	-	0	2	0.0	0.0	2.2
Giant floater	0	1	0.0	0.0	0.4	1	0	100.0	0.4	0.4	-	-	-	-	-
Southern mapleleaf	221	1	99.5	99.5	98.2	228	29	88.7	98.7	98.5	9	67	11.8	75.0	82.6
Texas lilliput	-	-	-	-	-	-	-	-	-	-	2	4	33.3	16.7	6.5
Pondhorn sp.?	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	1.1
Total specimens	222	4	98.2%L			231	30	88.5%L			12	80	13.0%L		
	226(L+D)					261(L+D)					92(L+D)				
Total species	2	4				3	2				3	6			

	5(L+D)	3(L+D)	6(L+D)
Cedar Creek Reservoir combined CPUE comparison	1993	1997	2005
Mean *N* live/man-hour	876.0	420.0	5.9
Mean T (L+D)/man-hour	876.0	468.0	41.8

Cedar Creek Reservoir has not had a particularly diverse unionid assemblage, but the dominance of southern mapleleafs in the mussel community is unusual. In 1993 and 1997, 88 to 98% of the unionids present were southern mapleleafs. This and other mapleleaf species are rarely such dominant taxa. This reservoir experienced a major decline in pool elevation just prior to being surveyed in 1997. Although a similar number of specimens were examined in both 1993 and 1997, the 1997 survey found overall CPUE declined by half. Had this decline been associated with extensive harvest, the size range of mapleleafs would have been expected to decline (musselers would have taken larger animals). However, size distribution (shell height) of southern mapleleafs did not change significantly 1993 and 1997 (Howells 1998a, b). Losses were more likely related to dewatering mortality. When SFASU examined this impoundment again in 2005, water levels were very low. Although southern mapleleaf continued to dominate the assemblage, CPUE dropped by more than a factor of 10 for live and dead combined. In 2005, less than 12% of the southern mapleleafs were found alive compared to 88.7% or more previously. It appears that this mussel assemblage was able to endure intense harvest pressure in the early 1990s, but dewatering was probably more important in reducing it to its current low level.

Lake Livingston

Lake Livingston, exact location not stated, Polk-Trinity-San Jacinto counties, Texas, 5 August 2005.

During other work on this reservoir, the HOH staff collected the following specimens:

Lake Livingston Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	0	1.0	relatively recently dead	50.0
Giant floater	0	1.0	relatively recently dead	50.0
Totals specimens	0	2	2(L+D) 0.0%L	
Totals species	0	2	2(L+D)	

Lake Livingston, boat ramp area adjacent to Lakeside RV Resort off US 190, SFASU Site 1, 30°48.647' N, 95°07.753' W, Polk County, Texas, 6 October 2005.

SFASU examined this location using timed searches (1.5 man-hours).

Lake Livingston, ramp at Lakeside RV Resort, 1.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	0.5x1	very recently dead	1.8
Yellow sandshell	0	8.0+0.5x1	very recently dead	16.4
Fragile papershell	0	2.0	very recently dead	3.6
Bankclimber	0	1.0+0.5x1	very recently dead	3.6
Texas heelsplitter	0	3.0+0.5x2	very recently dead	9.1
Giant floater	0	4.0	very recently dead	7.3
Threehorn wartyback	0	1.0	very recently dead	1.8

Southern mapleleaf	4	18.0+0.5x8	very recently dead		54.5
Texas lilliput	0	1.0	relatively recently dead		1.8
Totals specimens	4	51	55(L+D)	7.3%L	
Totals species	1	9	9(L+D)		

Lake Livingston, Yaupon Cove at Onalaska off US 190, SFASU Site 2, 30°49.500' N, 95°05.343' W, San Jacinto County, Texas, 7 October 2005.
SFASU examined this location using timed searches (3.0 man-hours).

Lake Livingston, Yaupon Cove at Onalaska, 3.0 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Flat floater	0	8.0+0.5x1	very long dead		4.5
Giant floater	0	98.0	very recently dead-long dead		48.8
Southern mapleleaf	3	91.0	very recently dead-relatively long dead		46.7
Totals specimens	3	198	201(L+D)	1.5%L	
Totals species	1	3	3(L+D)		

Lake Livingston, at Patrick's Ferry road opposite Patrick's Ferry Park, SFASU Site 3, 30°47.971' N, 95°09.796' W, San Jacinto County, Texas, 7 October 2005.
SFASU examined this location using timed searches (1.0 man-hours).

Lake Livingston, at Patrick's Ferry Road, 1.0 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	0	0.5x1	relatively recently dead		2.1
Yellow sandshell	0	7.0	very recently dead		14.6
Fragile papershell	0	3.0	very recently dead		6.3
Bankclimber	0	1.0+0.5x1	very recently dead		4.2
Texas heelsplitter	0	2.0+0.5x1	very recently dead		6.3
Giant floater	0	0.5x1	very recently dead		2.1
Threehorn wartyback	0	4.0	very recently dead		8.3
Southern mapleleaf	2	21.0+0.5x2	very recently dead-long dead		52.1
Western pimpleback	1	0.0	-		2.1
Gulf mapleleaf	1	0.0	-		2.1
Totals specimens	4	44	48(L+D)	8.3%L	
Totals species	3	8	10(L+D)		

Lake Livingston, southwest shoreline at Holiday Drive, SFASU Site 4, 30°42.371' N, 95°10.670' W, San Jacinto County, Texas, 7 October 2005.
SFASU examined this location using timed searches (1.5 man-hours).

Lake Livingston, southwest side at Holiday Drive, 1.5 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Yellow sandshell	0	8.0	very recently dead		14.8
Bankclimber	0	2.0	recently dead to long dead		3.7

Giant floater	1	11.0	very recently dead	22.2
Threehorn wartyback	0	1.0	recently dead	1.9
Texas heelsplitter	0	12.0	very recently dead-long dead	22.2
Bleufer	0	1.0	very recently dead	1.9
Southern mapleleaf	0	15.0+0.5x1	very recently dead-long dead	29.6
Gulf mapleleaf	2	0.0	-	3.7
Total specimens	3	51	54(L+D) 5.6%L	
Totals species	2	7	8(L+D)	

Lake Livingston, south shore at the west side of the dam, SFASU Site 5, 30°36.898' N, 95°02.602' W, San Jacinto County, Texas, 6 October 2005.
SFASU examined this location using timed searches (0.75 man-hours).

Lake Livingston, south shore near dam, 0.75 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	1.0+0.5x2	very recently dead	7.1
Fragile papershell	0	11.0	very recently dead	26.2
Giant floater	0	7.0	very recently dead	16.7
Threehorn wartyback	0	2.0	very recently dead	4.8
Texas heelsplitter	0	1.0	very recently dead	2.4
Southern mapleleaf	4	10.0+0.5x1	very recently dead-long dead	35.7
Gulf mapleleaf	1	0.0	-	2.4
Texas lilliput	0	2.0	very recently dead	4.8
Totals specimens	5	37	42(L+D) 11.9%L	
Totals species	2	7	8(L+D)	

Although HOH had mussel survey information from Lake Livingston, most was incidental to other ongoing research in the area, or was taken under conditions that were not favorable to effective mussel sampling. Lake Livingston is generally maintained at a relatively constant water level. Although it was not originally selected as one of the SWG-survey sites, when low-water conditions occurred during the SWG-funded mussel survey work, the SFASU staff was directed to include this impoundment to their designated survey sites. This impoundment had been visited by HOH in early 1994 when sampling was thwarted by high waters (Howells 1996a). In July, August, and September 1996, brail and shallow-water shoreline collections were taken (Howells 1997a). Volunteer data was sent to HOH in 1999 (Howells 2000) and 2000 (Howells 2001); however, these data covered only as small number of sites at a lakeside school camp that repeatedly surveyed the same few sites and ultimately offered little to characterize the mussel assemblage in the reservoir.

Lake Livingston combined site comparison	Jul 1996					Aug-Sep 1996					Oct 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	7	4	63.6	4.4	6.3	-	-	-	-	-	0	5	0.0	0.0	1.2
Flat floater	1	0	100.0	0.6	0.6	0	2	0.0	0.0	5.6	0	9	0.0	0.0	2.2
Louisiana fatmucket	1	2	33.3	0.6	1.7	-	-	-	-	-	-	-	-	-	-
Yellow sandshell	16	0	100.0	10.1	9.1	0	8	0.0	0.0	22.2	0	24	0.0	0.0	6.0
Fragile papershell	5	1	83.3	3.1	3.4	0	3	0.0	0.0	8.3	0	16	0.0	0.0	4.0
Washboard	-	-	-	-	-	0	1	0.0	0.0	2.8	-	-	-	-	-
Threehorn wartyback	1	0	100.0	0.6	0.6	-	-	-	-	-	0	8	0.0	0.0	2.0

Bankclimber	7	0	100.0	4.4	4.0	-	-	-	-	-	0	6	0.0	0.0	1.5
Texas heelsplitter	-	-	-	-	-	0	1	0.0	0.0	2.8	0	20	0.0	0.0	5.2
Bleufer	1	1	50.0	0.6	1.1	0	5	0.0	0.0	13.9	0	1	0.0	0.0	0.2
Giant floater	8	5	61.5	5.0	7.4	0	7	0.0	0.0	19.4	1	121	0.8	5.3	31.5
Southern mapleleaf	91	4	95.8	57.2	54.8	0	9	0.0	0.0	25.0	13	167	7.2	68.4	44.2
Western pimpleback	-	-	-	-	-	-	-	-	-	-	1	0	100.0	5.3	0.3
Gulf mapleleaf	-	-	-	-	-	-	-	-	-	-	4	0	100.0	21.1	1.0
Texas lilliput	20	0	100.0	12.6	11.4	-	-	-	-	-	0	3	0.0	0.0	0.7
Paper pondshell	1	0	100.0	0.6	0.6	-	-	-	-	-	-	-	-	-	-
Total specimens	159	17	90.3%L			0	36	0.0%L			19	384	4.7%L		
	176(L+D)					36(L+D)					403(L+D)				
Total species	12	6	12(L+D)			0	8	8(L+D)			4	11	13(L+D)		

Collectively, 17 unionid taxa were documented in these collections and several others are almost certainly present. The August and September 1996 records were based on casual collections made by HOH biologists during other research and are not fully representative of the mussel assemblage in Lake Livingston. The July 1996 and October 2005 data are likely more typical. During stable, normal pool levels in 1996, over 90% of the specimens located were alive. However, by fall 2005, dewatering resulted in fewer than 5% being found alive. In 1996, C.M. Mather and J.A.M. Bergmann found mussel populations in the Trinity River at several sites upstream of Lake Livingston to be rebounding from earlier losses (Howells 1997a). Among the rare, endemics found living and reproducing at upstream sites was Texas heelsplitter. Although no living specimens were taken in Lake Livingston, shells that were very-recently dead (soft tissue still present on valves) indicate the species is surviving in this impoundment as well.

San Jacinto River Drainage

Lake Houston

Lake Houston, east of islands, north of FM 1960, 30°01.200' N, 95°08.100' W, Harris County, Texas, 7 October 2005.

SFASU staff examined this site using a timed search (3.0 man-hours total):

Lake Houston, east of islands on north side of FM 1960, 3.0 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	0	13.0	long dead	10.2
Louisiana fatmucket	0	2.0+0.5x5	long dead	5.5
Yellow sandshell	0	1.0	long dead	0.8
Fragile papershell	0	0.5x1	long dead	0.8
Washboard	1	0.0	-	0.8
Bankclimber	17	4.0	long dead	16.5
Bleufer	1	10.0+0.5x1	long dead-very long dead	9.4
Giant floater	3	2.0	long dead	3.9
Southern mapleleaf	46	16.0	relatively long dead-long dead	48.8
Western pimpleback	3	0.0	-	2.4
Deertoe	1	0.0	-	0.8
Total specimens	72	55	127(L+D) 56.7%L	
Total species	7	8	11(L+D)	

This site was examined by HOH in June 1996 (Howells 1997a) and unionids were found to be relatively

abundant. At that time, it appeared that sand deposition was filling the upper reaches of this impoundment and that mussels would ultimately be harmed by this process. In 1999, HOH received calls from local residents reporting that much of the upper reaches of Lake Houston were dewatered and vast numbers of mussels were dying (Howells 2000). No salvage efforts occurred and it was assumed the mussel losses would be extensive. The SFASU survey was the first time this area was reexamined following the low-water period.

Lake Houston Comparison	Jun 1996						Oct 2005					
	L	D	%L	%T	*N*L/h	*N*T/h	L	D	%L	%T	*N*L/h	*N*T/h
Threeridge	1	19	2.4	20.4	0.3	6.7	0	13	0.0	10.0	0.0	4.3
Louisiana fatmucket	2	5	4.9	7.1	0.7	2.3	0	7	0.0	5.5	0.0	2.3
Yellow sandshell	0	2	0.0	2.0	0.0	0.7	0	1	0.0	0.8	0.0	0.3
Fragile papershell	0	2	0.0	2.0	0.0	0.7	0	1	0.0	0.8	0.0	0.3
Washboard	-	-	-	-	-	-	1	0	1.4	0.8	0.3	0.3
Bankclimber	5	1	12.2	6.1	1.7	2.0	17	4	23.6	16.5	5.7	7.0
Bleufer	1	12	2.4	13.3	0.3	4.3	1	11	1.4	9.4	0.3	4.0
Giant floater	0	3	0.0	3.1	0.0	1.0	3	2	4.2	3.9	1.0	1.7
Southern mapleleaf	11	5	26.8	16.3	3.7	5.3	46	16	63.9	48.8	15.3	20.7
Western pimpleback	21	8	51.2	29.6	7.0	9.7	3	0	4.2	2.4	0.0	1.0
Deertoe	-	-	-	-	-	-	1	0	1.4	0.8	0.0	0.3
Total specimens	41	57	41.8%L	13.7 L/h	32.7T/h		72	55	56.7%L	24.0 L/h	42.3 T/h	
	98(L+D)						127(L+D)					
Total species	6	9	9(L+D)				7	8	11(L+D)			

Comparison of the previous 1996 HOH survey data with the 2005 SFASU data indicates that despite dewatering and associated unionid mortality, the abundance and diversity of this mussel assemblage has remained relatively similar. Interestingly, bankclimber appears to have increased in abundance since the low-water period. However, this may only be an artifact of bankclimbers being forced to move to new locations due to these changes in water levels (i.e., these mussels may have been present, during the earlier HOH survey, but may have been in another location at that time). Another apparent change is the shift in abundance between western pimpleback and southern mapleleaf. Western pimpleback, the most abundant species in 1996, was reduced to just over 2% of the mussels documented in 2005. Conversely, in 1996, southern mapleleaf accounted for only 17% of the living and dead mussels found, but have now increased to represent nearly half of the population today. The western pimpleback form in Lake Houston was unusually large and heavy-shelled -- shells that would be of interest to commercial shell harvesters. However, southern mapleleafs from this population tend to be relatively small, not especially thick-shelled, and usually laterally compressed, making them less desirable to commercial shellers. It is possible that selective shell harvest occurred during the low-water period, thus creating the shift in dominance between the two quadrulids.

Buffalo Bayou

Bear Creek

Bear Creek, below Addicks Dam, north of I-10 and east of SH 6 (29°47.369' N and 95°37.428' W), Harris County, Texas, 15 August 2005.

Staff from Stephen F. Austin State University used hand collections and timed searches (4.0 man-hours) and 0.25-m^2 quadrats (N = 18) to survey this site and recorded the following specimens:

Bear Creek, below Addicks Dam, 4.0 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)

Round pearlshell	19	6.0+0.5x3	relatively recently-very long dead		13.0
Yellow sandshell	0	5.0+0.5x1	relatively recently-very long dead		2.8
Giant floater	5	0.0	-		2.3
Southern mapleleaf	156	13.0+0.5x9	relatively recently-very long dead		82.0
Total specimens	180	37	217(L+D)	82.9%L	
Total species	3	3	4(L+D)		

Bear Creek, below Addicks Dam, mean/18, 0.25-m^2 quadrats (total *N*)

	N/18 quadrats		*N*/m^2			
Species	alive	dead	alive	dead	Condition	Percent of total (L+D)
Round pearlshell	2	0.0	0.4	0.0	-	9.5
Giant floater	1	0.0	0.2	0.0	-	4.8
Southern mapleleaf	18	0.0	4.0	0.0	-	85.7
Total specimens	21	0	21(L+D)	100.0%L		
Total species	3	0	3(L+D)			

Among all mussel taxa combined, 64.8 specimens/man-hour were documented in 2004 (Howells 2005). Quantitative sample with 20, 0.25 m^2 quadrats produced 9 southern mapleleafs (mean = 0.45; *N*/m^2 =1.8) in 2004 (Howells 2005). This site was surveyed in June 1994, then again in July 1994 by a group 30 malacologists from the American Malacological Union (Howells 1996a). An additional brief survey was conducted in 1996 (Howells 1997a).

Bear Creek below Addicks Dam comparison	Jun 1994						Jul 1994					Oct 1996					
	L	D	%Lsp	%L	%T	*N*/h	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	*N*/h
Round pearlshell	1	2	33.3	5.6	12.5	1.0	73	12	85.9	25.3	25.4	5	1	83.3	20.0	17.2	12.0
Yellow sandshell	1	2	33.3	5.6	12.5	1.0	8	11	42.1	2.8	5.7	-	-	-	-	-	-
Giant floater	-	-	-	-	-	-	2	0	100.0	0.7	0.6	1	0	100.0	3.3	3.4	2.0
Southern mapleleaf	15	2	88.2	83.3	70.8	15.0	193	20	90.6	67.0	64.0	23	0	100.0	76.7	79.3	46.0
Western pimpleback	1	0	100.0	5.6	4.2	1.0	3	1	75.0	1.0	1.2	-	-	-	-	-	-
Paper pondshell	-	-	-	-	-	-	3	1	75.0	1.0	1.2	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	2	1	75.0	0.3	0.9	-	-	-	-	-	-
Tapered pondhorn	-	-	-	-	-	-	4	1	80.0	1.4	1.5	-	-	-	-	-	-
Asian clam	abundant						abundant					present					
Total specimens	18	6	75.0%L				288	47	86.0%L			29	1	96.7%L			
	24(L+D)						335(L+D)					30(L+D)					
Total species	4	3	4(L+D)				8	7	8(L+D)		3	3	1	3(L+D)			continued

Bear Creek below Addicks Dam comparison	Oct 2004						Aug 2005					
	L	D	%Lsp	%L	%T	*N*/h	L	D	%Lsp	%L	%T	*N*/h

Round pearlshell	10	4	71.4	10.0	13.9	8.8	19	9	67.9	10.6	12.9	7.0
Yellow sandshell	-	-	-	-	-	-	0	6	0.0	0.0	2.8	1.5
Giant floater	1	1	50.0	1.0	1.9	1.3	5	0	100.0	2.8	2.3	1.3
Southern mapleleaf	88	3	96.7	88.0	84.3	56.9	156	22	87.6	86.7	82.0	44.5
Western pimpleback	1	0	100.0	1.0	0.1	0.6	-	-	-	-	-	-
Asian clam	present						present					
Total specimens	100	8	108(L+D)		92.6%L		180	37	217(L+D)		82.9%L	
Total species	4	3	4(L+D)				3	3	4(L+D)			

The dominant species (southern mapleleaf and round pearlshell) were maintained over time; however, yellow sandshell appears to be in decline at this site. Utilization of skilled malacologists in July 1994 resulted in documentation of a number of less-common unionids that were often overlooked in less intensive surveys. This location is within the city of Houston in a highly developed area. Since the 1996 survey, extensive high-rise construction occurred within a few hundred meters of this site and highway work is ongoing downstream. Nonetheless, this mussel assemblage has endured for an extended period of years.

Brazos River Drainage

Stillhouse Hollow Reservoir

Stillhouse Hollow Reservoir, Union Grove Park (SFASU Site 1), 31°00.548' N, 97°36.954' W, Bell County, Texas, 24 November 2005.
SFASU staff examined this site using random shallow water searches (100 m of shoreline) and timed searches (0.33 man-hours), but found no living unionids or their shells. Asian clams were preset.

Stillhouse Hollow Reservoir, southwest corner at bridge at CR 3481 (SFASU Site 2), 31°00.456' N, 97°36[~~8~~].745' W, Bell County, Texas, 24 November 2005.
SFASU staff examined this site using random shallow water searches (100 m of shoreline) and timed searches (0.33 man-hours), but found no living unionids or their shells. Asian clams were preset.

Stillhouse Hollow Reservoir, Dana Peak Park along northcentral shoreline (SFASU Site 3), 31°00.446' N, 97°36.155' W, Bell County, Texas, 24 November 2005.
SFASU staff examined this site using random shallow water searches (100 m of shoreline) and timed searches (0.75 man-hours), but found no living unionids or their shells. Asian clams were preset. Additionally, SFASU reported that a previously-sampled site at Brewer Road on the southcentral shoreline was closed to access.

This impoundment was surveyed at four sites (combined below) by HOH in August 1996 (Howells 1997).

Stillhouse Hollow Reservoir combined site comparison	Aug 1996					Nov 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	21	2	91.3	20.0	19.5	-	-	-	-	-
Tampico pearlymussel	33	2	94.3	31.4	30.2	-	-	-	-	-
Louisiana fatmucket	5	3	62.5	4.8	6.9	-	-	-	-	-
Yellow sandshell	2	0	100.0	1.9	1.7	-	-	-	-	-
Giant floater	37	3	92.5	35.2	34.5	-	-	-	-	-
Southern mapleleaf	6	0	100.0	5.7	5.2	-	-	-	-	-
Pistolgrip	1	1	50.0	1.0	1.7	-	-	-	-	-
Total specimens	105	11	116(L+D)		90.5%L	0	0	0(L+D)		

Total species	7	5	7(L+D)	0	0	0(L+D)

When examined in 1996, Stillhouse Hollow Reservoir had a unionid assemblage typical of the central Brazos River drainage. Extended drought and low-water appear to have negatively affected this impoundment.

