

The trade in native and exotic turtles in Texas

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Abstract There are growing concerns among conservationists that commercial trade in many species of wild-caught turtles may not be sustainable. Little information on the turtle trade and its impact on populations is available at the national level, and there are no analyses of the commercial trade in turtles in Texas. To quantitatively describe the turtle trade in Texas, we surveyed government organizations, pet and meat establishments, reptile expositions, zoos, aquariums, and Texas herpetological societies by mail, phone calls, or visits. We used the United States Fish and Wildlife Service's (USFWS) Law Enforcement Management Information System (LEMIS) database to quantify the turtle trade in Texas from 1995–2000. Five turtle species accounted for 99% of collections from the wild in 1999, but at least 69 native and exotic species were available in the pet and meat markets. Nonnative species were exported from Texas, implying that they were either imported from other states and re-exported from Texas or were bred in captivity. Unfortunately, the current national wildlife trade monitoring system does not distinguish between export and re-export, making it difficult to fully understand wildlife trade patterns. Turtle populations in general were susceptible to overexploitation. We recommend that populations of commercially exploited turtles be monitored to build databases required for establishing harvest quotas and size limits. Methods used in this study could be implemented by other states to monitor their turtle trade.

Key words tortoise, turtle, United States Fish and Wildlife Service LEMIS database, wildlife trade

Turtles traditionally have been traded to supply meat, pets, oil, medicines, and manufactured products. However, there are growing concerns among conservationists that commercial trade in many species of wild-caught turtles may not be sustainable. Diverse turtle taxa around the world are in decline, and the turtle trade has been cited as one of the most dangerous causes of population declines for some species (Salzberg 1995, Dixon 2000, Gibbons et al. 2000). Indeed, turtle specialists have suggested that some North American species are being increasingly targeted to supply the Asian food market in the United States of America (USA) and Asia due to depletion of wild populations of Asian turtle species (Behler 1997). In their review, Gibbons et al. (2000) reported that of 293 species and subspecies of turtles, tortois-

es, and sea turtles, 3% were extinct in the wild, 15% were endangered, and 21% were vulnerable.

The pattern of population decline among diverse turtle taxa can be explained by the susceptibility of most turtle species to overharvest. The life history of turtles generally can be characterized by delayed onset of maturity, high adult survivorship, and low survivorship of neonates. Populations with these life-history traits are unlikely to withstand harvest of adults and subadults without intense management because population growth is extremely sensitive to adult survivorship (Crouse et al. 1987, Heppell 1998). This life-history pattern, combined with the vulnerability of some turtles to trapping, makes many populations susceptible to overharvest (Congdon et al. 1993, 1994).

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Although positive steps are being taken to implement monitoring systems, record keeping for the turtle trade has been lacking. Turtle trade in the USA has not been well regulated in the past, and the turtle market is poorly understood. Therefore, evaluations of the magnitude and impact of commercial trade in turtles is extremely difficult. Data on exports of turtles from the USA have been reported (Salzberg 1995), with only one study of the nongame wildlife trade in Texas (Jester 1992). Jester (1992) identified 5 genera of turtles commercially traded in Texas—box turtles (*Terrapene* spp.), mud turtles (*Kinosternon* spp.), pond sliders (*Trachemys scripta*), map turtles (*Graptemys* spp.), and softshells (*Apalone* spp.)—and concluded that these species were collected in response to market demand. More recently, Dixon (2000) noted an increase in commerce of some turtle species for food and pets in Texas since the 1970s. He listed species noted by Jester (1992) and others, such as alligator snapping turtles (*Macrolemys temminckii*), chicken turtles (*Deirochelys reticularia*), and cooters (*Pseudemys* spp.). Although none of the 24 Texas native species are listed under the Federal Endangered Species Act, 3 are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and the Texas Parks and Wildlife Department (TPWD) lists 1 as endangered, 2 as threatened, and 17 as nongame. This study is the first attempt to describe and quantify the use and trade of aquatic and terrestrial native and exotic turtles in Texas. We provide quantitative and qualitative information about turtle species collected from the wild, exotic species being imported and locally traded during the study period, areas of collection and trade, prices, and uses. We employed several strategies to survey turtle collectors and user groups, and report on the efficacy of our methods.

