

DISTRIBUTIONAL SURVEYS OF
FRESHWATER BIVALVES IN TEXAS:
PROGRESS REPORT FOR 1994

by

Robert G. Howells

MANAGEMENT DATA SERIES
No. 120
1996

Texas Parks and Wildlife Department
Inland Fisheries Division
4200 Smith School Road
Austin, Texas 78744

ACKNOWLEDGMENTS

Many biologists and technicians with Texas Parks and Wildlife Department's Inland Fisheries Research and Management offices assisted with collection of freshwater mussels. Thanks also go to Pam Baker (Kerrville, Texas) who assisted with collection of specimens, and to Sue R. Martin and D. Mike Bagwell who sent specimens for identification. Thanks also go to Dr. Ray W. Neck (Houston Museum of Natural Science), Dr. Harold D. Murray (Trinity University), Joe A.M. Bergman (Boerne, Texas), Dr. Charles M. Mather (University of Science and Arts of Oklahoma) who identified specimens and provided information.

ABSTRACT

During 1994, over 3,000 unionid specimens were obtained. A total of 202 locations around the state were directly examined or actively sampled, or were represented by specimens sent to Heart of the Hills Research Station. Among the unionid taxa, of 39 species (about 76% of those reported in Texas) were found during these surveys. Living specimens or recently-dead shells (indicating mussels may still persist in the area) were found at 44% of the sites examined. However, many such sites contained few mussels and little likelihood of large, healthy populations. Only long-dead or subfossil shells were found at 10% of the sites examined and no evidence of unionids was found at approximately 31% of the sites.

Based on previous survey work in 1992 and 1993 in conjunction with the present 1994 findings, unionids appear extirpated, or nearly so, from the Pedernales, Blanco, San Marcos, Llano, Medina, upper Guadalupe, upper Sulphur, areas of the San Jacinto, and much of the San Saba rivers. Tributaries of these and others off the Rio Grande, Sabine, and Neches rivers also have lost most or all of their mussel populations. Good species abundance and diversity were found in the Sabine, central Neches, parts of the Concho, central Colorado, central Brazos, portions of Buffalo Bayou, lower-central Guadalupe, and portions of the Frio and Nueces river systems.

Primary sport and commercial species of unionids are generally still sufficiently abundant that regulated fisheries can be maintained. However, many other species have declined dramatically in abundance and distribution in recent years. Unique endemic forms have been particularly impacted. Some species have been found alive (1992-1994) at only one to three locations and others have not been found at all. Losses appear to most often reflect wide-reaching ecological modifications, especially poor land management, rather than point-source pollution or overharvest.

CONTENTS

Introduction.....	1
Methods and Materials.....	1
Results and Discussion.....	5
Red River Drainage.....	5
Sabine River Drainage.....	7
Neches River Drainage.....	10
Trinity River Drainage.....	15
San Jacinto River Drainage.....	18
Buffalo Bayou.....	19
Brazos River Drainage.....	21
Colorado River Drainage.....	29
Guadalupe River Drainage.....	36
Nueces River Drainage.....	37
Rio Grande Drainage (Texas).....	40
Rio Grande Drainage (Mexico).....	42
Species Summary.....	43
River System Summary.....	46
Literature Cited.....	49
Figure.....	52

INTRODUCTION

Beginning in January 1992 (Howells 1994; In Press), Texas Parks and Wildlife Department (TPWD) began surveys of freshwater mussels to increase understanding of this resource in the state. Indeed, there have been relatively few scientific studies in Texas waters to provide even baseline data. Field survey information has centered on freshwater mussel populations and habitat condition to help define status of the resource and harvest.

Around the turn of the century, a major industry developed in the Mississippi Valley harvesting freshwater mussel shells to produce buttons. This fishery generally reached as far southwest as Arkansas and the Red River (Coker 1919; Coker et al. 1921), but Texas was largely spared from what could be considered massive overharvest seen elsewhere. Mussel harvest for button shells did occur in Texas (Garrett 1929), but was comparatively minor by contrast to that seen in eastern rivers. The development of plastic buttons ultimately helped cause the demise of this fishery.

Although the intense Mississippi Valley fishery provoked study by the U.S. Fish Commission (Jones 1950), such scientific attention largely overlooked Texas unionids. A number of papers that have addressed local mussels have typically focused on site-specific species composition reports (e.g., Murray 1972, 1978; Littleton 1979; Metcalf 1982; Neck 1982a, 1982b, 1982c, 1986a, 1986b, 1989a, 1989b; Neck and Metcalf 1988). Shira (1913) discussed mussels associated with a pearl fishery in Caddo Lake. Two manuscripts listed species reported in Texas (Strecker 1931; Murray and Roy 1968). Studies of species distribution, abundance, changes in population structure, and associated fisheries were essentially lacking.

By late 1991, the commercial fishery in Texas for mussel shells used by the cultured pearl industry had increased to levels that could no longer be ignored. In the absence of baseline data, initial TPWD efforts first focused on a questionnaire survey of mussel-license holders (Howells 1993). Concurrently, in spring 1992, TPWD began statewide surveys of mussel populations in Texas. Results from preliminary field work in 1992 have since been reported (Howells 1994). Discussed here are findings from continuing surveys conducted in 1994.

MATERIALS AND METHODS

Various habitats were sampled at each collection site examined. Collection methods and sampling effort varied between sites depending upon personnel, equipment, and time available as well as field conditions at the time of sampling. Minimal sampling efforts involved visual examination of shoreline and shallow-waters with hand collection. Where possible, sites were sampled by wading and snorkeling with hand collection. On several occasions, SCUBA or hookah pump diving was used to examine deeper-water situations. Dive protocols followed Prentice (1995). A trail, similar to that reported by

Starrett (1971), was used at several locations when waters were too deep, fast, or cold to be otherwise sampled safely.

At some locations where mussel densities were initially estimated to exceed 1-2/m², quantitative samples were taken by placing a grid (PVC pipe, 0.25 m²) on the substrate and removing all bivalves and their shells found within the grid. Where mussel densities were estimated to be somewhat lower than 1-2/m², a 6.1-m rope was stretched between two poles and all specimens located 0.6 m on either side of this transect line were enumerated. In still lower-density situations (approximately 1-2/100 m²), where mussels present appeared to have been clearly disturbed or numbers altered (numbers present were not representative of undisturbed populations), or where time constraints or environmental conditions restricted sampling effort, more-broadly ranging, random hand-collections were made. Additionally, use of a 0.09-m² Peterson dredge (sampled a 30.5 x 30.5 cm area) in an unrelated HOH fish spawning habitat study occasionally produced unionids or their shells which were subsequently documented. Efforts in 1994 focused more on examining a large number of locations for estimates of presence or absence and general species composition than on obtaining density estimates. Densities of mussels at most sites were so low, large numbers of replicate samples needed for statistically valid density estimates would have been prohibitive.

Results are presented in numbers collected and percent composition of the collection. Caution should be used in considering calculated percentages from collections where few specimens were taken, where mussel abundance and species composition had been altered (e.g., after harvest by musselers), or where collection efforts focused on obtaining large numbers of particular species (for laboratory work or reference specimens). Where a species at a given locality was represented only by fragments, it was recorded as present but fragments were not used in percent-composition calculations.

Mussels taken were identified to species whenever possible. Some subfossil or badly-weathered individuals could not be identified to species. Ill-defined taxonomic status of some "species" also precluded assigning specific identifications at this time. Other, non-unionid bivalves were also documented. Where identifications were in doubt, R.W. Neck (Houston Museum of Natural Science), H.D. Murray (Trinity University), or J.A.M. Bergman (Boerne, Texas) were consulted. Electrophoretic analysis using horizontal starch gel techniques following Morizot and Schmidt (1990) was employed in some instances to assist with species identification.

Common and scientific names used generally follow Turgeon et al. (1988) and include:

Family: Unionidae

- Threeridge (*Amblema plicata*),
- Giant floater (*Anodonta grandis*),
- Paper pondshell (*Anodonta imbecillis*),
- Flat floater (*Anodonta suborbiculata*),
- Floater sp. (*Anodonta* sp.) - Collections in B.A. Steinhagen Reservoir in 1993 produced specimens of an undescribed (or at least unrecognized) floater somewhat intermediate between giant floater and flat floater.

This same species has been found by P. Hartfield (U.S. Fish and Wildlife Service, Jackson, Mississippi; personal communication, pers. comm.) in Mississippi,

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),
Louisiana fatmucket (Lampsilis hydiana),
Sandbank pocketbook (Lampsilis satura),
Yellow sandshell (Lampsilis teres),
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 dombevanus),
Louisiana pigtoe (Pleurobema riddelli),
Texas heelsplitter (Potamilus amphichaenus),
Pink papershell (Potamilus ohiensis),
Bluefer (Potamilus purpuratus),
Southern mapleleaf (Quadrula apiculata),
Rio Grande monkeyface (Quadrula couchiana),
"Gulf mapleleaf" (Quadrula nobilis - This species was originally described by Conrad (1854) as Unio nobilis and later by Simpson (1900) as Tritogonia verrucosa obesa; however, subsequent electrophoretic analyses at Heart of the Hills Research Station (HOH) successfully distinguished this species as distinct from both Q. quadrula and Q. apiculata. Examination of gill morphology places it in Quadrula and not with Tritogonia. No common name has been recognized, so the term "Gulf mapleleaf" has been applied herein,

"Mapleleaf sp(p)." or Quadrula sp(p). - used when Q. apiculata and Q. quadrula could not be distinguished (pending electrophoretic analysis),
Golden orb (Quadrula aurea),
"Pimpleback sp(p)." - used where confusion between Q. aurea, Q. houstonensis, Q. mortoni, or Q. pustulosa (but not Q. petrina) could not be resolved,
Smooth pimpleback (Quadrula houstonensis),
Western pimpleback (Quadrula mortoni),
Wartyback (Quadrula nodulata),
Texas pimpleback (Quadrula petrina),
Pimpleback (Quadrula pustulosa),
Mapleleaf (Quadrula quadrula),
False spike (Quincuncina mitchelli),
Squawfoot (Strophitus undulatus),
Lilliput (Toxolasma parva),
Texas Lilliput (Toxolasma texasensis) - including T. mearnsi-types,

Pistolgrip (Tritogonia verrucosa),
Mexican fawnsfoot (Truncilla cognata)
Fawnsfoot (Truncilla donaciformis),
Texas fawnsfoot (Truncilla macrodon),
Deertoe (Truncilla truncata),
Tapered pondhorn (Uniomerus declivis),
Pondhorn (Uniomerus tetralasmus),
Pondhorn sp. or spp. (Uniomerus spp.),
Little spectaclecase (Villosa lienosa),
Family: Corbiculidae,
Asian clam (Corbicula sp(p).) - no effort was made to define species,
Family: Mactridae,
Atlantic rangia (Rangia cuneata); and
Family: Sphaeriidae,
Fingernail clams - no effort was made to define species

Although once dead, varying environmental conditions can confound attempts to accurately define how long a given specimen has been dead, a number of terms have been used herein to convey an approximation of this. While inherently inaccurate, none the less, these attempts to characterize time since death are useful in distinguishing between animals that have been dead for many decades from others that clearly died only days or weeks before collection. Terminology used here includes:

Very Recently Dead (very recent): 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 (recent): No soft tissue remains attached to the shell, but shell is otherwise in good condition, essentially as it would be in a living specimen. Internally nacre is still glossy and without indication of algal staining, deposition of calcium, or external erosive effects. Internal and external colors are not faded.

Relatively-recently dead (relatively recent): Shell is in good condition, but internally the nacre is loosing or has lost its glossy nature; algal staining, calcium deposition, or effects of external erosion (or some combination of these) are present on the nacre. Internal and external colors may have faded somewhat.

Long dead: Shell shows early signs of internal and external erosion, staining, calcium deposition, or some combination of these. Most or all internal coloration has faded, especially in species with colored naces. Shell epidermis often largely absent, or if present, clearly aged and flaking.

Very long dead: Shell shows significant signs of erosion, staining, and calcium deposition more widely pronounced than above. Coloration often faded to white or nearly so. Relatively little intact epidermis left. For specimens in erosive environments, internal (e.g., lateral teeth) and external (e.g., pustules) features often weathered and smoothed, or otherwise partially exfoliated. Shells often brittle and crumbling.

Subfossil: Shells with little or no epidermis. Nacre usually faded white; entire shell often completely white. Often with extensive signs of erosion, staining, and calcium deposition. Shells often brittle and crumbling.

In the following discussion, sampling sites are generally presented north to south and east to west across the state, and upstream to downstream for each major river system. In the following in-text tables, the condition of dead valves and shells found has been noted. Counts for dead shells and valves include the following notations:

- 0.5 - one valve (one half shell); counted as one specimen in calculations.
- 1.0 - one complete shell consisting of two matching valves.
- 0.5 x 2 - one valve each from two individuals; counted as two specimens in calculations.
- 3.0 + 0.5 x 2 - three shells (paired valves) and two additional unpaired valves from two additional individuals; counted as five specimens in calculations.