Somerville Reservoir

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 1, Overlook Park boat ramp off SH 36 (30°18.570' N, 96°31.066 W), Washington County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.32 man-hours) and found the following specimens:

Somerville Reservoir, Overlook Park, 0.32 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	0	1.0	very long dead	2.4
Bleufer	0	1.0	relatively recently dead	2.4
Giant floater	10	11.0+0.5x1	relatively recently-very long dead	52.4
Southern mapleleaf	10	2.0+0.5x2	relatively recently-very long dead	33.3
Texas lilliput	0	0.5x2	relatively recently dead	4.8
Paper pondshell	0	2.0	relatively recently-recently dead	4.8
Total specimens	20	22	42(L+D) 47.6%L	
Total species	2	6	6(L+D)	

Overlook Park was examined by HOH in September 1996 (Howells 1997a).

Somerville Reservoir Overlook Park comparison	Sep 1996						Nov 2005					
	L	D	%L	%T	*N*L/h	*N*T/h	L	D	%L	%T	*N*L/h	*N*T/h
Threeridge	0	3	0.0	10.7	0.0	1.5	-	-	-	-	-	-
Yellow sandshell	-	-	-	-	-	-	0	1	-	2.4	0.0	2.4
Bleufer	-	-	-	-	-	-	0	1	-	2.4	0.0	2.4
Giant floater	-	-	-	-	-	-	10	12	50.0	52.4	31.3	11.0
Southern mapleleaf	14	1	100.0	53.6	7.0	7.5	10	4	50.0	33.3	31.3	7.0
Texas lilliput	0	10	0.0	35.7	0.0	5.0	0	2	-	4.8	0.0	1.0
Paper pondshell	-	-	-	-	-	-	0	2	-	4.8	0.0	1.0
N specimens	14	14	50.0%L	7.0L/h	14.0T/h		20	22	47.6%L	62.6L/h	21.0T/h	
	28(L+D)						42(L+D)					
N species	1	3	3(L+D)				2	6	6(L+D)			

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 2, Yegua Creek Park boat ramp (30°18.461' N, 96°32.741' W), Washington County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.5 man-hours) and found the following specimens:

Somerville Reservoir, Yegua Creek Park, 0.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	0.0	-	1.7

Yellow sandshell	6	12.0	relatively recently dead	30.0
Bleufer	1	0.0	-	1.7
Giant floater	4	15.0+0.5x1	very recently to recently dead	33.3
Southern mapleleaf	8	7.0	relatively recently-relatively long dead	25.0
Texas lilliput	0	3.0	relatively recently dead	5.0
Paper pondshell	0	2.0	relatively recently dead	3.3
Total specimens	20	40	60(L+D)	33.3%L
Total species	5	5	7(L+D)	

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 3, Rocky Creek Park boat ramp (30°17.980' N, 96°34.328' W), Washington County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.5 man-hours) and found the following specimens:

Somerville Reservoir, Rocky Creek Park, 0.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	5	2.0	relatively recently-relatively long dead	13.5
Giant floater	0	1.0	relatively recently dead	1.9
Southern mapleleaf	29	12.0+0.5x3	relatively recently-relatively long dead	84.6
Total specimens	34	18	52(L+D)	65.4%L
Total species	2	3	3(L+D)	

Rocky Creek Park was surveyed by HOH in September 1996 (Howells 1997a).

Rocky Creek Park comparison	Sep 1996						Nov 2005					
	L	D	%L	%T	*N*L/h	NT/h	L	D	%L	%T	*N*L/h	*N*T/h
Threeridge	0	1	0.0	5.9	0.0	0.5	-	-	-	-	-	-
Yellow sandshell	-	-	-	-	-	-	5	2	16.7	13.5	2.5	3.5
Bleufer	0	1	0.0	5.9	0.0	0.5	-	-	-	-	-	-
Giant floater	-	-	-	-	-	-	0	1	0.0	1.9	0.0	0.5
Southern mapleleaf	5	7	100.0	70.6	2.5	6.0	29	15	85.3	84.6	14.5	22.0
Texas lilliput	0	3	0.0	17.6	0.0	1.5	-	-	-	-	-	
N specimens	5	12	29.4%L		2.5L/h	8.5T/h	34	18	65.4%L		17.0L/h	26.0T/h
	17(L+D)						52(L+D)					
N species	1	4	5(L+D)				2	3	5(L+D)			

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 4, Nails Creek Park (30°17.720' N, 96°39.834' W), Lee County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.67 man-hours) and found the following specimens:

Somerville Reservoir, Nails Creek Park, 0.67 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	2	54.0	relatively long dead- long dead	80.0

Fragile papershell	0	1.0	relatively long dead	1.4
Bleufer	0	1.0	relatively long dead	1.4
Giant floater	0	9.0	relatively long dead-long dead	12.9
Texas lilliput	0	3.0	relatively long dead	4.3
Total specimens	2	68	70(L+D)	2.9%L
Total species	1	5	5(L+D)	

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 5, Burch Creek Park (30°18.553' N, 96°37.123' W), Burleson County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.5 man-hours) and found the following specimens:

Somerville Reservoir, Nails Creek Park, 0.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	0.0	-	5.0
Yellow sandshell	0	1.0	very recently dead	5.0
Giant floater	0	1.0	relatively long dead	5.0
Southern mapleleaf	10	3.0+0.5x4	very long dead-long dead	85.0
Total specimens	11	9	20(L+D)	55.0%L
Total species	2	3	4(L+D)	

Somerville Reservoir (Yegua Creek > Brazos River), SFASU Site 6, Big Creek Park (30°19.393' N, 96°34.325' W), Burleson County, Texas, 25 November 2005.
SFASU staff examined this site using timed searches (0.83 man-hours) and found the following specimens:

Somerville Reservoir, Nails Creek Park, 0.83 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	0	0.5x3	long dead	7.1
Giant floater	9	9.0	relatively recently-long dead	42.9
Southern mapleleaf	9	8.0	relatively recently-long dead	40.5
Texas lilliput	0	3.0	relatively recently dead	7.1
Paper pondshell	0	1.0	relatively long dead	2.4
Total specimens	18	24	42(L+D)	42.9%L
Total species	2	5	5(L+D)	

Somerville Reservoir combined sites comparison	Jul 1996					Sep 1996					Nov 2005				
	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h	L	D	%L	%T	*N*L/h
Threeridge	2	0	1.6	1.4	0.3	0	4	0.0	8.7	0.0	2	0	2.0	0.7	0.6
Tampico pearlymussel	1	0	0.8	0.7	0.2	-	-	-	-	-	-	-	-	-	-
Yellow sandshell	10	2	7.9	8.2	1.7	-	-	-	-	-	13	73	12.9	30.5	3.9
Fragile papershell	1	3	0.8	2.7	0.2	-	-	-	-	-	0	1	0.0	0.3	0.0
Bleufer	10	3	7.9	8.9	1.7	0	1	0.0	2.2	0.0	1	2	1.0	1.1	0.3
Giant floater	11	1	8.7	8.2	1.8	-	-	-	-		23	48	22.8	25.2	6.9

Southern mapleleaf	85	3	67.5	60.3	14.1	19	8	100.0	58.7	9.5	62	41	61.4	36.5	18.7
Texas lilliput	6	7	4.8	8.9	1.0	0	13	0.0	28.3	0.0	0	11	0.0	3.9	0.0
Tapered pondhorn	0	1	0.0	0.7	0.0	-	-	-	-	-	-	-	-	-	-
Paper pondshell	-	-	-	-	-	0	1	0.0	2.2	0.0	0	5	0.0	1.8	0.0
N specimens	126	20	86.3%L	21.0L/h		19	27	41.3%L	9.5L/h		101	181	35.8%L	30.4L/h	
	146 (L+D)					46(L+D)					282(L+D)				
N species	8	7	9(L+D)			1	5	5(L+D)			5	7	8(L+D)		
Combined *N* sites	8					3					6				

In July 1996, Somerville Reservoir and associated tributaries was surveyed by the HOH staff as part of standard TPWD mussel field surveys. However, in September 1996, several locations were used as mussel-survey training areas for a group of shell club volunteers. The number of people in the field at that time was increased, though sampling efficiency was somewhat lower. Despite low-water between 1996 and 2005, the mussel assemblage here appears to have endured reasonably well. Interestingly, although Tampico pearlymussel and bleufer occur together throughout much of central and southwestern Texas, these species are more morphologically similar here than at other locations.

Fort Bend County

Ditch, adjacent to the American Canal, Missouri City, Fort Bend County, Texas, 13 January 2005.

A TPWD employee visiting this area reported the following specimens:

Ditch adjacent to American Canal, Missouri City Species	*N* alive	*N* dead	Condition	Percent 0f total (L+D)
Yellow sandshell	1	4.0+0.5x11	very recently dead	100.0
Asian clam – present				
Total specimens	1	15	16(L+D) 6.3%L	
Total species	1	1	1(L+D)	

Colorado River Drainage

Spring Creek

Spring Creek, Foster Park upstream of Twin Buttes Reservoir (Concho River drainage), Tom Green County, Texas, 20 July 2005.

SFASU and TPWD personnel examined this site with timed searches (2.0 man-hours), but found only a single, long-dead shell of Texas fatmucket. This site had been surveyed by TPWD in 1993 (Howells 1995), 1996 (Howells 1997a), and 1997 (Howells 1998a), and was found to support a small population of endemic Texas fatmuckets (Howells et al. 2003).

Spring Creek Foster Park	May 1993						Jul 1997						Jul 2005					
comparison	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	*N*T/h
Texas fatmucket	0	8	0.0	0.0	57.1	2.7	2	15	11.8	100.0	94.4	5.7	0	1	0.0	0.0	100.0	0.5
Paper pondshell	0	6	0.0	0.0	42.9	2.0	0	1	0.0	0.0	5.6	0.3	-	-	-	-	-	-

Total specimens	0	14	14(L+D)	0.0%L		2	16	18(L+D)	11.1%L		0	1	1(L+D)	0.0%L		
Total species	0	2	2(L+D)			1	2	2(L+D)			0	1	1(L+D)			

Because Texas fatmucket is both endemic to Central Texas and has become quite rare in recent years, the discovery in 1993 of recently dead shells and valves at this location prompted a return survey in 1997; living specimens were again confirmed to be present. Also noteworthy: female Texas fatmuckets in Kerr and Runnels counties have mantle flaps that resemble small minnows, the only living female found in Spring Creek had a mantle flap resembling a white, surgical glove. In July 1997, the HOH staff located Texas fatmuckets (1 living, 5 dead) and a single dead paper pondshell upstream at Sherwood Cemetery Road (Howells 1998a). However, during drought conditions in 1999 (Howells 2000), local residents reported that this stream went dry. The survey in 2005 supports prior concern that this population may have been lost.

Nasworthy Reservoir

Nasworthy Reservoir (> Concho River > Colorado River), SFASU Site 1 at Red Bluff boat ramp, Tom Green County, Texas, 20 July 2005.

SFASU and HOH personnel and a local volunteer examined this site with timed searches (1.7 man-hours) and random shoreline searches (ca. 50 m) and found the following specimens:

Nasworthy Reservoir, at Red Bluff boat ramp, 1.7 man-hours					Percent of
Species	*N* alive	*N* shells	Condition		total (L+D)
Tampico pearlymussel	2	0.0	-		50.0
Bleufer	0	0.5x1	long dead		25.0
Southern mapleleaf	0	0.5x1	long dead		25.0
Total specimens	2	2	4(L+D)	50.0%L	
Total species	1	2	3(L+D)		

The HOH staff examined this site in June 1995 (Howells 1996a) and 1997 (Howells 1998a).

Nasworthy Reservoir Red Bluff ramp area	Jun 1995						Jun 1997						Jul 2005					
comparison	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	*N*T/h
Tampico pearlymussel	8	2+	80.0	21.6	21.7	2.5	14	12	53.8	19.7	23.4	8.7	2	0	100.0	100.0	50.0	1.2
Fragile papershell	1	0	100.0	2.7	2.2	0.3	3	0	100.0	4.2	2.7	1.0	-	-	-	-	-	-
Bleufer	0	2	0.0	0.0	4.3	0.5	2	2	50.0	2.8	3.6	1.3	0	1	0.0	0.0	25.0	0.6
Giant floater							3	0	100.0	4.2	2.7	1.0	-	-	-	-	-	-
Southern mapleleaf	28+	5	84.8	75.7	71.7	8.3	49	26	65.3	69.0	67.6	25.0	0	1	0.0	0.0	25.0	0.6
Total specimens	37+	9+	80.4%L				71	40	64.0%L				2	2	50.0%L			
	46+(L+D)						111(L+D)						4(L+D)					
Total species	3	3	4(L+D)				5	3	5(L+D)				1	2	3(L+D)			

Nasworthy Reservoir has long been recognized for its Tampico pearlymussels and their "Concho River pearls", as well as other freshwater mussels. However, this nutrient rich, city-owned, power-plant reservoir had been gathering deep, soft bottom sediments. It appeared that the shift to a softer bottom may have been contributing to the increase in proportions of thin-shelled, eutrophication-tolerant unionids like giant floater and fragile papershell. Prior to the 2006 survey, this impoundment was extensively suction-dredged. No formal efforts were made to salvage or relocate local unionids, though several area residents did attempt to collect mussels in the dredge path and then replace them after it had finished in each area. Nasworthy Reservoir did not contain any rare or sensitive unionids and all taxa present were known to be abundant elsewhere and would be expected to reinvade following dredging. The 2005 SFASU survey confirmed that a major portion of the local mussel assemblage had been killed during the dredging process. However, the improved post-dredge substrate conditions should provide better overall mussel habitat in the years ahead.

Nasworthy Reservoir (> Concho River > Colorado River), SFASU Site 2 at Hillside Drive (FM 2185) access point, Tom Green County, Texas, 20 July 2005.
SFASU and HOH personnel and a local volunteer examined this site with timed searches (1.3 man-hours) and random shoreline searches and found the following specimens:

Nasworthy Reservoir, at Hillside Driver access, 1.3 man-hours				Percent of
Species	*N* alive	*N* shells	Condition	total (L+D)
Fragile papershell	0	1.0	relatively recently dead	50.0
Bleufer	0	1.0	relatively long dead	50.0
Total specimens	0	2	2(L+D) 0.0%L	
Total species	0	2	2(L+D)	

The area off Hillside Driver (including the adjacent shore opposite the Red Bluff ramp) was examined by HOH in June 1997 (Howells 1998a); however, several earlier surveys in this area were pooled with other data.

Nasworthy Reservoir Hillside Drive area comparison	Opposite Red Bluff Jun 1997						Hillside Drive Jun 1997						Hillside Drive Jul 2005					
	L	D	%Lsp	%L	%T	*N*T/h	L	D	%Lsp	%L	%T	NL/h	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	1	0	100.0	1.4	1.1	0.3	1	0	100.0	1.1	-	0.3	-	-	-	-	-	-
Tampico pearlymussel	24	2	92.3	33.8	28.3	8.7	56	P	-	58.9	-	18.7	-	-	-	-	-	-
Fragile papershell	0	2	0.0	0.0	2.2	0.7	4	P	-	4.2	-	1.3	0	1	0.0	0.0	50.0	0.8
Bleufer	2	3	40.0	2.8	5.4	1.7	9	P	-	9.5	-	3.0	0	1	0.0	0.0	50.0	0.8
Giant floater	2	9	18.2	2.8	12.0	5.5	1	0	100.0	1.1	-	0.3	-	-	-	-	-	-
Southern mapleleaf	42	5	89.4	59.2	51.1	15.7	24	1	96.0	25.3	-	8.3	-	-	-	-	-	-
Total specimens	71	21	77.2%L 92(L+D)				95	-	-				0	2	00.0%L 2(L+D)			
Total species	5	5	6(L+D)				6	4	6(L+D)				0	2	2(L+D)			

Survey efforts at this location indicated a decline in abundance and diversity following extensive dredging.

Concho River

Concho River, SFASU Site 3 downstream of Twin Buttes Reservoir and upstream of Nasworthy Reservoir (> Concho River > Colorado River), at city park, Tom Green County, Texas, 20 July 2005 [counted as a Nasworthy Reservoir site in the summary below].

SFASU and HOH personnel and a local volunteer examined this site with timed searches (2.5 man-hours) and random shallow-water searches (ca 50 m) and found the following specimens:

Concho River, park between Twin Buttes and Nasworthy reservoirs, 2.5 man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Tampico pearlymussel	7	2.0		relatively long dead	50.0
Bleufer	0	1.0		relatively recently dead	5.6
Giant floater	0	5.0		relatively long dead	27.8
Southern mapleleaf	0	2.0+0.5x1		relatively long dead	16.7
Total specimens	7	11	18L+D)	38.9%L	
Total species	1	4	4(L+D)		

Previous sampling by HOH occurred upstream of this site (just below the dam at Twin Buttes Reservoir) and downstream (in the less riverine portions of Nasworthy Reservoir), but not at this exact location.

Concho River (> Colorado River), at Paint Rock pictographs, Concho County, Texas, 17 July 2005.

SFASU personnel examined this site with timed searches (5.0 man-hours) and snorkeled shallow waters and found the following species:

Concho River, at Paint Rock pictographs, 5.0 man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Fragile papershell	0	15.0+0.5x16		relatively recently dead-long dead	22.3
Bleufer	0	12.0+0.5x4		relatively recently dead-long dead	11.5
Southern mapleleaf	8	41.0+0.5x6		relatively recently dead-long dead	39.6
Texas pimpleback	8	25.0+0.5x2		relatively recently dead	25.2
Paper pondshell	0	1.0+0.5x1		relatively long dead	1.4
Total specimens	16	123	139(L+D)	11.5%L	
Total species	2	5	5(L+D)		

This site was examined by HOH in June 1993 (Howells 1995), August 1994 (Howells 1996a), June 1997 (Howells 1998a), and was observed in November 1999 (Howells 2000).

Concho River at Indian Pictographs Paint Rock area comparison	Jun 1993							Aug 1994						
	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Fragile papershell	9	11	45.0	18.0	25.6	4.5	5.0	4	P	-	6.0	-	2.4	-
Bleufer	1	2	33.3	2.0	3.8	0.5	0.7	3	P	-	4.5	-	1.8	-
Southern mapleleaf	28	14	66.7	56.0	53.8	14.0	10.5	32	P	-	47.8	-	18.8	-
Texas pimpleback	12	0	100.0	24.0	15.4	6.0	3.0	28	3	90.3	41.8	-	16.5	18.7
Paper pondshell	0	1	0.0	0.0	1.3	0.5	0.3	-	-	-	-	-	-	-

Total specimens	50	28	78(L+D)	64.1%L				67	-					
Total species	4	4	5(L+D)					4	4	4(L+D)				continued

Concho River at Indian Pictographs Paint Rock area comparison	Jun 1997							July 2005						
	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Fragile papershell	3	3	50.0	4.5	7.3	2.7	5.5	0	31	0.0	0.0	22.3	0.0	6.2
Bleufer	4	4	50.0	6.1	9.8	3.6	7.3	0	16	0.0	0.0	11.5	0.0	3.2
Southern mapleleaf	43	8	84.3	65.2	62.2	39.1	46.4	8	47	14.5	50.0	39.6	1.6	11.0
Texas pimpleback	16	1	94.1	24.2	20.7	14.5	15.0	8	27	22.9	50.0	25.2	1.6	7.0
Paper pondshell	-	-	-	-	-	-	-	0	2	0.0	0.0	1.4	0.0	0.4
Total specimens	66	16	82(L+D)	80.5%L				16	123	139(L+D)			11.5%L	
Total species	4	4	4(L+D)					2	5	5(L+D)				

This no-harvest sanctuary was one of only five locations where endemic Texas pimpleback was found alive during HOH mussel surveys (1992-2005) and supported the greatest number of that species found to date. It also had one of the greatest densities of Asian clam and its shells found in Texas by HOH and exceeded 2, 000/m^2 (Howells 1995). Asian clam and its shells constituted a major portion of the substrate in which Texas pimpleback and other unionids lived and reproduced (Howells 1995). In 1997, low-water and high temperatures killed large numbers of Texas pimplebacks and other mussels upstream, but those at the pictograph site survived. However, in late 1999 and early 2000, the Concho River in this area was reduced to standing pools of stagnant water or dry, exposed bottoms. Very few living animals were found alive (Howells 2000a). The SFASU survey here demonstrated that some mussels did survive the 1999-2000 dewatering, including Texas pimpleback, but abundance and diversity were both significantly reduced.

Concho River (> Colorado River), below dam at Paint Rock City Park, Concho County, Texas, 17 July 2005. SFASU personnel used timed searches (4.0 man-hours) and snorkeled shallow waters and found the following:

Concho River, below Paint Rock dam, 4.0 man-hours Species	*N* alive	*N* shells	Condition		Percent of total (L+D)
Tampico pearlymussel	0	0.5x1	relatively recently dead		2.3
Fragile papershell	0	3.0+0.5x24	relatively recently dead-relatively long dead		62.8
Bleufer	0	2.0+0.5x2	relatively recently dead-relatively long dead		9.3
Southern mapleleaf	0	4.0+0.5x6	relatively recently dead-relatively long dead		23.3
Texas pimpleback	0	1.0	relatively long dead		2.3
Total specimens	0	43	43(L+D)	0.0%L	
Total species	0	5	5(L+D)		

This location was examined in August 1999 (Howells 2000) as water levels were declining and again in April 2000 (Howells 2001) when only a few pools of stagnant water remained.