Methods

We used counties in Texas as the minimal geographic unit for analyses because Texas counties are relatively small and there exists a recent and complete compilation of the distribution of Texas turtle species organized by counties (Dixon 2000). Groups identified as being involved with the turtle trade in Texas were: the United States Fish and Wildlife Service (USFWS), TPWD, pet shops, meat and seafood markets, regional herpetological societies, zoos, aquariums, turtle breeders and vendors, and reptile expositions. These groups have different kinds of involvement with the turtle trade; thus, we

used different approaches to survey them (Ceballos 2001). All methods were approved by the Texas A&M University Institutional Review Board.

Surveys

The USFWS compiles and keeps records of all turtle shipments going in and out of the USA in its Law Enforcement Management Information System (LEMIS), a computerized and codified database for all declared wildlife imports and exports. These records are retained for 5 years and can be accessed through the Freedom of Information Act (5 U.S.C. § 552). We requested turtle import and export data from and to Texas between 8 August 1995 and 21 December 2000. These data included number of animals traded, country of origin and destination, whether turtles were wild-caught or captive-bred, and value of each shipment. The TPWD regulations require anyone wishing to collect or trade nongame species to buy a collection or dealer permit and submit an annual report of activities (Parks and Wildlife Code, Chapter 67, §65.325–§65.331). We requested collector reporting information from TPWD on turtle species collected, quantities, dates, collectors, and counties where activities were reported.

We conducted a telephone survey to obtain information on the market in pet turtles and turtle meat using a directory of pet shops and meat and seafood businesses purchased from *infoUSA*, Inc. We made phone calls to all pet shops and meat and seafood establishments listed in the directory located in the 31 counties of Texas with $\geq 100,000$ inhabitants. All phone calls were made between 12 February and 6 March 2001 (Ceballos 2001). We called each pet shop as if we were a potential customer and asked what turtle species were available, their prices, and sizes. We took this approach to maximize the response rate. Because the researcher remained anonymous and there were no questions about the respondents' identity, our protocol for using human subjects was approved by the Texas A&M University Institutional Review Board. In the case of meat and seafood markets, questions included species, availability, prices, and quantity of turtle meat in stock.

To obtain information from pet reptile vendors and the public, we visited all 7 expositions in Houston, San Antonio, and Arlington, Texas between September 2000 and April 2001. We recorded information from vendors and breeders on species offered, prices, and life stage. We used a standardized questionnaire to obtain information from the

public about turtle species they owned, why they liked those species, and what species they would like to see offered at expositions. Respondents' identities remained anonymous.

Regional herpetological societies in Texas are actively involved with the turtle trade, and they constituted the fourth study group. On 1 February and 29 March 2001, a letter of inquiry and a questionnaire were mailed to 13 societies known to exist in Texas, with questions regarding species they believe to be the most traded in Texas, life stages, prices, and uses. We also mailed a questionnaire to all 12 zoos and 4 aquariums operating in Texas with questions regarding species, sex, age, and origin of each turtle in their collection.

Because datasets were skewed, we reported the median as well as mean and standard deviation. We followed Crother (2000) for standard English names of North American turtle species and King and Burke (1989) for common names of species found outside North America.

Results

We documented 88 turtle species and 18 more to the level of genus being used or traded in Texas. Turtles identified only to genus were reported only by genus in the LEMIS or TPWD databases and may not all necessarily be different taxa from the 88 identified species. Of the identified species, 18 were native to Texas, 22 were native to the USA but not to Texas, and 48 were exotic (Table 1).