RESULTS AND DISCUSSION

Red River Drainage

Lake Wichita (Little Wichita River Drainage), Archer and Wichita counties, two dates:

18 January 1994 - During a low-water period, a brief examination of the exposed shoreline produced:

Lake Wichita				
Species	N live	N shell	Condition	Percent
Giant floater	0	0.5 x 2	relatively recent	20.0
Paper pondshell	0	1.0	relatively recent	10.0
Mapleleaf sp.	0	1.0 + 0.5 x 3	relatively recent	40.0
Pink papershell	0	3.0	relatively recent	30.0
<u>Asian clam (present)</u>				

12 July 1994 - Staff from HOH returned to this reservoir to obtain pink papershell and mapleleaf specimens needed for electrophoretic analysis. Mapleleaves found here and in Lake Arrowhead are taxonomically problematic, but most appear to be Q. quadrula. The following specimens were collected:

Lake Wichita				
Species	N live	N shell	Condition	Percent
Giant floater	2	3.0	recent	8.1
Pink papershell	3	10.5	recent	22.6
Mapleleaf sp.	34	9.0	recent	69.4

Lake Arrowhead (Wichita River Drainage), Clay County, 12 July 1994:
Wading and snorkeling in this reservoir produced:

Lake Arrowhead				
Species	N live	N shell	Condition	Percent
Giant floater	6	3.0	recent	7.6
Paper pondshell	5	0.0	-	4.2
Yellow sandshell	15	0.0	-	12.7
Fragile papershell	22	2.0	recent	20.3
Pink papershell	28	10.0	recent	32.2
Mapleleaf sp.	26	1.0	recent	22.9
Asian clam (present)				

Pat Mayse Reservoir (Sanders Creek Drainage), cove at the western-most U.S. Army Corps of Engineers camp ground on the north shore of the reservoir, Lamar County, 14 June 1994:
Wading and snorkeling was confounded by high water conditions, but the following species were found:

Pat Mayse Reservoir				
Species	N live	N shell	Condition	Percent
Yellow sandshell	0	1.0	relatively recent	14.3
Fragile papershell	0	1.0	recent	14.3
Pink papershell	0	1.0	relatively recent	14.3
Mapleleaf spp.	4	0.0	-	57.1

Crook Lake (Pine Creek Drainage), Lamar County, 13 June 1994:
Wading and snorkeling at this small impoundment (a mussel sanctuary) produced:

Crook Lake				
Species	N live	N shell	Condition	Percent
Giant floater	0	1.0	recent	16.7
Fragile papershell	1	0.0	-	16.7
Mapleleaf spp.	4	0.0	-	66.7

Pine Creek, Lamar County, 13 June 1994:
Efforts to sample this site were thwarted by heavy rainfall and high, fast water levels and the attempt was aborted.

Comments on Pat Mayse Reservoir, Crook Lake, and Pine Creek surveys: Examination of these sites reflected continued monitoring of Ouachita rock-pocketbook, a federally-endangered species found in the area the previous year. Additionally, mapleleaves were collected to provide tissue for electrophoretic analysis being conducted to define differences between mapleleaf and southern mapleleaf, and to clarify species present in Lamar County. Rains and flood conditions developed during travel from HOH to Lamar County preventing thorough survey efforts.

Sabine River Drainage

Lake Tawakoni (Sabine River Drainage), Hunt and Rains counties, 14 June 1994:
Wading shore-zone areas produced:

Lake Tawakoni				
Species	N live	N shell	Condition	Percent
Giant floater	1	0.0	-	6.3
Southern mapleleaf	15	0.0	-	93.7

Sabine River from dam at Lake Tawakoni ca. 3 km downstream, Hunt and Rains counties, 27 June 1994:
Wading this river yielded:

Sabine River: Lake Tawakoni Dam to ca. 3 km downstream				
Species	N live	N shell	Condition	Percent
Threeridge	2	1.0+ (many)	recent	5.1
Giant floater	1	5.0	relatively recent	10.2
Rock-pocketbook	0	0.5	relatively recent	1.7
Fragile papershell	2	24.0	recent	44.1
Pond mussel	0	1.0	long dead	1.7
Washboard	1	0.0	-	1.7
Texas heelsplitter	0	1.0	relatively recent	1.7
Bleufer	4	11.0	relatively recent	25.4
Texas lilliput	0	2.5	relatively recent	5.1
Deertoe	1	0.5	recent	3.4
<u>Asian clam (present)</u>				

Note: Number and percent for threeridge represent only those returned to HOH; far more specimens were present.

Sabine River, State Highway 14, Smith and Wood counties, 11 July 1994:
Wading shallow areas at this sanctuary site was confounded by heavy rains and rising water levels but yielded:

Sabine River: SH 14				
Species	N live	N shell	Condition	Percent
Rock-pocketbook	1	0.0	-	5.3
Fragile papershell	1	0.0	-	5.3
Washboard	0	14.5	long dead	78.9
Bankclimber	0	0.5	long dead	5.3
Pistolgrip	0	1.0	long dead	5.3

Sabine River, State Highway 155, Smith and Wood counties, 11 July 1994:
Wading shallow areas at this sanctuary site was confounded by heavy rains and rising water levels. No unionids were found.

Sabine River, State Highway 1804, Smith and Wood counties, 11 July 1994:
Wading shallow areas at this sanctuary site was confounded by heavy rains and rising water levels. No unionids were found.

Sabine River, U.S. Highway 155, Smith and Wood counties, 11 July 1994:
 Wading shallow areas at this sanctuary site was confounded by heavy rains and rising water levels. No unionids were found.

Lake Holbrook (Sabine River Drainage), Wood County, 11 July 1994:
 Wading and snorkeling this location produced:

Lake Holbrook				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	3.0	recent	15.8
Pond mussel	7	8.0	recent	78.9
Texas lilliput	0	1.0	recent	5.3
Asian clams (present)				

Lake Brenda (Sabine River Drainage), Wood County, 11 July 1994:
 Attempts to sample this small impoundment were thwarted by private lands and lack of access.

Lake Hawkins (Sabine River Drainage), Wood County, 11 July 1994:
 Wading and snorkeling this location produced:

Lake Hawkins				
Species	N live	N shell	Condition	Percent
Giant floater	1	1.0	recent	40.0
Pond mussel	0	3.0	relatively recent	60.0

Lake Fork Creek (Sabine River Drainage) at U.S. Highway 80, Wood County, 11 July 1994:
 Wading and snorkeling this location produced:

Lake Fork Creek				
Species	N live	N shell	Condition	Percent
Giant floater	3	1.0	relatively recent	17.4
Texas pigtoe	1	0.0	-	4.3
Yellow sandshell	1	1.0	relatively recent	8.7
Pond mussel	9	2.0	relatively recent	47.8
Bleufer	0	3.0	long dead	13.0
Texas lilliput	0	1.0	relatively recent	4.3
Tapered pondhorn	1	0.0	-	4.3

Duck Creek (Sabine River Drainage) at U.S. Highways 59 (two sites) and 37 and County Road 481, Smith County, 25 July 1994:

Duck Creek				
Species	N live	N shell	Condition	Percent
Louisiana fatmucket	1	2.0	relatively recent	37.5
Yellow sandshell	0	1.0	relatively recent	12.5
Tapered pondhorn	1	0.0	-	12.5
Little spectaclecase	0	2.5	long dead	37.5

Sabine River, State Highway 2517, Panola County, 6 July 1994:

Wading shallow areas at this site yielded:

Sabine River: SH 2517				
Species	N live	N shell	Condition	Percent
Giant floater	1	0.0	-	11.1
Yellow sandshell	0	4.5	relatively recent	55.6
Fragile papershell	0	2.5	recent	33.3

Sabine River, U.S. Highway 79, Panola County, 6 July 1994:

No mussels were found during wade sampling shallow areas at this site.

Sabine River, State Highway 1185, Panola County, 6 July 1994:

Wading shallow areas at this site yielded:

Sabine River: SH 1185				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	relatively recent	33.3
Yellow sandshell	0	2.0	relatively recent	66.7

Sabine River, U.S. Highway 59, Panola County, 5 July 1994:

Wading shallow areas at this sanctuary site yielded:

Sabine River: USH 59				
Species	N live	N shell	Condition	Percent
Threeridge	1	1.0	relatively recent	5.0
Texas pigtoe	6	6.5	relatively recent	32.5
Sandbank pocketbook	1	1.0	relatively recent	5.0
Yellow sandshell	0	2.0	relatively recent	5.0
Bankclimber	0	2.0	relatively recent	5.0
Texas heelsplitter	1	1.0	relatively recent	5.0
Bleufer	0	2.0	relatively recent	5.0
Western pimpleback	0	2.0	relatively recent	5.0
Pistolgrip	6	4.0	relatively recent	25.0
Deertoe	0	3.0	relatively recent	7.5
Unidentified fragment	0	fragment		

Previous collections by TPWD January 1992 through this date have only found pistolgrip alive twice (one individual in B.A. Steinhagen Reservoir and one in the upper reaches of Lake Buchanan) (Howells 1994; In Press); the species generally appears to be declining statewide, especially east of the Neches River drainage. The Texas heelsplitter taken in this collection (a short distance upstream from the type locality) appears to only be the second living specimen found in approximately the last 15 years (Neck and Howells 1994).

Sabine River, State Highway 43, Panola County, 5 July 1994:

Wading shallow areas at this sanctuary site yielded:

Sabine River: USH 43				
Species	N live	N shell	Condition	Percent
Threeridge	3	2.0	relatively recent	11.4

Rock-pocketbook	0	0.5	relatively recent	2.3
Texas pigtoe	7	3.0	relatively recent	22.7
Louisiana fatmucket	0	1.0	relatively recent	2.3
Sandbank pocketbook	1	0.0	-	2.3
Yellow sandshell	0	6.0	relatively recent	13.6
Fragile papershell	0	1.0	relatively recent	2.3
Washboard	1	1.0	relatively recent	4.5
Bankclimber	3	4.0	relatively recent	15.9
Bleufer	0	2.0	relatively recent	4.5
<u>Western pimpleback</u>	6	2.0	relatively recent	18.2

Lake Slough at U.S. Highway 79 (Sabine River Drainage), Panola County, 5 July 1994:

No unionids were found by wading and snorkeling at this site.

Cherokee Bayou (Sabine River Drainage) at ATS Railroad crossing, Rusk County, 5 July 1994:

No unionids were found by wading and snorkeling at this site.

Unnamed creek east of Cherokee Bayou (Sabine River Drainage) at ATS Railroad crossing, Rusk County, 5 July 1994:

No unionids were found by wading and snorkeling at this site.

Lake Murvaul (Sabine River Drainage), several locations on both north and south shores, Panola County, 5 July 1994:

No unionids were found by wading or snorkeling at this site. Dense beds of hydrilla (Hydrilla verticillatum) created unfavorable mussel habitat in this impoundment.

Murvaul Creek downstream of Lake Murvaul (Sabine River Drainage) at four sites (U.S. Highway 59 and State Highways 1970, 10 and 699), 5 July 1994:

No unionids were found by wading and snorkeling at any of these four sites.

Grogen Creek (Sabine River Drainage) at State Highway 3359, Panola County, 5 July 1994:

No unionids were found by wading and snorkeling at this site.

Mill Creek (Sabine River Drainage) at State Highway 3359, Panola County, 5 July 1994:

No unionids were found by wading and snorkeling at this site.

Toledo Bend Reservoir, cove at State Highway 39, Shelby County, 6 July 1994:

No mussels were found by wading and snorkeling this site.

Neches River Drainage

Kickapoo Creek off Lake Palestine (Neches River Drainage) at State Highway 1803, 3520, 3516, and 314, Henderson County, 26 July 1994:

Wading and snorkeling these sites produced only 1.5 relatively-recently dead Texas lilliput shells; no other unionids were found.

Lake Palestine (Neches River Drainage) at State Highway 315, Sun Ridge Road, and State Highway 155 at Coffee City, Henderson County, 26 July 1994: Wading and snorkeling these sites produced only two relatively-recently dead giant floater shells; Asian clam was found to be very abundant.

Neches River near boat ramp downstream of Lake Palestine, Anderson and Cherokee counties, 8 August 1994: Peterson dredge collections produced a single living bankclimber. Bank and sand-bar collections produced:

Neches River: near boat ramp downstream of Lake Palestine				
Species	N live	N shell	Condition	Percent
Yellow sandshell	0	2.0	long dead	66.7
Bankclimber	0	0.5	long dead	33.3

Neches River at Cuney, Anderson and Cherokee counties, 8 August 1994: Bank collections at this site produced two long-dead sandbank pocketbook shells.

Neches River at State Highway 7 northwest of Lufkin, Trinity and Angelina counties, two dates:
3 August 1994 - sand- and gravel-bar collections produced:

Neches River: SH 7				
Species	N live	N shell	Condition	Percent
Louisiana fatmucket	0	1.0	-	12.5
Sandbank pocketbook	0	0.5	-	12.5
Yellow sandshell	0	2.0	-	25.0
Fragile papershell	0	1.0	-	12.5
Bankclimber	0	0.5	-	12.5
Western pimpleback	0	2.0	-	25.0
<u>Asian clam (present)</u>				

8 August 1994 - during Peterson dredge samples taken as part of a paddlefish spawning habitat study, the following bivalves were taken:

Neches River: SH 7				
Species	N live	N shell	Condition	Percent
Bankclimber	1	0.0	-	25.0
Western pimpleback	2	0.0	-	50.0
Pistolgrip	1	0.0	-	25.0
<u>Asian clam (present)</u>				

Neches River at U.S. Highway 59 south of Lufkin, Polk and Angelina counties, 3 August 1994:
Sand- and gravel-bar collections produced:

Neches River: USH 59				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	-	16.7
Yellow sandshell	0	1.0	-	16.7
Washboard	0	1.0	-	16.7
Southern hickorynut	0	1.0	-	16.7
Bankclimber	0	1.0	-	16.7
Bleufer	0	1.0	-	16.7

Neches River at Evadale, Hardin and Jasper counties, 27 July 1994:
Sand- and gravel-bar collections produced:

Neches River: Evadale				
Species	N live	N shell	Condition	Percent
Yellow sandshell	0	0.5 x 2 + fragments	-	50.0
Bleufer	0	0.5 x 2	-	50.0

Angelina River (Neches River Drainage) at State Highway 343, 21, 1911, and 7,
Cherokee and Nacogdoches counties, 25 July 1994:
No unionids were found by wading and snorkeling at these sites.

Lake Nacogdoches (Angelina River Drainage), Nacogdoches County, 25 July 1994:
Wading and snorkeling this small impoundment produced:

Lake Nacogdoches				
Species	N live	N shell	Condition	Percent
Texas lilliput	1	8.0	relatively recent	100.0
Asian clam (abundant)				

Loco Bayou (Angelina River Drainage) immediately downstream of Lake
Nacogdoches and at State Highway 7, Nacogdoches County, 25 July 1994:
Wading these site revealed no unionids. This stream had undesirable low
flows and stagnant conditions.

