# PRELIMINARY SURVEY OF FRESHWATER MUSSEL HARVEST IN TEXAS

by

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## ABSTRACT

Significant increases in freshwater musseling activities in Texas beginning in 1978 and again in 1989 indicated need for closer examination of the fishery. Preliminary efforts to examine mussel harvest focused on a mail questionnaire to 395 individuals (233 Texas residents and 162 nonresidents) who had purchased Mussel, Clam and Naiad Licenses from September 1990 through December 1991. Returned questionnaires (19.2%) included 16.7% which were useful. Most individuals had been harvesting mussels 3 years or less, but over 20% had more than 10 years experience. Both impounded and flowing waters were musseled, including 15 reservoirs and 10 rivers or streams. The primary mussel species taken were washboards Megalonaias nervosa, threeridges Amblema spp. and mapleleafs Quadrula spp., which were primarily harvested for shell, and Tampico pearlymussel Cyrtonaias tampicoensis, taken primarily by noncommercial pearl hunters. Minimum sizes harvested were usually consistent with restrictive length limits in other states. Some mussel harvest was reported throughout the year, but greatest effort was in late spring through early fall. Most musselers reported using SCUBA or other underwater breathing devices and hand picking mussels; however, about half the residents indicated they waded shallow waters. Estimated total annual harvest in 1991 was 616-1,151 tons valued at $1.2-2.5 million. Half the nonresident musselers considered this activity their primary source of income, but less than 10% of the resident musselers rated mussel harvest and sale as primary income.

# INTRODUCTION

## Historical Perspective

Freshwater mussels were harvested from Texas waters long before recorded times by Native American Indians who sought them for meat, shells and pearls (Clemmens 1985; Kennedy 1985; Williams 1990). Early Spanish explorers who entered Texas in search of gold and silver may have been the first to record pearls from local mussels. Reportedly DeSoto found pearls in use among Indians in the eastern part of the state and relieved them of some 350 pounds of pearls on one occasion (Kennedy 1985). Other Spaniards searched the Concho River for pearls, but apparently obtained relatively few (Williams 1990). Thereafter, Texas freshwater mussels received little attention for an extended period.

Late in the last century, a major industry developed in the Mississippi Valley to harvest freshwater mussel shells to produce buttons. Indeed, harvest was so extensive that the U.S. Bureau of Fisheries became concerned this valuable natural resource might be depleted or lost (Jones 1950). In 1894 the Bureau began to actively examine freshwater mussels and ultimately built a biological station in Freeport, Iowa, to study them; additional work developed at the University of Missouri (Jones 1950). During the last years of the 1890's and first few decades of the 1900's, federal mussel fishery biologists directed an exceptional amount of effort toward understanding both mussels and mussel fisheries. However, virtually all this work centered on the Mississippi Valley drainage, with most efforts extending only as far southwest as the Red River and Caddo Lake, Texas (Coker 1921).

Interest in Texas mussels was rekindled in 1909 when the discovery of a gem-quality freshwater-mussel pearl by a Japanese immigrant working at Caddo Lake prompted a "pearl rush" of significant magnitude. This frenzy cooled only when a dam built downstream in 1914 caused lake levels to rise and block easy access to mussel beds (Blakely 1988). In more recent years, pearls have also been sought from mussels from the Concho River and associated reservoirs (Pinkard 1979; Williams 1990; Portwood 1992), and from Hill Country waters (Kennedy 1985). Additionally, there has been minor local interest in freshwater mussel harvest for meat as trotline bait, and shells and pearls for curios and jewelry.

An entirely new motivation developed within the last few years and has accounted for dramatic increases in mussel harvest. Selected species of American freshwater mussels have come under intense pressure for shells used in the cultured pearl industry (Ward 1985). Cultured pearls are produced in both marine and freshwater bivalves by introducing a bead (or any other shape) of freshwater mussel shell into the animal which subsequently deposits a thin veneer of pearly nacre (Ward 1985). Except for a limited number of such pearls generated in Burma, Australia, Polynesia, and Tennessee, Japan has almost total control of the cultured pearl industry worldwide (Ward 1985; Mead 1990). In part because of imbalance in the recent dollar-yen relationship, Japanese demand for American shells appears unquenchable. As recently as early March 1992, prices paid to musselers for certain species and sizes of

shells were reportedly as high as $7.30 per pound (J. De Villez, Kentucky Mussel Advisory Group, Kuttawa, Kentucky; pers. comm.). Many mussel populations were seriously depleted by the button industry a century earlier, while mussels in Texas were comparatively unscathed. Subsequently, the present demand for shell, which is impacting virtually all of the central U.S., has also impacted Texas waters where substantial numbers and sizes of industry-desired species remain.

Although some mussels from Texas waters were harvested as far south as the Rio Grande for the button industry (Garrett 1929), mussel populations in the state may have been largely spared from the apparent massive harvest seen in much of the Mississippi Basin. None the less, some overharvest within the state did occur. Spanish explorers reportedly removed large enough quantities of freshwater mussels from the Concho River to result in scarcities in some areas (Williams 1990). Earlier in this century, Strecker (1931) wrote "pearlers have almost exterminated mussels in many places in both the north and south branches of the [Llano] river." More recently, Neck (1982) discussed human interactions with freshwater mussels in Texas and Neck (1984) summarized published reports of decline in mussel populations in Texas waters.

## Texas Freshwater Mussel Fishery Regulations

The Texas Legislature, within the Parks and Wildlife Code, has provided for regulation and licensing of freshwater mussel fisheries (Chapter 78. Clams, Mussels, Sponge Crabs, and Blue Crabs; Subchapter A. Mussels, Clams, or Naiads). However, although licensing of freshwater mussel harvest has occurred for several decades, demand for licenses and impact on the resource has apparently been limited until relatively recently. Between 1963 and 1970, an average of only two licenses were sold annually (Kennedy 1985); none were sold from 1972 through 1977 (TPWD, unpublished data). Because of the minimal interest or drain on the resource, extensive regulations and detailed monitoring were unnecessary. License sales were well under 100 per year in 1987 and 1988; however, when sales from 1989 through 1991 abruptly increased to 200-300 per year, need for closer scrutiny arose.

## Understanding and Status of Freshwater Mussels in Texas

Although the U.S. Fish Commission provided major contributions to the understanding of freshwater mussels and the fisheries they supported earlier in this century, Texas populations and unique local species received little or no attention. Studies of freshwater mussels in Texas through the present have been largely limited to a small number of local species surveys. An additional confounding factor relates to problems with species identification and distribution. Differences in classification among present freshwater-mussel authorities makes interpretation of historical literature difficult. Neck (1984) wrote that any attempt to survey the nonmarine mollusks, including freshwater mussels in Texas which might be of special concern, would be difficult because the fauna of Texas was imperfectly known.

## Preliminary Review of the Texas Mussel Fishery: Present Study

In early January 1992, efforts began to examine the status of freshwater mussels and the fishery for them. Preliminary efforts to identify the species of commercial importance and obtain baseline information on the fishery are presented here.

## MATERIALS AND METHODS

To investigate long-term trends in Texas freshwater musseling activity, data on annual sales of Mussel, Clam, and Naiad Licenses for each fiscal year (1 September through 31 August) were obtained from TPWD license personnel. Information on number of licenses sold and dredge permits issued was obtained.

Because mussel harvest appeared to be increasing rapidly, and in the near-absence of baseline information, obtaining information quickly seemed paramount. Therefore, efforts centered on developing a brief questionnaire for circulation to Texas mussel license holders.

Names and addresses of all individuals who had purchased Mussel, Clam and Naiad Licenses and dredge permits between 1 September 1990 and 31 December 1991 were obtained from TPWD licensing personnel. A questionnaire containing 27 basic questions and eight opinion questions was designed and copies produced (Figure 1). Stamped, self-addressed questionnaires (395 total) were mailed along with explanatory cover letters to everyone who had purchased licenses during the designated period. Individuals whose licenses were illegible or incompletely filled out, or for which mailing addresses could not be determined were not included in the mailout. Mailings occurred randomly on 14 January 1992 (N=200) and 16 January 1992 (N=195). Responses were tallied through 29 February 1992.