Table 1. Turtle species in Texas reported by trade or use category based on data in the USFWS LEMIS database, reported by TPWD, or from phone surveys to pet stores, meat and seafood establishments, and zoos and aquariums.

Scientific name	Common name	Trade or use category ^a	Native to ^b
Family Chelydridae			
<i>Chelydra serpentina</i>	Common snapping turtle	I, W, P, F	Texas
<i>Macrochelys temminckii</i>	Alligator snapping turtle	I, P, Z	Texas
Family Kinosternidae			
<i>Kinosternon</i> spp.	Mud turtles	I, P	
<i>Kinosternon angustipons</i>	Narrow-bridged mud turtle	I	Exotic
<i>Kinosternon bauri</i>	Striped mud turtle	P	USA
<i>Kinosternon flavescens</i>	Yellow mud turtle	W, P	USA
<i>Kinosternon scorpioides</i>	Scorpio mud turtle	P	Exotic
<i>Kinosternon subrubrum</i>	Florida mud turtle	I, W, P	USA
<i>Staurotypus salvanii</i>	Chiapas giant musk turtle	I	Exotic
<i>Staurotypus triporcatus</i>	Mexican giant mud turtle	I	Exotic
<i>Sternotherus</i> spp.	Musk turtle	I, P	
<i>Sternotherus carinatus</i>	Razorback musk turtle	P, Z	Texas
<i>Sternotherus odoratus</i>	Common musk turtle	I, P	Texas
Family Emydidae			
<i>Chrysemys picta</i>	Painted turtle	I, W, P	Texas
<i>Callagur</i> spp.	Painted terrapin	I,	
<i>Callagur borneoensis</i>	Painted terrapin	I,	Exotic
<i>Clemmys</i> spp.	American pond turtles	I,	
<i>Clemmys guttata</i>	Spotted turtle	I, P, Z	USA
<i>Clemmys insculpta</i>	Wood turtle	P	USA
<i>Cuora</i> spp.	Asian box turtle	I, P	
<i>Cuora amboinensis</i>	South East Asian box turtle	I, P	Exotic
<i>Cuora galbinifrons</i>	Indochinese box turtle	I	Exotic
<i>Cuora trifasciata</i>	Chinese wood turtle	P	Exotic
<i>Cyclemys</i> spp.	Asian leaf turtle	P	
<i>Cyclemys dentata</i>	Asian leaf turtle	I,	Exotic
<i>Deirochelys reticularia</i>	Western chicken turtle	I, W, P	Texas
<i>Emys</i> spp.	European pond turtle	P	
<i>Emys orbicularis</i>	European swamp turtle	I	Exotic
<i>Emydoidea blandingii</i>	Blanding's turtle	I	USA
<i>Geoclemys hamiltonii</i>	Spotted pond turtle	Z	Exotic
<i>Geoemyda spengleri</i>	Black-bellied notched turtle	Z	Exotic
<i>Graptemys</i> spp.	Map turtle	I, P	
<i>Graptemys barbouri</i>	Barbour's map turtle	P	USA
<i>Graptemys caglei</i>	Cagle's map turtle	I, W	Texas
<i>Graptemys gibbonsi</i>	Pascagoula map turtle	I, P	USA
<i>Graptemys geographica</i>	Common map turtle	I	USA
<i>Graptemys pseudogeographica</i>	Mississippi map turtle	I, W, P, Z	Texas
<i>Graptemys nigrinoda</i>	Black-knobbed map turtle	I, P, Z	USA
<i>Graptemys ouachitensis</i>	Ouachita map turtle	I, W, P	Texas
<i>Graptemys pulchra</i>	Alabama map turtle	I, P	USA
<i>Graptemys versa</i>	Texas map turtle	I	Texas
<i>Heosemys</i> spp.	Forest turtle	I, P	
<i>Heosemys spinosa</i>	Spiny turtle	I, Z	Exotic
<i>Malaclemys terrapin</i>	Diamondback terrapin	I, P	Texas
<i>Notochelys platynota</i>	Malayan flatshell turtle	I	Exotic

(Continued)

^a Uppercase letters denote use categories: Import/export (I), wild-caught (W), pets (P), food (F), zoos and aquariums (Z). Totals: I = 66, W = 14, P = 58, F = 2, Z = 38.