Alazan Bayou (Angelina River Drainage) at unmarked county road just upstream
of the Angelina River, Nacogdoches County, 25 July 1994:
No unionids were taken during wade and snorkel sampling at this site.

Black Bayou (Angelina River Drainage) at unmarked county road just upstream of
the Angelina River, Nacogdoches County, 25 July 1994:
No unionids were taken during wade and snorkel sampling at this site.

Bonita Creek (Angelina River Drainage) at State Highway 698 and U.S. Highway
59 north of Nacogdoches, Nacogdoches County, 25 July 1994:
No unionids were found during examination of these sites. Little water
was present in the stream at these locations.

Bonita Creek (Angelina River Drainage) at county road downstream of State
Highway 698, and at State Highway 343 and 224, Nacogdoches County, 25
July 1994:

No unionids were found during examination of these sites. Little water was present in the stream at these locations.

Lanana Creek (Angelina River Drainage) at six sites (U.S. Highway 59 up- and downstream of North Bonita Creek, county road upstream of State Highway 224, State Highway 224-N and 224-S, and county road downstream of State Highway 224-S), Nacogdoches County, 25 July 1994:

No unionids were present during examination of these sites; however, a few Asian clams were found in the downstream locations. These sites typically contained little or no water. Lanana and Bonita creeks represent the type localities for triangle pigtoe; however, neither stream appears to support either it or other unionids at present.

Attoyac Bayou (Angelina River Drainage) at six sites (U.S. Highway 59, county road downstream of Timpson Creek, State Highway 138, 7, and 21, and county road upstream of State Highway 21); Shelby, Nacogdoches, and St. Augustine counties, 25 July 1994:

Wading and snorkeling at these sites indicated Asian clam was present at nearly all, but the following unionids were only taken at the county road crossing upstream of State Highway 21:

Attoyac Bayou				
Species	N live	N shell	Condition	Percent
Triangle pigtoe	1	0.0	-	12.5
Louisiana fatmucket	0	1.0	relatively recent	12.5
Western pimpleback	1	0.0	-	12.5
Pistolgrip	2	0.0	-	25.0
Little spectaclecase	3	0.0	-	37.5

Although the rare triangle pigtoe was not found at the type localities on Bonita and Lanana creeks nearby from where it may have been extirpated, some individuals continue to survive in the Attoyac Bayou system.

Lake Timpson (Angelina River Drainage), Shelby County, 25 July 1994:

Wading and snorkeling this small impoundment produced:

Lake Timpson				
Species	N live	N shell	Condition	Percent
Paper pondshell	3	2.0	relatively recent	62.5
Texas lilliput	1	2.0	relatively recent	37.5

Timpson Creek immediately downstream of Lake Timpson (Angelina River Drainage), Shelby County, 25 July 1994:

Wade sampling at this site only produced relatively-recent shells from two giant floaters.

Sandy Creek off Attoyac Bayou (Angelina River Drainage) at State Highway 2913, Shelby County, 25 July 1994:

Wading and snorkeling this stream produced the following unionids:

Sandy Creek: off Attoyac Bayou				
Species	N live	N shell	Condition	Percent
Threeridge	6	0.0	-	20.7
Giant floater	0	0.5	relatively recent	3.4
Triangle pigtoe	3	2.0	relatively recent	17.2
Louisiana fatmucket	2	8.0	relatively recent	34.5
Western pimpleback	1	0.0	-	3.4
Pistolgrip	3	2.0	relatively recent	17.2
Little spectaclecase	0	1.0	relatively recent	3.4

Neches River, sand and gravel bars downstream of B.A. Steinhagen Reservoir, Tyler and Jasper counties, 28 July 1994:
Sand- and gravel-bar collections by fishery management biologists produced:

Neches River: downstream of B.A. Steinhagen Reservoir				
Species	N live	N shell	Condition	Percent
Threeridge	0	11.0	-	57.9
Louisiana fatmucket	0	0.5	-	5.3
Western pimpleback	0	3.0	-	15.8
Threehorn wartyback	0	1.0	-	5.3
Bankclimber	0	1.5	-	10.5
Louisiana pigtoe	0	1.0	-	5.3

Pine Island Bayou including north and south branches and the area between their confluence and the Neches River, Hardin and Jefferson counties, 26 April 1994:

Brail sampling throughout this area produced no bivalves. Previous pollution problems in past decades (Harrel 1993) and current development in the area have probably eliminated some mussels and caused others to decline to densities so low that brail sampling failed to detect them.

Little Pine Island Bayou, Hardin County, 26 April 1994:

Wading and snorkeling several road crossings on this stream produced:

Little Pine Island Bayou				
Species	N live	N shell	Condition	Percent
Louisiana fatmucket	0	2.0	relatively recent	66.7
Tapered pondhorn	1	0.0	-	33.3

The Louisiana fatmuckets were relatively-recently dead. Few unionids remain here.

Neches River from Evadale to Massey Slough (just upstream of the mouth of Village Creek), Hardin and Jasper counties, 28 April 1994:

Brailing deeper waters of the river produced no unionids. Wading shore-zone areas yielded the following specimens:

Neches River: Evadale to Massey Slough				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	very long dead	3.6

Yellow sandshell	0	0.5	relatively recent	3.6
Fragile papershell	7	17.0	very recent	85.7
Western pimpleback	0	1.0	relatively recent	3.6
Mapleleaf sp.	0	1.0	long dead	3.6

Village Creek, Hardin County, 27 April 1994:

Wading and snorkeling in this stream produced only the following bivalves:

Village Creek				
Species	N live	N shell	Condition	Percent
Western pimpleback	0	1.5	very long dead	40.0
Atlantic rangia	0	0.5 x 3	long dead	60.0

Village Creek historically held one of the largest and most diverse unionid assemblages in the state. These persisted at least through 1977-1980 (Vidrine 1990). The HOH field survey crew observed extensive sand deposition caused by land clearing, highway construction, and basic development of the area has severely impacted this stream in recent years. They also reported pollution including some apparently oil-related impact as well. Although some small, isolated pockets of mussels may remain, such an extensive loss in less than 14 years is truly unfortunate.

Trinity River Drainage

Lake Jacksboro (Trinity River Drainage), Jack County, 16 June 1994:

Examination of this flooded, rock-quarry lake yielded only a single giant floater (a second specimen was observed but not collected). The deep, rocky nature of this site indicated poor mussel habitat.

Eagle Mountain Reservoir (Trinity River Drainage), Tarrant County, 24 June 1994:

Wading shallow waters and brailing deeper areas produced:

Eagle Mountain Reservoir				
Species	N live	N shell	Condition	Percent
Threeridge	7	14.0	-	56.8
Giant floater	0	2.0	-	5.4
Yellow sandshell	0	4.0	-	10.8
Bleufer	0	1.0	-	2.7
Pimpleback spp.	2	5.0	-	18.9
Deertoe	0	0.5 x 2	-	5.4

Pimplebacks from this and other upper Trinity River reservoirs are taxonomically problematic. Historically they have been called pimpleback, western pimpleback, and smooth pimpleback; however, they differ morphologically from most other populations in Texas and certain minor genetic differences have been indicated by preliminary electrophoretic analysis at HOH; small sample size has confounded firm conclusions to date.

Lake Lewisville (Trinity River Drainage), Denton County, 23 June 1994:
Wading and brailing 10 of 11 sites previously reported by Neck (1990)
found:

Lake Lewisville				
Species	N live	N shell	Condition	Percent
Threeridge	2	1.0	relatively recent	42.9
Southern mapleleaf	3	0.5	relatively recent	57.1

Neck (1990) found these sites contained 15 unionid species in addition to Asian clam in 1977 and 1978. Low-water conditions at the time of Neck's survey likely enhanced his ability to locate mussels. Further, low-water conditions then and on subsequent occasions may have negatively impacted the unionid populations in this reservoir as well.

Lake Worth (Trinity River Drainage), Tarrant County, 23 June 1994:
Wading and brailing this reservoir yielded:

Lake Worth				
Species	N live	N shell	Condition	Percent
Threeridge	1	7.0	-	66.7
Giant floater	0	0.5	-	8.3
Fragile papershell	0	1.0	-	8.3
Bleufer	0	0.5	-	8.3
Southern mapleleaf	0	0.5	-	8.3

Lake Grapevine (Trinity River Drainage), Tarrant County, 23 June 1994:
Wading and brailing this reservoir yielded:

Lake Grapevine				
Species	N live	N shell	Condition	Percent
Threeridge	1	0.0	-	16.7
Giant floater	0	0.5	relatively recent	16.7
Louisiana fatmucket	1	0.0	-	16.7
Southern mapleleaf	3	0.0	-	50.0

Denton Creek (Trinity River Drainage) at several sites, Denton County, 24 June 1994:

No unionids were found when these areas were sampled by wading; however, field-crew opinion was that some substrates were acceptable mussel habitat and in the absence of noteworthy negative environmental factors, isolated pockets of unionids could still remain in this creek.

Hubbard City Lake Number 2 (Trinity River Drainage), Navarro County, 14 September 1994:
Wading and snorkeling this reservoir produced:

Hubbard City Lake Number 2				
Species	N live	N shell	Condition	Percent
Giant floater	0	2.5	relatively recent	60.0
Paper pondshell	0	2.0	recent	40.0

Navarro Mills Reservoir (Richland Creek Drainage), Navarro County, 14 September 1994:

Wading and snorkeling shallow areas near the dam produced only 1.5 southern mapleleaf shells which were relatively recent.

Richland Creek at State Highway 31, Navarro County, 9 June 1994:

Wade sampling produced:

Richland Creek				
Species	N live	N shell	Condition	Percent
Threeridge	5	12.0	relatively recent	36.2
Giant floater	3	1.0	recent	8.5
Louisiana fatmucket	0	7.5	long dead	17.0
Yellow sandshell	0	1.0	relatively recent	2.1
Fragile or pink papershell	0	0.5	long dead	2.1
Southern mapleleaf	10	3.0	relatively recent	27.7
Tapered pondhorn	0	2.5	relatively recent	6.4
<u>Asian clam (present)</u>				

Trinity River, gravel bar at the mouth of Big Eddy upstream of Lake Livingston, Trinity County, 22 June 1994:

No unionids were taken during wading and Peterson dredge sampling in this area. However, the following long-dead and subfossil material was obtained on a gravel bar:

Trinity River: gravel bar at Big Eddy				
Species	N live	N shell	Condition	Percent
Threeridge	0	3.0	long dead to subfossil	20.0
Washboard	0	0.5	long dead	6.7
Bankclimber	0	6.0	long dead to subfossil	40.0
Pistolgrip	0	1.5	long dead to subfossil	13.3
Louisiana fatmucket	0	0.5	long dead	6.7
Unidentified	0	2.0	subfossil	13.3
<u>Asian clam (one, recently dead)</u>				

The unidentified valves taken here and at the site below superficially resembled Louisiana pigtoe, a rare species which once occurred in this river. The specimens were too badly worn for positive identification but were more likely threeridges with poorly-developed or exfoliated ridges.

Trinity River, gravel bar near Black Creek between Big Eddy and Lake

Livingston, 22 June 1994:

No unionids were taken during wading and only one (a single living fawnsfoot) was found in Ponar dredge sampling in this area. However, the following long-dead and subfossil material was obtained in the gravel bar:

Trinity River: gravel bar near Black Creek				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	subfossil	12.5

Bankclimber	0	1.0	subfossil	12.5
Bleufer	0	0.5	subfossil	12.5
Pimpleback sp.	0	0.5	subfossil	12.5
Pistolgrip	0	3.0	subfossil	37.5
Unidentified	0	1.0	subfossil	12.5

Lake Livingston, embayments and islands in the upper reaches of the reservoir, San Jacinto and Livingston counties, 24-25 May 1994:
Wading and snorkeling to depths of ca. 1.5 m yielded neither unionids or Asian clams. Commercial musselers have reported abundant unionids in this reservoir in past years with concentrations from about 1.8 m deep. It was unusual to find none in the shallows, including old shells. Future survey work here will need to employ diving, brail, or dredge to examine deeper areas.

San Jacinto River Drainage

East Branch Sandy Creek at State Highway 1374 (northeast of Stubblefield Crossing), Walker County, 30 March 1994:
This stream was filled with deep-shifting sand and wade sampling here yielded only a few Asian clam valves.

West Branch Sandy Creek at State Highway 1374 (northeast of Stubblefield Crossing), Walker County, 30 March 1994:
This stream appeared intermittent and even one deep hole located near the highway bridge contained stagnant water. No bivalves were found.

West Branch San Jacinto River at Stubblefield Crossing upstream of Lake Conroe, Walker County, 30 March 1994:
Wading and snorkeling here yielded only a single living yellow sandshell.

Lake Conroe, four sites, Montgomery County, 30 March 1994:
Site 1: Shore zone east of State Highway 1375 - Wading two areas here yielded only a small number of Asian clam valves.
Site 2: Cove on eastern lake shore north of State Highway 1097 - Brail sampling in deeper cover waters produced no bivalves. Wading the shore zone of an island in near the mouth of the cove yielded southern mapleleaves (15 live and 1 recently dead) and numerous Asian clams.
Site 3: Embayment south of State Highway 1097 - Brail sampling at this site produced no bivalves.
Site 4: Cove downstream of Lake Lewis at State Highway 1097 - Brail sampling at this site produced no bivalves.

West Branch San Jacinto River at State Highway 105 just downstream of Lake Conroe Dam, Montgomery County, 29 March 1994:
Active bridge construction at this site contributed to excessive sand deposition. No bivalves were found.

West Branch San Jacinto River ca 0.5 km up- and downstream from State Highway 2858, Montgomery County, 29 March 1994;

Wade-sampling at this site produced only long-dead valves of bleufer, southern mapleleaf, and Asian clam. One gravel riffle was present, but most of the substrate was deep-shifting sand.