Concho River below Paint Rock dam comparison	Aug 1999						Apr 2000						Jul 2005					
	L	D	%Lsp	%L	%T	NL/h	L	D	%Lsp	%L	%T	NL/h	L	D	%Lsp	%L	%T	*N*L/h

Threeridge	-	-	-	-	-	-	0	1	0.0	0.0	-	0.0	-	-	-	-	-	-
Tampico pearlymussel	1	4	20.0	14.3	10.6	1.0	2	P	-	15.4	-	0.5	0	1	0.0	0.0	2.3	0.0
Yellow sandshell	-	-	-	-	-	-	0	1	0.0	0.0	-	0.0	-	-	-	-	-	-
Fragile papershell	4	13	23.5	57.1	36.2	4.0	5	P	-	38.5	-	1.3	0	27	0.0	0.0	62.8	0.0
Bleufer	2	9	18.2	28.5	23.4	2.0	6	P	-	46.2	-	1.5	0	4	0.0	0.0	9.3	0.0
Southern mapleleaf	0	5	0.0	0.0	10.6	0.0	0	P	-	0.0	-	0.0	0	10	0.0	0.0	23.3	0.0
Texas pimpleback	0	8	0.0	0.0	17.2	0.0	0	P	-	0.0	-	0.0	0	1	0.0	0.0	2.3	0.0
Pondhorn	0	1	0.0	0.0	2.1	0.0	-	-	-	-		-	-	-	-	-	-	-
Paper pondshell	-	-	-	-	-	-	0	3	0.0	0.0	-	0.0	-	-	-	-	-	-
Total specimens	7	40	14.9%L				13	5+					0	43	0.0%L			
	47(L+D)						18+(L+D)						43(L+D)					
Total species	3	6					3	8					0	5				
	6(L+D)						8(L+D)						5(L+D)					

Most of the substrate in this area was bedrock and cobble; both are undesirable mussel habitat. However, mussels were found in pockets of gravel, sand, and mud and at least 8 species were present at this site. Stresses associated with declining water levels were obvious during the 1999 examination and many were very recently dead. By April 2000, the Concho River had ceased flowing and only a few pools of water remained. At that time, even more recently dead mussels were apparent. When SFASU surveyed this location, declines in both abundance and diversity were apparent and no unionids were found alive.

Brady Lake

Brady Lake (Brady Creek > Colorado River), composite of 4 sites from the east side of the dam and along the north shore, McCulloch County, Texas, 17 July 2005.

SFASU personnel examined this reservoir with a series of timed searches (2 man-hours total) and examined 200 m of shoreline, but failed to find either unionids or their shells. High water level confounded sampling.

This reservoir was examined by HOH during very high-water conditions in July 1993 (Howells 1995); only paper pondshell was found. It was briefly examined again in November 1999 (Howells 2000) and again in April 2000 (Howells 2001). None of the surveys are sufficient to characterize the unionid assemblage.

Brady Lake northeast corner comparison	Nov 1999							Apr 2000	Jul 2005
	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L+D	L+D
Tampico pearlymussel	3	42	6.7	60.0	61.6	1.5	22.5	P	-
Giant floater	0	9	0.0	0.0	12.3	0.0	4.5	P	-
Southern mapleleaf	2	15	11.8	40.0	23.3	0.5	8.5	P	-
Paper pondshell	0	2	0.0	0.0	2.7	0.0	1.0	-	-
Total specimens	5	68	73(L+D)		6.8%L			-	-
Total species	2	5	5(L+D)					3	0

Elm Creek

Elm Creek, FM 261 north of Ballinger (Colorado River drainage), Runnels County, Texas, 22 July 2005. SFASU staff examined this site using timed searches (3.0 man-hours) and documented the following:

Elm Creek, FM 266 crossing, 3.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	21	32.0+0.5x13	relatively long dead-very long dead	76.7
Fragile papershell	0	0.5x1	very long dead	1.2
Southern mapleleaf	0	6.0+0.5x3	relatively long dead – long dead	10.5
Texas pimpleback	0	6.0+0.5x3	relatively recently dead – relatively long dead	10.5
Texas fatmucket	0	1.0	very long dead	1.2
Total specimens	21	65	86(L+D) 24.4%L	
Total species	1	5	5(L+D)	

This site was previously surveyed by TPWD in 1993 (Howells 1995), 1994 (Howells 1996a), 1995 (Howells 1996b), and 1997 (Howells 1998a) and by a volunteer in July 2001(Howells 2002a). It initially supported populations of rare, endemic Texas fatmuckets and Texas pimplebacks (Howells 1997f; Howells et al. 2003).

Elm Creek at FM 216 comparison	Aug 1993				Mar-Aug 1994	Jul 1995						Jul 2005					
	L	D	%L	*N*L/hr	L+D	L	D	%Lsp	%L	%T	*N*L/hr	L	D	%Lsp	%L	%T	*N*L/hr
Tampico pearlymussel	20	P	57.1	0.6	P	26	15	63.4	65.0	70.7	8.7	21	45	31.8	100.0	77.6	11.0
Texas fatmucket	10	P	28.6	0.3	P	2	2	50.0	5.0	6.9	0.7	0	1	0.0	0.0	1.2	0.0
Yellow sandshell	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-	-	-
Fragile papershell	-	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	1.2	0.0
Southern mapleleaf	4	P	11.4	0.1	P	10	1	90.9	25.0	19.0	3.3	0	9	0.0	0.0	10.6	0.0
Texas pimpleback	1	P	2.9	<0.1	P	2	0	100.0	5.0	3.4	0.7	0	9	0.0	0.0	10.6	0.0
Paper pondshell	0	2	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Total specimens	35	2+ 37+(L+D)			- 58(L+D)	40	18	69.0%L				21	65	24.4%L 86(L+D)			
Total species	5				5	4	3	4(L+D				1	5	5(L+D)			

In March and August 1994, survey efforts were confounded by cold, high-water conditions. The area also showed signs of extensive scouring. High waters also confounded sampling in July 1997. Between the July 1995 survey and site examination in 2001, severe drought and scouring flood conditions occurred. During this period, an environmental group released details regarding the location of rare unionids at this site over the internet. Rare-mollusk collectors may have used this information to find and harvest Texas fatmuckets and Texas pimplebacks. In 1993 and 1995, collection efforts produced 12-13 living specimens per hour of effort, but no living specimens were found in 2001 and in 2005, catch was reduced to less than 4 specimens/hour. The 2005 collection indicates survival following drought, flooding, and over-harvesting was better than expected. However, both overall abundance and diversity have been reduced, and no living Texas fatmuckets or Texas pimplebacks have been confirmed here in over a decade. Nonetheless, the presence of living Tampico pearlymussels suggests that other unionids may have survived here as well.

San Saba River

San Saba River, at Bevens River Road west of Menard (Colorado River drainage), Menard County, Texas, 20 July 2005.

SFASU and TPWD personnel examined this site with timed searches (2.7 man-hours) and found:

San Saba River, at Bevens River Road, 2.7 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	1.0+0.5x3	relatively recently dead	11.1
Tampico pearlymussel	3	2.0+0.5x2	relatively recently-relatively long dead	15.6
Texas fatmucket	1	0.5x1	relatively recently dead	4.4
Southern mapleleaf	7	1.0+0.5x10	relatively long dead	40.0
Pistolgrip	8	3.0	relatively recently-relatively long dead	24.4
Paper pondshell	0	2.0	relatively recently dead	4.4
Total specimens	20	25	45(L+D) 44.4%L	
Total species	5	6	6(L+D)	

When examined in 2005, both riffles and pools were being covered by extensive macrophyte growths. Yellow cowlily *Nuphar advena* dominated in fully aquatic areas. This and other macrophytes were present in when this site was examined by TPWD in 1997 (Howells 1998a), but to a lesser extent. In 1997, the number of dead shells and valves were not counted for some species, therefore comparisons between sampling years was restricted to living specimens and was adjusted for effort.

San Saba River at Bevens River Road	Jul 1997			Jul 2005		
	L	%L	*N*L/hr	L	%L	*N*L/hr
Threeridge	3	6.1	1.0	1	5.0	0.4
Tampico pearlymussel	2	4.1	0.7	3	15.0	5.6
Texas fatmucket	3	6.1	1.0	1	5.0	0.4
Southern mapleleaf	18	36.7	6.0	7	35.0	2.6
Texas pimpleback	5	12.8	1.7	-	-	-
Pistolgrip	14	28.6	4.7	8	40.0	3.0
Unidentified quadrulid	3	6.1	1.0	-	-	-
Paper pondshell	1	2.0	0.3	0	0.0	0.0
Total specimens	49	-	16.3	20	-	12.0
Total species	8			5 (+ 1 dead)		

When total number of unionids was adjusted for effort, the 2005 survey produced only about 40% of the number found in 1997 and with fewer species. The most abundant species 1997, southern mapleleaf and pistolgrip remained dominant taxa in 2005. Rare, endemic Texas pimpleback had only been found alive at this and three other locations, but was not found in 2005; however, Texas fatmucket (another rare endemic) probably still persists here. Despite the experienced staff conducting the survey in 2005, heavy macrophyte growths dramatically confounded collection effort efficiency.

San Saba River, at Menard, Menard County, Texas, 26 June 2005.

During other work at this site, the HOH staff found the following specimen:

San Saba River, Menard County	Percent of

Species	*N* alive	*N* dead	Condition	total (L+D)
Southern mapleleaf	0	1.0	relatively recently dead	100.0
Total specimens	0	1	1(L+D) 0.0%L	
Total species	0	1	1(L+D)	

Live Oak Creek

Live Oak Creek (> Pedernales River > Colorado River), at Lady Bird Johnson Park, Fredericksburg, Gillespie County, Texas, 16 July 2005.

SFASU and HOH personnel conducted timed searches (5.0 man-hours) and found the following species:

Live Oak Creek, Gillespie County, 5.0 man-hours Species	*N* alive	*N* shells	Condition	Percent of total (L+D)
Texas fatmucket	2	2.0+0.5x1	relatively recently dead-long dead	45.5
Paper pondshell	5	0.5x1	relatively recently dead	54.5
Total specimens	7	4	11(L+D) 70.0%L	
Total species	2	2	2(L+D)	

In 2002, endemic Texas fatmuckets were found at this site during research on mollusk feeding habits of local turtles (Howells 2003a; Howells et al. 2003). This stream was surveyed six times in 2003 by HOH and volunteers and once in 2004 (Howells 2004).

Live Oak Creek Gillespie County comparison	Jul 2002					Jan-Dec 2003					Apr 2004					Jul 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Texas fatmucket	0	11	0.0	0.0	45.8	1	6	14.3	50.0	41.2	0	17	0.0	0.0	12.8	2	3	40.0	28.6	4.5
Texas lilliput	0	1	0.0	0.0	4.2	0	6	0.0	0.0	35.3	0	9	0.0	0.0	6.8	-	-	-	-	-
Paper pondshell	0	12	0.0	0.0	50.0	1	3+	25.0	50.0	23.5	0	107	0.0	0.0	80.5	5	1	16.7	71.4	54.5
Total specimens	0	24	0.0%L			2	15+	11.8%L			0	133	0.0%L			7	4	70.0%L		
	24(L+D)					17+(L+D)					133(L+D)					11(L+D)				
Total species	0	3				2	3				0	3				2	2			
	3(L+D)					3(L+D)					3(L+D)					2(L+D)				

Most sampling efforts here have been initiated after rises and flood events that stranded unionids on flood plains and bars where they could not survive, but where they could be easily located. The SFASU survey efforts in 2005 confirmed that living Texas fatmuckets persist at this location. However, repeated sampling and observations support the belief that this is an extremely small population.

Lake Buchanan

Lake Buchanan, three sites combined (Llano County Park cove, cove on southwest corner, Garrett Island), Llano and Burnet counties, Texas, 21 July 2005.

SFASU and TWPD staff examined three locations on this reservoir. However, this impoundment had

experienced very low water levels for an extended period of time, but had a significant increase in water level just prior to this survey. As a result, living mussels were likely reduced in abundance and diversity, and scattered into deeper waters. Shells found on this survey generally represented those specimens that failed to follow the declining water line and then died. An accurate survey was not possible at this time. This reservoir has been surveyed by TPWD on a number of occasions since 1992, but any comparison of current to previous data would not be extremely meaningful.

Lake Buchanan, three sites combined Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	0.5x1	long dead	25.0
Tampico pearlymussel	0	fragments	long dead	-
Giant floater	0	2.0	relatively recently dead	50.0
Southern mapleleaf	0	0.5x1	relatively long dead	25.0
Total specimens	0	4+	4+(L+D) 0.0%L	
Total species	0	4	4(L+D)	

This reservoir was sampled on several occasions in 1992 (Howells 1994), 1994 (Howells 1996a), and 1996 (Howells 1997a). Often these collections were made during other fisheries work in the area.

Lake Buchanan pooled sites comparison	1992					1994					1996					2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	11	0	0.0	0.0	3.8	11	8	57.9	13.6	9.6	0	8	0.0	0.0	7.3	0	1	0.0	0.0	25.0
Tampico pearlymussel	254	0	0.0	0.0	87.3	30	42	41.7	37.0	36.4	0	31	0.0	0.0	28.2	0	frag	0.0	0.0	-
Fragile papershell	2	0	0.0	0.0	0.7	0	11	0.0	0.0	5.6	0	7	0.0	0.0	6.4	-	-	-	-	-
Bleufer	11	0	0.0	0.0	3.8	2	7	22.2	2.5	4.5	0	20	0.0	0.0	18.2	-	-	-	-	-
Giant floater	2	0	0.0	0.0	0.7	7	11	38.9	8.6	9.1	0	1	0.0	0.0	0.9	0	2	0.0	0.0	50.0
Southern mapleleaf	11	0	0.0	0.0	3.8	30	30	50.0	37.0	30.3	0	39	0.0	0.0	35.5	0	1	0.0	0.0	25.0
Pistolgrip	-	-	-	-	-	1	0	100.0	1.2	0.5	0	2	0.0	0.0	1.8	-	-	-	-	-
Lilliput	-	-	-	-	-	-	-	-	-	-	-	2	0.0	0.0	1.8	-	-	-	-	-
Paper pondshell	-	-	-	-	-	0	8	0.0	0.0	4.0	-	-	-	-	-	-	-	-	-	-
Total Specimens	291	0	100.0%L			81	117	40.9%L			0	110	0.0%L			0	4	0.0%L		
	291(L+D)					198(L+D)					110(L+D)					4(L+D)				
Total species	6	0	(6L+D)			6	7	8(L+D)			0	8	8(L+D)			0	4	(L+D)		

When first examined by HOH in mid-1992, this large reservoir had increased nearly to normal pool levels from an extended period of elevations over 12 m lower. As a result, few unionid remains were found at depths less than 10 m. About 12 months later, the living unionids that had been in much deeper water began to reappear in shallow areas where they could be more effectively sampled. Specimens taken in 1993 were living animals. The composite collections in 1994 likely represent the typical mussel assemblage in this impoundment. Specimens documented in 1996 were casually collected during a low-water period and during other research (only a limited number of dead specimens were picked up on exposed bottom areas). The SFASU survey took

place after another dewatering event and subsequent refilling. Snorkeling to depths of 6-7 m revealed footprints only recently flooded.

Inks Lake

Inks Lake, access points, both sides of state park boat launch peninsula, Burnet County, Texas, 21 July 2005. SFASU and TPWD personnel briefly examined these two sites, but an extended period of low water, followed by a recent increase in pool elevation left few shells or living specimen in shallow waters.

Inks Lake, at state park access Species	*N* alive	*N* shells	Condition	Percent of total (L+D)
Tampico pearlymussel	0	fragments	long dead	-
Southern mapleleaf	0	1.0	relatively recently dead	100.0
Total specimens	0	1+	1+(L+D) 0.0%L	
Total species	0	2	1(L+D)	

This reservoir was examined by HOH in 1994 (Howells 1996a), 1996 (Howells 1997a), and 1998 (Howells 1999).

Inks Lake sites and dates comparison	Sep 1994					Feb 1996					Feb 1998					Jul 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	0	1	0.0	0.0	12.5	7	9+	43.8	9.5	15.1	3	13	18.8	14.3	32.0	-	-	-	-	-
Tampico	-	-	-	-	-	31	6+	83.8	41.9	34.9	7	1+	87.5	33.3	16.0	0	frag	0.0	0.0	-
Fragile	-	-	-	-	-	0	1	0.0	0.0	0.9	-	-	-	-	-	-	-	-	-	-
Bleufer	-	-	-	-	-	0	1	0.0	0.0	0.9	0	1+	0.0	0.0	2.0	-	-	-	-	-
Giant floater	0	5	0.0	0.0	62.5	17	2+	89.5	23.0	17.9	1	2	33.3	4.8	6.0	-	-	-	-	-
Southern mapleleaf	0	2	0.0	0.0	25.0	16	8+	66.7	21.6	22.6	10	7	58.8	47.6	34.0	0	1	0.0	0.0	100.0
Smooth pimpleback	-	-	-	-	-	0	4	0.0	0.0	3.8	0	5	0.0	0.0	10.0	-	-	-	-	-
Paper pondshell	-	-	-	-	-	3	1	75.0	4.1	3.8	-	-	-	-	-	-	-	-	-	-
Total Specimens	0	8	0.0%L 8(L+D)			74	32	69.8%L 106(L+D)			21	29	42.0%L 50(L+D)			0	1	0.0%L 1(L+D)		
Total species	0	3	3(L+D)			5	8	8(L+D)			4	6	6(L+D)			0	2	2(L+D)		

Inks Lake operators stage a rapid (24-36 hours) 3-m reduction in impoundment elevation in February every second year for repair and maintenance. When HOH staff first examined this reservoir, few living unionids were found at depths of less than 3 m. Drawdowns here occur so quickly that any unionids that have relocated from deeper areas to the shallows are generally killed every two years. The 1996 and 1998 surveys took place just after these biannual drawdowns when mussels were exposed and readily observable. The SFASU survey took place some months after such a drawdown, but after return to normal pool levels. This resulted in few animals remaining in shallow areas. Although no HOH surveys have found living smooth pimplebacks in Inks Lake, repeated collection of shells suggests a limited population may persist in deeper areas of the reservoir.

Lake LBJ

Lake LBJ, Sunset Point park (north of dam), 30.56281° N, 98.34599° W, Burnet County, Texas, 26 January 2005. Staff from HOH examined this site during a partial drawdown (ca 3.5 m) a random area search found:

Lake LBJ, Sunset Point Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	0	1.0	very long dead	1.2
Tampico pearlymussel	0	12.0+0.5x34	very recently dead-very long dead	55.4
Fragile papershell	5	6.0+0.5x1	very recently dead-very long dead	14.5
Giant floater	0	2.0	very recently dead-very long dead	2.4
Southern mapleleaf	4	10.0+0.5x7	very recently dead-very long dead	25.3
Bleufer	0	0.5x1	very long dead	1.2
Asian clam – Present				
Total specimens	9	74	83(L+D) 10.8%L	
Total species	2	6	6(L+D)	

Lake LBJ, Granite Shoals public boat ramp, 30.58255° N, 98.36064° W, Burnet County, Texas, 26 January 2005. Staff from HOH examined this site during a partial drawdown (ca 3.5 m) using a random area search and found only a limited number of Asian clams. Substrate was black, anoxic mud.

Lake LBJ, Granite Shoals at Park 13, 30.58260° N, 98.37212° W, Burnet County, Texas, 26 January 2005. Staff from HOH examined this site during a partial drawdown (ca 3.5 m); a random area search found:

Lake LBJ, Granite Shoals Park 13 Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Giant floater	0	1.0	very recently dead	100.0
Asian clam – Present (abundant)				
Total specimens	0	1	1(L+D) 0.0%L	
Total species	0	1	1(L+D)	

Lake LBJ, north of Deerhaven, from CR 311 to adjacent embayment, 30.55911° N, 98.42852° W, Burnet County, Texas, 26 January 2005.
Staff from HOH examined this site during a partial drawdown (ca 3.5 m); a random area search found:

Lake LBJ, Granite Shoals Park 13 Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Giant floater	0	5.0	very recently dead	100.0
Asian clam – Present (abundant)				
Total specimens	0	5	5(L+D) 0.0%L	
Total species	0	1	1(L+D)	

Adams Branch Creek

Adams Branch Creek (Pecan Bayou > Lake Brownwood > Colorado River drainage), about 4.0 km north of Brownwood, Brown County, Texas, 2 January 2005.

A volunteer examined this site and reported the following specimens:

Adams Branch Creek, north of Brownwood Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Threeridge	0	1.0	unstated		14.3
Tampico pearlymussel	0	1.0	unstated		14.3
Yellow sandshell	0	0.5x1	unstated		14.3
Fragile papershell	0	0.5x2	unstated		28.6
Southern mapleleaf	0	2.0	unstated		28.6
Total specimens	0	7	7(L+D)	0.0%L	
Total species	0	5	5(L+D)		

The fragile papershell above was initially reported as a pink papershell, however, this was assumed to be a misidentification; pink papershell has never been reported in the basin and fragile papershell is often abundant.

Brownwood Reservoir

Brownwood Reservoir (Pecan Bayou > Colorado River), Brownwood State Park, SFASU Site 1, Brown County, Texas, 25 July 2005.

The SFASU staff surveyed this site with timed searches (3.25 man-hours) and found the following specimens:

Brownwood Reservoir, Brownwood State Park, 3.25 man-hours Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Threeridge	1	1.0	relatively recently dead		66.7
Giant floater	1	0.0	-		33.3
Total specimens	2	1	3(L+D)	66.7%L	
Total species	2	1	2(L+D)		

Brownwood Reservoir (Pecan Bayou > Colorado River), Brownwood State Park fishing pier area, SFASU Site 2, Brown County, Texas, 25 July 2005.

The SFASU staff surveyed this site with timed searches (0.67 man-hours) and found the following specimens:

Brownwood Reservoir, Brownwood State Park pier, 0.67 man-hours Species	*N* alive	*N* dead	Condition		Percent of total (L+D)
Threeridge	3	6.0+0.5x2	relatively recently dead-long dead		30.6
Fragile papershell	1	2.0+0.5x3	very recently dead-long dead		16.7
Bleufer	0	3.0+0.5x6	relatively long dead-very long dead		25.0
Giant floater	1	0.0	-		2.8
Southern mapleleaf	0	1.0+0.5x2	relatively long dead		8.3
Paper pondshell	0	4.0+0.5x2	relatively recently dead		16.7
Total specimens	5	31	36(L+D)	13.9%L	
Total species	3	5	6(L+D)		

Brownwood Reservoir (Pecan Bayou > Colorado River), bay at park road 15 and at FR 2237E crossing at Hog Creek (combined), SFASU Site 3, Brown County, Texas, 25 July 2005.