^b This column indicates whether the species was native to Texas, the USA (excluding Texas), from a different country (exotic), or unknown (blank). Totals: Texas = 18, USA = 22, Exotic = 48. Individuals identified to the genera level are left blank.

Table 1 (continued). Turtle species in Texas reported by trade or use category based on data in the USFWS LEMIS database, reported by TPWD, or from phone surveys to pet stores, meat and seafood establishments, and zoos and aquariums.

Scientific name	Common name	Trade or use category ^a	Native to ^b
Family Emydidae (continued)			
<i>Pseudemys</i> spp.	Cooter turtle	I, P	
<i>Pseudemys rubriventris</i>	American red-belly turtle	I, P	USA
<i>Pseudemys concinna</i>	River cooter	I, W, P	Texas
<i>Pseudemys floridana</i>	Florida cooter	I, P	USA
<i>Pseudemys nelsoni</i>	Florida red belly	I, P	USA
<i>Pseudemys texana</i>	Texas river cooter	W, P	Texas
<i>Sacalia bealei</i>	Beale's turtle	Z	Exotic
<i>Terrapene</i> spp.	Box turtle	P	
<i>Terrapene carolina</i>	Eastern box turtle	I, W, P, Z	Texas
<i>Terrapene ornata</i>	Ornate box turtle	I, W, P, Z	Texas
<i>Trachemys</i> spp.	Slider	I	
<i>Trachemys scripta</i>	Pond slider	I, W, P, Z	Texas
<i>Rhinoclemmys</i> spp.	Wood turtle	I, P	
<i>Siebenrockiella crassicolis</i>	Fat-headed turtle	I	Exotic
Family Testudinidae			
<i>Gopherus agassizii</i>	Desert tortoise	I, Z	USA
<i>Gopherus berlandieri</i>	Texas tortoise	I, Z	Texas
<i>Gopherus flavomarginatus</i>	Bolson tortoise	Z	Exotic
<i>Gopherus polyphemus</i>	Gopher tortoise	Z	USA
<i>Geochelone carbonaria</i>	Red foot tortoise	I, P, Z	Exotic
<i>Geochelone denticulata</i>	Yellow foot tortoise	P, Z	Exotic
<i>Geochelone elegans</i>	Indian star tortoise	I, P, Z	Exotic
<i>Geochelone elephantopus</i>	Galapagos giant tortoise	Z	Exotic
<i>Geochelone sulcata</i>	African spurred tortoise	I, P, Z	Exotic
<i>Geochelone pardalis</i>	Leopard tortoise	I, P, Z	Exotic
<i>Geochelone radiata</i>	Radiated tortoise	Z	Exotic
<i>Indotestudo elongata</i>	Elongated tortoise	I, Z	Exotic
<i>Indotestudo forsterii</i>	Travancore tortoise	I	Exotic
<i>Kinixys</i> spp.	Hingeback tortoise	P	
<i>Kinixys belliana</i>	Bell's hinged tortoise	I, P	Exotic
<i>Kinixys erosa</i>	Serrated tortoise	I	Exotic
<i>Kinixys homeana</i>	Home's hinged tortoise	I	Exotic
<i>Malacochersus tornieri</i>	African pancake tortoise	Z	Exotic
<i>Manouria emys</i>	Burmese brown tortoise	I	Exotic
<i>Pyxis arachnoides</i>	Spider turtle	I	Exotic
<i>Pyxis planicauda</i>	Madagascar flat-shelled	I	Exotic
<i>Testudo graeca</i>	Spur-thighed turtle	I, P	Exotic
<i>Testudo hermanni</i>	Hermann's tortoise	I, P	Exotic
<i>Testudo horsfieldii</i>	Russian tortoise	P	Exotic
Family Trionychidae			
<i>Amyda</i> spp.	Softshell	I	
<i>Apalone</i> spp.	Softshell turtle	I, P, F	
<i>Apalone spinifera</i>	Spiny softshell	I, W, P	Texas
<i>Apalone ferox</i>	Florida softshell	I, P	USA
<i>Apalone sinensis</i>	Softshell	I	USA