Data reported here are based upon the number of respondents to each question. For example, if 100 questionnaires were returned from the 395 mailed, and 35 of those respondents indicated they used a boat to harvest mussels, it was reported as 35% using a boat to harvest mussels. In the case of numbers, weights and dollar values, these percentages were extrapolated to calculate estimates based on the total number of mussel license holders; it was assumed nonrespondents were proportionally similar to respondents as reported by Kulzer (1985) who found no statistically significant differences between respondent and nonrespondent groups in a survey of Texas anglers.

Several mussel license holders from the Corpus Christi-Rockport area and the Houston area purchased licenses to harvest marine quahogs Mercenaria spp. or other marine bivalves. Responses from these individuals were not tallied.

Terminology for both scientific and common names follows Turgeon et al. (1988) unless otherwise indicated, except where several local vernacular names were also used. Except for introductory license-related information, data is presented on a question-by-question basis with results and discussion reported

for each. The terms resident and nonresident refer to the mailing address of the license holder (TPWD sold only a single license to all musselers regardless of residency status).

## RESULTS AND DISCUSSION

### License-related Information

#### Long-term Trends

Based on mussel license sales from 1963 through 1977, there was very limited musseling activity in Texas. Two dramatic increases occurred beginning in 1978 and again in 1989 (Table 1). The unusually high number of licenses sold in 1980 followed very closely after the publication of an article on pearls from Concho River mussels in Texas Highways magazine (Pinkard 1979). Increases in license sales following publication of several similar magazine articles was also apparent, though less pronounced. These peaks in license sales in the early and mid-1980's likely reflected short-term interest in a unique fishery for pearls, and not the increased demand for freshwater mussel shell for the cultured-pearl industry reflected in license sales from 1989 through 1991.

#### License Characteristics

Among the 395 license holders during the designated period, 233 (58.9%) were Texas residents (Table 2) and 162 (41.0%) were nonresidents (Table 3).

Resident license holders were distributed among 76 towns and cities (Table 2). The greatest number of licenses were sold to residents of Kemp (16.3%) and Mabank (8.2%). Houston (7.3%) and San Angelo (5.6%) were the only other cities accounting for more than 4% of the total resident license sales (Table 2). Regionally, almost half the resident licenses were from Northeast Texas; collectively, nearly 70% were held by residents east of a north-south line drawn just east of Dallas to just west of Lake Livingston. None listed addresses from the Rio Grande Valley, Southcentral or West Texas.

The 162 nonresident licenses purchased included individuals from 13 states (Table 3). Among these, 59% resided in Oklahoma or Tennessee.

### Questionnaire-related Information

#### Return Rates

Among 233 questionnaires mailed to Texas residents, 44 (18.9%) were returned, with 36 (15.5%) providing useful data and eight (3.4%) which were not usable (returned blank, defaced, or applied only to harvest of marine species). Additionally, 16 (6.9%) were undeliverable and were returned by the Post Office, and 173 (74.2%) were not returned. Kemp, Texas, which had the greatest number of licenses sold, also had the greatest undeliverable rate.

Among 162 questionnaires sent to mussel license holders with addresses in other states, 32 (19.8%) were returned, with 30 (18.5%) providing useful information and two (1.2%) which were unusable; 15 were undeliverable (9.3%), and 115 (70.9%) did not respond.

Most resident and nonresident responses were received within the first 23 days following mailing; undeliverable questionnaires which were returned by the Post Office were received within 20 days.

Response rates to mailed questionnaires have been reported as 20-26% from angler surveys (Hoyt 1982; Kinman and Hoyt 1984); however, these percentages often required a second mailing to reach the 26% level (Hoyt 1982). In Texas, Kulzer (1985) reported a response rate to angler questionnaires of over 60%, but that study included multiple mailings, reminder post cards, and telephone follow-ups. Considering the present survey consisted of only a single mailing and queried musselers rather than anglers, the resulting 19.2% response rate was probably not exceptionally low.

**Questionnaire Responses**

Question: How many years have you been harvesting mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Years | N | % | N | % |
| 1 | 14 | 41.2 | 6 | 27.3 |
| 2 | 5 | 14.7 | - | - |
| 3 | 3 | 8.8 | 4 | 18.2 |
| 4 | 4 | 11.8 | 2 | 9.1 |
| 5 | - | - | 1 | 4.5 |
| 7-8 | 1 | 2.9 | 2 | 9.1 |
| >10 | 7 | 20.5 | 7 | 31.8 |

Discussion: Responses reflect the recent increase in interest in mussel harvest. Nearly 65% of the residents and 46% of the nonresidents fished for mussels 3 years or less. Only about 23% of residents musseled 5 years or more, compared to about 45% for nonresidents. This suggests nonresident musselers were generally involved in this field longer than resident musselers; however, both groups contain substantial numbers of individuals only recently beginning to mussel.

Question: Where do you usually collect mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Water body type | N | % | N | % |
| Lakes/reservoirs | 17 | 50.0 | 7 | 25.0 |
| Rivers/streams | 3 | 8.8 | 9 | 32.0 |
| Both | 14 | 41.2 | 12 | 42.9 |

Discussion: Residents musseled mostly in lakes and reservoirs, or both in lakes and reservoirs and in rivers and streams; relatively fewer centered

their mussel harvest only on flowing waters. A much higher proportion of nonresidents musseled in flowing waters.

Question: In which water bodies do you usually fish for mussels?
Results: (Residents and nonresidents combined)

| Lakes/reservoirs | N | Rivers/streams | N |
|---|---|---|---|
| Buchanan | 5 | Big Cypress Creek | 1 |
| Caddo Lake | 3 | Brazos River | 8 |
| Cedar Creek | 14 | Colorado River | 9 |
| Cypress Creek | 1 | Concho River | 11 |
| Eagle Mountain | 1 | Dove Creek | 2 |
| Lake Gonzales | 1 | Guadalupe River | 2 |
| LBJ | 1 | San Saba River | 1 |
| Livingston | 7 | Sabine River | 13 |
| Nasworthy | 3 | Spring Creek | 1 |
| O.C. Fisher | 2 | Sulphur River | 11 |
| Pat Mayse | 3 | | |
| Tawakoni | 2 | | |
| Twin Buttes | 2 | | |
| Wright Patman | 2 | | |
| Lake Wood | 1 | | |

Discussion: Water bodies fished for mussels are widely dispersed across the state, except for extreme South and West Texas, the Panhandle and the Rio Grande Valley. In general, respondents indicated rivers and reservoirs in eastern and northeastern Texas are the primary areas of intense shell harvest for the cultured pearl industry. Reservoirs and rivers from the San Angelo area to the highland lakes in the Texas Hill Country are most frequently fished by novice or experienced pearl hunters, though some of these areas are also musseled for shell.

The intense effort at Cedar Creek Reservoir southeast of Dallas is apparently greater than at any other impoundment. This may reflect both the loss of aquatic macrophytes that occurred about 7-8 years ago following an extremely cold winter, and the increased eutrophication and turbidity associated with loss of aquatic vegetation and increased residential development around the reservoir. Because many mussel species avoid heavily vegetated areas (Coker et al. 1922), the loss of macrophytes likely benefited mussel populations in Cedar Creek Reservoir. Further, nutrients initially utilized by macrophytes may have (in conjunction with an increasing human-related nutrient input) served to enhance phytoplankton in the reservoir and increase food supply for mussels. Collectively, these factors appear to have served as a basis for large mussel populations which in turn attracted musselers.