The SFASU staff surveyed this site with timed searches (2.75 man-hours) and found the following specimens:

Brownwood Reservoir, two locations combined, 2.75 man-hours					Percent of
Species	*N* alive	*N* dead		Condition`	total (L+D)
Giant floater	0	2.0+0.5x1		relatively recently dead	13.0
Paper pondshell	0	20.0		relatively recently dead	87.0
Total specimens	0	23	23(L+D)	0.0%L	
Total species	0	2	2(L+D)		

Brownwood Reservoir (Pecan Bayou > Colorado River), Sandy Beach Villa Resort, SFASU Site 4, Brown County, Texas, 25 July 2005.

The SFASU staff surveyed this site with timed searches (3 man-hours) and found the following:

Brownwood Reservoir, Sandy Beach Villa Resort					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Threeridge	21	3.0		very recently dead	53.3
Fragile papershell	15	2.0		very recently dead	37.8
Giant floater	3	0.0		-	6.7
Paper pondshell	0	1.0		relatively recently dead	2.2
Total specimens	39	6	45(L+D)	88.6%L	
Total species	3	3	4(L+D)		

These SFASU collections demonstrate the degree to which species composition and abundance can vary between sites within the same waterbody, as well as the proportion of living and dead specimens. It also demonstrates the need to sample a sufficient number of locations when characterizing a mussel population. This reservoir was visited by musselers in fall 1993 who sent 1 yellow sandshell and 3 Texas lilliputs to HOH for examination (Howells 1995). Brownwood Reservoir was surveyed on 16-17 July 1996 when 11 sites around the impoundment were surveyed (Howells 1997a). Pooled HOH and SFASU data are presented below:

Brownwood Reservoir pooled sites summary	16-17 Jul 1996					25 Jul 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Threeridge	3	6	33.3	75.0	23.1	25	12	67.6	54.3	34.6
Yellow sandshell	0	3	0.0	0.0	7.7	-	-	-	-	-
Fragile papershell	0	11	0.0	0.0	28.2	16	7	69.6	34.8	21.5
Bleufer	0	4	0.0	0.0	10.3	0	9	0.0	0.0	8.4
Giant floater	0	2	0.0	0.0	5.1	5	3	62.5	10.9	7.5
Southern mapleleaf	1	6	14.3	25.0	17.9	0	3	0.0	0.0	2.8
Pistolgrip	0	2	0.0	0.0	5.1	-	-	-	-	-
Paper pondshell	0	1	0.0	0.0	2.6	0	27	0.0	0.0	25.2
Total specimens	4	35	39(L+D)		10.3%L	46	61	107(L+D)		43.0%L
Total species	2	8	8(L+D)			3	6	6(L+D)		

Both HOH and SFASU collections are generally representative of mussel assemblages in Central Texas reservoirs. There does appear to have been a noteworthy increase in the proportion of living mussels in 2005 as well as an increase in threeridge numbers. Tampico pearlymussel, often one of the dominant species in the upper and central Colorado River system, was absent in these surveys as well as earlier collections.

Guadalupe River Drainage

Guadalupe River, Kerr County

Guadalupe River, Upper Guadalupe River Authority dam downstream to Lemos Street, Kerr County, Texas, 16 July 2005.
SFASU staff examined this area with timed searches (1.5 man-hours), but did not find unionids or their shells.

Local river authority personnel and HOH staff examined the area immediately below the Upper Guadalupe River Authority dam in October 1996. The examination occurred following a flood that deposited rare, endemic Texas fatmuckets onto an island below this dam (Howells 1997a). This site was reexamined in February 1997 after a second flood and in June 1997 following a third high-water event (Howells 1998a).

Guadalupe River below UGRA dam comparison	Oct 1996					Feb 1997					Jun 1997	Jul 2005
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L+ D	L+D
Texas fatmucket	0	5	0.0	0.0	31.3	0	3	0.0	0.0	33.3	-	-
Golden orb	-	-	-	-	-	0	3	0.0	0.0	33.3	-	-
Texas lilliput	0	5	0.0	0.0	31.3	0	1	0.0	0.0	11.1	-	-
Paper pondshell	0	6	0.0	0.0	37.5	0	2	0.0	0.0	22.2	1	-
Total specimens	0	16	0.0%L			0	9	0.0%L			1	-
	16(L+D)					9(L+D)						
Total species	0	3				0	4				1	-
	3(L+D)					4(L+D)						

Since 1996, when the first unionid specimens were found here, there has been no evidence that any living populations are present in the immediate area below the UGRA dam, despite snorkel surveys of this site. While species like Texas lilliput and paper pondshell could have originated from the UGRA impoundment upstream, Texas fatmucket has never been found in impounded waters and likely originated elsewhere. Given that unionids have only been found here following intense flooding and known populations of these species occur downstream, perhaps back-flow from downstream areas periodically contributes to the present of freshwater mussels found stranded here after floods. The failure of the SFASU staff to locate unionids further supports the belief that no mussel populations are present in the area immediately downstream of the UGRA dam.

Guadalupe River, Louise Hayes Park at SH 16 upstream to the Francisco Lemos Street low-water crossing, 30.04246° N, 99.14620° W, Kerr County, Texas, 16 July 2005.
SFASU staff examined this area with timed searches (4.0 man-hours) and located the following unionids:

Guadalupe River, Hayes Park, 4.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Texas fatmucket	6	1.0	relatively-recently dead	50.0
Golden orb	2	0.0	-	14.3
Texas lilliput	4	1.0	relatively recently dead	35.7

Total specimens	12	2	14(L+D)	85.7%L
Total species	3	2	3(L+D)	

This area was briefly examined by HOH in summer 1992, but only a subfossil shell fragment was found. In June 1998, the city of Kerrville drained the area to construct a footbridge in Louis Hayes Park, leaving a minimal flow of water in the old river channel. This site was examined on three consecutive days at that time. Stranded, rare Texas fatmuckets and golden orbs were noted (Howells 1999).

Guadalupe River above dam at Hayes Park comparison	17-19 Jun 1998							16 Jul 2005						
	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Texas fatmucket	0	20	0.0	0.0	36.4	0.0	5.0	6	1	85.7	50.0	50.0	1.5	1.8
Golden orb	0	1	0.0	0.0	1.8	0.0	0.3	2	0	100.0	16.7	14.3	0.5	0.5
Texas lilliput	0	33	0.0	0.0	60.0	0.0	8.3	4	1	80.0	33.3	35.7	1.0	1.3
Paper pondshell	0	1	0.0	0.0	1.8	0.0	0.3	-	-	-	-	-	-	-
Total specimens	0	55	55(L+D)		0.0%L			12	2	14(L+D)		85.7%L		
Total species	0	4	4(L+D)					3	2	3(L+D)				

The mussel population in the Guadalupe River immediately upstream of the dam at Louis Hayes Park in Kerrville has probably been small in recent decades, accounting for the failure to find living or recently dead specimens in the earliest examination of this area. When this section of river was drained down to only a small channel, the removal of this water exposed mussels that had not been seen here before. However, no trails were found to indicate these mussels had followed the declining water line and no live mussels were found in the clear, shallow waters that remained. When Kerrville drained this area for bridge construction, there was no evidence that any unionids had survived. When SFASU staff surveyed this area and found both Texas fatmuckets and golden orbs alive, it was unexpected. Both rare Central Texas endemics have been reduced to only a few populations. While these species do persist at this site, further modifications of the river in this area would increase concern for the well-being of these species.

San Marcos River

San Marcos River, at Palmetto State Park, immediately up- and down-stream of the low-water footbridge, Gonzales County, Texas, 27 July 2005.

Staff from SFASU and HOH examined this location using timed searches (5.0 man-hours) and found:

San Marcos River, Palmetto State Park, footbridge, 5.0 man-hours				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	9	13.0+0.5x8	relatively long dead	39.5
Tampico pearlymussel	0	0.5x3	relatively long dead	3.9
Louisiana fatmucket	0	0.5x1	very long dead	1.3
Yellow sandshell	0	3.0+0.5x2	relatively recently dead- long dead	6.6
Golden orb	11	6.0+0.5x8	long dead	32.9
Texas pimpleback	0	0.5x1	long dead	1.3
Pistolgrip	3	0.5x7	relatively long dead	13.2
False spike (?)	0	0.5x1	subfossil	1.3
Unidentifiable fragments	-	5	long dead	-
Total species	23	53	76(L+D)	30.3%L

Total specimens	3	9	9(L+D) *fragments not included in calculations

The San Marcos River at Palmetto State Park (PSP) was first surveyed by HOH under high-water conditions in 1992 when only long dead shells and valves of threeridge, washboard, southern mapleleaf, and Texas lilliput were documented (Howells 1994), but it appeared that few unionids remained in this area. During other work at a site 5.6 km downstream of PSP, HOH personnel found a single recently dead golden orb, one of the rare endemic species from Central Texas (Howells 1996b). In 2000, reports were sent to HOH from volunteers and Mussel Watch staff indicating long-dead and subfossil threeridge and yellow sandshell specimens in the area (Howells 2001). However, in April 2000, a mussel expert visiting PSP located both living golden orb specimens and recently dead valves of two false spike (Howells 2001). Given that no living or recently dead false spikes had been documented in approximately 20 years, these valves were the only recent suggestion that this species was not extinct. In August 2000, HOH briefly searched this area (Howells 2001).

	Apr 2000				Aug 2000			Jul 2005					
	L	D	%L	%T	L	D	%L	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	-	-	-	-	1	P	50.0	9	21	30.0	39.1	39.5	6.0
Tampico pearlymussel	-	-	-	-	0	P	-	0	3	0.0	0.0	3.9	0.6
Louisiana fatmucket	-	-	-	-	-	-	-	0	1	0.0	0.0	1.3	0.2
Yellow sandshell	-	-	-	-	0	P	-	0	5	0.0	0.0	6.6	1.0
Washboard	-	-	-	-	0	P	-	-	-	-	-	-	-
Golden orb	5	0	100.0	71.4	1	P	50.0	11	14	44.0	47.8	32.9	5.0
Southern mapleleaf	-	-	-	-	0	P	-	-	-	-	-	-	-
Texas pimpleback	-	-	-	-	-	-	-	0	1	0.0	0.0	1.3	0.3
Pistolgrip	-	-	-	-	-	-	-	3	7	30.0	13.0	13.2	2.0
False spike	0	2	0.0	28.6	0	P	-	0	1	0.0	0.0	1.3	0.3
Total specimens	5	2	7(L+D)		2	P	-	23	53	76(L+D)		15.4T/h	
Total species	1	1	2(L+D)		2	7	7(L=D)	3	9	9(L+D)			

Drought conditions in the late 1970s and several major flood events in 1978 and 1981 likely had negative impacts on the unionid assemblage in this area. The San Marcos River at PSP includes areas of deep shifting sand, collapsing sand banks, and scoured cobble, all undesirable mussel habitats. Mussels at PSP appear to be restricted to limited areas of microhabitat. Populations of freshwater mussels still persist downstream in the Guadalupe River below the dam at Lake Wood and could support reinvasion of this area. Whether the living specimens found recently represent reinvasion from downstream, reproduction among a limited number of survivors that were actually present in the area, or both, is unclear. However, some species are clearly living in this river at PSP and threeridge, golden orb, and pistolgrip appear to be successfully reproducing here as well. Since 2000, no additional living or recently dead false spike specimens have been located. If false spike still survives here, the population is probably quite small and there is concern about possible extinction.

Nueces River Drainage

Lake Corpus Christi

Lake Corpus Christi, SFASU Site 1 at west end of FM 888 Lagarto Ferry Road/Canal Street, 28.13132° N, 97.90243° W, Live Oak County, Texas, 23 July 2005.

SFASU staff examined this area with timed searches (4 man-hours) and located the following unionids:

Lake Corpus Christi, FM 888, 4.0 man-hours	Percent of

Species	*N* alive	*N* dead	Condition	total (L+D)
Tampico pearlymussel	1	2.0	relatively long dead-long dead	10.7
Yellow sandshell	16	0.5x1	relatively recently dead	60.7
Giant floater	1	0.0	-	3.6
Golden orb	0	0.5x1	long dead	3.6
Southern mapleleaf	0	0.5x1	long dead	3.6
Texas lilliput	4	0.0	-	14.3
Paper pondshell	1	0.0	-	3.6
Total specimens	23	5	28(L+D) 82.1%L	
Total species	5	4	7(L+D)	

Lake Corpus Christi, SFASU Site 2 at West Lakefield Drive adjacent to FM 888 (28.13193° N, 97.90283° W), Live Oak County, Texas, 23 July 2005.

SFASU staff examined this area with timed searches (1.5 man-hours) and located the following unionids:

Lake Corpus Christi, West Lakefield Drive, 1.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	8	6.0	relatively recently dead	58.3
Giant floater	5	2.0	relatively recently dead	29.2
Southern mapleleaf	0	1.0	very long dead	4.2
Texas lilliput	2	0.0	-	8.3
Total specimens	15	9	24(L+D) 62.5%L	
Total species	3	3	4(L+D)	

HOH staff examined this site on the western shore of Lake Corpus Christi in August 1994 (Howells 1996a). It was surveyed again in November 1995 (Howells 1996b). In July 1996, staff from HOH documented mussels left stranded as the reservoir waters were released downstream to reduce salinity in coastal bays (Howells 1997a). The HOH staff and volunteers returned in May 1998 after the impoundment had refilled.

Lake Corpus Christi at FM 888	Aug 1994							Nov 1995						
comparison	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Threeridge	-	-	-	-	-	-	-	2	1	66.7	5.0	4.7	1.0	1.5
Tampico pearlymussel	8	2	80.0	42.1	27.0	2.7	3.3	18	4	81.8	45.0	34.4	9.0	11.0
Yellow sandshell	1	1	50.0	5.3	5.4	0.3	0.7	2	0	100.0	5.0	3.1	1.0	1.0
Bleufer	1	1	50.0	5.3	5.4	0.3	0.7	1	2	33.3	2.5	4.7	0.5	1.5
Giant floater	5	0	100.0	26.3	13.5	1.7	1.7	4	0	100.0	10.0	6.3	2.0	2.0
Southern mapleleaf	0	9	0.0	0.0	24.3	0.0	3.0	1	3	75.0	2.5	6.3	0.5	2.0
Golden orb	4	5	44.4	21.1	24.3	1.3	3.0	9	14	39.1	22.5	35.9	4.5	11.5
Texas lilliput	-	-	-	-	-	-	-	3	0	100.0	7.5	4.7	1.5	1.5
Total specimens	19	18	37(L+D)		51.4%L			40	24	64(L+D)		62.5%L		
Total species	5	5	6(L+D)					8	5	8(L+D)				

Lake Corpus Christi	Jul 1996	July 2005 *

at FM 888 comparison	1993 L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	1995 L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Tampico pearlymussel	32	1	97.0	22.1	-	16.0	-	1	2	33.3	2.6	5.8	0.2	0.5
Yellow sandshell	10	P	-	6.9	-	5.0	-	24	7	77.4	63.2	59.6	4.4	5.6
Giant floater	-	-	-	-	-	-	-	6	2	75.0	15.8	15.4	1.1	1.5
Southern mapleleaf	7	P	-	4.8	-	3.5	-	0	2	0.0	0.0	3.8	0.0	0.4
Golden orb	70	0	100.0	48.3	-	35.0	-	0	1	0.0	0.0	1.9	0.0	0.2
Texas lilliput	26	P	-	17.9	-	13.0	-	6	0	100.0	15.8	11.5	1.1	1.1
Paper pondshell	-	-	-	-	-	-	-	1	0	100.0	2.6	1.9	0.2	0.2
Total specimens	145	-	-					38	14	52(L+D)		73.1%L		
Total species	5	5	5(L+D)					5	5	7(L+D)				

*SFASU Sites 1 and 2 were combined in this table.

This impoundment is representative of southern Texas unionid fauna (north of the Rio Grande) and is the southern-most range limit for several species (e.g., threeridge). It is also unique in being the only reservoir to support a population of golden orbs. This Central Texas endemic has otherwise been found only in flowing rivers and streams. Presumably, its presence on wind-swept points in Lake Corpus Christi simulates conditions similar to those in lotic systems. Despite the ecological significance of this mussel assemblage, comparisons between the data sets above are problematic at best. The 1994 and 1995 data sets are probably representative of this assemblage prior to dewatering in 1996. The 1996 collection was aimed at finding living golden orbs (in hopes of saving stranded individuals) or their shells (for distribution to other university and museum researchers) when declining water levels were certain to cause significant mortality of this rare mussel. The July 2005 SFASU sample was taken after Lake Corpus Christi refilled and water levels again began to decline.

Lake Corpus Christi, SFASU Site 3 at KOA Camp CR 371 boat ramp cove, 28.20449° N, 97.90160° W, Live Oak County, Texas, 23 July 2005.
SFASU staff examined this area with timed searches (4 man-hours) and located the following unionids:

Lake Corpus Christi, KOA Camp cove, 4.0 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	41	3.0+0.5x1	recently dead-relatively long dead	40.2
Yellow sandshell	21	6.0+0.5x1	relatively recently dead-recently dead	25.0
Bleufer	0	0.5x1	relatively long dead	0.9
Giant floater	5	7.0+0.5x1	relatively recently-relatively long dead	11.7
Golden orb	0	1.0	very long dead	0.9
Southern mapleleaf	0	1.0+0.5x1	very long dead	1.8
Texas lilliput	12	9.0+0.5x1	relatively recently dead-very long dead	19.6
Total specimens	79	33	112(L+D) 70.5%L	
Total species	4	7	7(L+D)	

The HOH staff first sample the cove at the KOA Camp cove area in October 1993 (Howells 1995). It was surveyed again in November 1995 (Howells 1996b) and July 1996 (Howells 1997a).

Lake Corpus Christi at KOA cove comparison	Oct 1993 L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	Nov 1995 L	D	%Lsp	%L	%T	*N*L/h	*N*T/h

Tampico pearlymussel	1	4	80.0	1.9	5.3	0.3	1.7		8	0	100.0	17.4	12.1	4.0	4.0
Yellow sandshell	14	8	63.6	25.9	23.2	4.7	7.3		8	0	100.0	17.4	12.1	4.0	4.0
Bleufer	27	8	77.1	50.0	36.8	9.0	11.7		1	0	100.0	2.2	1.5	0.5	0.5
Giant floater	8	4	66.7	14.8	12.6	2.7	4.0	3	0	100.0	6.5	4.5	1.5	1.5	
Southern mapleleaf	3	3	50.0	5.5	6.3	1.0	2.0	5	0	100.0	10.9	7.6	2.5	2.5	
Golden orb	-	-	-	-	-	-	-	21	18	53.8	45.7	59.1	10.5	19.5	
Texas lilliput	1	14	6.7	1.9	15.8	0.3	5.0	-	-	-	-	-	-	-	
Paper pondshell	-	-	-	-	-	-	-	0	2	0.0	0.0	3.0	0.0	1.0	
Total specimens	54	41	95(L+D)	56.8%L				46	20	66(L+D)	69.7%L				
Total species	6	6	6(L+D)					6	2	7(l+D)					continued

Lake Corpus Christi at KOA cove comparison	Jul 1996							Jul 2005						
	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Tampico pearlymussel	105	P	-	46.3	-	52.5	-	41	4	91.1	51.9	40.2	10.3	11.3
Louisiana fatmucket	5	0	100.0	2.2	-	2.5	-	-	-	-	-	-	-	-
Yellow sandshell	20	P	-	8.8	-	10.0	-	21	7	75.0	26.6	25.0	5.3	7.0
Bleufer	0	1	0.0	0.0	-	0.0	-	0	1	0.0	0.0	0.9	0.0	0.3
Giant floater	4	P	-	1.8	-	2.0	-	5	8	38.5	6.3	11.7	1.3	3.3
Southern mapleleaf	52	P	-	22.9	-	26.0	-	0	1	0.0	0.0	0.9	0.0	0.3
Golden orb	15	0	100.0	6.6	-	7.5	-	0	2	0.0	0.0	1.8	0.0	0.5
Texas lilliput	26	P	-	11.5	-	13.0	-	12	10	54.5	15.2	19.6	3.0	5.5
Total specimens	227	-		-				79	33	112(L+D)		70.5%L		
Total species	7		6	8(L+D)				4	7	7(L+D)				

Sampling dates at the KOA embayment, like those at the FM 888 site to the south, varied dramatically regarding sampling conditions and survey focus. As a result, direct comparisons from one survey to another need to be made with caution. Louisiana fatmucket reaches its southwestern-most range limit in Lake Corpus Christi, but the species is not abundant. Bleufer was apparently not native to the Nueces-Frio system and was not found by H.D. Murray (1978) during his 1977 survey made during a dewatered period; however, it has been introduced and seems to be established here (Howells 1997c). The Texas lilliput form found here has been considered to be western lilliput (*Toxolasma mearnsi*), but genetic analysis conducted by HOH failed to find a difference between Texas and western lilliputs (Howells 1997e), so subsequent HOH reports have considered the Lake Corpus Christi populations to be Texas lilliput.

The golden orb population in Lake Corpus Christi was seriously reduced during the 1995-6 dewatering. A survey by HOH in May 1998 (Howells 1999) failed to find even long-dead shells of this species and the 2005 SFASU efforts located only shell remains from two individuals. However, in 2006 as water levels continued to recede, H. McCullaugh (Jacksonville, Florida; pers. comm.) found living specimens and recently dead shells on recently exposed bottoms in early 2006. As water levels continued to fall, SFASU personnel again visited this impoundment and confirmed that golden orb was present.