(Continued)

^a Uppercase letters denote use categories: Import/export (I), wild-caught (W), pets (P), food (F), zoos and aquariums (Z). Totals: I = 66, W = 14, P = 58, F = 2, Z = 38.

^b This column indicates whether the species was native to Texas, the USA (excluding Texas), from a different country (exotic), or unknown (blank). Totals: Texas = 18, USA = 22, Exotic = 48. Individuals identified to the genera level are left blank.

Wild collection

During 1999, 92% of dealer permit holders ($n = 118$) and 57% of collector permit holders ($n = 238$) submitted annual reports to TPWD. Based on these reports, 16,110 turtles of 14 species were collected from the wild, with 99% of the total consisting of only 5 species: spiny softshell (*Apalone spinifera*) (59.9%), pond slider (27.2%), yellow mud turtle (*Kinosternon flavescens*) (6.2%), ornate box turtle (*Terrapene ornata*) (4.75%), and eastern box turtle (*T. carolina*) (1.1%). Turtles were collected from 30 counties, but 78% ($n = 12,581$ turtles) came from only 3 counties: Hidalgo, Cameron, and Lamar (Figure 1). Hidalgo County was the origin of 5,512 spiny softshells, Cameron County of 3,533 spiny softshells and 915 pond sliders, and Lamar County of 2,621 pond sliders.

Collection of turtles was not uniform throughout the year, being substantially higher from February–August and almost non-existent from September–January (Figure 2). Interestingly, the 2 most productive collectors accounted for 76% of total turtle harvest. Overall, number of turtles collected per person varied between 1 and 9,502. The first-ranked collector reported 9,502 turtles (86% spiny softshells and 14% pond sliders), and the second-ranked collector reported 2,778 turtles (94% pond sliders, 3% spiny softshells, and 3% common snapping turtles (*Chelydra serpentina*); Figure 3).

Turtle use

We made 1,467 phone calls to 507 pet shops, 709 meat markets, and 251 seafood mar-

Table 1 (continued). Turtle species in Texas reported by trade or use category based on data in the USFWS LEMIS database, reported by TPWD, or from phone surveys to pet stores, meat and seafood establishments, and zoos and aquariums.

Scientific name	Common name	Trade or use category ^a	Native to ^b
Family Trionychidae			
<i>Amyda</i> spp.	Softshell	I	
<i>Apalone</i> spp.	Softshell turtle	I, P, F	
<i>Apalone spinifera</i>	Spiny softshell	I, W, P	Texas
<i>Apalone ferox</i>	Florida softshell	I, P	USA
<i>Apalone sinensis</i>	Softshell	I	USA
Family Pelomedusidae			
<i>Pelusios</i> spp.	African side-neck turtle	P	
<i>Pelusios subniger</i>	African mud turtle	Z	Exotic
<i>Pelomedusa</i> spp.	Sideneck turtle	P	
<i>Podocnemis expansa</i>	Amazon river turtle	Z	Exotic
<i>Podocnemis unifilis</i>	Yellow-spotted Amazon river turtle	Z	Exotic
Family Platysternidae			
<i>Platysternon megacephalum</i>	Chinese big-headed turtle	P, Z	Exotic
Family Chelidae			
<i>Chelus fimbriatus</i>	Matamata	P, Z	Exotic
<i>Eseya novaeguineae</i>	New Guinea snapper	P	Exotic
<i>Eseya latisternum</i>	Bellinger river turtle	Z	Exotic
<i>Chelodina longicollis</i>	Eastern snake-necked turtle	Z	Exotic
<i>Chelodina parkeri</i>	Parker's snake-necked turtle	Z	Exotic
<i>Chelodina steindachneri</i>	Flat-shelled turtle	Z	Exotic
Family Carettochelyidae			
<i>Carettochelys insculpta</i>	Pig-nose turtle	P	Exotic
Family Cheloniidae			
<i>Caretta caretta</i>	Loggerhead sea turtle	Z	USA
<i>Chelonia mydas</i>	Green sea turtle	Z	USA
<i>Eretmochelys imbricata</i>	Hawksbill turtle	Z	USA
<i>Lepidochelys kempii</i>	Kemp's ridley sea turtle	Z	USA