West Branch San Jacinto River ca. 3 km up- and downstream from U.S. Highway 45, Montgomery County, 29 March 1994:

Four members of the HOH staff surveyed this site extensively by wading and snorkeling but found no living unionids. Only long-dead shells and fragments of threeridge, yellow sandshell, bleufer, southern mapleleaf, and Asian clam were found. Earlier in this century, this site contained numerous species (Strecker 1931) and continued to maintain an abundant and diverse assemblage into 1972 when the American Malacological Union collected specimens (C.E. Boone, Houston Museum of Natural Science; pers. comm.). Land clearing, bridge construction, and general development of the area appears to have disturbed fragile, sandy soils and caused extensive sand deposition and resultant deep-shifting sand bottoms (undesirable mussel habitat).

East Branch San Jacinto River, five crossings north of FM 2025, Montgomery County, 25 May 1994:

Wading and snorkeling produced:

East Branch San Jacinto River				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	long dead	11.1
Wabash pigtoe	0	1.5	long dead	22.2
Pimpleback sp.	0	2.5	long dead	33.3
Southern mapleleaf	1	1.5	long dead	33.3
Unidentified fragments	0	fragments	long dead	-
Asian clam (several)				

Much like many ares on the West Branch of the San Jacinto River, these sites also appeared to be degrading due to excess sand deposition.

Buffalo Bayou Drainage

Buffalo Bayou upstream of Barker Dam at Westheimer Parkway, Harris County, 14 July 1994:

On this date, about 30 malacologists attending an American Malacological Union Meeting in Houston assisted in a survey of the area with the following results:

Buffalo Bayou: Westheimer Parkway				
Species	N live	N shell	Condition	Percent
Giant floater	4	0.0	-	13.8
Round pearlshell	1	0.0	-	3.4
Southern mapleleaf	18	1.0	recent	62.1
Texas lilliput	6	0.0	-	20.7

Buffalo Bayou from Barker Dam spillway 100 m downstream, 1 June 1994:
 Wading this area during a restriction in flow to assist with collection efforts produced:

Buffalo Bayou: downstream of Barker Dam				
Species	N live	N shell	Condition	Percent
Round pearlshell	3	0.0	-	10.0
Yellow sandshell	1	1.5	recent	10.0
Southern mapleleaf	19	1.5	recent	70.0
Texas lilliput	2	0.5	recent	10.0
<u>Asian clam (common)</u>				

This location had been sampled by the American Malacological Union in 1972 at which time unionids were much more abundant and Asian clams were not present (C.E. Boone, Houston Museum of Natural History; pers. comm.). The Texas lilliputs taken here were atypically large, heavy, and rounded (they could easily have been mistaken for southern hickorynut); however, subsequent electrophoretic analysis at HOH was unable to genetically differentiate them from other Texas lilliputs taken elsewhere in Texas.

Addicks Reservoir, stream immediately upstream of the spillway, Harris County, 1 June 1994:

Wading and snorkeling produced neither unionids or Asian clams. Periodic dewatering and accumulation of silt and sand likely prevent establishment of bivalves here.

Bear Creek from the Addicks Reservoir spillway to about 300 km downstream, Harris County, two dates:

1 June 1994: Briefly wading this area to confirm the presence of unionids prior to the more-detailed 14 July 1995 survey produced:

Bear Creek: downstream of Addicks Dam				
Species	N live	N shell	Condition	Percent
Round pearlshell	1	2.0	recent	12.5
Yellow sandshell	1	1.5	recent	12.5
Southern mapleleaf	15	1.5	recent	70.8
Western pimpleback	1	0.0	-	4.2
<u>Asian clam (abundant)</u>				

14 July 1994: On this date, about 30 malacologists attending an American Malacological Union Meeting in Houston assisted in a more-detailed survey of the area with the following results:

Bear Creek: downstream of Addicks Dam				
Species	N live	N shell	Condition	Percent
Giant floater	2	0.0	-	0.6
Paper pondshell	3	1.0	recent	1.2
Round pearlshell	73	12.0	recent	25.4
Yellow sandshell	8	10.5	recent	5.7
Southern mapleleaf	193	20.0	recent	63.6
Western pimpleback	3	1.0	recent	1.2

Texas lilliput	2	0.5	recent	0.9
Tapered pondhorn	4	1.0	recent	1.5
<u>Asian clam (abundant)</u>				

Brazos River Drainage

South (Old) Anson Lake (Brazos River Drainage), Jones County, 14 February 1994:

Shoreline examination produced only a single pair of recently-dead Tampico pearlymussel valves.

Fort Phantom Hill Reservoir (Brazos River Drainage), Jones County, 14 February 1994:

Collections taken on exposed bottom areas during a low-water period yielded:

Fort Phantom Hill Reservoir				
Species	N live	N shell	Condition	Percent
Giant floater	0	18.0 + 0.5 x 2	relatively recent	30.6
Paper pondshell	0	6.0 + 0.5 x 2	relatively recent	19.4
Tampico pearlymussel	0	3.0 + 0.5 x 17	relatively recent	33.3
Southern mapleleaf	0	1.0	relatively recent	2.8
Fragile papershell	0	3.0	relatively recent	8.3
Bleufer	0	0.5 x 2	subfossil	5.6
<u>Asian clam (abundant)</u>				

Lake Kirby (Brazos River Drainage), Taylor County, 17 February 1994:

Collections taken on exposed bottom areas during a low-water period yielded:

Lake Kirby				
Species	N live	N shell	Condition	Percent
Giant floater	0	22.5	very recent	27.7
Tampico pearlymussel	0	6.0 + 0.5 x 13	relatively recent	22.9
Southern mapleleaf	0	8.0 + 0.5 x 33	relatively recent	49.4
<u>Asian clam (very abundant)</u>				

David Lake (Brazos River Drainage), Stephens County, 16 June 1994:

Wading and snorkeling in the upper end of this impoundment yielded no bivalves, but a second site near the dam produced the following unionids:

Lake Kirby				
Species	N live	N shell	Condition	Percent
Giant floater	0	2.0	relatively recent	40.0
Paper pondshell	0	1.0	relatively recent	20.0
Tampico pearlymussel	0	0.5	relatively recent	20.0
Lilliput	0	0.5	relatively recent	20.0
<u>Asian clam (present)</u>				

Hubbard Creek downstream of Hubbard Creek Reservoir (Brazos River Drainage),
 Stephens County, 16 June 1994:
 Wading and snorkeling this stream yielded:

Hubbard Creek				
Species	N live	N shell	Condition	Percent
Giant floater	1	0.0	-	11.1
Paper pondshell	0	1.0	recent	11.1
Yellow sandshell	0	4.0	recent to long dead	44.4
Bleufer	0	2.0	long dead	22.2
Lilliput	0	0.5	relatively recent	11.1
Asian clam (present)				

Clear Fork Brazos River at Fort Griffin, Shackleford County, 8 August 1994:
 Fishery management biologists working in the area reported accumulations
 of dead unionid shells on the river bottom in this area and obtained the
 following examples:

Clear Fork Brazos River: Fort Griffin				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	1.0	recent	16.7
Tampico pearlymussel	0	4.0	recent to long dead	66.7
Pink papershell	0	1.0	relatively recent	16.7

Clear Fork Brazos River (two sites), Stephens County, 16 June 1994:
 Wading and snorkeling these sites produced (sites combined):

Clear Fork Brazos River: Stephens County				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	11.5	recent to long dead	38.7
Yellow sandshell	0	6.0	recent to long dead	19.4
Fragile papershell	3	7.0	relatively recent	22.6
Pink papershell	0	1.5	recent	6.5
Bleufer	0	0.5	long dead	3.2
Southern mapleleaf	0	1.0	relatively recent	3.2
Texas fawnsfoot	0	2.0	very recent	6.5

This was the first collection of Texas fawnsfoot since TPWD survey work
 began in 1992; two other recently-dead shells were found by J.A.M.
 Bergman (Boerne, Texas; pers. comm.) several weeks earlier in this area.
 Although it appears extremely rare, the good condition of these shells
 suggests at least a small number of living individuals may still
 survive.

Small impoundment on North Elm Creek northeast of Temple, Falls County, 26
 January 1994:

Shoreline collections made by a volunteer here produced a single pair
 relatively-recently dead valves from one of the pondhorns (sp.).

Pond on tributary of Possum Creek off Farm to Market Road 3369, Bell County,
 17 September 1994:

A volunteer examined this site during a drought-related drop in water level. Only Asian clams were found in deep, black clay, mud, and silt.

Pecan Branch off Elm Creek, Bell County, 5 September 1994:
Shoreline collections by a volunteer produced:

Pecan Branch off Elm Creek: Bell County				
Species	N live	N shell	Condition	Percent
Pondhorn sp.	1	2.0 + 0.5 x 3	recent	100.0

North Elm Creek, Falls and Bell counties, 8 August 1994:
Shoreline collection made by a volunteer here produced:

North Elm Creek: Falls and Bell counties				
Species	N live	N shell	Condition	Percent
Pondhorn sp. (probably tapered pondhorn)	1	16.5	recent	100.0

Pond Creek, Falls County, 10 August 1994:
Shoreline collections made by a volunteer here produced:

Pond Creek: Falls County				
Species	N live	N shell	Condition	Percent
Tapered pondhorn	0	16.5	relatively recent	100.0

Brazos River just upstream of Waco (two sites), McClellan County, 15-17 August 1994:
Sand- and gravel-bar collections here produced only one long-dead Tampico pearlymussel shell and several Asian clams.

Brazos River downstream of State Highway 340, McClellan County, 9-12 August 1994:
Sand- and gravel-bar collections produced:

Brazos River: downstream of SH 340				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	1.0 + 0.5 x 3	long dead	40.0
Yellow sandshell	0	0.5	long dead	10.0
Bleufer	0	0.5	relatively recent	10.0
Southern mapleleaf	0	1.0 + 0.5 x 2	long dead	30.0
Texas fawnsfoot	0	0.5	long dead	10.0
Asian clam (present)				

Brazos River near sewage treatment plant at Waco, McClellan County, 9-12 August 1994:
Sand- and gravel-bar collections produced:

Brazos River: near Waco sewage treatment plant				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	0.5 x 2	long dead	28.6
Yellow sandshell	0	0.5	subfossil	14.3
Fragile papershell	0	1.0	recent	14.3

Pink papershell	0	0.5	recent	14.3
Southern mapleleaf	0	1.0	long dead	14.3
Smooth pimpleback	0	0.5	long dead	14.3
<u>Asian clam (present)</u>				

Brazos River downstream of low-water dam near Baylor, McClellan County, 9-12 August 1994:

Sand- and gravel-bar collections produced:

Brazos River: downstream of low-water dam near Baylor				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	0.5 x 4	long dead	40.0
Yellow sandshell	0	2.0	long dead	20.0
Fragile papershell	0	1.0	long dead	10.0
Pink papershell	0	1.0	long dead	10.0
Pistolgrip	0	0.5	long dead	10.0
Unidentified fragment	0	0.5	long dead	10.0
<u>Asian clam (present)</u>				

Brazos River near Marlin, Falls County, 9-12 August 1994:

Sand- and gravel-bar collections produced:

Brazos River: near Marlin				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	1.0	recent	25.0
Tampico pearlymussel	0	0.5	subfossil	25.0
Pink papershell	0	1.0	recent	25.0
Pistolgrip	0	0.5	subfossil	25.0
<u>Asian clam (present)</u>				

Impoundment on the headwaters of Indian Hollow Creek south of Buckholts, Milam County, 15 October 1994:

Shoreline examination by a volunteer produced:

Impoundment - Indian Hollow Creek				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	7.0	relatively recent	58.3
Pondhorn sp.	0	5.0	relatively recent	41.7
<u>Asian clam (present)</u>				

Brazos River near the mouth of Little River, Milam and Robertson counties, 3 August 1994:

Sand- and gravel-bar collections produced:

Brazos River: near mouth of Little River				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.5	long dead	22.2
Tampico pearlymussel	0	0.5	long dead	11.1
Yellow sandshell	0	2.5	relatively recent	33.3
Fragile papershell	0	0.5	long dead	11.1
Bleufer	0	0.5	long dead	11.1
Smooth pimpleback	0	0.5	long dead	11.1

Sandy Creek unmarked farm road south of Calvert (Little Brazos River Drainage), Robertson County, 21-22 June 1994:
Wade sampling at this site yielded:

Sandy Creek: south of Calvert				
Species	N live	N shell	Condition	Percent
Threeridge	6	0.0	-	24.0
Giant floater	0	0.5	relatively recent	4.0
Yellow sandshell	0	0.5	relatively recent	4.0
Southern mapleleaf	9	0.0	-	36.0
Smooth pimpleback	6	1.0	relatively recent	28.0
Lilliput	0	1.0	relatively recent	4.0

Sandy Creek west-southwest of Calvert (Little Brazos River Drainage), Robertson County, 21-22 June 1994:
Little water was present in Sandy Creek and it was very narrow in the area; no bivalves were found.

Little Brazos River upstream of Calvert, Robertson County, 21-22 June 1994;
Wade sampling at this site produced only two living southern mapleleaves.

Little Brazos River at several sites upstream from State Highway 979 northwest of Calvert, Robertson County, 21-22 June 1994:
The stream appeared intermittent in this area and no bivalves were found.

Little Brazos River at State Highway 979 west of Calvert, Robertson County, 21-22 June 1994:
When examined this site was found to contain only a hard clay bottom without good mussel habitat; no unionids were found.