Rio Grande Drainage

Rio Grande, Webb County

Rio Grande, at Santa Isabel Creek, 27°38.21' N, 99°37.50' W, Webb County, Texas, 30 December 2005.

LCC personnel examined this site and reported the following specimens:

Rio Grande at Santa Isabel Creek Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	0.5x2	very long dead	66.7
Mexican fawnsfoot	0	1.0	relatively recently dead	33.3
Total specimens	0	3	3(L+D) 0.0%L	
Total species	0	2	2(L+D)	

Rio Grande, at Sombrerito Creek, 27°36.86' N, 99°33.32' W, Webb County, Texas, 30 December 2005.
LCC personnel examined this site and reported the following specimens:

Rio Grande at Sombrerito Creek Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	2.0+0.5x2	relatively recently dead	12.9
Texas hornshell	0	17.0+0.5x3	very recently dead-relatively long dead	64.5
Southern mapleleaf	0	6.0	recently dead	19.4
Mexican fawnsfoot	0	0.5x1	relatively long dead	3.2
Asian clam (present)				
Total specimens	0	31	31(L+D) 0.0%L	
Total species	0	4	4(L+D)	

Rio Grande, Las Palmas Nature Trail, Laredo, Webb County, Texas, 12 December 2005.
LCC personnel examined this section of river and documented the following specimens:

Rio Grande at Las Palmas Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	1	0.0	-	1.0
Texas hornshell	0	6.0+0.5x4	very recently dead-relatively recently dead	10.3
Washboard	0	1.0	relatively recently dead	1.0
Southern mapleleaf	2	81.0	recently dead-very recently dead	85.6
Mexican fawnsfoot	0	1.0+0.5x1	recently dead	2.1
Asian clam (present)				
Total specimens	3	94	97(L+D) 3.1%L	
Total species	2	5	5(L+D)	

Although the HOH statewide mussel survey efforts that began in 1992 included sites in the Rio Grande drainage from the outset (Howells 1994), these early efforts were focused from Falcon Reservoir downstream and from Amistad Reservoir upstream. From 1998 through , TPWD joined with New Mexico Department of Game and Fish (supported by federal funding) to conduct detailed surveys of the Rio Grande drainage in both states. During this survey, another agency that surveyed waters in Webb County, Texas, for TPWD reported no unionids were found in this section of river. When the final survey results were reported (Howells a, b; 2003a. b), several unionid species were described as not having been found in recent surveys and were suspected of being extirpated, reflecting findings and comments of Neck and Metcalf (1988) years earlier. However, shortly thereafter personnel from LCC reported finding recently dead and living specimens of several unionid taxa believed to have been lost. Therefore, in 2002 and 2003, LCC and HOH staff examined numerous sites in the

Rio Grande and adjacent waters from the upstream reaches of Webb County to the Falcon Reservoir area downstream. Rio Grande survey results from Webb County are combined by year and reported below.

Rio Grande Webb County sites comparison	2002					2003					2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Tampico pearlymussel	3	114	2.6	6.8	22.1	7	381	1.8	41.2	59.5	0	6	0.0	0.0	5.0
Yellow sandshell	3	21	12.5	6.8	4.5	0	25	0.0	0.0	3.8	1	0	100.0	33.3	0.8
Washboard	2	16	11.1	4.5	3.4	4	22	15.4	23.5	4.0	0	1	0.0	0.0	0.8
Texas hornshell	24	190	11.2	54.5	40.4	1	90	1.1	5.9	14.0	0	20	0.0	0.0	16.5
Salina mucket	-	-	-	-	-	0	8	0.0	0.0	1.2	-	-	-	-	-
Southern mapleleaf	12	63	16.0	27.3	14.2	4	23	14.8	23.5	4.1	2	87	2.2	66.7	73.6
Mexican fawnsfoot	0	80	0.0	0.0	15.1	1	82	1.2	5.9	12.7	0	4	0.0	0.0	3.3
Paper pondshell	0	2	0.0	0.0	0.4	0	4	0.0	0.0	0.6	-	-	-	-	-
Total specimens	44	486	8.3%L			17	635	2.6%L			3	118	2.5%L		
	530 (L+D)					652(L+D)					121(L+D)				
Total species	5	7				5	8				2	5			
	7(L+D)					8(L+D)					6(L+D)				

The number of collections, collection sites, and personnel involved was significantly greater in 2002 and 2003 than in 2005 making direct comparisons between years problematic. Although a noteworthy freshwater mussel assemblage is present in the Webb County stretch of the Rio Grande, this region is experiencing significant commercial development and human population growth. Concerns remain about the mussel populations here.

Lower Rio Grande

Rio Grande, at Dolores Creek, 27°12.60' N, 99°25.98' W, Zapata County, Texas, 17 December 2005.

LCC personnel examined this site and reported the following specimens:

Rio Grande at Dolores Creek Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	6.0+0.5x13	very recently dead-subfossil	47.5
Texas hornshell	0	0.5x1	relatively recently dead	2.5
Salina mucket	0	0.5x2	very long dead	5.0
Mexican fawnsfoot	0	0.5x18	long dead	45.0
Asian clam (present)				
Total specimens	0	40	40(L+D) 0.0%L	
Total species	0	4	4(L+D	

The Dolores Creek area was surveyed by LCC in December 2002 (Howells 2003) with the following result:

Rio Grande at Dolores Creek comparison	Dec 2002					Dec 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Tampico pearlymussel	0	4+	0.0	0.0	23.5+	0	19	0.0	0.0	47.5

Yellow sandshell	0	3	0.0	0.0	17.6	-	-	-	-	-
Texas hornshell	-	-		-	-	0	1	0.0	0.0	2.5
Southern mapleleaf	0	4	0.0	0.0	23.5	-	-	-	-	-
Salina mucket	-	-	-	-	-	0	2	0.0	0.0	5.0
Mexican fawnsfoot	0	5	0.0	0.0	29.4	0	18	0.0	0.0	45.0
Paper pondshell	0	1	0.0	0.0	5.9	-	-	-	-	-
Total specimens	0	17+ 17+(L+D)	0.0%L			0	40 40(L+D)	0.0%L		
Total species	0	5	5(L+D)			0	4	4(L+D)		

Although this location has not produced living unionids, many of the specimens collected were recently dead. Living mussels probably occur here in limited numbers or do so in adjacent areas upstream.

Rio Grande, downstream of Falcon Reservoir at Roma, 26°24.278' N, 99°01.161' W, Starr County, Texas, 17 March 2005.

LCC personnel examined this site and reported the following specimens:

Rio Grande at Roma Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	0.5x6	very long dead	42.9
Texas hornshell	0	1.0	long dead	7.1
Southern mapleleaf	0	3.0+0.5x2	long dead-very long dead	35.7
Paper pondshell	0	0.5x2	long dead	14.3
Asian clam (present)				
Total specimens	0	14	14(L+D) 0.0%L	
Total species	0	4	4(L+D	

The Rio Grande downstream from the dam at Falcon Reservoir was briefly surveyed by HOH in 1992, but high-water conditions confounded sampling and only Asian clams were found (Howells 1994). It was surveyed again by HOH in March 1994 (Howells 1996a) and July 1996 (Howells 1997a). Another collection in August 2003 produced only Asian clams (Howells 2004).

Rio Grande at Roma below Falcon Reservoir comparison	Mar 1994					Jul 1996					Mar 2005				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Tampico pearlymussel	0	14	0.0	0.0	56.0	-	-	-	-	-	0	6	0.0	0.0	42.9
Yellow sandshell	0	5	0.0	0.0	20.0	-	-	-	-	-	-	-	-	-	-
Washboard	0	1	0.0	0.0	4.0	-	-	-	-	-	-	-	-	-	-
Texas hornshell	-	-	-	-	-	-	-	-	-	-	0	1	0.0	0.0	7.1
Southern mapleleaf	0	5	0.0	0.0	20.0	0	4	0.0	0.0	80.0	0	5	0.0	0.0	35.7
Paper pondshell	-	-	-	-	-	0	1	0.0	0.0	20.0	0	2	0.0	0.0	14.3
Total specimens	0	25	0.0%L			0	5	0.0%L			0	14	0.0%L		
	25(L+D)					5(L+D)					14(L+D)				
Total species	0	4	4(L+D)			0	2	2(L+D)			0	4	14(L+D)		

Although several species have been found here, none have been found alive. Shells and valves have been long dead to very long dead and subfossil and there is little indication that significant mussel populations remain.

Resaca de la Palma, exact location unstated, Cameron County, Texas, 28 March 2005.
Nature Conservancy personnel found the following specimens:

Resaca de la Palma Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Yellow sandshell	0	0.5x2	very long dead-subfossil	100.0
Total specimens	0	2	2(L+D) 0.0%L	
Total species	0	1	1(L+D)	

JANUARY – JUNE 2006

Big Cypress Bayou

Big Cypress Bayou

Big Cypress Bayou, 500 m downstream of Fort Sherman Dam, SFASU Site 3 ca 33°05.524'N, 95°00.875'W, Titus County, Texas, 4 June 2006.
SFASU and UT-Tyler staff conducted timed searches (0.5 man-hours) at this location.

Big Cypress Bayou, 500 m downstream of Fort Sherman Dam, 0.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Giant floater	0	5.0	relatively long dead	100.0
Total specimens	0	5	5(L+D) 0.0%L	
Total species	0	1	1(L+D)	

Big Cypress Bayou, 0.8 km m downstream of Fort Sherman Dam, SFASU Site 2 ca 33°05.524'N, 95°00.875'W, Titus County, Texas, 4 June 2006.
SFASU and UT-Tyler staff conducted timed searches (1.0 man-hour) at this location.

Big Cypress Bayou, 0.8 km downstream of Fort Sherman Dam, 1.0 man-hour Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	13	0.0	-	21.7
Yellow sandshell	20	3.0	long dead	38.3
Pond mussel	1	0.0	-	1.7
Washboard	2	0.0	-	3.3
Bankclimber	9	0.0	-	15.0
Western pimpleback	3	0.0	-	5.0
Mapleleaf	9	0.0	-	15.0
Total specimens	57	3	60(L+D) 95.0%L	
Total species	7	1	7(L+D)	

Big Cypress Bayou, 1.2 km downstream of Fort Sherman Dam, SFASU Site 1ca 33°05.524'N, 95°00.875'W, Titus County, Texas, 4 June 2006.
SFASU and UT-Tyler staff conducted timed searches (1.5 man-hours) at this location.

Big Cypress Bayou, 1.2 km downstream of Fort Sherman Dam, 1.5 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	10	1.0	relatively long dead		9.2
"Texas" pigtoe	2	0.0	-		1.7
Yellow sandshell	16	8.0	relatively long dead		20.2
Pond mussel	4	0.0	-		3.4
Bankclimber	54	0.0	-		45.4
Giant floater	5	1.0	relatively long dead		5.0
Mapleleaf	13	0.0	-		10.9
Texas lilliput	3	0.0	-		2.5
Tapered pondhorn	0	2.0	relatively long dead		1.7
Total specimens	107	12	119(L+D)	89.9%L	
Total species	8	4	9(L+D)		

This site was surveyed by TPWD in July 1996 (Howells 1996c, 1997a). These data are compared to pooled data from the 2006 SFASU survey below.

Big Cypress Bayou below Ft. Sherman Dam comparison	Jul 1996						Jun 2006					
	L	D	%Lsp	%L	%T	T*N*/h	L	D	%Lsp	%L	%T	T*N*/h
Threeridge	18	5	78.3	36.7	28.4	11.5	23	1	95.8	14.0	13.0	8.0
Pigtoe (*Fusconaia* sp.)	1	2	33.3	2.0	3.7	1.5	2	0	100.0	1.2	1.1	0.7
Louisiana fatmucket	0	2	0.0	0.0	2.5	1.0	-	-	-	-	-	-
Yellow sandshell	3	5	37.5	6.1	9.9	4.0	36	11	76.6	22.0	25.5	15.7
Pond mussel	-	-	-	-	-	-	5	0	100.0	3.0	2.7	1.7
Washboard	3	1	25.0	6.1	4.9	2.0	2	0	100.0	1.2	1.1	0.7
Bankclimber	5	0	100.0	10.2	6.2	2.5	63	0	100.0	38.4	34.2	21.0
Western pimpleback	3	2	60.0	6.1	6.2	2.5	3	0	100.0	1.8	1.6	1.0
Giant floater	0	1	0.0	0.0	1.2	0.5	5	6	45.5	3.7	6.0	1.7
Mapleleaf	11	1	91.7	22.4	14.8	6.0	22	0	100.0	13.4	12.0	7.3
Pistolgrip	1	6	14.3	2.0	8.6	3.5	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	3	0	100.0	1.8	1.6	1.0
Tapered pondhorn	4	7	36.4	8.2	13.6	5.5	0	2	0.0	0.0	1.1	0.7
Total specimens	49	32	81(L+D)	60.5%L		40.5T/h	164	20	184(L+D)	89.1%L		61.3T/h
Total species	9	10	11(L+D)				10	4	11(L+D)			

Although species composition and general abundance was similar between these two surveys, there are some noteworthy differences. Yellow sandshell increased in abundance and bankclimber was found to be more abundant in 2006 than it had been a decade earlier. It is not clear why these changes occurred and these variations may only reflect differential sampling of slightly different microhabitats in the area. The fusconaid pigtoes taken by HOH in 1996 were not identified to species, but those found by SFASU in 2006 were considered Texas pigtoe; however, genetic confirmation of their identity has not been obtained to date. The

pimpleback quadrulids here were confirmed genetically to be western pimpleback by Serb et al. (2004).

Sabine River Drainage

Sabine River

Sabine River, between FM 14 south of Hawkins and SH 155 southwest of Big Sandy, Wood and Smith counties, Texas, 12 and 22 May 2006 (combined).

University of Texas at Tyler staff examined this region of the Sabine River by float trip and used timed searches (4, 15-minute searches) and quadrat sampling (20, 0.25-m^2). The following specimens reported are listed below (N. Ford, University of Texas at Tyler, pers. comm.):

Sabine River, at US 43 crossing, 32°22.184 N, 94°27.466 W, Panola County, Texas, 30 May 2005.

UT-Tyler staff examined this location using 15-minute timed searches at four locations combined below (N. Ford; pers. comm.):

Sabine River	12-22 May 2006 FM 14 - SH 155 4, 15-minute searches		12-22 May 2006 FM 14 – SH 155 20, 0.25-m^2 quadrats			30 May 2006 US 43 4, 15-minute searches	
Species	*N*T/h	%T	*N*T	*N*T/m^2	%T	*N*T/h	%T
Threeridge	2	0.5	1	0.2	0.5	3	1.4
Rock-pocketbook	4	1.0	2	0.4	1.0	3	1.4
Texas pigtoe	84	20.1	21	4.2	10.7	42	19.5
Louisiana fatmuckets	-	-	-	-	-	5	2.3
Sandbank pocketbook	-	-	-	-	-	3	1.4
Yellow sandshell	7	1.7	-	-	-	27	12.6
Fragile papershell	-	-	2	0.4	1.0	8	3.7
Washboard	12	2.9	2	0.4	1.0	3	1.4
Threehorn wartyback	12	2.9	19	3.8	9.6	8	3.7
Bankclimber	6	1.4	1	0.2	0.5	7	3.3
Texas heelsplitter	-	-	-	-	-	1	0.5
Bleufer	12	2.9	4	0.8	2.0	18	8.4
Southern mapleleaf	68	16.3	49	9.8	24.9	16	7.4
Western pimpleback	9	2.2	2	0.4	1.0	26	12.1
Pistolgrip	177	42.3	33	6.6	16.8	39	18.1
Deertoe	25	6.0	61	12.2	31.0	7	3.3
Asian clam (present)							
Total specimens	418 (L+D)		197 (L+D)			216 (L+D)	
Total species	12		12			16	

The HOH staff have surveyed sites on the Sabine River between Lake Tawakoni and Toledo Bend Reservoir since 1992 and SFASU and UT-Tyler surveyed sites in this area in 2005. Texas pigtoe, rare and endemic to this region, appeared more frequently in surveys in 2005 and 2006 than earlier studies indicated. Sandbank pocketbook and Texas heelsplitters also persist in this area, but neither appears to be abundant here. The UT-Tyler staff observed numerous dead unionids at the US 43 crossing in May 2006 and noted pipeline construction work that may have been a contributing factor.

Brazos River Drainage

Leon River

Leon River (Brazos River drainage), CR 301 northwest of Hamilton, 31.80954° N, 98.20469° W, Hamilton County, Texas, 26 May 2006.

Staff from HOH, UT-Tyler, and Texas Department of Transportation (TexDOT) examined this site relative to planned bridge replacement to be implemented later in 2006 at the downstream site listed below. This examination was a preliminary range-finding survey in advance of more-detailed work in the future. This location experienced a bridge replacement that was completed in spring 2005.

Leon River, at CR 301 Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	-	P	very recently dead-very long dead	-
Fragile papershell	P	P	very recently dead-very long dead	-
Southern mapleleaf	-	P	very recently dead-very long dead	-
Smooth pimpleback	P	P	recently dead-long dead	-
Pistolgrip	P	P	very recently dead-very long dead	-
Asian clam (present)				

Despite recent bridge construction here, living specimens were still present downstream (including larger, older animals that were likely present when the construction occurred). Both upstream and downstream of the new bridge, large numbers of Asian clams and native unionids appeared to have been recently killed, including a number of juvenile pistolgrips. No cause for these losses was apparent, but deposition of specimens on gravel bars by high-water, followed by declining water levels and high summer temperatures may have been factors.

Leon River (Brazos River drainage), CR 284 (301) east of Hamilton, 31.69467°N, 97.98443° W, Hamilton County, Texas, 26 May 2006.

Staff from HOH, UT-Tyler, and TexDOT examined this site relative to planned bridge replacement to be implemented later in 2006. This too was a range-finding effort, but a more detailed study will be conducted in fall or winter 2006. The following specimens were noted:

Leon River, at CR 284 Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	P	P	very recently dead-very long dead	-
Fragile papershell	P	P	very recently dead-very long dead	-
Southern mapleleaf	-	P	very recently dead-very long dead	-
Smooth pimpleback	P	P	long dead	-
Pistolgrip	P	P	very recently dead-very long dead	-
Asian clam (present)				

Although the mussel assemblage at this site was not extraordinarily abundant or diverse, it was typical of many area streams prior to extensive scouring that has reduced and eliminated mussels populations in many other waters. Rare, endemic smooth pimpleback still occurs here, as does a noteworthy population of pistolgrips (often lost from other central and western Texas waters).

Guadalupe River Drainage

Lake Gonzales

Lake Gonzales, mid-reservoir islands, 29°30.118' N, 97°37.642' W, Gonzales County, Texas, 29 April 2006. SFASU staff surveyed this site with timed searches (3.0 man-hours):

Lake Gonzales, mid-reservoir islands , 3.0 man-hours					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Threeridge	24	3.0	relatively long dead		17.2
Tampico pearlymussel	10	1.0	relatively recently dead		7.0
Louisiana fatmucket	5	0.0	-		3.2
Yellow sandshell	28	12.0+0.5x1	relatively recently dead		26.1
Washboard	3	0.0	-		1.9
Giant floater	38	28.0	relatively recently dead		42.0
Southern mapleleaf	0	1.0	relatively long dead		0.6
Texas lilliput	3	0.0	-		1.9
Total specimens	111	46	157(L+D)	70.7%L	
Total species	7	5	8(L+D)		

Prior to the first examination of this relatively small impoundment on the Guadalupe River by HOH in 1992, local homeowners reported that a crew of some 50 non-resident musselers heavily harvested beds of washboards and threeridges here (Howells 1994; Howells et al 1996). However, a local resident directed the HOH team to an area that had escaped earlier commercial harvest. This area, on the south side of a mid-reservoir island was formally surveyed by HOH in 1993 (Howells 1995). In June 2005, three HOH biologists used this site to train a visiting biologist from another state (Howells 1996a) and personnel from Southwest Texas State University (SWTSU, now Texas State University) surveyed the same mid-reservoir island and other adjacent sites (Arsuffi et al. 1995). In 1997, biologists from the North American Benthological Society toured this site, but only presence or absence records were taken (Howells 1998a). SFASU returned to the mid-reservoir island in 2006 to update the status of mussels here.