The intense efforts on the Sulphur and Sabine rivers reflects interest in the same mussel species sought throughout the Mississippi Basin. Although some of the same species taken in the northeast also occur much farther west and southwest within the state, apparently large specimens and dense populations are less common outside these easterly-flowing rivers.

Question: How far from your home do you usually travel to collect mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Miles | N | % | N | % |
| <50 | 18 | 47.2 | 2 | 7.1 |
| 50-100 | 6 | 15.8 | 3 | 10.7 |
| 101-200 | 2 | 5.3 | 2 | 7.1 |
| >200 | 8 | 21.1 | 19 | 67.9 |
| mixed | 4 | 10.5 | 2 | 7.1 |

Discussion: Most residents travel less than 100 miles to fish for mussels; those that travel farther often represent commercial harvesters. Logically, most nonresidents travel over 200 miles to mussel-harvest sites; respondents indicating less than 200 miles were often from Oklahoma or Arkansas. However, some musselers responded either by listing multiple answers or by listing travel distances clearly too short relative to their mailing addresses. Atypical responses probably indicated (1) non-Texas specific answers, (2) distance from a temporary residence in Texas to the fishing site or (3) attempts to list distances to several sites. Some nonresidents who travelled long distances to harvest mussels in Texas waters were vacationing SCUBA divers with little or no commercial harvest intent.

Question: Which species of mussels do you collect most frequently?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Mussel species | N | % | N | % |
| Don't know/uncertain | 11 | 30.6 | 4 | 13.3 |
| Washboards *Megalonaias nervosa* | 23 | 63.9 | 24 | 80.0 |
| Threeridges/roundlakes *Amblema* spp. | 21 | 58.3 | 20 | 66.7 |
| Mapleleafs/pimplebacks *Quadrula* spp. | 20 | 55.5 | 19 | 63.3 |
| Tampico pearlymussel *Cyrtonaias tampicoensis* | 12 | 33.3 | 6 | 20.0 |
| Ebonyshell *Fusconaia ebena* | - | - | 6 | 20.0 |
| Pigtoes *Fusconaia* spp./*Pleurobema* spp. | - | - | 5 | 16.7 |
| Asiatic clam *Corbicula* sp(p). | - | - | - | - |
| Others | 1 | 2.8 | - | - |

Discussion: The checklist of potential species presented on the questionnaire was comprised of mussels which logically would have been objects of harvest efforts based upon distribution in Texas waters, species of interest to cultured pearl industry or species which regularly produce natural pearls, as well as Asiatic clam. Only a single respondent indicated taking a species not provided on the initial checklist. Nearly three times as many residents were uncertain what species they harvested than were nonresidents; this may reflect many residents were relatively new in the field, and the lack of species-specific regulations in Texas. Nonresidents who have musseled longer and in

states where detailed mussel regulations were in place were much more likely to indicate they knew which species they were harvesting.

Washboard mussel was the major species harvested by both resident and nonresident musselers, with nearly as many musselers taking species from the threeridge and mapleleaf groups. These data are consistent with reports of the primary species being purchased from musselers for the cultured pearl industry. About half as many residents and a third to a quarter as many nonresidents sought Tampico pearlymussels which produce pearls, but whose shells are of little apparent interest in pearl culture. The Tampico pearlymussel fishery is far more sport oriented than the fishery for washboards, threeridges and mapleleafs which is heavily dominated by commercial harvest.

Six nonresident musselers indicated they harvested ebony mussel, and five also reported they took pigtoe mussels. Although ebonyshell is one of the most desirable species for button or pearl-seed use (Buchanan 1980), it does not occur in Texas waters. Several pigtoe mussels in Texas are probably not major sport or commercial species in Texas because of small size and relative rarity. However, recent taxonomic trends which consider one local species to be Wabash pigtoe Fusconaia flava, a commercial mussel elsewhere, suggest some local harvest of pigtoe mussels may occur. Musselers who indicated harvest of ebony and pigtoe mussels quite probably included these species although they harvested them from sites outside Texas.

One resident musseler reported taking "hill-splitters." This report likely refers to collection of one or more of several species of mussels known as "heelsplitters" and probably refers to bleufer Potamilus purpuratus, or possibly pink or Texas heelsplitters Potamilus spp., or white heelsplitters Lasmigona spp. There was no other indication of harvest of these mussels in Texas. Additionally, one resident reported harvesting "Texas pinks" and another "unio-mussels"; both were tallied under Tampico pearlymussel which is also sometimes called "purpleshell mussel."

Asiatic clam Corbicula sp(p)., a potentially-noxious exotic species which invaded the state several decades ago, is considered a prohibited species under Harmful and Potentially Harmful Fishes, Shellfishes and Aquatic Plants regulations. None the less, it was added to the list of possible species harvested because regulations in other states often specifically address Asiatic clam harvest. Further, the names of a substantial number of resident mussel license holders appeared to be from cultures which could be expected to harvest and consume Asiatic clams. However, none of the respondents indicated they harvested Asiatic clams.

Question: Which sizes of mussels do you collect most frequently?
Results: (Residents and nonresidents combined)

| Species | Size (in.) | N | % | Species | Size (in.) | N | % |
|---|---|---|---|---|---|---|---|
| Washboard | 3.0 | 1 | 3.2 | Mapleleaf | 2.0 | 1 | 3.1 |
| | 3.5 | 1 | 3.2 | | 2.5 | 8 | 25.0 |
| | 3.75 | 11 | 35.5 | | 2.75 | 16 | 50.0 |
| | 4.0 | 14 | 45.2 | | 3.0 | 6 | 18.8 |
| | 5.0 | 4 | 12.9 | | 4.5 | 1 | 3.1 |
| Threeridge | 2.0 | 2 | 5.6 | Tampico | 2.5 | 1 | 7.7 |
| | 2.5 | 8 | 22.2 | pearly- | 2.75 | 2 | 15.4 |
| | 2.75 | 13 | 36.1 | mussel | 3.0 | 2 | 15.4 |
| | 3.0 | 6 | 16.7 | | 3.5 | 1 | 7.7 |
| | 3.25 | 1 | 2.8 | | 4.0 | 4 | 30.8 |
| | 4.0 | 4 | 11.1 | | 5.0 | 2 | 15.4 |
| | 4.5 | 1 | 2.8 | | 6.0 | 1 | 7.7 |
| | 5.0 | 1 | 2.8 | | | | |

Discussion: Harvest sizes for washboard, threeridge and mapleleaf mussels largely reflect the minimum legal sizes in other states which were often listed by nonresidents and residents who mussel elsewhere. Additionally, numerous sources have indicated shell buyers will not purchase shells below certain minimum sizes (e.g., reportedly, most presently reject washboard mussels less than 4.0 inches in shell height). Small specimens do not have shells thick enough to produce sufficiently large pearl-culture seeds, so are typically not purchased by shell buyers, or harvested by musselers. Therefore, at least to a limited extent, the shell fishery is somewhat self-regulating in terms of minimum harvest size.

It should be noted that minimum size limits in most states are based on the minimum size shell that will pass through a ring of a specified inside diameter (I.D.). The question in this survey did not request a specific type of minimum size measurement; however, responses for washboard, threeridge and mapleleaf mussels generally appear to be minimum I.D.-type sizes.

Harvest sizes reported for Tampico pearlymussels were much more variable than those given for the primary commercial shell species. This variability probably reflects (1) different types of measurements reported, (2) no similar minimum size limits in other states and (3) the major fishery for the species is largely enjoyed by resident musselers with little or no experience collecting mussels in other states, or under other state regulations. Minimum size at maturity for Tampico pearlymussels is apparently unknown, therefore it is difficult to speculate at what size harvest of immature individuals could be problematic for the species. During this survey, a report of a 0.43-inch pearl being taken from a 3.5-inch Tampico pearlymussel was received; this suggests Tampico pearlymussel musselers may be less influenced by self-imposed minimum size restrictions than are commercial shell musselers.