Little Brazos River at State Highway 1644 south of Calvert, Robertson County, 21-22 June 1994:
Wade sampling at this site yielded:

Little Brazos River: at SH 1644				
Species	N live	N shell	Condition	Percent
Giant floater	1	0.0	-	11.1
Washboard	3	1.0	relatively recent	44.4
Southern mapleleaf	3	0.0	-	33.3
Pistolgrip	0	1.0	relatively recent	11.1

An extensive mussel kill observed downstream in August 1993 (Howells In Press) at a location where a large, diverse assemblage of unionids existed in 1992 (Howells 1994) may have originated at this site. During this survey, 5-gallon buckets and lids from 55-gallon drums in conjunction with other trash were found here suggesting some toxic materials may have been dumped and contributed to the die-off seen earlier downstream.

Little Brazos River at U.S. Highway 79 west of Hearne, Robertson County, 21-22 June 1994:

The following species were collected by wading:

Little Brazos River: at USH 79				
Species	N live	N shell	Condition	Percent
Threeridge	13	0.0	-	26.0
Washboard	4	0.0	-	8.0
Bleufer	0	1.0	long dead	2.0
Southern mapleleaf	29	0.0	-	58.0
Smooth pimpleback	0	1.0	relatively recent	2.0
Pistolgrip	0	2.0	long dead	4.0

When this site was examined in 1992 (Howells 1994), large numbers of unionids were present; however, when revisited in August 1993 (Howells In Press), it was apparent massive mortalities had occurred since the 1992 survey. Dead shell was abundant, but very few live bivalves of any species remained. This 1994 reexamination of the site indicated although initial mortalities were massive, more unionids actually survived in the area than first thought.

Brazos River near the mouth of the Little Brazos River, Burleson and Brazos counties, 26 July and 3 August 1994:
Sand- and gravel-bar collections produced (dates combined)

Brazos River: near mouth of Little Brazos River				
Species	N live	N shell	Condition	Percent
Threeridge	0	7.5	relatively recent	16.7
Tampico pearlymussel	0	2.5	relatively recent	6.3
Yellow sandshell	0	4.5	recent	10.4
Fragile papershell	0	3.0	recent	6.3
Pink papershell	0	22.0	recent	45.8
Bleufer	0	1.0	relatively recent	2.1
Texas fawnsfoot	0	4.0 + 0.5 x 2	recent	12.5

Lake Georgetown (San Gabriel River drainage), Williamson County, 19 April 1994:

A brief shoreline examination produced one live and two very recently-dead paper pondshells, one recently-dead Texas lilliput, and abundant Asian clams.

Lake Limestone (Navasota River Drainage) at a park on the southeast corner of the reservoir (Leon County) and a marina on the westcentral shore (Limestone County), 21-22 June 1994:

Wading shore-zone areas produced only a single southern mapleleaf shell, one valve from Texas lilliput, and fragments from Tampico pearlymussel or bleufer, all of which were relatively-recently dead.

Duck Creek downstream of Twin Oak Reservoir (Navasota River Drainage) at State Highways 797 and 2096 and U.S Highway 79, Robertson County, 21-22 June 1994:

The creek at all three sites was narrow, filled with silt, and no unionids were found.

Navasota River at U.S. Highway 79, Robertson and Leon counties, 21-22 June 1994:

Steep sand and mud banks in conjunction with fast-water conditions prevented sampling during this attempt.

Normangee Park Lake (Navasota River Drainage), Leon County, 21-22 June 1994:

This impoundment was completely choked with vegetation without open bottom areas; no bivalves were found.

Brazos River ca. 2 km north of Koppe Creek Bridge Road, Brazos and Burleson counties, 30 August 1994:

Sand- and gravel-bar collections produced (dates combined)

Brazos River: Brazos and Burleson counties				
Species	N live	N shell	Condition	Percent
Threeridge	0	2.0 + 0.5 x 3	recent to long dead	9.6
Tampico pearlymussel	0	0.5 x 2	long dead to subfossil	3.8
Yellow sandshell	0	1.0 + 0.5 x 2	recent to long dead	5.8
Fragile papershell	0	4.0	recent	7.7
Pink papershell	0	5.0	recent	9.6
Bleufer	0	0.5 x 3	long dead	5.8
Southern mapleleaf	0	0.5 x 4	long dead to subfossil	7.7
Smooth pimpleback	0	6.0 + 0.5 x 7	recent to subfossil	25.0
Texas fawnsfoot	0	13.0	recent	25.0
Unidentified fragments	0	2.0	-	-
<u>Asian clam (present)</u>				

Oxbow lakes adjacent to the lower-central Brazos River; Waller, Washington, Burleson, and Brazos counties; several dates:

Specimens were collected at several locations in oxbow lakes adjacent to the Brazos River by Dr. Kirk Winemiller, Texas A&M University, and sent to HOH for identification.

Garrett Lake, Waller County, 14 August 1994:

Garrett Lake: Walker County				
Species	N live	N shell	Condition	Percent
Giant floater	0	0.5 x 20	recent	-
Paper pondshell	0	0.5 x 14	recent	-
Yellow sandshell	0	1.0	recent	-
Fragile papershell	1	1.5	recent	-
Pondhorn sp.	0	4.0	recent	-

Korthaus Bottom, Washington County, 1 September 1994:

Korthaus Bottom: Washington County				
Species	N live	N shell	Condition	Percent
Giant floater	0	0.5 x 31	recent	-
Paper pondshell	0	0.5	relatively recent	-

Siegerts Oxbow, Burleson County, 12 October 1994:

Brazos River: Brazos and Burleson counties				
Species	N live	N shell	Condition	Percent
Giant floater	0	0.5 x 31	recent	-

Mexican Bend Oxbow, Waller County, 27 July 1994:

Mexican Bend Oxbow: Walker County				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	1.0	relatively recent	-

Brazos River at State Highway 21, Brazos County, 9 November 1994:

Bivalve collections made by Dr. Kirk Winemiller, Texas A&M University, and sent to HOH for identification included only Asian clams (three living and two unmatched valves).

Brazos River near mouth of the Navasota River, Grimes and Washington counties, 30 August 1994:

Sand- and gravel-bar collections produced:

Brazos River: Brazos and Burleson counties				
Species	N live	N shell	Condition	Percent
Threeridge	0	4.0 + 0.5 x 8	recent to subfossil	13.3
Rock-pocketbook	0	0.5	relatively long dead	1.1
Tampico pearlymussel	0	2.0 + 0.5 x 11	long dead to subfossil	14.4
Yellow sandshell	0	8.0 + 0.5 x 7	recent to subfossil	16.7
Fragile papershell	0	0.5 x 15	recent to long dead	16.7
Pink papershell	0	4.0 + 0.5 x 8	recent to long dead	13.3
Bleufer	0	0.5	subfossil	1.1
Southern mapleleaf	0	0.5 x 6	long dead to subfossil	6.7
Smooth pimpleback	0	0.5 x 6	recent to subfossil	6.7
Texas fawnsfoot	0	8.5	recent	10.0
Asian clam (present)				

Flat Bank Creek at State Highway 6, Harris County, 2 June 1994:

Wade sampling this creek produced:

Flat Bank Creek				
Species	N live	N shell	Condition	Percent
Texas lilliput	1	3.5	recent	83.3
Pondhorn sp.	1	0.0	-	16.7

An apparent abundance and diversity of unionids at this site in the 1970s (C.E. Boone, Houston Museum of Natural History; pers. comm.) appears to have been displaced by scouring and heavy silt and mud deposition. This pondhorn and another collected several weeks earlier by C.E. Boone were unusual. Both were strongly tapered posteriorly, but externally were pale yellow in color and subglossy (inconsistent with either pondhorn or tapered pondhorn). Subsequent electrophoretic

electrophoretic analysis at HOH has thus far failed to assist in assigning it to a specific species.

Colorado River Drainage

Old (Upper) Ballinger City Reservoir (Valley Creek Drainage), Runnels County, 23 March 1994:

Several Asian clam valves were the only bivalves taken; however, residents reported "freshwater oysters" were occasionally found between the dam and a tributary on the west side of the reservoir.

New (Lower) Ballinger City Reservoir (Valley Creek Drainage), Runnels County, 23 March 1994:

Limited numbers of Asian clam valves were located but no unionids were found. Local residents reported southern mapleleaves and other species as occasional in deeper water. Rocky shorelines provided generally poor habitat for unionids.

Valley Creek (Colorado River Drainage), downstream of New Ballinger City Reservoir, Runnels County, 23 March 1994:

No bivalves were found. This area may become dry when water flow from the reservoir upstream is stopped during drought periods.

Colorado River tributary stream upstream of Ballinger Country Club Lake, Runnels County, 23 March 1994:

This proved to be an intermittent, pasture-land stream; no bivalves were present.

Elm Creek at U.S. Highway 83 upstream of Elm Creek Lake (Colorado River Drainage), Runnels County, 23 March 1994:

Tampico pearlymussel and Asian clam valves (both recently dead) were common on the flood plain at this site, but steep banks and high, cold waters prevented sampling when examined. This location displayed signs of excessive run-off damage and scouring.

Elm Creek, second crossing upstream of Elm Creek Lake (Colorado River Drainage), Runnels County, two dates:

23 March 1994 - Tampico pearlymussel (five live and one recent shell) and Asian clams were the only unionids found; however, high, cold waters prevented all but the most superficial sampling. Previous collections at this location in 1993 (Howells In Press) yielded Texas fatmucket and several other species. Living Texas fatmuckets and Texas pimpleback as well as several other unionids had been found alive only at this location in 1993. Unfortunately there were numerous signs of severe scouring (e.g., extensive piles of sand and gravel, trash and fencing up to 6 m above normal river level in tree branches, etc.). The continued security of the Texas fatmucket and Texas pimplebacks here seems in doubt.

9 August 1994 - A second attempt to resurvey this site was again confounded by a sudden, local storm and high-water conditions. However, the following specimens were found:

Elm Creek: second crossing upstream of Elm Creek Lake				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	3	many	relatively recent	-
Texas fatmucket	0	1.5	relatively recent	-
Yellow sandshell	0	fragments	relatively recent	-
Southern mapleleaf	0	many	relatively recent	-
Texas pimpleback	0	1.5	relatively recent	-
<u>Asian clams (present)</u>				

Colorado River tributaries from Menard (Menard County) north to Eden (Concho County) and east to Melvin (McCulloch County), 31 July 1994:

Road crossings on streams in this area were found to be dry, or nearly so, and have signs of major scouring during heavy rains except at Kelly-Hardin Creek near Eden (not sampled) and Saddle Creek (Menard County) where two long-dead lilliput shells and one long-dead pondhorn sp. valve were found.

Middle Concho River at State Highway 2355, Tom Green County, 30 August 1994:
Examination of this area during a low-water period produced:

Middle Concho River: SH 2355				
Species	N live	N shell	Condition	Percent
Southern mapleleaf	0	2.5	very recent	13.0
Bleufer	15	4.5	very recent	87.0

Twin Buttes Reservoir (Concho River Drainage), Tom Green County, 30 August 1994:

Examination of this reservoir during a draw-down for dam repair produced:

Twin Buttes Reservoir				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	4	21.5	very recent	65.0
Southern mapleleaf	2	4.5	very recent	17.5
Bleufer	4	2.5	very recent	17.5

Field personnel from HOH who surveyed this site reported numerous recent tracks left in the exposed reservoir bottom by musselers who walked the water line, picked up and opened, then discarded countless unionids (typically Tampico pearlymussels and bluefers) after searching for pearls. Most of the shells collected contained very fresh tissue. Several specimens had large blemishes on the nacre suggesting one or more large pearls had been present when the animal was killed.

North Concho River at O.C. Fisher Reservoir, Tom Green County, 27 January 1994:

Shoreline collections found only recent shells of paper pondshell.

O.C. Fisher Reservoir (Concho River Drainage), Tom Green County, two dates:

26 January 1994 - Shoreline collections in the Potts Creek area produced shells from the following species:

O.C. Fisher Reservoir

<u>Species</u>	<u>N live</u>	<u>N shell</u>	<u>Condition</u>	<u>Percent</u>
Giant floater	0	0.5	relatively recent	16.7
Paper pondshell	0	2.0 + 0.5 x 2	relatively recent	66.7
Tampico pearlymussel	0	0.5	relatively recent	16.7

21 July 1994 - Collections made by wading, snorkel, and hookah pump diving produced the following specimens from three locations around the reservoir:

O.C. Fisher Reservoir

<u>Species</u>	<u>N live</u>	<u>N shell</u>	<u>Condition</u>	<u>Percent</u>
Giant floater	0	1.5	long dead	33.3
Paper pondshell	0	fragments	relatively recent	-
Tampico pearlymussel	2	2.0	long dead	66.7
Asian clam (present)				

North Concho River at 29th Street Bridge, San Angelo, Tom Green County, 26 January 1994:

A single relatively-recent Tampico pearlymussel valve was taken during shoreline examination of this area.

Nasworthy Reservoir (Concho River Drainage), three sites, Tom Green County, 21 July 1994:

Collections made by wading, snorkel, and hookah pump diving produced the following specimens:

Nasworthy Reservoir

<u>Species</u>	<u>N live</u>	<u>N shell</u>	<u>Condition</u>	<u>Percent</u>
Giant floater	1	0.0	-	0.9
Tampico pearlymussel	14	1.0	relatively recent	14.2
Bleufer	1	1.0	relatively recent	1.9
Southern mapleleaf	85	3.0	relatively recent	83.0
Asian clam (present)				

This reservoir contained significant unionid populations when examined in 1992 (Howells 1994), but experienced a significant drawdown in 1993 for maintenance and repair work. With the reservoir now refilled, the unionid populations appeared to have survived the dewatering experience reasonably well. Juveniles and adults were present for all of the species found.

Concho River at State Highway 281 WSW of Ballinger, Runnels County, 23 March 1994:

Only a few Asian clam shells were located on banks and washes. No unionids were found.

Kickapoo Creek west of Paint Rock (Concho River Drainage), Concho County, 10 October 1994:

During a brief survey of the creek shoreline, a bulldozed area was found to have uncovered subfossil shells of threeridges. This species has not

been taken by TPWD in surveys of the adjacent areas of the Concho River but it apparently occurred in this area at one time (Strecker 1931).