Lake Gonzales comparison	Jul 1992	Mid-lake island May 1993							Mid-lake island Jun 1995						
	L+D	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Threeridge	P	42	1	97.7	89.4	87.8	14.0	14.3	9+	many	-	25.0	-	2.3	-
Tampico pearlymussel	P	-	-	-	-	-	-	-	2	0	100.0	5.6	-	0.5	0.5
Louisiana fatmucket	P	-	-	-	-	-	-	-	2	0	100.0	5.6	-	0.5	0.5
Yellow sandshell	P	-	-	-	-	-	-	-	4	many	-	11.1	-	1.0	-
Washboard	P	-	-	-	-	-	-	-	3	0	100.0	8.3	-	0.8	0.8
Bleufer	P?	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Giant floater	P	1	1	50.0	2.1	4.1	0.3	0.7	5	3	62.5	13.9	-	1.3	2.0
Southern mapleleaf	P	4	0	100.0	8.5	8.2	1.3	1.3	11	0	100.0	30.6	-	5.5	5.5
Texas lilliput	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paper	P	-	-	-	-	-	-	-	0	1	0.0	0.0	-	0.0	0.3

pondshell																		
Total specimens	-		47	2	49(L+D)	95.9%L					36	4+						
Total species	10		3	2	3(L+D)						7	4	8(L+D)					

continued

Lake Gonzales comparison	Mid-lake island-SWTSU Jul 1995					All sites-SWTSU Jul 1995					May 1997	Apr 2006					
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L+D	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	10	3	76.9	33.3	23.2	70	13	84.3	59.3	43.5	P	24	3	88.9	21.6	17.2	9.0
Tampico pearlymussel	11	0	100.0	20.0	19.6	11	8	57.9	9.3	9.9	-	10	1	90.9	9.0	7.0	3.7
Louisiana fatmucket	3	7	30.0	10.0	17.9	3	8	27.3	2.5	5.8	P	5	0	100.0	4.5	3.2	1.7
Yellow sandshell	7	3	70.0	23.3	17.9	20	11	64.5	16.9	16.2	P	28	13	68.3	25.2	26.1	13.7
Washboard	3	0	100.0	10.0	5.4	3	0	100.0	2.5	1.6	-	3	0	100.0	2.7	1.9	1.0
Giant floater	0	8	0.0	0.0	14.3	9	31	22.5	7.6	20.9	P	38	28	57.6	34.2	42.0	22.0
Southern mapleleaf	-	-	-	-	-	1	2	33.3	0.8	1.6	P	0	1	0.0	0.0	0.6	0.3
Paper pondshell	1	0	0.0	3.3	1.8	1	0	100.0	0.8	0.5	P	3	0	100.0	2.7	1.9	1.0
Total specimens	35	21	62.5%L			118	73	61.8%L			-	111	46	70.7%L			
	56(L+D)					191(L+D)					-	157(L+D)					
Total species	6	4	7(L+D)			8	6	8(L+D)				6	7	5	8(L+D)		

Although relative abundance and CPUE have shifted over time, general species composition has remained relatively unchanged. One noteworthy change is the increase in abundance of giant floater in 2006 when it was the most abundant unionid in this impoundment. One possible explanation may relate to the methods that the managing river authority has employed in water-level manipulation. Throughout out much of the 1990s, water discharge from dams like that at Lake Gonzales and Lake Wood was reduced overnight to increase reservoir levels. Then, in late morning when electric demands were peaking, rapid releases were used to support additional electric generation. While this functioned well for power production purposes, it also caused erosion of riverbanks and substrates between impoundments and, in turn, flushed large amounts of silt and mud into downstream reservoirs. The mid-island mussel bed first seen by HOH in 1992 was located adjacent to a channel that was some 3-4 m deep. However, by 1995 and 1997, this channel had been largely filled and was only covered with water to a depth of about 1.5 m. Bleufer was recorded as present during the first survey here, but has not been documented since, here or elsewhere in the Guadalupe River system. It seems likely this record was either a misidentification or had been an unsuccessful introduction by local musselers or anglers (southern mapleleafs morphologically similar to those from the upper Trinity River drainage and dissimilar to native specimens in the Guadalupe River were found at a boat ramp downstream, confirming relocation of mussels in this area).

Guadalupe River, between Lakes Gonzales and Wood

Guadalupe River, approximately 300-400 m downstream of the dam at Lake Gonzales, SFASU Site 2, 29°29.704' N, 97°37.355' W, Gonzales County, Texas, 28 April 2006.

SFASU staff examined this location using timed searches (1.5 man-hours total):

Guadalupe River, about 300-400 m below Lake Gonzales dam, 1.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	11	0.0	-	34.4
Yellow sandshell	8	0.0	-	25.0
Washboard	8	0.0	-	25.0
Golden orb	3	0.0	-	9.4
Pistolgrip	2	0.0	-	6.3
Total specimens	32	0.0	2(L+D) 100.0%L	
Total species	5	0	5(L+D)	

Guadalupe River, approximately 500 m downstream of the dam at Lake Gonzales, SFASU Site 1, 29°29.663' N, 97°37.309' W, Gonzales County, Texas, 28 April 2006.
SFASU staff examined this location using timed searches (1.75 man-hours total).

Guadalupe River, about 500 m below Lake Gonzales dam,1.75 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	15	6.0	long dead	28.4
Tampico pearlymussel	2	1.0	relatively recently dead	4.1
Louisiana fatmucket	1	0.0	-	1.4
Yellow sandshell	5	0.0	-	6.8
Washboard	17	14.0	long dead	41.9
Giant floater	2	0.0	-	2.7
Southern mapleleaf	0	2.0	long dead	2.7
Pistolgrip	9	0.0	-	12.2
Total specimens	51	23	74(L+D) 68.9%L	
Total species	7	4	8(L+D)	

The Guadalupe River between the dam at Lake Gonzales and the upper reaches of Lake Wood downstream was first examined by HOH during in 1995 (Howells 1996b) and again in 1996 (Howells 1997a) during other fisheries work in the area. Data pooled annually are shown below:

Guadalupe River between lakes Gonzales and Wood comparison	1995					1996					2006					
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	*N*T/h
Threeridge	0	2	0.0	0.0	50.0	2	1	33.3	15.4	15.0	26	6	81.2	31.3	30.2	9.8
Tampico pearlymussel	-	-	-	-	-	-	-	-	-	-	2	1	66.7	2.4	2.8	0.9
Louisiana fatmucket	-	-	-	-	-	2	0	100.0	15.4	10.0	1	0	100.0	1.2	0.9	0.3
Yellow sandshell	-	-	-	-	-	3	3	50.0	23.1	30.0	13	0	100.0	15.7	12.3	4.0
Washboard	0	1	0.0	0.0	25.0	3	2	60.0	23.1	25.0	25	14	64.1	30.1	36.8	12.0
Giant floater	-	-	-	-	-	1	0	100.0	7.7	5.0	2	0	100.0	2.4	1.9	0.6
Southern mapleleaf	-	-	-	-	-	0	1	0.0	0.0	5.0	0	2	0.0	0.0	1.9	0.6
Golden orb	0	1	0.0	0.0	25.0	1	0	100.0	7.7	5.0	3	0	100.0	3.6	2.8	0.9
Pistolgrip	-	-	-	-	-	1	0	100.0	7.7	5.0	11	0	100.0	13.3	10.4	3.4

Total specimens	0 4 0.0%L 4(L+D)	13 7 65.0%L 20(L+D)	83 23 78.3%L 106(L+D)
Total species	0 3 3(L+D)	7 4 8(L+D)	8 4 9(L+D)

In 1995, specimens documented were only those found during brief examination of exposed gravel bars. Even the pooled collection data in 1996 reflected limited survey efforts. The SFASU collections in 2006, despite being confounded by high waters, likely better represent the unionid assemblage at this site. Rare golden orb has maintained a population here but its population seems small.

Lake Wood

Lake Wood, area adjacent to the boat ramp at the Guadalupe-Blanco River Authority park on the north side of the Lake Wood dam, 29°28.252' N, 97°29.696' W, Gonzales County, Texas, 29 April 2006.
SFASU staff examined this location using timed searches (1.0 man-hour):

Lake Wood, area adjacent to park boat ramp near dam, 1.0 man-hour Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	1	6.0	long dead	8.5
Tampico pearlymussel	7	1.0	long dead	9.8
Louisiana fatmucket	7	0.0	-	8.5
Yellow sandshell	25	4.0	long dead	35.4
Giant floater	20	3.0	long dead	28.0
Southern mapleleaf	0	1.0	long dead	1.2
Texas lilliput	5	0.0	-	6.1
Paper pondshell	2	0.0	-	2.4
Total specimens	67	15.0	82(L+D) 81.7%L	
Total species	7	5	8(L+D)	

The HOH staff briefly surveyed Lake Wood in 1992 and reported the mussel assemblage to be similar to that in Lake Gonzales upstream, but no Louisiana fatmuckets were found at that time and numbers found were not recorded (Howells 1994). A mid-reservoir flat was examined by HOH in 1995, but only a single giant floater valve was found (Howells 1996b). Also, in 1995, SWTSU staff (Arsuffi et al. 1995) surveyed Lake Wood and reported the following specimens (all sites pooled):

Lake Wood comparison	1995					2006						
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	*N*L/h	*N*T/h
Threeridge	34	24	58.6	45.3	50.0	1	6	14.3	1.5	8.5	1.0	7.0
Tampico pearlymussel	3	4	42.9	4.0	6.0	7	1	87.5	10.4	9.8	7.0	8.0
Louisiana fatmucket	9	1	90.0	12.0	8.6	7	0	100.0	10.4	8.5	7.0	7.0
Yellow sandshell	25	9	73.5	33.3	29.3	25	4	86.2	37.3	35.4	25.0	29.0
Washboard	0	1	0.0	0.0	0.9	-	-	-	-	-	-	-
Giant floater	3	2	60.0	4.0	4.3	20	3	87.0	29.9	28.0	20.0	23.0
Southern mapleleaf	1	0	100.0	1.3	0.9	0	1	0.0	0.0	1.2	0.0	1.0
Texas lilliput	-	-	-	-	-	5	0	100.0	7.5	6.1	5.0	5.0
Paper pondshell	-	-	-	-	-	2	0	100.0	3.0	2.4	2.0	2.0
Total specimens	75	41	116(L+D)		64.7%L	67	15	82(L+D)		81.7%L		
Total species	6	6	7(L+D)			7	5	8(L+D)				

Comparison of the SWTSU 1995 survey and that conducted in 2006 by SFASU shows two noteworthy differences. Threeridge, the dominant species in 1995, dropped to less than 10% of the total living and dead unionids found in 2006. The percent of living threeridge that was nearly 60% in 1995 fell to less than 2% in 2006. Given that the 2006 survey documented shell material in addition to living specimens, this decrease in abundance is probably not indicative of a die-off in Lake Wood. Rather, threeridge is a commercial shell mussel and it seems more likely that the observed shift in abundance reflects harvest and removal of specimens. The second significant change in this faunal group was the increase in giant floaters. Silt and mud deposition and eutrophication associated with anthropogenic factors favor species like floaters over heavier-shelled unionids that prefer other substrates.

Guadalupe River, downstream of Lake Wood

Guadalupe River, approximately 200 m downstream of the dam at Lake Wood, SFASU Site 3, 29°28.243' N, 97°29.383' W, Gonzales County, Texas, 29 April 2006.
SFASU staff examined this location using timed searches (0.5 man-hours total) and 0.25-m^2 quadrats (10).

Guadalupe River, about 200 m below Lake Wood dam, 0.5 man-hours

Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	78	0.0	-	82.1
Louisiana fatmucket	1	0.0	-	1.1
Yellow sandshell	3	0.0	-	3.2
Washboard	7	0.0	-	7.4
Golden orb	6	0.0	-	6.3
Total specimens	95	0	95(L+D) 100%L	
Total species	5	0	5(L+D)	

Guadalupe River, about 200 m below Lake Wood dam, 120 m^2

	Total/120 m^2		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Golden orb	45	0.0	0.4	0.0	-	100.0
Total specimens	45	0	45(L+D) 100%L			
Total species	1	0	1(L+D)			

Guadalupe River, about 200 m below Lake Wood dam, 10 0.25-m^2 quadrats

	Total/10 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	20	0.0	8.0	0.0	-	76.9
Washboard	3	0.0	1.2	0.0	-	11.5
Golden orb	3	0.0	1.2	0.0	-	11.5
Total specimens	26	0	26(L+D) 100%L			
Total species	3	0	3(L+D)			

The area immediately below Lake Wood dam in the vicinity of the gravel bar used as a boat launch at the Guadalupe-Blanco River Authority park was examined several times by TPWD including August 1993 (Howells 1995), May and November 1995 (Howells 1996b), May 1996 (Howells 1997a), May 1997 (Howells 1998), and May 2002 (Howells 2003a).

Guadalupe River immediately Below Lake Wood dam	Aug 1993					May 1996			May 2002				Apr 2006					
comparison	L	D	%Lsp	%L	%T	L	D	%Lsp	L	D	%Lsp	%L	L	D	%Lsp	%L	%T	*N*L/h
Threeridge	14	0	100.0	77.8	73.7	3+	1+	75.0	2	many	-	6.9	78	0	0.0	82.1	82.1	156.0
Tampico pearlymussel	1	0	100.0	5.6	5.3	-	-	-	3	0	100.0	10.3	-	-	-	-	-	-
Louisiana fatmucket	-	-	-	-	-	-	-	-	-	-	-	-	1	0	100.0	1.4	1.1	2.0
Yellow sandshell	-	-	-	-	-	-	-	-	20	many	-	79.3	3	0	86.2	3.2	3.2	6.0
Washboard	3	0	100.0	16.7	15.8	2+	4+	33.3	1	many	-	3.4	7	0	100.0	7.4	7.4	14.0
Giant floater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southern mapleleaf	-	-	-	-	-	P	P	-	-	-	-	-	-	-	-	-	-	-
Golden orb	-	-	-	-	-	11	5+	68.8	1	0	100.0	3.4	6	0	100.0	6.3	6.3	12.0
Pistolgrip	0	1	0.0	5.6	5.3	0	1	0.0	-	-	-	-	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	-	-	2	0	100.0	6.9	-	-	-	-	-	-
Paper pondshell	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total specimens	18	1	94.7%L			16+	7+		29	-			95	0	95(L+D)	100.0%L		
	19(L+D)					23+(L+D)			29+ (L+D)				95 (L+D)					
Total species	3	1	4(L+D)			4	5	5(L+D)	6	-			5	0	5(L+D)			

Guadalupe River immediately below Lake Wood dam density estimate comparison	Aug 1993 Mean *N*/m^2 (3, 0.25 m^2) L + D/m^2	Apr 2006 Mean *N*/m^2 (10, 0.25 m^2) L + D/m^2	Apr 2006 Mean *N*/m^2 (120 m^2) L + D/m^2
Threeridge	8.0	8.0	-
Washboard	2.7	1.2	-
Golden orb	-	1.2	0.4
Total specimens/m^2	10.7	10.4	0.4
Total species/m^2	2	3	1

In May 1995, three living washboards were noted and dead threeridge and washboard shells were found but not counted and in November 1995, only a dump of commercially harvest shells was reported. Flood conditions precluded sampling in 1997, restricting observations to shells deposited on the riverbanks. The collection in 2002 was to obtain living specimens for display at HOH and was not intended to be a formal survey. Therefore, the April 2006 survey by SFASU is likely the most representative assessment of the unionid assemblage at this site. Though comparisons between years are difficult at best, it does appear the giant floater has become much more abundant than it appeared to be in the past.

Guadalupe River, approximately 1 km downstream of the dam at Lake Wood, SFASU Site 2, 29°28.447' N, 97°29.097' W, Gonzales County, Texas, 29 April 2006.
SFASU staff examined this location using timed searches (0.33 man-hour) and 0.25-m^2 quadrats (20).

Guadalupe River, about 1 km below Lake Wood dam, 0.33 man-hours					Percent of
Species	*N* alive	*N* dead		Condition	total (L+D)
Threeridge	15	0.0	-		50.0
Washboard	3	0.0	-		10.0
Golden orb	12	0.0	-		40.0
Total specimens	30	0	30(L+D)	100%L	
Total species	3	0	3(L+D)		

Guadalupe River, about 1 km below Lake Wood dam, 20 0.25-m^2 quadrats						
	Total/20 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)
Threeridge	16	0.0	3.2	0.0	-	44.4
Washboard	16	0.0	3.2	0.0	-	44.4
Golden orb	4	0.0	0.8	0.0	-	11.1
Total specimens	36	0	7.2	0.0		
Total species	3	0	3	0		

Guadalupe River, approximately 2 km downstream of the dam at Lake Wood, SFASU Site 1, 29°28.235' N, 97°28.758' W, Gonzales County, Texas, 29 April 2006.
SFASU staff examined this location using timed searches (1.58 man-hours) and 0.25-m^2 quadrats (21).

Guadalupe River, about 2 km below Lake Wood dam, 1.58 man-hours					Percent of
Species	*N* alive	*N* shells		Condition	total (L+D)
Threeridge	149	0.0	-		67.7
Tampico pearlymussel	19	0.0	-		8.6
Louisiana fatmucket	2	0.0	-		0.9
Yellow sandshell	7	0.0	-		3.2
Washboard	13	0.0	-		5.9
Giant floater	1	0.0	-		0.5
Golden orb	26	1.0	relatively recently dead		11.8
Southern mapleleaf	2	0.0	-		0.9
Pistolgrip	1	0.0	-		0.5
Total specimens	216	1	217(L+D)	99.5%L	
Total species	9	1	9(L+D)		

Guadalupe River, about 2 km below Lake Wood dam, 21 0.25-m^2 quadrats						
	Total/21 quadrats		Mean *N*/m^2			
Species	*N* alive	*N* dead	*N* alive	*N* dead	Condition	Percent of total (L+D)

Threeridge	54	1.0	10.3	0.2	-	84.6
Tampico pearlymussel	4	0.0	0.8	0.0	-	6.2
Washboard	2	1.0	0.4	0.2	long dead	4.6
Golden orb	3	0.0	0.6	0.0	-	4.6
Total specimens	63	2	65(L+D)		96.9%L	
Total species	4	1	4(L+D)			

Locations approximately 1.2 km (Site HOH-1) and 2.0 km (HOH-2) downstream of Lake Wood were examined by HOH in 1996 (Howells 1997a). Sampling included 0.25-m^2 and 10-m^2 quadrats as well as random area collections. Density estimates from these sites are compared to corresponding SFASU sample sites located 1.0 and 2.0 km downstream of Lake Wood surveyed in 2006.

Guadalupe River 1.0 to 2.0 km downstream from Lake Wood – Mean N/m^2										
Date	May 1996		May 1996		Apr 2006		May 1996		Apr 2006	
Site	HOH-1		HOH-1		SFASU-1		HOH-2		SFASU-2	
N quadrats	10		1		20		10		21	
Quadrat type	0.25-m^2		10-m^2		0.25-m^2		0.25-m^2		0.25-m^2	
	L	D	L	D	L	D	L	D	L	D
Threeridge	2.8	5.6	4.1	8.1	3.2	0.0	14.8	22.1	10.3	0.2
Tampico pearlymussel	0.0	0.4	0.0	0.1	-	-	0.0	0.4	0.8	0.0
Louisiana fatmucket	-	-	-	-	-	-	0.4	0.0	-	-
Yellow sandshell	-	-	0.4	0.0	-	-	0.4	0.8	-	-
Washboard	4.4	0.4	0.7	0.2	3.2	0.0	4.8	0.8	4.4	0.2
Southern mapleleaf	0.0	0.8	0.0	0.3	-	-	0.0	6.8	-	-
Golden orb	2.0	0.0	0.3	0.1	0.8	0.0	2.0	0.0	0.6	0.0
Pistolgrip	0.0	0.4	0.0	0.1	-	-	0.0	0.4	-	-

At the sample sites 1.0 to 1.2 km downstream of Lake Wood, fewer species (4) were found by SFASU in 2006 than encountered by the HOH staff in 1996 (7) and two of those species appeared to be less abundant. Reasons for this shift were not entirely clear. At the sample site 2.0 km downstream of Lake Wood, species composition was similar in 1996 and 2006. Threeridges had similar total densities of 26.9 and 28.4/m^2 in 1996 and 2006, respectively; however, all were alive in 2006, but only 55% were found alive in 1996. No obvious reason for this shift in condition was apparent.

San Marcos River

San Marcos River, Palmetto State Park, (up- and downstream from the low-water footbridge and downstream at a gravel bar adjacent to the park camper facilities), Gonzales County, Texas, 27 April 2006.

The HOH staff and H. McCullough examined these locations with random area searches in shallow waters and exposed bars. In addition to living and recently dead unionids now being found in this area, the site is important to two rare, endemic mussels. Golden orb has been found alive here several times in recent years, including during the SWG survey work in 2005 described herein. Also, in April 2000, McCullough found two recently dead valves of false spike at the site downstream from the park low-water foot bridge (Howells 2001). This current examination focused on seeking evidence of the continued existence of false spike. Unfortunately, during this survey neither the footbridge area nor the downstream gravel bar that produced living or recently dead specimens of false spike. Threeridge, Tampico pearlymussel, golden orb, southern mapleleaf, false spike, yellow sandshell, washboard, and pistolgrip shells were found at both sites. Threeridge, golden orb, and

pistolgrip were not only found alive, but juveniles were present as well. The shells and valves of yellow sandshell and false spike found were all very long-dead to subfossil. False spike has not been found alive in Central Texas since prior to 1980 (Howells et al. 1997), this stretch of the San Marcos River is the only location in recent years that may still support it.

Nueces River Drainage

Lake Corpus Christi

Lake Corpus Christi, west shore at FM 888, SFASU Site 1, 28°07.682' N, 97°54.003' W, Live Oak County, Texas, 6 May 2006.

The SFASU staff examined this site using timed searches (1.0 man-hour), but only documented living unionids.

Lake Corpus Christi, FM 888, 1.0 man-hour, live unionids only				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	5	-	-	2.6
Tampico pearlymussel	31	-	-	16.4
Yellow sandshell	116	-	-	61.4
Giant floater	5	-	-	2.6
Southern mapleleaf	14	-	-	7.4
Golden orb	8	-	-	4.2
Texas lilliput	10	-	-	5.3
Total specimens	189	-		
Total species	7	-		

Lake Corpus Christi, west shore at FM 888, SFASU Site 1 28°07.682' N, 97°54.003' W, Live Oak County, Texas, 6 May 2006.

The SFASU staff examined this site (CPUE not reported), but only documented golden orbs.

Lake Corpus Christi, FM 888, golden orbs only					Percent of
Species	*N* alive	*N* dead	Condition		total (L+D)
Golden orb	9	13	very recently dead to long dead		100.0
Total specimens	9	13	22(L+D)	40.9%L	
Total species	1	1			

Lake Corpus Christi, west shore at KOA campground at CR 371 and Camp Circle Road, SFASU Site 2, 28.20449° N, 97. 90160° W, Live Oak County, Texas, 6 May 2006.