Musselers who reported taking ebonyshell gave minimum sizes from 2.25 inches (25.0%) through 2.75 inches (25.0%), and those who took pigtoe mussels gave minimum sizes from 2.0 inches (16.6%) through 2.75 inches (33.3%).

However, data for ebonyshell must refer to mussels taken outside Texas or misidentifications. Data for pigtoes may or may not refer to Texas.

Question: Do you collect only certain mussel species, release unwanted species or retain all species?
Question: Do you collect only large mussels, release small mussels or retain all sizes?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Species and sizes | N | % | N | % |
| Collect only certain species | 31 | 86.1 | 27 | 90.0 |
| Release unwanted species | 22 | 61.1 | 19 | 63.3 |
| Retain all species | 2 | 5.6 | 1 | 3.3 |
| Collect only large mussels | 36 | 100.0 | 26 | 86.7 |
| Release small mussels | 29 | 80.6 | 19 | 63.3 |
| Retain all sizes | 2 | 5.6 | 1 | 3.3 |

Discussion: These questions appeared to be misread by a large number of the respondents who indicated they both collected only certain species or large sizes, but also indicated they released unwanted species and small sizes. Because nearly all mussels in Texas are collected by hand, most musselers appear to collect only large specimens of certain species, but because of turbid water conditions, identifications are largely made by feel (at the site of collection). If upon removal from the water, specimens are found to represent unwanted species, or to be below self-imposed size limits, then those animals are released.

Interestingly, only two residents and one nonresident reported they took all species and retained all sizes collected. Although to date Texas has had no limitations on species or sizes that can be harvested, most musselers appear to be following self-imposed limitations based on what can be sold or used.

Question: What months do you usually fish for mussels?
Results:

| | | Percentage of Musselers Fishing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Residents | 36 | 27.8 | 27.8 | 44.4 | 52.8 | 61.1 | 86.1 | 91.7 | 94.4 | 69.4 | 55.6 | 41.7 | 27.8 |
| Nonresidents | 28 | 46.4 | 57.1 | 60.7 | 64.3 | 75.0 | 75.0 | 75.0 | 75.0 | 75.0 | 67.9 | 75.0 | 35.7 |

Discussion: Both resident and nonresident musselers in general fish during all months of the year. Although 25.0% of residents and 35.7% of nonresidents indicated they fished during all months of the year, more individuals harvested mussels from late spring through summer and into fall than during the coldest months of winter. Musselers fishing from late fall through the winter may represent efforts on the part of a few commercial musselers to avoid warmer months when musseling is more likely to conflict with other user groups.

Question: Do you consider mussel collection sport/personal or commercial/professional?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Type | N | % | N | % |
| Sport/personal | 21 | 55.3 | 3 | 10.0 |
| Commercial/ professional | 13 | 34.2 | 24 | 80.0 |
| Both | 4 | 10.5 | 3 | 10.0 |

Discussion: The majority of resident musselers harvested mussels for sport or personal reasons. Conversely, only 10% of nonresident musselers harvested exclusively for sport or personal reasons. Likely several musselers who indicated their harvest was commercial represent sport divers who attempt to sell shells or whole mussels in an effort to recover basic expenses. Question wording did not allow differentiation of these individuals from others for whom commercial harvest is likely to generate substantial profit.

Question: What are the primary reasons you collect mussels?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Reason | N | % | N | % |
| Shell | 31 | 86.1 | 27 | 90.0 |
| Pearls | 20 | 55.6 | 9 | 30.0 |
| Meat | 7 | 19.4 | 3 | 10.0 |
| Other | - | - | - | - |

Discussion: Harvest of mussels for shell was the major reason for resident and nonresident musseling. A higher proportion of residents mussel for pearls. Several individuals indicated they sold harvested mussels whole, or "green", to shell buyers, and did not encounter pearls themselves. Mussel meat was actually sought by several individuals, and harvest specifically for meat was more frequent among residents than nonresidents. Minor harvest for the shell jewelry industry, seen recently in Missouri, or for other reasons was not indicated here.

Question: What do you do with mussel shells?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Disposition | N | % | N | % |
| Personal use | 13 | 36.1 | 3 | 10.0 |
| Sell to others | 18 | 50.0 | 28 | 93.3 |
| Discard | 2 | 5.6 | - | - |
| Other | 1 | 2.8 | - | - |

Discussion: Harvested mussel shells were sold by half of the residents and all but a few of the nonresidents. A small number of individuals who discarded shells or found other uses for them generally harvested Tampico pearlymussels. Some musselers who indicated personal use (undefined) also harvested Tampico pearlymussels, or took washboard, threeridge or mapleleaf mussels, but were not inclined to discuss sale of those shells.

Question: What do you do with pearls?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Disposition | N | % | N | % |
| Personal use | 21 | 55.3 | 23 | 76.7 |
| Sell to others | 14 | 36.8 | 5 | 16.7 |
| Discard | - | - | - | - |
| Other | 3 | 7.9 | 2 | 6.7 |

Discussion: Most residents and nonresidents reported pearls were either retained for personal use or sold to others. None of the respondents indicated taking exceptionally large numbers of pearls; indeed, several noted they had found very few, or none. When the questionnaire was drafted it was not apparent that at least some, possibly many, commercial musselers sold whole mussels to shell buyers and never knew whether or not pearls were present in the harvested mussels. Reportedly, many shell buyers subcontract mussel cooking and shell cleaning to others, with an agreement to share any pearls recovered during the process (R. Todd, Mussel Coordinator, Tennessee Wildlife Resources Agency, Nashville; pers. comm.).

Question: What do you do with mussel meat?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Disposition | N | % | N | % |
| Personal use | 2 | 5.6 | - | - |
| Sell to others | 3 | 8.3 | 3 | 10.0 |
| Discard | 20 | 55.6 | 18 | 60.0 |
| Bait | 15 | 41.7 | 14 | 46.7 |
| Human consumption | 3 | 8.3 | - | - |
| Other | 1 | 2.8 | 2 | 6.7 |

Discussion: Over half of both resident and nonresident musselers indicated they discarded mussel meat; however, over 40% of both groups retained at least some meat for use as bait (frequently trotline bait). Individuals who reported selling mussel meat to others were typically the same musselers who used meat for bait, suggesting sale of meat may have been to bait dealers for resale.

Three resident musselers reported they harvested mussel meat for human consumption. This included one each from Lake Livingston, Lake Nasworthy and the lower Brazos River in Brazoria County. Anecdotal information received during this period claimed other individuals also harvested mussel meat for human consumption. Although freshwater mussels are usually considered rather unpalatable, descriptions of preparing and cooking mussels have been published (e.g., Bigony 1979). However, harvest of freshwater mussels for human consumption is expressly prohibited under both state and federal regulations (R. Thompson, Texas Department of Health, TDH, Shellfish Sanitation Control, Austin; pers. comm.). These regulations prohibit harvest for human consumption of bivalve mollusks from waters that have not been certified as safe by TDH personnel. No fresh waters are examined for certification, therefore inland waters in Texas are by default not available for shellfish collection for human consumption.

Freshwater mussels, like other filter-feeding bivalves, can concentrate potentially harmful bacteria, viruses and other potentially toxic microorganisms such as those associated with red tides. Additionally, they may also accumulate certain environmental contaminants like heavy metals or pesticides (Bedford et al. 1968; Manley and George 1977; Adams et al. 1981; Havlik and Marking 1987). Because environmental conditions can often change more rapidly in freshwater than marine situations, any attempt to certify inland waters would represent a massive, continuing effort which would be difficult to justify in view of the high probability of contamination, great expense and relatively limited resource utilization.

Quite possibly some ethnic groups may view freshwater mussel consumption as part of their cultural heritage. Personnel with TDH have been apprised of survey results and future information releases to caution about both health and legal risks of eating freshwater mussels have been discussed.