Concho River mussel sanctuary upstream from Paint Rock at Indian Pictographs landing, Concho County, 8 August 1994:

Wading and snorkeling at this location produced:

Concho River: at Indian Pictographs upstream of Paint Rock				Percent
Species	N live	N shell	Condition	live
Fragile papershell	4+	present	relatively recent	6.0
Bleufer	3	present	relatively recent	4.5
Southern mapleleaf	32	present	relatively recent	47.8
Texas pimpleback	28	2.5	relatively recent	41.8
<u>Asian clam (very abundant)</u>				

The only living Texas pimplebacks found during TPWD surveys included one specimen located just upstream from this location, one from Elm Creek (Runnels County), and 12 specimens found here in 1993 (Howells In Press). During survey work at this site in 1993, it took two biologists two hours to locate 12 specimens (TPWD; unpublished data); however, during this collection, two biologists located 28 living specimens in about 45 minutes, suggesting more living specimens than initially thought in 1993. This remains the only location where more than a single living specimen was found by TPWD. Densities of Asian clams in 1993 exceeded 2,000/m² (Howells In Press) and appeared to be similarly abundant in 1994.

Brady City Park Lake at Richards Park (Brady Creek Drainage), McCulloch County, two dates:

5 May 1994 - Shoreline collections located 10 shells of paper pondshells and additional fragments deposited on the banks by predators.

This was the only species found here during more-detailed surveys in 1993.

14 September 1994 - shoreline collections produced:

Brady City Park Lake				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	0.5 x 9	recent	81.8
Texas lilliput	0	1.5	recent	18.2

Colorado River between U.S. Highway 90 and State Highway 580, Mills and San Saba counties, 24 August 1994:

Shells collected on banks and gravel bars and sent to HOH for identification by a local game warden included:

Colorado River: between USH 90 and SH 580				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	2.5	very long dead	37.5
Fragile papershell	0	1.0	recent	12.5
Bleufer	0	3.0	very long dead	37.5
Southern mapleleaf	0	0.5	very long dead	12.5
<u>Asian clam (present)</u>				

Buck Lake, Llano River State Park (Llano River Drainage), Kimble County, 9 June 1994:

Two recently-dead paper pondshells were found during fish survey work at this site. Previous TPWD survey efforts throughout the Llano River in 1992 and 1993 failed to find living unionids of any kind (Howells 1994; In Press). This represents the first recent record of possible living specimens in the system.

San Saba River at County Road 2092 west of Menard, Menard County, 8 August 1994:

Examination of this site found heavy cobble and signs of significant scouring during floods. Only three subfossil valves of threeridge were present.

San Saba River downstream of dam at city park west of Menard, Menard County, 8 August 1994:

This site contained only heavy cobble with significant signs of scouring during floods. Only a few Asian clam valves were located.

Colorado River from first rapids downstream of Colorado Bend State Park to Lake Buchanan; San Saba, Llano, and Burnet counties, 5 May 1994: Wading and snorkeling located the following species:

Colorado River: downstream of Colorado Bend State Park				
Species	N live	N shell	Condition	Percent
Giant floater	1	15.0	relatively recent	18.0
Paper pondshell	0	3.0	relatively recent	3.4
Tampico pearlymussel	2	30.0	recent to long dead	36.0
Fragile papershell	0	18.5	recent to long dead	21.3
Bleufer	2	2.5	relatively recent	6.7
Southern mapleleaf	3	8.5	relatively recent	13.5
Unidentified juvenile	0	0.5	long dead	1.1

Lake Buchanan, Llano and Burnet counties, sampled on several dates: Upper reaches, 1 May 1994: Wading shore-zone areas produced:

Lake Buchanan: upper reaches				
Species	N live	N shell	Condition	Percent
Threeridge	1	2.0	recent to very recent	11.5
Giant floater	0	2.0	recent to very recent	7.7
Tampico pearlymussel	3	5.0	recent to very recent	30.8
Fragile papershell	0	1.0	recent to very recent	3.8
Bleufer	0	5.0	recent	19.2
Southern mapleleaf	2	4.0	recent	23.1
Pistolgrip	1	0.0	-	3.8

Nearly all shells collected were recently dead. Reservoir levels were very low in early 1992 but heavy rains that spring elevated levels ca. 30 m by July 1992. Living unionids were too deep to easily sample in 1992, but by August 1993 many, especially younger individuals and more active species, had crawled upward to the shore-zone area. Throughout 1994 water levels began to decline again prompting several trips to the

reservoir as new areas became accessible. The pistolgrip taken alive here represented the only living specimen found by TPWD west of the Neches River 1992-1994 during sampling.

Upper reaches (Breezy Point and Garrett Island), 5 May 1994: Wading and snorkeling yielded the following specimens:

Lake Buchanan: upper reaches				
Species	N live	N shell	Condition	Percent
Threeridge	10	6.0	recent to relatively recent	9.2
Giant floater	7	9.0	recent to relatively recent	9.2
Paper pondshell	0	8.0	recent to relatively recent	4.6
Tampico pearlymussel	27	37.0	recent to relatively recent	37.0
Fragile papershell	0	10.0	recent to relatively recent	5.8
Bleufer	2	1.5	recent to relatively recent	2.9
Southern mapleleaf	28	25.5	recent to relatively recent	31.2

This return trip to Lake Buchanan specifically sought other pistolgrip specimens, but none were located. The number of dead shells found in both May collections reflects mortalities associated with falling water levels and stranding.

Inks Lake (Colorado River Drainage), Llano and Burnet counties, 14 September 1994:

Brief shoreline collections produced:

Inks Lake				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	long dead	12.5
Giant floater	0	2.0 + 0.5 x 3	recent	62.5
Southern mapleleaf	0	1.5	recent	25.0

Creeks along the Blanco and Burnet County line (Colorado and Pedernales River tributaries) at U.S. Highway 281 and State Highway 962, 71, and 12, 21 August 1994:

Examination of these sites found all to be either intermittent or subject to intense scouring during floods. No bivalves were found.

Lake Travis (Colorado River Drainage), Travis County, 14-16 September 1994:

Brief shoreline collections produced:

Lake Travis				
Species	N live	N shell	Condition	Percent
Giant floater	0	0.5	relatively recent	33.3
Tampico pearlymussel	0	1.0	relatively recent	33.3
Southern mapleleaf	0	0.5	long dead	33.3

Because this reservoir is very rocky and undergoes significant water level fluctuations, most unionids are likely confined to deeper-water areas with acceptable substrates. Shoreline collections are not likely representative of the abundance or diversity of the local mussel populations.

Private impoundment 4.8 km north of Giddings (Colorado River Drainage), Lee County, 20 September 1994:
Brief shoreline collections produced:

Private pond: 4.8 km north of Giddings				
Species	N live	N shell	Condition	Percent
Texas lilliput	0	1.0	relatively recent	33.3
Tapered pondhorn	0	2.0	relatively recent	66.7

Turkey Creek (Colorado River Drainage), Williamson County, 7 August 1994:
Examination of this nearly-dry stream bed found only two long-dead valves from pondhorn sp. and one Asian clam.

Lake Winedale (Colorado River Drainage), Fayette County, 2 April 1994:
Shoreline sampling produced no bivalves. Interviews with local residents revealed none had historically seen bivalves in the reservoir.

Eagle Lake at the Lower Colorado River Authority pumping station intake canal, Colorado County, 1 June 1994:
Wading and snorkeling produced:

Eagle Lake				
Species	N live	N shell	Condition	Percent
Threeridge	0	1.0	relatively recent	2.6
Giant floater	2	5.0	recent	17.9
Paper pondshell	0	1.0	relatively recent	2.6
Tampico pearlymussel	1	3.5	relatively recent	12.8
Yellow sandshell	2	18.0	recent to long dead	51.3
Fragile papershell	0	3.0	relatively recent	7.7
Texas lilliput	1	1.0	recent	5.1
Asian clam (only one living individual)				

Lampasas River at Bowmer Ranch, Bell County, 20 August 1994:
Shoreline collections made by a volunteer included:

Lampasas River at Bowmer Ranch				
Species	N live	N shell	Condition	Percent
Threeridge	0	8.0	recent to long dead	34.8
Tampico pearlymussel	0	1.5	recent to long dead	8.7
Louisiana fatmucket	0	2.5	recent to long dead	13.0
Southern pimpleback	0	1.5	recent to long dead	8.7
Pistolgrip	0	8.0	recent to long dead	34.8
Asian clam (abundant)				

Lake Granger (San Gabriel River Drainage), Williamson County, 25 1994:
Shoreline examination of several sites on this impoundment by a volunteer produced only Asian clam and its shells.

Guadalupe River Drainage

Dietert Creek (Guadalupe River Drainage) upstream of State Highway 27, Kerr County, 27 June 1994:

Shore-zone wading here produced 12.5 recently-dead shells of Texas lilliput. Previous collections of a single Texas lilliput upstream at Hunt and several paper pondshells just upstream of Ingram Dam have been the only living or recently-dead unionids found in the upper Guadalupe River during TPWD surveys. In general, only subfossil shell remains.

Turtle Creek (Guadalupe River Drainage) at Lower Turtle Creek Road, Kerr County, 24 April 1994:

Shoreline examination of low-water crossings in this area revealed only a small number of Asian clam valves.

Lions Camp Pond (Guadalupe River Drainage), Kerr County, 27 January 1994:

Shoreline examination produced a single long-dead valve of Texas lilliput.

Guadalupe River, first low-water crossing upstream of Comfort, Kerr County, 27 June 1994:

This area contained heavy rock and cobble deposits with signs of extensive scouring; no bivalves were found.

Geronimo Creek at State Highway 90 at Seguin, Guadalupe County, 2 June 1994:

Wading and snorkeling at this site produced only two unidentified unionid shell fragments and several Asian clam valves. Because the Guadalupe River just downstream once contained false spike, which has not been found alive or recently dead anywhere during TPWD surveys, and much of the Guadalupe River had itself been badly scoured by floods, this site was examined as a possible place false spike may still survive. However, the stream had steep banks and signs of severe scouring with a heavy cobble bottom and signs of flood damage 5 m above normal water levels. It appears U.S. Highway 10 just upstream contributes large amounts of water during heavy rainfall. Large unionid populations would not be expected to endure here.

Guadalupe River from ca. 4 km upstream of Victoria to Victoria City Park, Victoria County, 18 April 1994:

Brail sampling produced only abundant Asian clams in this area. However, wading, snorkeling, and examination of gravel-bar deposits produced:

Guadalupe River: upstream of Victoria				
Species	N live	N shell	Condition	Percent
Threeridge	0	fragments	long dead	-
Threeridge	0	0.5	relatively recent	-
Yellow sandshell	1	0.5 x 3	long dead	-
Yellow sandshell	0	0.5 x 3	recent	-
Washboard	0	fragments + 0.5	long dead	-
Southern mapleleaf	0	fragments	very long dead	-

A number of very-recently dead paper pondshell valves were found. They appeared to have been killed by a predator the night before.

Frio River at Tilden, McMullen County, several dates:

4 April and 20 May 1994 - Flood waters prevented sampling on both dates.

26 July 1994 - Wading and snorkeling areas both up- and downstream from this crossing produced:

Frio River: at Tilden				
Species	N live	N shell	Condition	Percent
Giant floater	0	2.5	long dead	7.5
Tampico pearlymussel	0	12.0	long dead	30.0
Yellow sandshell	0	19.0	long dead	30.0
Washboard	0	0.5	long dead	2.5
Southern mapleleaf	0	2.5	long dead	7.5
Golden orb	0	8.5	long dead	22.5
<u>Asian clam (common to abundant)</u>				

Frio River at first boat ramp downstream of Tilden, McMullen County, two dates:

20 May 1994 - High waters limited access to wading and snorkeling shallow bank areas where one Tampico pearlymussel, two giant floaters, and abundant Asian clams (all alive) were found. This area accumulates extremely deep, soft mud and silt.

26 July 1994 - Wading, snorkeling, and hookah pump diving samples collected at this site yielded:

Frio River: downstream of Tilden				
Species	N live	N shell	Condition	Percent
Giant floater	1	0.0	-	2.1
Tampico pearlymussel	4	0.0	-	8.5
Yellow sandshell	4	2.0	recent	12.8
Southern mapleleaf	35	0.0	-	74.5
Golden orb	0	1.0	recent	2.1
<u>Asian clam (very abundant)</u>				

San Miguel Creek (Frio River Drainage) at State Highway 3445, McMullen County, two dates:

20 May 1994 - Wading and snorkeling produced:

San Miguel Creek				
Species	N live	N shell	Condition	Percent
Giant floater	4	2.0	very recent	75.0
Paper pondshell	0	1.0	very recent	12.5
Tampico pearlymussel	0	0.5	long dead	12.5
<u>Asian clam (abundant)</u>				

26 July 1994 - Wading and snorkeling produced:

San Miguel Creek				
Species	N live	N shell	Condition	Percent
Giant floater	11	0.0	-	30.6

Paper pondshell	8	3.0	relatively recent	30.6
Southern mapleleaf	9	1.0	recent	27.8
Texas lilliput	4	0.0	-	11.1
<u>Asian clam (common to abundant)</u>				

Choke Canyon Reservoir (Frio River Drainage), Live Oak and McMullen counties:

4 April 1994: Shoreline collections on the upper reaches of the reservoir produced 1 living and 4 recent shells of yellow sandshell in addition to those of Asian clams.

6 April 1994: Shoreline collections at several sites on the lower reaches of the reservoir near the dam yielded:

Choke Canyon Reservoir				
Species	N live	N shell	Condition	Percent
Giant floater	6	10.0	recent to relatively recent	10.1
Paper pondshell	3	25.0	recent to relatively recent	17.6
Tampico pearl mussel	9	46.5	recent to relatively recent	35.2
Yellow sandshell	7	38.5	recent to relatively recent	28.9
Texas lilliput	0	12.5	recent to relatively recent	8.2
<u>Asian clam (present)</u>				

Calliham State Park Lake, Live Oak County, 6 April 1994:

Casual shoreline examination here produced relatively-recent fragments of Texas lilliput and Asian clam valves.