SFASU staff examined this site using timed searches (1.0 man-hour), but only documented living specimens:

Lake Corpus Christi, KOA campground, 1.0 man-hour				Percent of
Species	*N* alive	*N* dead	Condition	total (L+D)
Threeridge	1	-	-	3.0
Tampico pearlymussel	6	-	-	18.2
Yellow sandshell	8	-	-	24.2
Giant floater	11	-	-	33.3
Southern mapleleaf	2	-	-	6.1

Texas lilliput	5	-	-	15.2
Total specimens	33	-		
Total species	6	-		

Lake Corpus Christi, west shore at KOA campground at CR 371 and Camp Circle Road, SFASU Site 2, 28.20449° N, 97. 90160° W, Live Oak County, Texas, 6 May 2006.
The SFASU staff examined this site using a random search along the shoreline and in shallow, but only documented "certain species":

Lake Corpus Christi, KOA campground Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Bleufer	0	present	long dead to very long dead	-
Golden orb	0	2	long dead to very long dead	-
Total specimens	-	2+	2+(L+D)	
Total species	-	2	2(L+D)	

Lake Corpus Christi, northwest corner of the reservoir, SFASU Site 3, 28.213° N, 97. 925° W, Live Oak County, Texas, 6 May 2006.
The SFASU staff examined this site using a random search along the shoreline and in shallow specifically for golden orb specimens, but also reported the additional information below as well:

Lake Corpus Christi, northwest corner Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	few	relatively long dead-very long dead	-
Yellow sandshell	0	present	relatively long dead-very long dead	-
Giant floater	0	present	relatively recently dead-very long dead	-
Bleufer	0	present	long dead	-
Southern mapleleaf	0	1.0	relatively recently dead	-
Texas lilliput	1	present	relatively recently dead-very long dead	-
Total specimens	1	-		
Total species	6	6		

Lake Corpus Christi, southeast corner of the reservoir at Hidden Acres boat ramp at the end of CR 507, SFASU Site 4, 28.113° N, 97. 855° W, San Patrico County, Texas, 6 May 2006.
The SFASU staff examined this site using a timed search (0.5 man-hours); only recorded living and recently dead specimens:

Lake Corpus Christi, southeast corner, 0.5 man-hours Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	1	20.0	very recently dead	-
Yellow sandshell	3	25.0	very recently dead	-
Giant floater	6	2.0	very recently dead	-
Southern mapleleaf	4	11.0	very recently dead	-
Golden orb	0	1.0	very recently dead	-

Texas lilliput	5	29.0	very recently dead	-
Total specimens	19	"88" [note that this may not represent all dead specimens or species]		
Total species	5	"6"		

This site (the southeast corner of the reservoir) had not been previously examined by HOH. However, this and the other 6 May 2006 data above from SFASU surveys deviated from previous sampling protocols in several ways including documenting only certain species, only living specimens, or only living and recently dead specimens. This limits comparisons to some previous data that were collected or reported differently. However, this reservoir was surveyed earlier (23 July 2005) and the 6 May 2006 data still provides a sense of presence or absence and live-dead status.

Rio Grande Drainage

Rio Grande, various sites

Rio Grande, vicinity of John's Marina (Dryden Crossing), 29°48.00' N, 102°09.12' W (and several adjacent locations, pooled), Terrell County, Texas, 7 January 2006.

LCC personnel examined this area and documented the following specimens:

Rio Grande, John's marina area Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	1.0	relatively recently dead	9.1
Texas hornshell	0	1.0	relatively recently dead	9.1
Salina mucket	0	2.0+0.5x7	recently dead-relatively long dead	81.8
Asian clam (present)				
Total specimens	0	11	11(L+D) 0.0%L	
Total species	0	3	3(L+D)	

The Rio Grande in Terrell County, in the vicinity of John's Marina (between San Francisco Creek and the Pecos River), was briefly examined by HOH in January 1992 during desert fishes surveys in the area (Howells 1994) and was again surveyed by HOH as part of a study of Rio Grande mussels in March 1988 (Howells 1999). In June 2003, LCC staff accompanied personnel from the U.S. Geological Survey and surveyed 22 sites (Howells 2004).

Rio Grande vicinity of Dryden Crossing comparison	Jan 1993					Mar 1998					Jun 2002					Jan 2006				
	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T	L	D	%Lsp	%L	%T
Tampico pearlymussel	0	1	0.0	0.0	25.0	-	-	-	-	-	3	10	23.1	60.0	15.1	0	1	0.0	0.0	9.1
Texas hornshell	0	1	0.0	0.0	25.0	0	1	0.0	0.0	14.3	0	5	0.0	0.0	5.8	0	1	0.0	0.0	9.1
Salina mucket	0	2	0.0	0.0	50.0	0	6	0.0	0.0	85.7	2	66	2.9	40.0	79.1	0	9	0.0	0.0	81.8
Total specimens	0	4	0.0%L			0	7	0.0%L			5	81	5.8%L			0	11	0.0%L		
	4(L+D)					7(L+D)					86(L+D)					11(L+D)				
Total	0	3	3(L+D)			0	2	2(L+D)			2	3	3(L+D)			0	3	3(L+D)		

Although Texas hornshell was not taken alive in this area, some of the valves and shells were recently dead and suggest a small population does persist here (as well as in Webb County downstream). The Salina mucket specimens found alive (a third living individual was also collected on this same date) may be the only living specimens of this species found. Otherwise, very recently dead and recently dead shells and valves have been the only evidence that this species still lives in the Rio Grande between Big Bend and the mouth of the Pecos River. Although this section of the Rio Grande is difficult to reach (offering local unionids some protection from human harvest), low-water and siltation are concerns.

Rio Grande, 0.5-1.0 km downstream of Los Moras Creek, 28°59.02' N, 100°38.82' W, Kinney County, Texas, 8 January 2006.

LCC personnel examined this area and documented the following specimens:

Rio Grande, downstream of Los Moras Creek Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	0.5x2	very long dead	100.0
Total specimens	0	2	2(L+D) 0.0%L	
Total species	0	1	1(L+D)	

This location has not been previously examined in HOH mussel surveys.

Rio Grande, at Salineno, Starr County, Texas, 4 February 2006.

LCC personnel examined this site and documented the following specimens:

Rio Grande, at Salineno Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	1.0+o.5x3	relatively long dead-long dead	40.0
Washboard	0	0.5x1	subfossil	10.0
Southern mapleleaf	0	3.0+0.5x2	relatively long dead-long dead	50.0
Asian clam (present)				
Total specimens	0	10	10(L+D) 0.0%L	
Total species	0	3	3(L+D)	

This location has not been previously examined in HOH mussel surveys.

Lake Casa Blanca

Lake Casa Blanca, Webb County, Texas, 7 March 2006.

LCC personnel examined this impoundment and documented the following specimens:

Lake Casa Blanca Species	*N* alive	*N* dead	Condition	Percent of total (L+D)
Tampico pearlymussel	0	1.0	relatively recently dead	2.4
Southern mapleleaf	0	0.5x1	relatively recently dead	2.4
Paper pondshell	0	35.0+0.5x5	recently dead-relatively recently dead	95.2
Asian clam (present)				

Total specimens	0	42	42(L+D)	0.0%L
Total species	0	3	3(L+D)	

Lake Casa Blanca was previously examined in September and October 1994 (Howells 1996a), August 1996 (Howells 1997a), and on four dates in 2002 (Howells 2003a, b).

Lake Casa Blanca comparison	Sep 1994				Oct 1994				Aug 1996				2002				Mar 2006			
	L	D	%L	%T	L	D	%L	%T	L	D	%L	%T	L	D	%L	%T	L	D	%L	%T
Tampico pearlymussel	0	2	0.0	66.7	1	11	8.3	32.4	1	31	100.0	97.0	12	*	50.0	-	0	40	0.0	95.2
Southern mapleleaf	0	1	0.0	33.3	0	21	0.0	56.8	-	-	-	-	12	*	50.0	-	0	1	0.0	2.4
Lilliput	-	-	-	-	0	1	0.0	2.7	-	-	-	-	-	-	-	-	-	-	-	-
Texas lilliput	-	-	-	-	-	-	-	-	-	-	-	-	0	2	0.0	-	-	-	-	-
Paper pondshell	-	-	-	-	0	3	0.0	8.1	0	1	0.0	3.0	-	-	-	-	0	1	0.0	2.4
Total	0	3	0.0%L		1	36	2.7%L		1	32	3.0%L		24	2	92.3%L		0	42	0.0%L	
	3(L+D)				37(L+D)				33(L+D)				26(L+D)				42(L+D)			
Total	0	2			1	4			1	2			2	1			0	3		
	2(L+D)				4(L+D)				2(L+D)				3(L+D)				3(L+D)			

The mussel assemblage in Lake Casa Blanca has been dominated by Tampico pearlymussels and southern mapleleafs. In 2002, efforts to renovate this impoundment resulted in the loss of many thousands of mussels.

SUMMARY

Among the locations examined in 2005, 60.0% yielded living specimens or very recently and recently dead shells and valves, but no unionids or remains were found at 5.6% of these sites. In 2006, 90.4% of the sites surveyed produced living, very recently dead, or recently dead specimens. Most of the effort in 2005 and 2006 was directed at sites selected for survey because they had been known to support unionid assemblages in the past, held populations of rare species, or both.

Generally, too few specimens are documented in a single collection to allow conclusions about status of freshwater mussels at most locations in Texas. However, repeated examination of sites can provide an indication of stability and shifts in species composition and abundance. Comments below summarize status of selected species of mussels, for which this study contributed to an improved understanding.

Texas pigtoe *Fusconaia askewi*: Statewide surveys conducted by HOH from 1992 through 2004 found this species in the upper reaches of the Sabine River, as did studies by Lamar University in Village Creek, Harden County. Several specimens from Big Cypress Bayou and the West Branch San Jacinto River may belong to this species as well. The species was not found to be abundant anywhere in Texas in the early years of TPWD work. However, in 2005 and 2006, surveys by SFASU and UT-Tyler found this species in the upper Sabine, Attoyac Bayou and Sandy Creek (a tributary of Attoyac Bayou), and Village Creek. At all four sites, it was found to be more abundant than in earlier TPWD surveys. Several specimens found by SFASU in Big Cypress Bayou in 2006 may be this as well.

Triangle pigtoe *Fusconaia lananensis*: This pigtoe is endemic to eastcentral Texas, with type localities in Lanana

and Bonita creeks in Nacogdoches County. It and other unionids are apparently extirpated from these streams. However, the species persists in limited numbers in parts of Attoyac Bayou and at least one of its tributaries, and apparently Village Creek in Hardin County. Reports from the San Jacinto River system have not been confirmed genetically. With limited distribution and only a few, small populations known, the security of this species seems doubtful.

Texas fatmucket *Lampsilis bracteata*: This fatmucket is endemic to the Colorado, Guadalupe, and possibly the Brazos systems of Central Texas. Drought-related dewatering, scouring floods, and possibly over-collecting have dramatically reduced its abundance and distribution. Since 1992, Texas fatmucket has only been found alive streams in Gillespie and Runnels, and Tom Green counties; a site on the San Saba River in Menard County; and a site on the Guadalupe River in Kerr County. However, survey efforts in 2005 failed to find any evidence of survivors in Runnels or Tom Green counties. Additionally, development on the Guadalupe River only a short distance upstream from the Kerr County population raises concerns for that population.

Louisiana fatmucket *Lampsilis hydiana*: This species remains relatively abundant in eastern Texas. Limited numbers are present in the lower Guadalupe and Nueces rivers of the coastal plain. A number of morphologically distinct populations in Texas may be undescribed sister species or simply unique ecophenotypes. Fatmucket (*L. siliquoidea*) from the northcentral states is apparently present as far south in Oklahoma as the Red River (with Louisiana fatmuckets replacing it on the Texas side of the Red River). However, genetic confirmation of the identity of specimens from populations in the area where ranges of these two species meet has not been published to date.

Sandbank pocketbook *Lampsilis satura* (also *satur*): Among the pocketbook lampsiliids, this is the species that does occur in the eastern drainage basins of Texas, and apparently occurs in Louisiana and southern Arkansas as well. In Texas, living specimens have only been found in the central Neches River, Village Creek in Hardin County, and upper Sabine River. The report of plain pocketbook from Big Cypress Bayou could be this species as well.

Yellow sandshell *Lampsilis teres*: Throughout much of Texas, this mussel is often locally abundant. It is absent from far western Texas, reports from the Canadian River drainage remain unproven, and a population in the lower Rio Grande is present, but has declined significantly in recent decades.

Washboard *Megalonaias nervosa*: This commercial shell species occurs in all major drainages of the state, except for the Canadian River. It is typically more abundant in eastern Texas and coastal plain area. Washboard is typically absent from upriver areas, but has been introduced at upstream sites by musselers (including Nasworthy Reservoir in Tom Green County). A small population, once thought lost, is still present in the lower Rio Grande. Some populations show little evidence of successful reproduction and recruitment in recent years.

Southern hickorynut *Obovaria jacksoniana*: Few southern hickorynut specimens have been found since HOH mussel survey work began in 1992. A single valve found upstream of B.A. Steinhagen Reservoir is of questionable identity. The only living specimens found in Texas in recent decades have been in Village Creek, Hardin County.

Louisiana pigtoe *Pleurobema riddellii*: Abundance and distribution have declined dramatically in recent decades. Living specimens were found by HOH at only one site in the central Neches River. Others were found more recently in Village Creek in Hardin County. Though still present at several eastern Texas sites, Louisiana pigtoe have become very rare in Texas waters.

Texas hornshell *Popenaias popeii*: Surveys in the Rio Grande drainage by HOH in the early and mid-1990s located recently dead valves or shells that indicated a small population was probably still present in the Rio Grande between Big Bend and the Pecos River. More recently, living specimens have been found at several locations in the Webb County run of the Rio Grande, with another population known from the Black River of New Mexico. In Texas, the upstream population is threatened by silt deposition and the Webb County animals occur in a major border development area.

Texas heelsplitter *Potamilus amphichaenus*: This is a sister species to pink papershell, but is taxonomically valid (Roe and Lydeard 1998). It is restricted to the Sabine, Neches, and Trinity drainage basins of eastern Texas. Neck and Howells (1994) considered specimens from the Brazos River system to be pink papershell. Records from Oklahoma are doubtful. Currently, populations appear stable in the Sabine River upstream of Toledo Bend Reservoir, B.A. Steinhagen Reservoir and the Neches River immediately downstream of Town Bluff Dam, and in Lake Livingston and a stretch of the Trinity River upstream of the reservoir. Texas heelsplitter was present in the upper Trinity drainage, including impoundments. However, pink papershell was present in the region by 1992 when HOH survey work began. Since then, pink papershell appears to have either replaced Texas heelsplitter or perhaps hybridized with it. Specimens from Lewisville Reservoir and other reservoirs in the upper Trinity drainage now display traits more like pink papershell than Texas heelsplitter; however, none have been subjected to genetic analysis to date and their exact taxonomic status remains unclear.

Golden orb *Quadrula aurea*: This Central Texas endemic is native to the Colorado, Guadalupe-San Antonio, and Nueces-Frio drainage basins. Several old reports from the Brazos drainage (e.g., Strecker 1931) are likely misidentified smooth pimplebacks. Dewatering during droughts and habitat loss and modification during floods has reduced this species to only five known locations: two sites in the Guadalupe River upstream of Gonzales, the lower San Marcos River, one small area in the Guadalupe River at Kerrville, and in Lake Corpus Christi. Relatively few appear to be present in the San Marcos River, but that population is actively reproducing and may be rebounding from earlier flood-related losses. In Lake Corpus Christi, the only impoundment where golden orb has been found, the population was badly reduced by dewatering in the mid-1990s, but in 2006, living and very recently dead specimens were found. The Kerrville population appears to be extremely small.

Rio Grande monkeyface *Quadrula couchiana*: This Rio Grande endemic has not been found alive since 1898 and is likely extinct. Neither HOH, nor LCC, nor others working in the Rio Grande drainage, have reported even shell fragments of this species in recent years.

Smooth pimpleback *Quadrula houstonensis*: Smooth pimpleback is native to the Brazos and Colorado drainage basins of central Texas. Reports from the upper Trinity River and elsewhere are misidentifications. In recent years, several specimens have been found alive in lakes LBJ and Marble Falls, and repeated collection of shells in Inks Lake suggest some may survive there. Living or recently dead specimens have been found in the Colorado River downstream from Columbus over the past decade. Other populations persist at sites in the Brazos River (between Possum Kingdom Reservoir dam and the mouth of the Navasota River), the Little Brazos River, and the Leon River. Archeological records suggest smooth pimpleback have been declining for several thousand years, possibly related to the region becoming more arid over the past 10,000 to 15,000 years.

Wartyback *Quadrula nodulata*: Wartyback occurs in Texas tributaries of the Red River downstream of Lake Texoma, Big Cypress Bayou, Sabine River, and the Neches-Angelina system. Reports from the Trinity River basin are incorrect. Wartyback is not abundant anywhere in Texas; however, it can be found in the Neches River downstream of Town Bluff Dam, Jasper and Tyler counties, and in Sanders Creek downstream of Pat Mayse Reservoir, Lamar County; it is sporadic elsewhere. The Neches population is typical of the species, but those from Sanders Creek have pustules more randomly scattered.

Texas pimpleback *Quadrula petrina*: Like other Central Texas endemics, Texas pimpleback has declined in recent decades. Its original range includes the upper and central Brazos, Colorado, and Guadalupe-San Antonio systems. Since HOH mussel work began in 1992, this species has only been found alive at four locations: a site on the San Saba River west of Menard, a Runnels County creek north of Ballinger, the Concho River near Paint Rock, and the upper San Marcos River near its confluence with the Blanco River. Evidence of a population in the Colorado River (upstream of Lake Buchanan) was found in 1999; but, the site had been dewatered and no living specimens were found. The Runnels County population may have been eliminated by dewatering, scouring, and over collecting. No live specimens were found during the 2005-2006 surveys in the San Saba River; eight live specimens were found in the Concho river. The San Marcos record includes a single living individual in recent years.

Mapleleaf *Quadrula quadrula*: Early Texas records of this species were often based on southern or Gulf mapleleaf

specimens. In Texas, 'common' mapleleaf appears to be restricted to tributaries of the Red River, including the Wichita and Little Wichita rivers, Pine and Sanders creeks, the Sulphur River, and Big Cypress Bayou where mapleleaf coexists with southern mapleleaf and often Gulf mapleleaf. Texas specimens are often poorly sculptured with few pustules or with pustules more randomly placed and not in two beak-to-margin rows typical of the species.

Pistolgrip *Quadrula verrucosa*: Pistolgrip occurs from the Red River drainage of eastern Texas, south and west to the lower Guadalupe River. Populations occur at least as far west as Fort Phantom Hill Reservoir in Jones County. It appears to have declined at many sites west of the Neches River, but still has noteworthy populations in the Leon River and Fort Phantom Hill Reservoir. Populations from the Brazos, Colorado, and Guadalupe systems appear less sexually dimorphic and have shells that are more rectangular in outline than is typical of the species. However, no genetic analysis has been performed to assess the significance of these atypical specimens.

False spike *Quincuncina mitchelli*: False spike has been recognized as having two disjunct populations: in the Rio Grande, and in the Brazos, Colorado, and Guadalupe drainages of Central Texas. Those in the Rio Grande may have vanished around the time of European contact and no living or recently dead specimens are known. In central Texas, this species was present until the late 1970s or early 1980s when droughts and floods eliminated most populations; no live individuals have been found since then. Surveys by HOH throughout its range found no living individuals or recently dead shells. However, in 2000, two recently dead valves were found in the lower San Marcos River. This area has been reexamined several times, but no additional living or recently dead specimens have been located.

Mexican fawnsfoot *Truncilla cognata*: Most mussel species in the Rio Grande have declined, many dramatically, over the past century. The range of the endemic Mexican fawnsfoot appears greatly reduced. Only two living specimens have been found in recent decades, both in the Webb County, Texas, stretch of the lower Rio Grande.

Fawnsfoot *Truncilla donaciformis*: This species is common in parts of its central U.S. range, but occurs sporadically in Texas. Fawnsfoot occurs frequently in the Neches River immediately downstream of Town Bluff Dam and somewhat less frequently in B.A. Steinhagen Reservoir. It occurs elsewhere from the San Jacinto and Trinity drainages northward and eastward, but never abundantly.

Little spectaclecase *Villosa lienosa*: This is the only member of the genus in Texas. It occurred from the San Jacinto River system north and east throughout eastern Texas. However, little spectaclecase seems to be in decline, with far fewer specimens found at fewer locations than in past decades. If this apparent decrease in abundance and distribution is occurring, causes are unclear. Species like Texas lilliput, pond mussel, and sometimes yellow sandshell (stained dark in richly organic bottoms) can be confused with little spectaclecase, especially where acidic water causes extensive erosion to beaks and other parts of the shell (sometimes eroding the interior of the shell and damaging the pseudocardinal tooth morphology).

STATEWIDE POPULATION TRENDS AND MANAGEMENT IMPLICATIONS

Many surveys conducted in 2005 and early 2006 were focused on locations where noteworthy unionid assemblages were found during earlier HOH surveys or where rare, endemic mussels had been found. When these new surveys were contrasted to earlier findings, a wide range of results was produced.

Some sites that once held abundant and diverse populations of freshwater mussels were found to have changed little over the past 10 to 14 years (e.g., B.A. Steinhagen Reservoir, Neches River downstream from Town Bluff Dam, Pine and Sanders creeks in Lamar County). Several such sites were surveyed in greater detail in 2005 and 2006 with new results revealing even more species present than originally found (e.g., Pat Mayse Reservoir). A number of water bodies that had experienced one or more low-water periods since earlier studies and this current effort and which had very recently increased dramatically in pool elevations could not be effectively surveyed due to apparent reductions in mussel abundance and diversity and relocation of survivors to deeper, hard-to-sample waters (Lake Wichita, Lake Arrowhead, Lake Lewisville, Lake Buchanan). Time, perhaps one to several years, will be required before

meaningful evaluations of these waters can be conducted. Dredging conducted in recent years at Nasworthy Reservoir in the Concho River drainage was found to have substantially reduced the mussel populations, but in the absence of extensive and organized salvage efforts, such a loss was expected.