Question: How do you collect mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Method | N | % | N | % |
| Wade | 22 | 61.1 | 8 | 26.7 |
| Free dive | 5 | 13.9 | 2 | 6.7 |
| SCUBA, etc.[a] | 18 | 50.0 | 27 | 90.0 |
| Other | - | - | - | - |

[a] Includes pump and hose units, and other underwater breathing gear.

Discussion: About half of the resident musselers used some form of underwater breathing apparatus to harvest mussels; far more nonresidents used underwater breathing devices. Most individuals using these devices were commercial harvesters. Far more residents waded shallow waters to search for mussels with hands or feet than nonresidents; nonresident wade-musselers appeared usually to be noncommercial, low-volume harvesters. Only a small number in each group indicated they free dive (without underwater breathing devices) to harvest mussels.

Question: Do you use a boat to collect mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 23 | 63.9 | 27 | 93.1 |
| No | 13 | 36.0 | 2 | 6.9 |

Discussion: Most residents and nonresidents indicated they used boats to mussel; nearly all nonresidents used boats. Virtually all respondents who mussel commercially reported using boats.

Question: What gear do you use to collect mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Gear | N | % | N | % |
| Hand | 32 | 94.1 | 30 | 100.0 |
| Brail | 1 | 2.9 | 1 | 3.3 |
| Dredge | - | - | - | - |
| Dip net | - | - | - | - |
| Rake | 1 | 2.9 | 3 | 10.0 |
| Other | - | - | - | - |

Discussion: Most musselers reported harvesting in Texas by hand. Several added collection by "feet" under "Other", but these were tallied here under "Hand". Toe-digging is sometimes considered a distinct harvest type elsewhere. Only a small number of individuals indicated they used a rake to take mussels. None reported using dip nets, although this gear is sometimes used in other states.

Although five dredge permits were sold in 1990 and three in 1991 (TPWD, unpublished data), dredge permit holders either failed to return questionnaires or did not report using a dredge. Texas has been unusual among freshwater mussel-harvesting states in permitting the use of dredges in fresh water. Telephone interviews with several resident musselers suggested most who obtain dredge permits usually have poor success with dredges and generally do not purchase a second permit. Indeed, only one musseler reported seeing a single individual successfully and repetitively harvesting mussels with a dredge, and then only at one location.

Only one resident and one nonresident reported using a brail to harvest mussels. However, the resident respondent also indicated he did not use a boat. Brails are usually large, heavy metal rods with trailing lines of hooks (crowfoot hooks) which are pulled along the bottom by a boat. The resident musseler may not have understood what typical brail harvesting is, and may have answered incorrectly. The nonresident respondent may have referred to brail use in non-Texas waters; the question did not specify "only in Texas".

Gear and sampling methodology in Texas is somewhat problematic. The Texas Parks and Wildlife Code provides for harvest by dredge, but otherwise does not discuss or restrict methods or gears. However, the Mussels, Clams and Naiads License has printed on it "by hand collection methods only". As a result, nearly all individuals harvesting mussels from Texas water believe mussels may only be taken by hand or hand-held devices (e.g., rakes), other than those harvested under a dredge permit. The result has been that devices like brails, pumps and mechanical digging devices, which can be destructive to the substrate, have not been widely used to harvest freshwater mussels in state waters. Accordingly, hand harvesting has allowed greater harvest selectivity and less damage to undersized mussels and to mussel habitat than may occur elsewhere.

Question: Estimate the number of mussels you harvested in 1991.
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| N | N | % | N | % |
| < 500 | 16 | 44.4 | 7 | 25.0 |
| 501-1,000 | 3 | 8.3 | 5 | 17.9 |
| 1,001-5,000 | 8 | 22.2 | 7 | 25.0 |
| 5,001-20,000 | 5 | 13.9 | 6 | 21.4 |
| > 20,000 | 4 | 11.1 | 3 | 10.7 |

| Extrapolation to total musselers | | |
|---|---|---|
| < 500 | 51,700 | 20,250 |
| 501-1,000 | 9,669-19,300 | 14,529-29,000 |
| 1,001-5,000 | 51,752-258,500 | 40,541-202,500 |
| 5,001-20,000 | 107,021-648,000 | 173,535-694,000 |
| > 20,000 | 518,000 | 840,000 |

Total number harvested:

| | |
|---|---|
| Residents | 738,142-1,960,800 |
| Nonresidents | 1,088,855-1,786,250 |
| Grand total | 1,826,997-3,747,050 |

Discussion: Collectively, resident and nonresident mussel harvest was estimated at 1.8 - 3.7 million in 1991. Proportionally, more residents than nonresidents indicated harvesting less than 500 mussels in 1991; this likely reflects the greater level of sport or noncommercial harvest among resident musselers, than among nonresidents who are more likely to be commercially oriented. Additionally, although the questionnaire was intended to be specific to Texas waters, some musselers may have included harvest from other states.

Question: Estimate the pounds of mussels you harvested in 1991.
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Pounds | N | % | N | % |
| < 500 | 19 | 52.8 | 7 | 25.0 |
| 501-1,000 | 4 | 11.1 | 7 | 25.0 |
| 1,001-5,000 | 5 | 13.9 | 7 | 25.0 |
| 5,001-20,000 | 5 | 13.9 | 3 | 10.7 |
| > 20,000 | 3 | 8.3 | 4 | 14.3 |

| Extrapolation to total musselers | | |
|---|---|---|
| < 500 | 6,150 | 20,250 |
| 501-1,000 | 12,976-25,900 | 20,291-40,500 |
| 1,001-5,000 | 32,432-162,000 | 40,541-202,500 |
| 5,001-20,000 | 162,032-648,000 | 86,517-346,000 |
| > 20,000 | 386,000 | 464,000 |

Total pounds harvested:

| | |
|---|---|
| Residents | 599,590-1,228,050 |
| Nonresidents | 631,599-1,073,250 |
| Grand total | 1,231,189-2,301,300 |

Discussion: Collectively, resident and nonresident mussel harvest was 1.2 - 2.3 million pounds (616 - 1,151 tons) in 1991. De Villez (1991) listed mussel harvest reported in 1989 from 10 states including: Arkansas (298 tons), Illinois (1,469 tons), Kentucky (2,398 tons), Oklahoma (291 tons) and Tennessee (5,485 tons). He further indicated these states reported increases in weight harvested from 1988 to 1989 for many of these states ranging from 9% to 42%. No previous harvest data are available for Texas for comparative purposes. Additionally, although the questionnaire was intended to be specific to Texas waters, some musselers may have included harvest from other states.

Discussions with fisheries biologists, mussel authorities in other states and some resident musselers suggest reported harvest is generally underestimated by musselers, illegal and unreported harvest is often far greater than reported levels and many musselers are hesitant to report such figures.

Question: Have you ever attempted to rear or culture mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 9 | 25.0 | 3 | 10.0 |
| No | 27 | 75.0 | 27 | 90.0 |

Discussion: Responses from resident musselers indicated 25% had attempted or were attempting mussel culture; fewer nonresidents (10%) had done so. This question had been prompted by reports in recent years of a number of Texas residents who were attempting to culture Tampico pearlymussels for cultured pearl production. Freshwater pearl culture in North America is apparently restricted to a single operation in Tennessee (Ward 1985; Mead 1990); however, Tampico pearlymussels are not native to Tennessee waters, thereby representing a locally unique type of mussel and pearl. If projected distribution of introduced zebra mussel Dreissena polymorpha, which can be competitive with or destructive to native species, presented by Strayer (1991) is correct, Tennessee culturists may experience problems in the future which may not impact most of Texas. Local culture of mussels for pearl culture in Texas may have an advantage in future years.

Several musselers who responded "yes" to this question were in fact not culturing mussels, but relocating them to other water bodies. Several stated they moved certain species to waters where they seemed not to occur, or selected apparently healthy individuals from mussel beds which seemed to be suffering from diseases or parasites and transported them to other areas. One individual reported moving mussels from one location to another to hide them from other musselers.