^a Uppercase letters denote use categories: Import/export (I), wild-caught (W), pets (P), food (F), zoos and aquariums (Z). Totals: I = 66, W = 14, P = 58, F = 2, Z = 38.

^b This column indicates whether the species was native to Texas, the USA (excluding Texas), from a different country (exotic), or unknown (blank). Totals: Texas = 18, USA = 22, Exotic = 48. Individuals identified to the genera level are left blank.

kets. We achieved a response rate of 78.8%; there was no response from 312 calls. We categorized the remaining 1,156 successful calls as: "sellers," those who had live turtles or turtle meat available at the time of the phone call; "potential sellers," those who did not have turtles or turtle meat available but usually sell them upon request; and "not involved," those who never sold turtles or turtle meat.

Pet shops. Of the 401 successful calls made to pet shops, 61.5% were not involved with the turtle trade, 16.4% were potential sellers, and 21.9% were current sellers. Some pet shops ($n=88$) had >1 species available at the time of the call ($\bar{x}=2.18$, $SD=1.99$). Twenty-eight turtle species were reported from pet shops, including 7 species native to Texas,

5 species distributed in the USA but not in Texas, and 16 exotics. Species most traded were the pond slider ($n=49$), the exotic African spurred tortoise (*Geochelone sulcata*) ($n=18$), and the Russian tortoise (*Testudo horsfieldii*) ($n=12$). Softshells ($n=11$) and box turtles (*T. ornata*, *T. carolina*, and *Terrapene* spp.) ($n=18$) also were common in pet shops. Additionally, 6 pet shops mentioned the ability to obtain box turtles, and 5 pet shops reported greater availability of freshwater turtles during late spring and summer.

Exotic species had the highest average prices. The highest mean prices were for the matamata (*Chelus fimbriatus*) from South America and Guyana (\$300.00), followed by the red-footed tortoise (*Geochelone carbonaria*) from South America (\$243.00), the yellow-footed tortoise (*G. denticulata*) from South America (\$175.00), the leopard tortoise (*G. pardalis*) from Africa (\$163.00), the big headed turtle (*Platysternon megacephalum*) from southeastern Asia (\$120.00), and the African spurred tortoise (\$114.00). Species with the lowest mean

prices were native to Texas or the USA: painted turtles (*Chrysemys picta*) (\$10.80), river cooters (*Pseudemys concinna*) (\$11.88), mud turtles (\$12.00), Florida red-bellied cooters (*P. nelsoni*) (\$13.75), and pond sliders (\$13.80). Not surprisingly, the majority of pet-shop sellers and potential sellers were located in the most human-populated counties: Harris (24.6%), Dallas (11.6%), Bexar (9.7%), Travis (6.5%), and Tarrant (8.4%; Figure 1).