Some locations that previously supported rare unionids (e.g., lower San Marcos River, sites in the lower Guadalupe River, the upper San Saba River, Live Oak Creek in Gillespie County) were found in 2005 and 2006 to still harbor these same species. Two rare endemic mussels in the Guadalupe River in Kerr County, that were thought to have been lost during an earlier drawdown, were found to have survived, but in limited numbers. Several other locations, where drought-related dewatering, scouring floods, and possibly over-collecting were believed to have eliminated or reduced rare endemic taxa were found to contain either no living unionids (e.g., Spring Creek, Tom Green County) or a limited number of more-common species, with no rare endemics (e.g., Elm Creek in Runnels County; Concho River at Paint Rock in Concho County).

In summary, some Texas freshwater mussel assemblages have remained largely unchanged through recent years, a few may have increased and a few decreased in mussel abundance and diversity, at least one population thought lost has actually survived, and several sites lost most or all their original mussel populations. Sufficient water and stable conditions are among the most important factors relating to mussel survival or loss. Runoff and associated scouring remains a concern in many areas as does general human development and associated anthropogenic effects.

ACKNOWLEDGMENTS

Stephen F. Austin State University was the primary contractor on this State Wildlife Grant and Drs. Alex Y. Karatayev and Lyubov E. Burlakova and their students from that university conducted most of the 2005-6 site surveys. Dr. Tom Miller and the staff of Laredo Community College sampled provided most of the 2005-6 data from the Rio Grande. Dr. Neil B. Ford from University of Texas a Tyler also contributed field information from sites on the Sabine River and assisted the HOH personnel and staff from Texas Department of Transportation with preliminary surveys in the Leon River drainage. Others contributing data to these efforts included Susan Martin, Marvin Eisthen, Marsha Reimer, Michael Patrikeev, and numerous TPWD staff members. Survey data from prior to 2005 was generally collected by the author and numerous TPWD staff and volunteers.

LITERATURE CITED

Arsuffi, T.L., B.G. Whiteside, and R.D. Perry. 1995. Survey and condition of commercially-harvested mussels in H-4 (Lake Gonzales) and H-5 (Lake Wood) on the Guadalupe River, Texas. Southwest Texas State University, Aquatic Station, San Marcos.

Bordelon, V.L., and R.C. Harrel. 2004. Freshwater mussels (Bivalvia: Unionidae) of the Village Creek drainage basin in southeastern Texas. The Texas Journal of Science 56(1):63-72.

Ford, N.B., and M.L. Nicholson. In Press. A survey of freshwater mussels (Unionidae) of the Old Sabine Wildlife Management Area, Smith County, Texas. The Texas Journal of Science.

Howells, R.G. 1993a. Preliminary survey of freshwater mussel harvest in Texas. Texas Parks and Wildlife Department, Management Data Series 100, Austin.

Howells, R.G. 1993b. Mussel information brief: Cedar Creek Reservoir. Texas Parks and Wildlife Department, Heart of the Hills Research Station, Ingram. Unpublished in-house report.4 pp.

Howells, R.G. 1994. Preliminary distributional surveys of freshwater bivalves in Texas: progress report for 1992. Texas Parks and Wildlife Department, Management Data Series 105, Austin.

Howells, R.G. 1995. Distributional surveys of freshwater bivalves in Texas: progress report for 1993. Texas Parks and Wildlife Department, Management Data Series 119, Austin.

Howells, R.G. 1996a. Distributional surveys of freshwater bivalves in Texas: progress report for 1994. Texas Parks and Wildlife Department, Management Data Series 120, Austin.

Howells, R.G. 1996b. Distributional surveys of freshwater bivalves in Texas: progress report for 1995. Texas Parks and Wildlife Department, Management Data Series 125, Austin.

Howells, R.G. 1996c. Preliminary survey of freshwater mussels of the Big Cypress Bayou system, Texas. Texas Parks and Wildlife Department, Mussel Information Brief, Ingram, 9 pp.

Howells, R.G. 1996d. Freshwater mussel harvest: Guadalupe River between Lake Wood and Gonzales. Texas Parks and Wildlife Department, Mussel Information Brief, Ingram. 3pp.

Howells, R.G. 1996e. Distribution of freshwater mussels (Unionidae) in the Canadian River drainage: New Mexico and Texas. Section II. Survey of freshwater bivalve mollusks of the Canadian River of Texas. Report to the National Biological Services Partnership Program, Texas Parks and Wildlife Department, Ingram.

Howells, R.G. 1997a. Distributional surveys of freshwater bivalves in Texas: progress report for 1996. Texas Parks and Wildlife Department, Management Data Series 144, Austin.

Howells, R.G. 1997b. Freshwater mussels of the Wichita River, Texas, with comments on the Little Wichita and Pease rivers. Texas Parks and Wildlife Department, Management Data Series 142, Austin.

Howells, R.G. 1997c. Range extension for bleufer *Potamilus purpuratus* (Bivalvia: Unionidae) in Texas. The Texas Journal of Science 49(1):79-82.

Howells, R.G. 1997d. Status of freshwater mussels (Family Unionidae) of the Big Thicket Region of eastern Texas. The Texas Journal of Science, Special Supplement 49(3):21-34.

Howells, R.G. 1997e. Taxonomic status of western lilliput (*Toxolasma mearnsi*). Triannual Unionid Report (10):8

Howells, R.G. 1997f. Current status of Texas pimpleback (*Quadrula petrina*). Triannual Unionid Report (12):4.

Howells, R.G. 1998a. Distributional surveys of freshwater bivalves in Texas: progress report for 1997. Texas Parks and Wildlife Department, Management Data Series 147, Austin.

Howells, R.G. 1998b. Freshwater mussel population status in Cedar Creek Reservoir, Texas: 1993 and 1997 comparison. Information brief. Texas Parks and Wildlife Department, Heart of the Hills Research Station, Ingram. Unpublished in-house report. 5 pp.

Howells, R.G. 1999. Distributional surveys of freshwater bivalves in Texas: progress report for 1998. Texas Parks and Wildlife Department, Management Data Series 161, Austin.

Howells, R.G. 2000a. Distributional surveys of freshwater bivalves in Texas: progress report for 1999. Texas Parks and Wildlife Department, Management Data Series 170, Austin.

Howells, R.G. 2000b. Impacts of dewatering and cold on freshwater mussels (Unionidae) in B.A. Steinhagen Reservoir, Texas. The Texas Journal of Science 52(4) Supplement: 93-104.

Howells, R.G. 2001. Distributional surveys of freshwater bivalves in Texas: progress report for 2000. Texas Parks and Wildlife Department, Management Data Series 187, Austin.

Howells, R.G. 2002a. Distributional surveys of freshwater bivalves in Texas: progress report for . Texas Parks and Wildlife Department, Management Data Series 200, Austin.

Howells, R.G. 2002b. Freshwater mussels (Unionidae) of the pimpleback-complex in Texas. Texas Parks and Wildlife Department, Management Data Series 197, Austin.
Howells, R.G. 2003a. Distributional surveys of freshwater bivalves in Texas: progress report for 2002. Texas Parks and Wildlife Department, Management Data Series 214, Austin.
Howells, R.G. 2003b. Declining status of freshwater mussels of the Rio Grande, with comments on other bivalves. Pages 59-74 *in* G.P. Garrett and N.L. Allen. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publication 46, Lubbock.
Howells, R.G. 2004. Distributional surveys of freshwater bivalves in Texas: progress report for 2003. Texas Parks and Wildlife Department, Management Data Series 222, Austin.
Howells, R.G. 2005. Distributional surveys of freshwater bivalves in Texas: progress report for 2004. Texas Parks and Wildlife Department, Management Data Series 233, Austin.
Howells, R.G., J.L. Dobie, W.L. Lindermann, and J.A. Crone. 2003. Discovery of a new population of endemic *Lampsilis bracteata* in central Texas, with comments on species status. Ellipsaria 5(2):5-6.
Howells, R.G., C.M. Mather, and J.A.M. Bergmann. 1997. Conservation status of selected freshwater mussels in Texas. Pages 117-128 *in* K.S. Cummings, A.C. Buchanan, C.A. Mayer, and T.J. Naimo. Conservation and management of freshwater mussels II: initiatives for the future. Proceedings of a Upper Mississippi River Conservation Committee symposium, Rock Island, Illinois.
Howells, R.G., R.W. Neck, and H.D. Murray. 1996. Freshwater mussels of Texas. Texas Parks and Wildlife Press, Austin.
Karatayev, A.Y., R.G. Howells, L.E. Burlakova, and B.D. Sewell. 2005. History of spread and current distribution of *Corbicula fluminea* (Muller) in Texas. Journal of Shellfish Research 24(2):553-559.
Mather, C.M., and J.A.M. Bergmann. 1994. Freshwater mussels of the Cypress Bayou system, Northeast Texas. Malacology Data Net 33(5/6):139-145.
Murray, H.D. 1978. The freshwater mussels of Lake Corpus Christi, Texas. Bulletin of the American Malacological Union 1978:5-6.
Neck , R.W. 1989. Freshwater bivalves of Arrowhead Lake, Texas: apparent lack of extirpation following impoundment. The Texas Journal of Science 41:371-377.
Neck, R.W. 1990. Geological substrate and human impact on bivalves of Lake Lewisville, Trinity River, Texas. The Nautilus 104:16-25.
Neck, R.W., and A.L. Metcalf. 1988. Freshwater bivalves of the lower Rio Grande, Texas. The Texas Journal of Science 40: 259-268.
Neck, R.W., and R.G. Howells. 1994. Status survey of Texas heelsplitter, *Potamilus amphichaenus* (Frierson, 1898). Texas Parks and Wildlife Department, Special Report, Austin.
Roe, K.J., and C. Lydeard. 1998. Molecular systematics of the freshwater mussel genus *Potamilus* (Bivalvia: Unionidae). Malacologia 39:195-205.
Serb, J.M., J.E. Buhay, and C. Lydeard. 2003. Molecular systematics of the North American freshwater bivalve genus *Quadrula* (Unionidae: Ambleminae) based on mitochondrial ND1 sequences. Molecular Phylogenetics and Evolution 28(2003):1-11.
Shafer, D., A. Miller, and M. Farr. 1992. A survey of the freshwater mussels (Family: Unionidae) in the proposed Red River waterway, Texas and Louisiana, between Shreveport, Louisiana and Daingerfield, Texas. August 27 – September 2. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.
Strecker, J. 1931. The distribution of naiades or pearly fresh-water mussels of Texas. Baylor University Museum Bulletin 2.
Strenth, N.E., R.G. Howells, and A. Correa-Sandoval. 2004. New records of the Texas hornshell, *Popenaias popeii* (Bivalvia: Unionidae) from Texas and northern Mexico. The Texas Journal of Science 56(3):223-230.
Turgeon, D.D., and nine coauthors. 1998. Common and scientific names of aquatic invertebrates of the United States and Canada: Mollusks. American Fisheries Society Special Publication 16, Bethesda, Maryland.
Vidrine, M.F. 1990. Fresh-water mussels-mite and mussel-*Ablabesmyia* associations in Village Creek, Hardin County, Texas. Proceedings of the Louisiana Academy of Science 53:104.
Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of the freshwater mussels of the United States and Canada. Fisheries (Bethesda) 18(9):6-22.

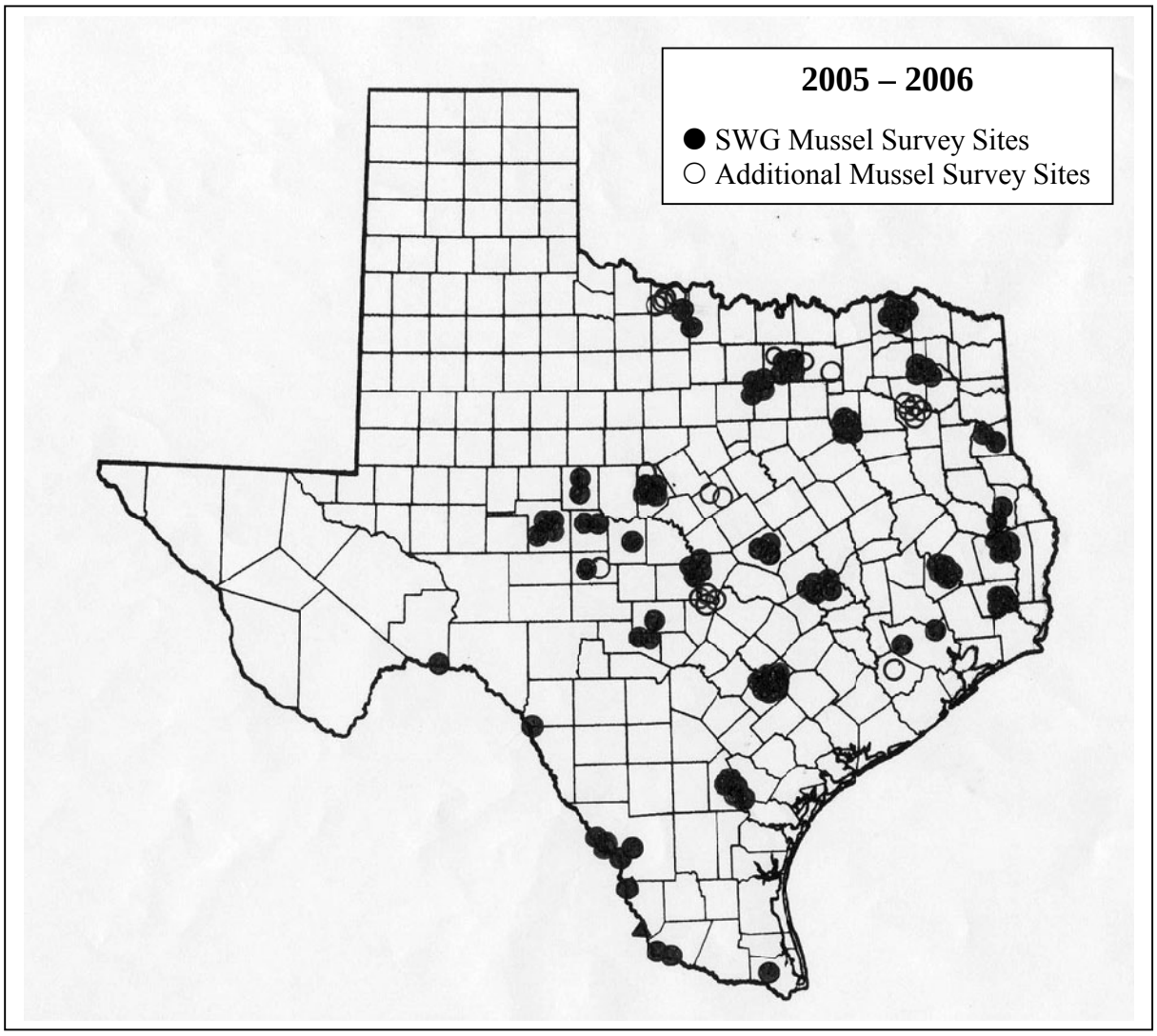

Figure 1. Locations of freshwater mussel (Family Unionidae) survey sites conducted from January 2005 through June 2006 by personnel from Texas Parks and Wildlife Department (TPWD), Stephen F. Austin State University, and Laredo Community College under State Wildlife Grant (SWG) funding and additional sites examined by TPWD and including survey information sent to Heart of the Hills Fisheries Science Center by volunteers.

APPENDIX I.

COMMON AND SCIENTIFIC NAMES

Common names and scientific names used in this and previous TPWD mussel reports include:

Family: Unionidae

Threeridge *Amblema plicata*
Flat floater *Anodonta suborbiculata*
Floater sp. *Anodonta* sp. – Collections in B.A. Steinhagen Reservoir in 1993 produced specimens that appear intermediate between giant floater and flat floater. They have higher beaks and darker coloration than flat floater and are more inflated and less deep-bodied. Similar specimens have been found by P. Hartfield (US Fish and Wildlife Service, Jackson, Mississippi; pers. com.) in Mississippi. Whether these represent an undescribed species, unusual ecophenotype of flat floater, or a hybrid remains unresolved.
Rock-pocketbook *Arcidens confragosus*
Ouachita rock-pocketbook *Arkansia wheeleri*
Tampico pearlymussel *Cyrtonaias tampicoensis*
Spike *Elliptio dilatata*
Texas pigtoe *Fusconaia askewi*
Wabash pigtoe *Fusconaia flava*
Triangle pigtoe *Fusconaia lananensis*
Round pearlshell *Glebula rotundata*
Texas fatmucket *Lampsilis bracteata*
Plain pocketbook *Lampsilis cardium*
Louisiana fatmucket *Lampsilis hydiana*
Sandbank pocketbook *Lampsilis satura*
Yellow sandshell *Lampsilis teres*
Pocketbook *Lampsilis ovata* – not present in Texas
Pocketbooks – collectively refers to plain pocketbook, sandbank pocketbook, or both
Fatmuckets – collectively refers to Texas fatmucket, Louisiana fatmucket, or both
White heelsplitter *Lasmigona complanata*
Fragile papershell *Leptodea fragilis*
Pond mussel *Ligumia subrostrata*
Washboard *Megalonaias nervosa*
Threehorn wartyback *Obliquaria reflexa*
Southern hickorynut *Obovaria jacksoniana*
Bankclimber *Plectomerus dombeyanus*
Louisiana pigtoe *Pleurobema riddellii*
Texas hornshell *Popenaias popeii*
Texas heelsplitter *Potamilus amphichaenus*
Pink papershell *Potamilus ohiensis*
Bleufer *Potamilus purpuratus*
Salina mucket *Potamilus metnecktayi* – this species has also been called *Disconaias salinasensis* and *Potamilus salinasensis*
Giant floater *Pyganodon grandis*
Rio Grande monkeyface *Quadrula couchiana*
Southern mapleleaf *Quadrula apiculata*
Golden orb *Quadrula aurea*
Smooth pimpleback *Quadrula houstonensis*
Western pimpleback *Quadrula mortoni* – also known as *Quadrula pustulosa mortoni*
Gulf mapleleaf *Quadrula nobilis*

Wartyback *Quadrula nodulata*
Texas pimpleback *Quadrula petrina*
Pimpleback *Quadrula pustulosa*
Mapleleaf or common mapleleaf *Quadrula quadrula*
Pimpleback sp. or sp(p). – refers to golden orb, smooth pimpleback, western pimpleback, Texas pimpleback, pimpleback, or some combination of those species; identification of worn specimens and others from the Trinity River drainage can be difficult or impossible
Pistolgrip *Quadrula verrucosa* – previously placed in *Tritogonia*
False spike *Quincuncina mitchelli*
Creeper *Strophitus undulatus* – previously called squawfoot
Lilliput *Toxolasma parvus*
Texas lilliput *Toxolasma texasiensis* – western lilliput *Toxolasma mearnsi* is considered only a form of Texas lilliput herein
Pistolgrip *Tritogonia verrucosa* - Serb et al. (2003) used DNA analysis to demonstrate this species should be moved to the genus *Quadrula.*
Mexican fawnsfoot *Truncilla cognata*
Fawnsfoot *Truncilla donaciformis*
Texas fawnsfoot *Truncilla macrodon*
Deertoe *Truncilla truncata*
Tapered pondhorn *Uniomerus declivis*
Pondhorn *Uniomerus tetralasmus*
Paper pondshell *Utterbackia imbecillis*
Little spectaclecase *Villosa lienosa*

Family: Corbiculidae
Asian clam *Corbicula* sp(p). – Most recognize all American corbiculas as *Corbicula fluminea*; however, some genetic studies suggest a second species may be present in Texas; no efforts were made to define species in this study

Family: Dreissenidae
Zebra mussel *Dreissena polymorpha*
Quagga mussel *Dreissena bugensis*
Zebra mussels – collectively zebra mussel, quagga mussel, or both

Family : Mactridae
Atlantic rangia *Rangia cuneata*

Family: Sphaeriidae
Fingernail clams and their relatives – no effort was made to identify species herein

SHELL CONDITION TERMINOLOGY

It is difficult to determine exactly how long a freshwater mussel shell has been dead. Different conditions such as water and substrate pH, erosive or corrosive environments, and exposure to sun can affect specimen condition and rate of disintegration. Nonetheless, some qualitative estimate of time-since-death can be useful. The following terms are used in TPWD freshwater mussel surveys:

Very-recently dead: Soft tissue remains attached to the shell; shell in good condition, essentially as it would be in a living specimen; internal and external colors are not faded.

Recently dead: No soft tissue remains, but shell otherwise in good condition (looks like a live specimen); internal nacre is glossy without evidence of algal staining, calcium deposition, or external

erosive effects; internal and external colors are not faded.

Relatively-recently dead: Shell in good condition, but internal nacre is losing its gloss; some algal staining, calcium deposition, or external erosion evident on the nacre; internal and external colors somewhat faded.

Long dead: Shell shows signs of internal and external erosion, staining, calcium deposition, or some combination of these; most or all of the internal coloration and gloss has faded (especially in species with colored nacre); shell epidermis with major sections absent or aged and flaking.

Very-long dead: Shell shows significant signs of erosion, staining, and calcium deposition; coloration often faded white or nearly so; relatively little intact epidermis; for specimens in erosive environments, internal features (*e.g.,* pseudocardinal teeth) and external features (*e.g.,* pustules) often weathered and smoothed, or otherwise exfoliated; shells often chalky, brittle, and crumbling.

Subfossil: Shells with little or no epidermis; nacre faded white and entire shell often white; sometimes with signs of erosion, staining, or calcium deposition; typically chalky; shells often brittle and crumbling.

SHELL COUNTING METHODS

0.5 x 1 = one valve (one-half shell); counted as one specimen in some calculations.
1 = one living specimen with a complete shell (two matched valves);
1.0 = one complete shell consisting of two, matching valves.
0.5 x 2 = one valve from each of two individuals; counted as two specimens in some calculations.
3.0+ 0.5 x 2 = three complete shells (pairs of matched valves) and two additional unpaired valves from two additional individuals; counted as five specimens in some calculations.