Question: Have you ever experienced conflicts or problems with other natural resource user groups?

Results:

| Choice | Residents N | Residents % | Nonresidents N | Nonresidents % |
|---|---|---|---|---|
| No | 25 | 69.4 | 23 | 76.7 |
| Yes - Other musselers | 4 | 11.1 | 2 | 6.7 |
| Yes - Private landowners | 3 | 8.3 | 1 | 3.3 |
| Yes - Rod and reel fishermen | 2 | 5.6 | 2 | 6.7 |
| Yes - Trotline anglers | 9 | 25.0 | 1 | 3.3 |
| Yes - Commercial fishermen | 1 | 2.8 | 1 | 3.3 |
| Yes - Boaters | 7 | 19.4 | 4 | 13.3 |
| Yes - Sand/gravel operations | - | - | - | - |
| Yes - Other | - | - | - | - |

Discussion: Although conflicts between musselers and other water resource user groups have been problematic in other states (De Villez 1991), problems in Texas appear minimal. Nearly 70% of resident and over 70% of nonresident musselers reported having no problems. The two most frequently mentioned groups with which conflicts did occasionally arise were trotline anglers and boaters.

Musselers occasionally become entangled in trotlines and must cut leaders or portions of lines to free themselves. Some musselers are reportedly over-zealous in cutting away as much line as possible or removing trotlines.

Boaters were reported to often fail either to recognize a "dive" flag which is displayed when divers are submerged, or may not allow sufficient safety margins in terms of distance or boat speed when in the vicinity of a diver.

Only a small number of musselers indicated having problems with private landowners (often related to access rights). It should be noted that telephone calls and letters from private landowners and other water resource users have been received by TPWD expressing concern over musseling operations, especially in intensely fished waters (e.g., Cedar Creek Reservoir). This situation does not appear to be a major problem at this time, but may warrant attention in the future.

Question: Estimate the annual value (to you) of the mussels and pearls you harvest.

Results:

| Dollars | Residents N | Residents % | Nonresidents N | Nonresidents % |
|---|---|---|---|---|
| < 100 | 16 | 50.0 | 3 | 12.0 |
| 101-1,000 | 5 | 15.6 | 5 | 20.0 |
| 1,001-5,000 | 5 | 15.6 | 8 | 32.0 |
| 5,001-20,000 | 4 | 12.5 | 5 | 20.0 |
| > 20,000 | 2 | 6.3 | 4 | 16.0 |

| | Extrapolation to total musselers ($) | |
|---|---|---|
| < 100 | 11,650 | 1,940 |
| 101-1,000 | 3,666-36,300 | 3,272-32,400 |
| 1,001-5,000 | 36,336-181,500 | 51,852-259,000 |
| 5,001-20,000 | 145,529-582,000 | 162,032-648,000 |
| > 20,000 | 294,000 | 476,000 |

Total annual value ($):

| | |
|---|---|
| Residents | 491,181-1,105,150 |
| Nonresidents | 695,096-1,417,340 |
| Grand total | 1,186,277-2,522,490 |

Discussion: Collectively, responses from residents and nonresidents extrapolated over the total number of musselers estimated an annual harvest value of $1.2 - 2.5 million. Again, these data should be viewed with caution due to possible inaccurate responses from some mussel harvesters, possible inclusion of value from mussels harvested elsewhere, etc. Further, musseler responses represent value to the musseler (at the harvester level); additional value to shell buyers in the U.S. or abroad, or to jewelers or others purchasing mussels or mussel products, has not been estimated.

De Villez (1991) reported annual harvest values in 1989 from nine other mussel-harvest states including: Arkansas ($0.3 million), Illinois ($1.5 million), Kentucky ($4.5 million), Oklahoma ($0.5 million) and Tennessee ($9.6 million).

Question: Mussel harvest is a primary source of income, additional income or a sport or hobby?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Type | N | % | N | % |
| Primary income | 3 | 8.3 | 17 | 56.7 |
| Secondary income | 18 | 50.0 | 11 | 36.7 |
| Sport/hobby | 21 | 58.3 | 5 | 16.7 |

Discussion: Less than 10% of the resident musselers, but over half of the nonresidents, considered mussel harvest to be their primary source of income. Conversely, over half of residents rated musseling as a sport or hobby; far fewer nonresidents viewed mussel harvest in this manner.

This question drew a large number of multiple responses where two options were both indicated. This likely reflects sport divers who use mussel harvest to obtain a limited amount of additional income, or at least help pay for the sport itself. These individuals may harvest mussels for sale to shell buyers, but usually at low harvest levels.

Question: Have you ever observed mussel die-offs in Texas?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 18 | 50.0 | 7 | 23.3 |
| No | 18 | 50.0 | 23 | 76.7 |

Discussion: Half of the residents responded they had observed mussel die-offs in Texas waters, but less than a quarter of the nonresidents indicated they had seen die-offs. Some supplied locations and dates where mortalities had been observed. A few speculated on causes for the observed die-offs, but generally a reason was not evident.

Because mussels often occupy habitats that are not readily sampled or observed by fishery management biologists, musseler reports may represent a source of information on problems which might otherwise go unnoticed. Developing a good relationship between fishery managers and musselers could provide an early-warning system of reporting mussel population problems.

Question: Have you ever had problems with mussel identification?
Question: Have you ever needed a technical expert for advise and information on mussels?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| | **Identification problems** | | | |
| Yes | 12 | 33.3 | 6 | 20.0 |
| No | 24 | 66.7 | 24 | 80.0 |
| | **Needed expert advise** | | | |
| Yes | 16 | 44.4 | 10 | 33.3 |
| No | 20 | 55.6 | 20 | 66.7 |

Discussion: More residents than nonresidents indicated having problems with mussel identification. This reflects, in part, the fact that many nonresidents have been harvesting mussels longer and are more often commercially motivated, where proper identification is usually essential. Considering the difficulty even trained fishery scientists sometimes have with mussel taxonomy, it is somewhat surprising so many musselers feel confident in their identifications.

More residents reported needing expert advise on mussels and mussel-related matters than did nonresidents; however, substantial proportions of each group indicated they had sought authoritative individuals and experienced difficulties securing information on mussels. Unfortunately expert freshwater mussel authorities are much less common than are experts on game fishes. Clearly though, a need for such experts exists.

Opinion: The number of mussels available for harvest in recent years has...
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Increased | 2 | 5.6 | 2 | 7.1 |
| Decreased | 19 | 52.8 | 9 | 32.1 |
| Remained the same | 4 | 11.1 | 7 | 25.0 |
| Don't know | 11 | 30.6 | 10 | 35.7 |

Discussion: Over half the resident musselers and about half the nonresidents felt the number of available mussels had decreased in recent years. Interestingly, several in both groups felt mussel numbers had increased.

Opinion: The size of individual mussels available for harvest in recent years has...

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Increased | 2 | 5.9 | 6 | 20.7 |
| Decreased | 13 | 38.2 | 7 | 24.1 |
| Remained the same | 9 | 26.4 | 7 | 24.1 |
| Don't know | 10 | 29.4 | 9 | 31.0 |

Discussion: This question was posed in response to reports that intense harvest of exceptionally large washboard mussels had occurred during the last 2-3 years in Texas and concerns that such large specimens may be overfished. Further, minimum purchase sizes imposed by shell buyers may also have directed heavy harvest pressures toward large threeridge and mapleleaf mussels as well. Responses were relatively varied among the possible answers in most cases.

Opinion: Do mussels in Texas require management?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 21 | 61.8 | 15 | 50.0 |
| No | 5 | 14.7 | 5 | 16.7 |
| Don't know | 8 | 23.5 | 10 | 33.3 |

Discussion: Over 60% of the resident and 50% of the nonresident musselers felt management of mussel populations was necessary. Only about 15-17% considered management unnecessary. These results may suggest a desire by musselers to see active TPWD involvement with the freshwater mussel fishery in the state.