Meat and seafood markets. Of the 754 successful calls made to meat ($n=583$) and seafood establishments ($n=172$), 720 did not sell turtle meat, 26 were potential sellers, and only 8 had turtle meat available. Two respondents said most wild-caught turtles weighed 20–35 pounds (they were probably

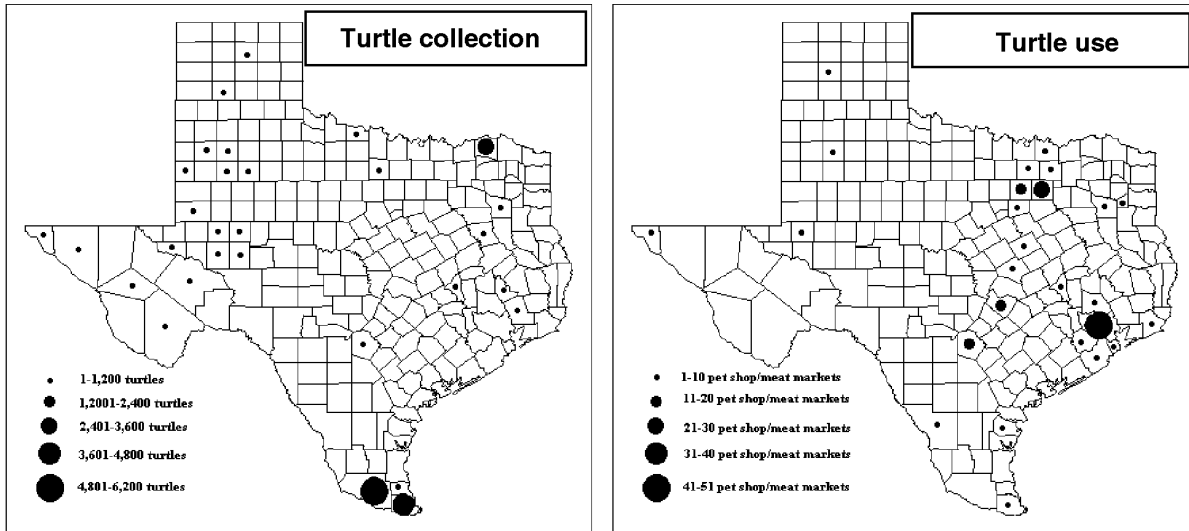


Figure 1. Distribution of collection and use of turtles in Texas counties. Left: Counties where turtles were reported collected in 1999. Right: Counties with pet shops and meat and seafood markets that had live turtles or turtle meat for sale or were classified as potential sellers.

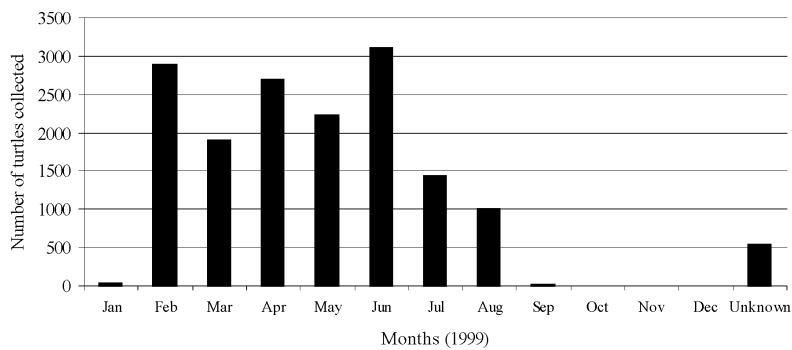


Figure 2. The number of turtles collected from the wild in Texas each month during 1999.