Frio River immediately downstream of Choke Canyon Reservoir Dam, Live Oak County, 20 May 1994:

Wading and snorkeling a gravel riffle and clay-bottom pool revealed only a single living yellow sandshell and abundant Asian clams.

Frio River ca. 0.5 km upstream of State Highway 72, Live Oak County, 26 July 1994:

Attempts to wade and snorkel the river at this site were confounded by high water and fast flows from water releases at Choke Canyon Reservoir Dam upstream. Initial efforts produced only Asian clams and flow rates were considered too dangerous so additional sampling was aborted.

Frio River downstream of State Highway 72, downstream of small dam, Live Oak County, two dates:

20 May 1994 - High waters from the Atascosa River entering upstream of this site prevented safe access to the Frio River on this date. However, examination of a mud bar downstream produced fragments of giant floater, a single yellow sandshell shell, and abundant Asian clams.

26 July 1994 - This second attempt to sample this site was again thwarted by high, fast waters. On this occasion high-volume water release from Choke Canyon Reservoir Dam to maintain level at Lake Corpus Christi downstream was the source of the increased flow. Attempts to snorkel areas in the deep pool immediately downstream of the small dam produced only a limited number of Asian clams.

Lake Corpus Christi, east side at State Highway 888, Live Oak County, 30 August 1994:
Wading and snorkeling at this site produced:

Lake Corpus Christ				
Species	N live	N shell	Condition	Percent
Giant floater	5	0.0	-	13.5
Tampico pearlymussel	8	2.0	recent	27.0
Yellow sandshell	1	1.0	recent	5.4
Southern mapleleaf	0	8.5	relatively recent	24.3
Golden orb	4	5.0	recent	24.3
Bleufer	1	1.0	recent	5.4

This represented the first and only location where golden orb has been found alive during TPWD surveys 1992-1994 (Howells 1994; In Press). A malacologist examining this site in July found four living golden orbs here and subsequently sent specimens to HOH for identification. It previously appeared golden orb may have been a species of flowing waters which tends to decline when reservoirs are constructed. This may generally still be true because the Lake Corpus Christi site was a sandy bottom off a point subject to extensive agitation by prevailing winds (perhaps somewhat simulating stream conditions). No living golden orbs have been found by TPWD elsewhere in the reservoir.

Nueces River ca. 1 km downstream of Lake Corpus Christi Dam, Live Oak County, 30 August 1994:

Wading and snorkeling this site found a mixed mud, sand, and fine gravel bottom but only Asian clams and its shells were found. However, sampling efforts were confounded by deep waters and timber and other snags; a more-detailed examination with diving gear will be needed.

Rio Grande Drainage (Texas)

Amistad Reservoir near mouth of the Devils River (several sites at San Pedro Canyon and Long Point), Val Verde County, two dates:

25 May 1994 - Two long-dead valves of Tampico pearlymussel were obtained during a fish-collection trip at this reservoir.

12 December 1994 - Brief shoreline collections produced 2.0 + 0.5 x 2 long-dead to relatively-recent shells of bleufer.

20 December 1994 - Wading shallow waters and examining exposed shore-zones produced:

Amistad Reservoir				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	13	0.5 x 51	relatively recent to long dead	-
Bleufer	0	6.0	relatively recent to long dead	-

Bleufer has not been known to occur in the Rio Grande drainage. Previous reports of this species have been based on misidentified

Tampico pearlymussels (R.W. Neck, Houston Museum of Natural Science; pers. comm.). When the 12 December specimens were found and appeared to differ slightly from typical bleufers found elsewhere in Texas, a second crew returned to the area on 20 December in an effort to obtain additional shells and living specimens. A third visit to the site finally found three living specimens in January 1995. Tissue samples from two of these specimens were examined electrophoretically and could not be differentiated from tissue obtained from bleufers in Texas. This indicates bleufer does indeed occur in the Rio Grande. Previous work with fossil unionids at deposits just upstream by Metcalf (1982) did not find this species. Therefore, bleufer has either been extremely rare and not previously noted (construction of Amistad Reservoir may have provided an environmental advantage) or was introduced at some time in the past. Some of the shells obtained were larger, older specimens which must have been in the area for an extended period. A previous introduction of bleufers was found by TPWD in Lake Corpus Christi on the Nueces River where it likewise did not previously occur (Howells In Press). Minor morphological differences in Rio Grande specimens are apparently only ecophenotypic. Tampico pearlymussel valves in this collection were not arranged into matched pairs to provide an accurate count of the number of individuals.

Devils River at Satans Canyon and Rough Canyon, Val Verde County, 19 April 1994:

Shoreline collections produced one living and 16 very recently-dead paper pondshells; Asian clam was abundant.

Devils River upstream of Recreation Road 2, Val Verde County, 20 December 1994:

Wading shallow waters and examining exposed shorelines produced:

Devils River				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	0.5 x 4	relatively recent	33.3
Tampico pearlymussel	0	0.5 x 8	relatively recent	66.7

Lake Casa Blanca (Rio Grande Drainage), Webb County, two dates:

6 September 1994 - brief shoreline collections produced two Tampico pearlymussel valves and one southern mapleleaf shell, all relatively-recently dead.

5 October 1994 - wading and snorkeling shore-zone areas produced:

Lake Casa Blanca				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	3.0	recent	8.1
Tampico pearlymussel	1	9.0 + 0.5 x 2	relatively recent	32.4
Southern mapleleaf	0	20.5	recent	56.8
Lilliput	0	0.5	relatively recent	2.7
Asian clam (present)				

Rio Grande tributaries between Del Rio (Val Verde County) and Quemando (Maverick County), 19 April 1994:

San Felipe Creek, Val Verde County: Wade sampling indicated hard bottom. No bivalves were found.

Zorro Creek at U.S. Highway 277, Val Verde County: Examination of this site found the creek dry. No bivalves were found.

Sycamore and Mud creeks at U.S. highways 277 and 90, Val Verde and Kinney counties: The only water present in these stream when examined was a small pool at U.S. Highway 277. Only Asian clam was found.

Pinto Creek at U.S. Highway 277, Kinney County: Only a small pool was present near the bridge and the stream was otherwise dry. Asian clam was abundant.

Las Moras Creek at U.S. Highway 277 and State Highway 1908, Kinney and Maverick counties: Possible sampling sites were located but not surveyed due to lack of access. This stream previously held Texas hornshell, but which was reported extirpated from the area (Murray 1975). Sufficient flows remain suggesting some unionids may still persist here.

Falcon Reservoir at Falcon State Park, Zapata County, 22-23 March 1994:
Shoreline collections produced:

Falcon Reservoir				
Species	N live	N shell	Condition	Percent
Paper pondshell	0	1.0	relatively recent	5.6
Tampico pearlymussel	0	2.0 + 0.5 x 10	long dead	66.7
Southern mapleleaf	0	2.0 + 0.5 x 3	recent	27.8
<u>Asian clam (present)</u>				

Rio Grande from Falcon Reservoir Dam to about 24 km downstream, Starr County, 2 and 22-23 March 1994:

Rio Grande: downstream from Falcon Reservoir				
Species	N live	N shell	Condition	Percent
Tampico pearlymussel	0	14.0	subfossil	56.0
Yellow sandshell	0	0.5 x 5	subfossil	20.0
Washboard	0	1.0	very long dead	4.0
Southern mapleleaf	0	3.0 + 0.5 x 2	long dead	20.0
<u>Asian clam (very abundant)</u>				

Rio Grande Drainage (Mexico)

Rio Grande just downstream of the eastern boundary of Big Bend National Park, Chihuahua, Mexico, 25 July 1994:

A volunteer wade-sampling deep, silty shoreline areas found only a single relatively-recent valve from Tampico pearlymussel as well as valves from Asian clam.

Rio Papagochi downstream from Matachic, Chihuahua, Mexico, 10 August 1994:

Wading shallow areas and examining shorelines during fish-survey work in the area produced:

Rio Papagochi: downstream of Matachic				
Species	N live	N shell	Condition	Percent
Unidentified anodontid	0	0.5	long dead	12.5
Unidentified sphaeriid	6	1.0	recent	87.5

Rio Conchos near Julimes, Chihuahua, Mexico, 6 August 1994:

Wading shallow areas and examining shorelines during fish-survey work in the area produced:

Rio Conchos: near Julimes				
Species	N live	N shell	Condition	Percent
Unidentified unionid	0	0.5 x 10	long dead except one relatively recent	100.0

The exact identity of these specimens is undetermined at this time. Photographs taken by J.A.M. Bergmann (Boerne, Texas) of museum specimens from the Rio Conchos area include some specimens which are probably the species found here. However, museum labels included them under several scientific names (past authorities were apparently confused as well).

SPECIES SUMMARY

Over 3,000 unionid specimens were obtained during 1994 field surveys. This included a total of 39 species (about 76% of the species reported in Texas). A number of endemic or regional species were either found in limited abundance, at few localities, or were not found at all. Examples include:

- 1) Ouachita rock-pocketbook: Previously found as one recently-dead shell each from Pine and Sanders creeks, Lamar County, Texas. None were found in 1994.
- 2) Texas pigtoe: This species from eastern Texas and adjacent Louisiana was not found in 1992 or 1993, but several living individuals were obtained from the Sabine River in 1994.
- 3) Triangle pigtoe: This endemic pigtoe was not found in 1992 or 1993. Examinations of the type localities of Lanana and Bonita creeks in Nacogdoches County, Texas, found unionids to have been extirpated from most areas. However, several living specimens were found in the adjacent Attoyac Bayou drainage in 1994.
- 4) Texas fatmucket: A single population in Runnels County, Texas, remains the only location living individuals of this endemic species have been found by TPWD. Reexamination of this location in 1994 found scouring and associated flood damage apparently increasing in severity and threatening the continued security of this species.
- 5) Sandbank pocketbook: This lampsiliid from eastern Texas and adjacent Louisiana (and perhaps Arkansas) was found alive only once in 1993 and once in 1994 by TPWD. Some areas where it once occurred, no longer

support significant mussel populations. Plain pocketbook, a closely-related species, reaches its southwestern range limit in northeastern Texas but has not been taken by TPWD to date. It is apparently more common elsewhere.

- 6) Southern hickorynut: A single pair of valves from the Neches River downstream of B.A. Steinhagen Reservoir represents the only specimen taken by TPWD to date.
- 7) Louisiana pigtoe: This rare species from eastern Texas and adjacent Louisiana has not been found by TPWD to date. Strecker (1931) reported apparent extirpation from the type locality in the upper Trinity River drainage and locations in southeastern Texas where it had previously been reported were found to have lost most or all their unionid populations when examined by TPWD in 1994.
- 8) Texas hornshell: A single recently-dead specimen found by TPWD upstream of Amistad Reservoir in 1992 remains the only specimen found in our surveys. Many tributaries of the Rio Grande that may once have supported populations, were examined in 1994 and found to have been dewatered in recent years; others show signs of scouring during floods.
- 9) Texas heelsplitter: This endemic species was the focus of additional attention in 1993 and 1994 because of its status for possible federal endangered-species listing in the future. Apparently only about 150 specimens have been found since its description in 1898, and only two living individuals have been reported (taken by TPWD) within the last 15 years (Neck and Howells 1994). The species persists in the Sabine and Neches River drainages, but its long-term security is in doubt.
- 10) Salina mucket: This Rio Grande endemic species remains represented in TPWD surveys by only a single pair of recently-dead valves found upstream from Amistad Reservoir in 1992. See comments under Texas hornshell.
- 11) Golden orb: This endemic pimpleback-type quadrulid was found alive by TPWD in 1994 in Lake Corpus Christi (the only living specimens located by TPWD to date). Relatively-recently dead valves have been found at several other locations suggesting other populations may persist, but the species has clearly declined to dangerously low levels in recent years.
- 12) Rio Grande monkeyface: Survey efforts by TPWD from 1992 through 1994 failed to locate even shell fragments of this species which is endemic to the Rio Grande. Its continued existence in Texas is in doubt. See comments under Texas hornshell.
- 13) Smooth pimpleback: This endemic species has been found alive by TPWD at a number of Central-Texas locations, and although more abundant than golden orb, appears to be declining or absent from most areas within its previous range.

- 14) Texas pimpleback: This endemic species has been found alive by TPWD at only three sites, of which, two produced only single specimens. The most significant population occurs in a mussel-sanctuary area on the Concho River. Examination of this area in 1993 and again in 1994 found an apparent increase in number of individuals present.
- 15) False spike: Disjunct populations historically occurred in the Rio Grande and Central Texas. Other than several subfossil fragments from the Guadalupe River near Seguin and the Pedernales River at Pedernales Falls State Park, no specimens have been found in TPWD surveys.
- 16) Texas fawnsfoot: This species is endemic to Central Texas. None were found in 1992 or 1993; however, a number of recently-dead valves were located in the Clear Fork of the upper Brazos River and the central Brazos River mainstream. Although it appears to have become exceedingly rare, some living populations apparently remain. A relative, fawnsfoot, has been found by TPWD only twice during the last three years. Another relative, deertoe, has only been found alive by TPWD on one occasion. However, both species reach their southwestern range limits in Texas and have never been reported as abundant here. Elsewhere in their range they may occur more frequently.
- 17) Mexican fawnsfoot: This species is endemic to the Rio Grande. None appear to have been reported since the early 1970s and none were found in TPWD surveys. See comments under Texas hornshell.

The primary sport and commercial unionids were often found to be more environmentally and numerically secure than many of the smaller, endemic species. Exceptionally large washboard populations have not been found anywhere by TPWD to date. Although numbers and distribution found can apparently still support a fishery, many populations fail to show signs of recent successful reproduction. Threeridge and southern mapleleaf are generally more abundant and more widely distributed; some, but not all, populations contained small juveniles. Tampico pearlymussel (primarily a sport-harvest species taken for pearls) remains abundant and reproductively active at a number of locations; it appears to have benefited from reservoir construction at some sites. Bleufer is abundant and reproductive at some locations as well.