Opinion: Are there areas where mussel harvest should be prohibited?

Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 11 | 31.4 | 6 | 20.0 |
| No | 8 | 22.9 | 9 | 30.0 |
| Don't know | 16 | 45.7 | 15 | 50.0 |

Discussion: Although nearly half of the respondents were not sure whether closed-harvest areas were needed, 20-30% indicated there should be areas where mussel harvest is prohibited. In fact, a number of individuals added comments to the questionnaires recommending sanctuary areas be designated.

Opinion: Has water pollution been a problem for Texas mussel populations?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 12 | 36.4 | 16 | 51.6 |
| No | 4 | 12.1 | 4 | 12.9 |
| Don't know | 17 | 51.5 | 11 | 35.5 |

Discussion: Between about one-third and half the musselers indicated they considered water pollution to be problematic for Texas mussel populations; a similar proportion did not know. Several respondents added exclamation points or underlining presumably to indicate they felt the problem was significant.

Opinion: Is illegal mussel poaching a problem in Texas?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 10 | 27.0 | - | - |
| No | 7 | 18.9 | 11 | 36.7 |
| Don't know | 20 | 54.1 | 19 | 63.3 |

Discussion: Although there were few restrictive regulations in place during this survey, some musselers felt illegal harvest was still a concern. Several added exclamations or underlines to their answers for emphasis. Most respondents did not know if illegal harvest was a problem.

Opinion: Should mussel license fees be higher for nonresident musselers?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 29 | 80.6 | 6 | 20.0 |
| No | 1 | 2.8 | 19 | 63.3 |
| Don't know | 6 | 16.7 | 5 | 16.7 |

Discussion: Most resident musselers felt nonresident fees should be higher; several respondents indicated they favored reciprocal fees in line with what other states charge Texas musselers. Not surprisingly, most nonresident musselers felt their license fees should not be higher than residents; however, 20% actually felt such fees should be increased. One nonresident musseler commented he would buy a Texas mussel license regardless of cost.

Opinion: Can Texas mussel populations support the present harvest rates?
Results:

| | Residents | | Nonresidents | |
|---|---|---|---|---|
| Response | N | % | N | % |
| Yes | 9 | 25.0 | 17 | 56.7 |
| No | 11 | 30.6 | 4 | 13.3 |
| Don't know | 16 | 44.4 | 9 | 30.0 |

Discussion: With virtually no data available on maximum sustainable harvest for freshwater mussels in Texas, assessments of mussel harvest rates can be little more than speculative. None the less, a number of residents and

nonresidents felt present harvest rates could not be maintained. A majority of nonresidents indicated they thought Texas mussel populations could support present harvest rates; however, while many nonresidents have somewhat greater harvest experience than many residents, a large number are also commercially oriented (their profits could suffer under restrictive regulations).

## SUMMARY

A review of the recent Mussel, Clam and Naiad License holders through a questionnaire survey indicated that about 60% were residents and 40% came from other states to harvest freshwater mussels in Texas. About 60% of resident musselers harvest mussels in limited quantities for sport and have fished for mussels fewer years than nonresidents, most of whom are commercially oriented.

All types of water bodies are fished; however, a greater number of nonresidents harvest mussels from rivers. Cedar Creek and Livingston reservoirs and the Sabine, Sulphur, and Concho rivers are the most heavily musseled waters, but harvest from the Concho River and associated reservoirs is primarily noncommercial harvest for pearls.

Most commercial harvest centers on washboard, threeridge and mapleleaf mussels in the eastern part of the state. Tampico pearlymussels are taken for pearls in central and west central Texas. Most musselers follow self-imposed minimum size limits based on minimum sizes that will be purchased by shell buyers and on the minimum size restrictions in place in other states. Most mussels are harvested for shell, with fewer taken for pearls, and fewer still for meat. Most shell is sold to commercial shell buyers. Most musselers use boats; fewer wade shallow waters. Harvest is almost completely by hand or hand-held tools.

Numbers of mussels harvested were estimated at 1.8 - 3.7 million annually with an estimated weight of 1.2 - 2.3 million pounds (600 - 1,151 tons). The value to the mussel harvesters was estimated at $1.2 - 2.5 million.

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Table 1. Number of Mussel, Clam and Naiad Licenses sold and number of Dredge Permits issued in Texas, 1963 through 1991 (TPWD unpublished data) based on fiscal years (1 September through 31 August).

| Year | Licenses sold | Dredge permits issued |
|---|---|---|
| 1963 | 1 | - |
| 1964 | 1 | - |
| 1965 | 1 | - |
| 1966 | 0 | - |
| 1967 | 2 | - |
| 1968 | 4 | - |
| 1969 | 3 | - |
| 1970 | 7 | - |
| 1971 | 0 | - |
| 1972 | 0 | 0 |
| 1973 | 0 | 0 |
| 1974 | 0 | 0 |
| 1975 | 0 | 0 |
| 1976 | 0 | 0 |
| 1977 | 0 | 0 |
| 1978 | 205 | 0 |
| 1979 | 111 | 2 |
| 1980 | 520 | 8 |
| 1981 | 115 | 0 |
| 1982 | 90 | 0 |
| 1983 | 172 | 0 |
| 1984 | 116 | 1 |
| 1985 | 132 | 1 |
| 1986 | 108 | 0 |
| 1987 | 84 | 2 |
| 1988 | 90 | 0 |
| 1989 | 285 | 3 |
| 1990 | 266 | 5 |
| 1991 | 334 | 3 |

Table 2. Number of Mussel, Clam and Naiad Licenses sold to Texas residents, September 1990 through December 1991.

| City | Number licenses | City | Number licenses |
|---|---|---|---|
| Alvarado | 1 | Kemp | 38 |
| Andrews | 1 | Kempner | 1 |
| Aransas Pass | 1 | Kingsland | 1 |
| Arlington | 4 | Lakeside | 1 |
| Austin | 7 | Lampasas | 2 |
| Azle | 1 | Leander | 1 |
| Bells | 1 | Liberty | 2 |
| Belton | 1 | Lindau | 2 |
| Brady | 1 | Livingston | 5 |
| Brownwood | 1 | Longview | 1 |
| Burnet | 4 | Mabank | 19 |
| Chandler | 1 | Malakoff | 4 |
| Conroe | 1 | Mesquite | 2 |
| Corsicana | 1 | Mineola | 1 |
| Dallas | 4 | Moscow | 1 |
| Daingerfield | 2 | Oakhurst | 2 |
| Dayton | 1 | Odessa | 1 |
| Dekalb | 2 | Onalaska | 2 |
| Denton | 1 | Paris | 3 |
| Denver City | 1 | Perrin | 1 |
| Edconch | 1 | Port Aransas | 1 |
| Eustace | 7 | Richardson | 2 |
| Fort Worth | 3 | Rockport | 2 |
| Galveston | 3 | Rosharon | 6 |
| Garland | 4 | San Angelo | 13 |
| Gilmer | 1 | Scurry | 1 |
| Gladewater | 3 | Seven Points | 9 |
| Grand Praire | 1 | Simms | 1 |
| Grapevine | 1 | Spring | 1 |
| Greenville | 1 | Springtown | 3 |
| Gun Barrel City | 5 | Stafford | 1 |
| Hamlin | 1 | Sugarland | 1 |
| Hooks | 1 | Sweeny | 1 |
| Horshoe Bay | 1 | Trinidad | 1 |
| Houston | 17 (+2 to CO) | Trinity | 4 |
| Humble | 1 | Tyler | 2 |
| Karnack | 1 | Wichita Falls | 1 |
| Kaufman | 3 | Wylie | 1 |
| | | Total | 233 |

Table 3. Number of Mussel, Clam and Naiad Licenses sold to Texas non-residents, September 1990 through December 1991.

| State | Number licenses |
|---|---|
| Oklahoma | 49 |
| Tennessee | 47 |
| Illinois | 16 |
| Arkansas | 16 |
| Alabama | 10 |
| Iowa | 10 |
| North Dakota | 3 |
| Kentucky | 2 |
| Wisconsin | 2 |
| Colorado | 2 |
| Oregon | 2 |
| Missouri | 2 |
| Florida | 1 |
| Total | 162 |

Figure 1. Freshwater mussel survey questionnaire mailed January 1992 to individuals who purchased Texas Mussel, Clam and Naiad licenses, 1 September 1990 through 31 December 1991.

**OPINIONS:**

**The number of mussels available for harvest in recent years has:**

- ☐ Increased
- ☐ Decreased
- ☐ Remained the same
- ☐ Don't know

**The size of individual mussels available for harvest in recent years has:**

- ☐ Increased
- ☐ Decreased
- ☐ Remained the same
- ☐ Don't know

**Do mussels in Texas require management?**

- ☐ Yes
- ☐ No
- ☐ Don't know

**Are there areas where mussel harvest should be prohibited?**

- ☐ Yes
- ☐ No
- ☐ Don't know

**If yes, where and why**

_____

_____

_____

**Has water pollution been a problem for Texas mussel populations?**

- ☐ Yes
- ☐ No
- ☐ Don't know

**Is illegal mussel poaching a problem in Texas?**

- ☐ Yes
- ☐ No
- ☐ Don't know

**Should mussel license fees be higher for non-resident musselers?**

- ☐ Yes
- ☐ No
- ☐ Don't know

**Can Texas mussel populations support the present harvest rates**

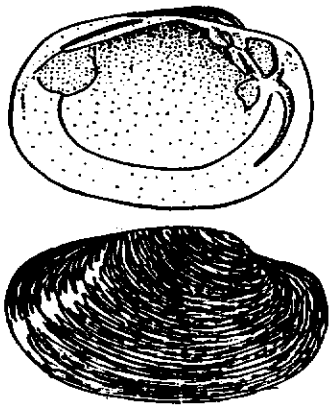
- ☐ Yes
- ☐ No
- ☐ Don't know

**TEXAS PARKS AND WILDLIFE DEPARTMENT**
**HEART OF THE HILLS RESEARCH STATION**
**HCO 7, Box 62**
**INGRAM, TEXAS 78025**

**Attention: Robert Howells**

**Texas Parks and Wildlife Department**
**Inland Fisheries**
**Heart of the Hills Research Station**

**FRESHWATER MUSSEL FISHERY SURVEY QUESTIONNAIRE**



**Large-scale collection of fresh-water mussels in Texas began as early as 1909 when Caddo Lake mussels were harvested for pearls. Mussels have gained additional interest in recent years. Unfortunately, there have been few biological studies of either mussels or of mussel fisheries in Texas. Now with increasing interest in pearls and shells, it is becoming increasingly important to better understand this natural resource.**

**Freshwater mussels are a valuable renewable resource that can provide harvests for decades to come. Your help can go a long way to understanding and maintaining mussel populations and preserving the fishery for future generations.**

**Please complete this questionnaire and return it to TPWD. Note also that aside from basic questions, there is also a section for your opinions about mussels and mussel fishing. This is a chance for you to call on your experience and let TPWD know what you think.**

**tape or staple here**

QUESTIONS:

Are you a Texas resident?
- [ ] Yes
- [ ] No

If yes, how long have you lived in Texas?
_____years

How many years have you been harvesting mussels?
_____ Years

Where do you usually collect mussels?
- [ ] Lakes and reservoirs
- [ ] Rivers and streams
- [ ] Other_____

In which water bodies do you usually fish for mussels?

| | Name | Near (city/land mark) |
|---|---|---|
| 1. | _____ | _____ |
| 2. | _____ | _____ |
| 3. | _____ | _____ |
| 4. | _____ | _____ |

How far from your home do you usually travel to collect mussels?
- [ ] less than 50 miles
- [ ] 50 - 100 miles
- [ ] 101 - 200 miles
- [ ] more than 200 miles

Which species and sizes of mussels do you collect most frequently?

| | Species | Size taken (in.) |
|---|---|---|
| [ ] | Don't know/uncertain | _____ |
| [ ] | Washboards | _____ |
| [ ] | Threeridges/roundlakes | _____ |
| [ ] | Mapleleafs/pimpleBacks | _____ |
| [ ] | Ebony mussels | _____ |
| [ ] | Pigtoes | _____ |
| [ ] | Purple-shell (Tampico) | _____ |
| [ ] | Asiatic clam (Corbicula) | _____ |
| [ ] | Other Species_____ | _____ |
| | _____ | _____ |
| | _____ | _____ |
| | _____ | _____ |

Do you
- [ ] Collect only certain mussel species?
- [ ] Release unwanted mussel species?
- [ ] Retain all species of mussels?

Do you
- [ ] Collect only large mussels?
- [ ] Release small mussels?
- [ ] Retain all sizes?

What months do you usually fish for mussels?
From_____ to _____

Do you consider mussel collection
- [ ] Sport or personal?
- [ ] Commercial or professional?

What are the primary reasons you collect mussels?
- [ ] Shells
- [ ] Pearls
- [ ] Meat
- [ ] Other_____

What do you do with mussel shells?
- [ ] Personal use
- [ ] Sell to others
- [ ] Discard
- [ ] Other_____

What do you do with pearls?
- [ ] Personal use
- [ ] Sell to others
- [ ] Discard
- [ ] Other_____

What do you do with mussel meat?
- [ ] Personal use
- [ ] Sell to others
- [ ] Discard
- [ ] Bait
- [ ] Human consumption
- [ ] Others_____

How do you collect mussels?
- [ ] Wade
- [ ] Dive (without SCUBA)
- [ ] Dive with SCUBA or breathing equipment
- [ ] Other_____

Do you use a boat to collect mussels?
- [ ] Yes
- [ ] No

What gear do you use to collect mussels?
- [ ] Hand
- [ ] Brailles/crowfoot
- [ ] Dredge
- [ ] Dip net
- [ ] Rake
- [ ] Other_____

Estimate the number of mussels you harvested in 1991.
- [ ] Less than 500
- [ ] 501 - 1,000
- [ ] 1,001 - 5,000
- [ ] 5,001 - 20,000
- [ ] More than 20,000

Estimate the pounds of mussels you harvested in 1991.
- [ ] Less than 500 pounds
- [ ] 501 - 1,000 pounds
- [ ] 1,001 - 5,000 pounds
- [ ] 5,001 - 20,000 pounds
- [ ] More than 20,000 pounds

Have you ever attempted to rear or culture mussels?
- [ ] Yes
- [ ] No

Have you ever experienced conflicts or problems with other natural resource user groups?
- [ ] No
- [ ] Yes - Other musselers
- [ ] Yes - Private landowners
- [ ] Yes - Rod and reel fisherman
- [ ] Yes - Trotline anglers
- [ ] Yes - Commercial fisherman
- [ ] Yes - Boaters (power, sail, etc.)
- [ ] Yes - Sand/gravel operations
- [ ] Yes - Other_____

Estimate the annual value (to you) of the mussels and pearls you harvest.
- [ ] Less than $100
- [ ] $101 - $1,000
- [ ] $1,001 - $5,000
- [ ] $5,001 - $20,000
- [ ] More than $20,000

Collecting mussels is
- [ ] Primary source of income
- [ ] Additional income
- [ ] Sport or hobby

Have you ever observed mussel die-offs in Texas?
- [ ] Yes
- [ ] No

If yes: when, where and why?_____
_____
_____

Have you ever had problems with mussel identification?
- [ ] Yes
- [ ] No

Have you ever needed a technical expert for advise and information on mussels?
- [ ] Yes
- [ ] No

continued on back....