Several unionids appear to have been introduced outside their historical ranges in Texas. Flat floater was not reported in Texas by Strecker (1931), but has since been found in eastern Texas by TPWD and Mather et al. (1990). Bleufer was not found in Lake Corpus Christi on the Nueces River system by Murray (1978), but was found there in 1993 (Howells 1994) and 1994 (Howells In Press) by TPWD. It has not been found by TPWD in Choke Canyon Reservoir or the Frio River upstream of Lake Corpus Christi. Additionally, the Lake Corpus Christi population is dominated by "young" adults. Because no large adults bleufers have been found there and none were present in the early 1970s, the introduction must have occurred in the late 1970s or 1980s. Bleufers were also discovered in Amistad Reservoir on the Rio Grande in late 1994. Metcalf (1982) failed to find this species in his study of fossil unionids of the area and Neck and Metcalf (1988) did not find it in the lower Rio Grande. Several

historical reports of bleufer from the Rio Grande were misidentified Tampico pearlymussels (R.W. Neck and C.E. Boone, Houston Museum of Natural Science; pers. comm.). Some of the Amistad specimens were larger, older adults suggesting either a much earlier introduction than seen in Lake Corpus Christ, or a rare native population previously overlooked (perhaps advantaged by reservoir construction).

RIVER SYSTEM SUMMARY: 1992-1994

During 1994, information concerning unionid status at over 200 sites was obtained (Fig. 1). Previously, over 50 locations were examined in 1992 (Howells 1994) and over 160 in 1993 (Howells In Press). A general picture of unionid populations in the major Texas drainage basins has emerged and now allows comment on some of these systems.

Although the main channel of the Red River has not been sampled by TPWD to date, unionid populations persist in reservoirs on the Wichita and Little Wichita rivers in the upper reaches of the system. Reservoirs and creeks in Lamar County, nearer the Arkansas border, also still support mussel populations.

The North, Middle, and South branches of the Sulphur, main channel upstream of White Oak Creek, and White Oak Creek were found to support few unionids. Channelization and other environmental modifications preclude significant populations in this area. Lower reaches of this system have not been surveyed by TPWD to date but have been reportedly fished by commercial musselers (Howells 1993). Mussels apparently still persist in the Big Cypress Bayou and Caddo Lake area, but these have not been surveyed by TPWD to date.

The Sabine River has been sampled from Lake Tawakoni to the Louisiana state line. Significant numbers and diversity of mussel populations are present at some locations. Additional effort to better survey deeper areas of this system will be needed in the future to better characterize local mussel fauna.

The central reaches of the Neches River contained one of the most abundant and diverse unionid assemblages found by TPWD thus far. However, some areas of the Angelina River, upper Neches River, Pine Island Bayou, and Village Creek (Hardin County) appear to support only small numbers of mussels. Village Creek, which once claimed one of the most significant mussel populations in the state, appears to have suffered from pollution and extensive sand deposition; few unionids remain.

The Trinity River system still maintains some significant mussel populations in certain reservoirs in the upper portions of the drainage basin. However, much of the main-stream areas of the system appear to have few living specimens left. Historically-significant Mussel Shoal Creek (San Jacinto County) still contains mussels, but access problems have limited survey efforts to date to its upper reaches.

The San Jacinto River also once contained an important mussel fauna (Strecker 1931). However, few were found by TPWD in Lake Conroe, none were found alive in the West Branch downstream of Lake Conroe, and few were present in the upper East Branch. Extensive sand deposition in and downstream of Lake Conroe has displaced unionids within approximately the last two decades.

Buffalo Bayou, despite being largely contained within the Houston metroplex, was found to support significant populations of several species at one location and limited populations at others. Several species including southern mapleleaf and Texas lilliput appear morphologically unique in this system. However, at one site previously examined in the early 1970s, far fewer individuals and species were found to be present when surveyed in 1994.

Both the Brazos and Colorado River systems contain areas of contrasting abundance and extirpation. Significant populations of sport and commercial species exist at some sites, but other areas apparently contain only long-dead and subfossil shells. Unionids are largely or wholly absent from the Llano, San Saba, and Pedernales rivers. Several sites on the Concho River and other upper Colorado River tributaries support some of what may be the last remnants of several endemic Central Texas species. Devastating, scouring floods have environmentally altered many areas in these drainage basins. Bonham (1939) considered scouring floods to be one of the major threats to the aquatic environment in Kerr County in Central Texas. Observations during HOH field surveys indicate Bonham's concerns apply to other area waters as well. Overgrazing began shortly after the Civil War with the development of the local cattle industry and continued with the introduction of sheep, goats, and other domestic, native, and exotic animals has removed much of the native terrestrial vegetative cover. General agricultural and general urban, highway, industrial, and military development has also served to clear lands of vegetative cover. Wells used to pump aquifer waters to supply agricultural, industrial, and urban water demands has reduced or eliminated spring flows in some areas and subsequently altered historical river flows (Brune 1975). Control of naturally-occurring fires has, at least in part, resulted in Ashe juniper (Juniperus ashie) becoming a dominant terrestrial macrophyte in many areas; this plant often precludes reestablishment of more-desirable vegetative cover (Nadkarni et al. 1985). Collectively, these and other factors have contributed to increased runoff during precipitation and subsequent flooding. Additionally, analysis at HOH of rainfall data obtained from the office of the State Climatologist (College Station, Texas) indicates 10-year means show a pattern of increasing rainfall from 1900 through the present. Finally, global weather trends demonstrate a decreasing frequency of low to moderate rainfall events with an increase in severe storms when precipitation occurs [see summary in River Crossings, Bettendorf, Iowa, September/October 1995 4(5)]. Reduced natural terrestrial vegetative cover in conjunction with a trend in increasing annual rainfall amounts and increase in the number of severe storm events have combined to produce destructively scouring floods which have, in turn, eliminated both mussels and mussel habitat from many areas.

The upper Guadalupe River has similarly been subjected to extensive scouring and no longer supports significant mussel populations. Some short-lived, fast-growing species like paper pondshell occasionally appear, survive

for a time, and are then lost again. These may reflect introductions by stocked fish. Few living populations of heavy-shelled, slow-growing species have been found by TPWD upstream of Lake Gonzales on the Central Guadalupe system downstream of Seguin. In the lower reaches upstream of Victoria, scouring has again displaced much of the original mussel fauna. No living unionids have been found by TPWD in the Blanco or San Marcos rivers; scouring again appears to be the primary factor in their decline. Areas of the central San Marcos River have apparently been impacted by pollutants related to nearby oil fields (based on HOH observations and interviews with local oil field workers), and bridge construction (which directs large amounts of runoff during rains) at some downstream sites probably contributed to these losses as well (based on HOH observations). Mussel populations remain in some stretches of Cibolo Creek off the San Antonio River, but these also appear to be declining. Only the upper-most reaches of the San Antonio River have been examined to date, but no living unionids were found. None were found in the Medina River.

The Frio and lower Nueces rivers, and their associated reservoirs, still contain significant mussel populations. Water fluctuation in Choke Canyon Reservoir is problematic for populations there and scouring appears to be increasing in the Frio River upstream of Choke Canyon Reservoir.

Within the Rio Grande, none of the five endemic mussel species has been found alive during TPWD surveys and other species are rarely abundant at any locations examined thus far. Pollution, environmental modifications, low water levels, and fluctuating water levels appear to have reduced mussel populations throughout this system. Surveys of a number of Mexican tributaries have likewise been unproductive.

LITERATURE CITED

- Bonham, K. 1939. Report of stream survey of Guadalupe River in Kerr County, Texas. The Agricultural and Mechanical College of Texas, College Station. (Mimeo.)
- Brune, G. 1975. Major and historical springs of Texas. Texas Water Development Board, Report 189, Austin.
- Coker, R.E. 1919. Freshwater mussels and mussel industries of the United States. U.S. Bureau of Fisheries Document 685, Washington, D.C.
- Coker, R.E., A.F. Shira, H.W. Clark, and A.D. Howard. 1921. Natural history and propagation of freshwater mussels. U.S. Bureau of Fisheries Bulletin (Document 893):75-181.
- Conrad, T.A. 1854. Descriptions of new species of Unio. Journal of the Academy of Natural Sciences of Philadelphia, Art. 27: 297, Plate 27, Figure 3.
- Garrett, B. 1929. Pearl buttons from Valley clams. Monty's Monthly 11(6):46-48.
- Harrel, R.C. 1993. Origin and decline of the estuarine clam Rangia cuneata in the Neches River, Texas. American Malacological Bulletin 10:153-159.
- Howells, R.G. 1993. Preliminary survey of freshwater mussel harvest in Texas. Texas Parks and Wildlife Department, Management Data Series 100, Austin.
- Howells, R.G. 1994. Preliminary distributional surveys of freshwater bivalves in Texas: Progress report for 1993. Texas Parks and Wildlife Department, Management Data Series 105, Austin.
- Howells, R.G. In Press. Distributional surveys of freshwater bivalves in Texas: Progress report for 1994. Texas Parks and Wildlife Department, Management Data Series, Austin.
- Jones, R.O. 1950. Propagation of freshwater mussels. The Progressive Fish-Culturist 12:13-25.
- Littleton, T.G. 1979. The distribution and abundance of freshwater mussels (Bivalvia: Unionacea) of the Navasota River. Master's thesis. Texas A&M University, College Station.
- Mather, C.M., J.A.M. Bergmann, and R.W. Neck. 1990. New records of Anodonta suborbiculata Say in Texas. Texas Conchologist 26:41-43.
- Metcalf, A.L. 1982. Fossil unionacean bivalves from three tributaries of the Rio Grande. Pages 43-59 in K.R. Davis, editor. Proceedings of the

- symposium on recent benthological investigations in Texas and adjacent states. Texas Academy of Science, Austin.
- Morziot, D.C., and M.E. Schmidt. 1990. Starch gel electrophoresis and histochemical visualization of proteins. Pages 23-80 in D.H. Whitmore. Electrophoretic and isoelectric focusing techniques in fisheries management. CRC Press, Ann Arbor, Michigan.
- Murray, H.D. 1972. Freshwater mussels of Lake LBJ, Texas. Bulletin of the American Malacological Union 1971:36-37.
- Murray, H.D. 1975. Melanoides tuberculata (Muller), Las Moras Creek, Brackettville, Texas. Bulletin of the American Malacological Union 1975:43.
- Murray, H.D. 1978. Freshwater mussels of Lake Corpus Christi, Texas. Bulletin of the American Malacological Union, Inc. 1978:5-6.
- Murray, H.D., and E.C. Roy, Jr. 1968. Checklist of fresh-water and land mollusks of Texas. Sterkiana 30:25-42.
- Nadkarni, N.M., P.J. Fonteyn, and J. Baccus. 1985. Putting the brakes on cedar. Texas Parks and Wildlife 43(6):36-38.
- Neck, R.W. 1982a. A review of interactions between humans and freshwater mussels in Texas. Pages 169-182 in K.R. Davis, editor. Proceedings of the symposium on recent benthological investigations in Texas and adjacent states. Texas Academy of Science, Austin.
- Neck, R.W. 1982b. Ecological zoogeography of the freshwater mussels of Texas. Pages 33-42 in K.R. Davis, editor. Proceedings of the symposium on recent benthological investigations in Texas and adjacent states. Texas Academy of Science, Austin.
- Neck, R.W. 1982c. Significant Texas naiad records. Texas Conchologist 19:1-3.
- Neck, R.W. 1986a. Freshwater bivalves of Lake Tawakoni, Sabine River, Texas. The Texas Journal of Science 38:241-249.
- Neck, R.W. 1986b. Corbicula in public recreation waters of Texas: habitat spectrum and clam-human interactions. American Malacological Bulletin, Special Edition 2:179-184.
- Neck, R.W. 1989a. Freshwater bivalves of Arrowhead Lake, Texas: apparent lack of extirpation following impoundment. The Texas Journal of Science 41:371-377.
- Neck, R.W. 1989b. Freshwater bivalves of Medina Lake, Texas: factors producing a low-diversity fauna. The Texas Journal of Science 41:319-325.

- 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 R.G. Howells. 1994. Status survey of Texas heelsplitter, Potamilus amphichaenus (Frierson, 1898). Texas Parks and Wildlife Department, Special Report, Austin.
- Neck, R.W., and A.L. Metcalf. 1988. Freshwater bivalves of the lower Rio Grande, Texas. *The Texas Journal of Science* 40:259-268.
- Prentice, J.A. 1995. Standard scientific diving program procedures manual. Version 1.0. Texas Parks and Wildlife Department, Austin.
- Shira, A.F. 1913. The mussel fisheries of Caddo Lake and the Cypress and Sulphur rivers of Texas and Louisiana. U.S. Bureau of Fisheries Economic Circular 6, Washington, D.C.
- Simpson, C.T. 1900. A descriptive catalogue of the naiades or pearly fresh-water mussels. B. Walker, Detroit, Michigan.
- Starrett, W.C. 1971. A survey of the mussels (Unionidae) of the Illinois River: a polluted stream. *Illinois Natural History Survey Bulletin* 30(5):267-401.
- Strecker, T. 1931. The distribution of naiades or pearly fresh-water mussels of Texas. *Baylor University Museum Bulletin* 2, Waco, Texas.
- Turgeon, D.D., and nine coauthors. 1988. 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 mussel-mite and mussel-Ablabesmyia associations in Village Creek, Hardin County, Texas. *Proceedings Louisiana Academy of Science* 53:1-4.

Figure 1. Texas locations examined for the presence of freshwater mussels (Family: Unionidae) by Texas Parks and Wildlife Department Inland Fisheries staff in 1994 (dots) and where mussels were collected by other parties and sent to TPWD for examination (triangles).