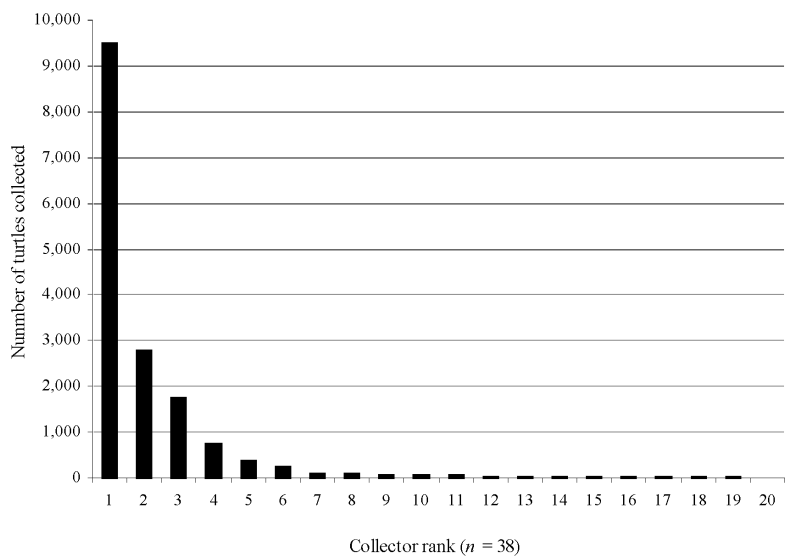


Figure 3. The ranked distribution of the number of turtles reported by collector during 1999.

referring to snapping turtles) and provided 8–10 pounds of meat after processing. The head, carapace, claws, and viscera were considered waste. Meat sellers did not usually know what species of turtle they were selling, but 3 sellers said it was “softshell” and 3 said it was “snapping turtle.”

Most respondents claimed not to know the origin of turtle meat, but 9 said it came from Louisiana and 1 said it came from Houston, Texas. Seven people said turtle meat comes frozen, and 12 that it comes packed in “2–5 pound buckets” (0.91–2.27 kg). The amount of meat available varied among establishments, from individual retail purchases to large amounts for restaurants, as was the case of one seller in Houston who had around 1,133.98 kg of boneless turtle meat for sale. Prices per kilogram of turtle meat varied among locations and whether it was boneless (\bar{x} =\$6.56 kg, SD=1.99, n =10), semi-boneless (\bar{x} =\$4.30 kg, SD=\$0.32, n =2), or bone-in (\bar{x} =\$4.79 kg, SD=1.48, n =3). Some sellers quoted the price without specifying bone content (\bar{x} =\$6.11 kg, median=\$4.54, SD=2.83, n =7). The lowest price per kilogram was \$3.00, the highest \$10.89, for an overall mean of \$5.38 per kilogram, (SD=\$2.38, n =22). Two people mentioned there were 7 “types of meat” in a turtle, each with different textures and colors, and that meat comes mainly from the legs, neck, and breast.

As in the trade of turtles for pets, most sellers and potential sellers of turtles for meat were in Harris County (43%), Bexar County (11%), Dallas County (9%), and Travis County (9%). These results suggested there was a tendency to market turtle meat in metropolitan areas such as Houston (5 sellers, 7 potential), San Antonio (4 potential), Dallas (3 potential), and Austin (3 sellers). In fact, we found a statistically significant relationship between population size of the county and number of pet shops ($F_{30}=273.05$, $P<0.0001$, $R^2=0.90$) and between the population size and number of meat and seafood markets ($F_{30}=63.48$, $P<0.0001$, $R^2=0.68$).

Reptile expositions. Reptile expositions were organized events, similar to swap meets, where professional and amateur traders assembled to sell reptiles and amphibians. We visited 7 expositions between 9 September 2000 and 14 April 2001: 3 in Houston, 3 in Arlington, and 1 in San Antonio. Of 27 concession stands with turtles for sale, the pond slider was the most common species (n =11), followed by the African spurred tortoise, the eastern box turtle (n =9 stands each), and the red-footed tortoise (n =6). Prices followed the same pattern

observed for turtles at pet shops: exotic species fetched higher mean prices than native species. Highest asking prices were paid for pig-nosed turtle (*Carettochelys insculpta*) (\$300.00) from Papua New Guinea and Australia, followed by the cherry-headed tortoise, a variety of the red-footed tortoise (\$212.00), and Hermann’s tortoise (*Testudo hermanni*) (\$165.00) from Europe and the Middle East. Among the species native to North America but not found in Texas were the spotted turtle (*Clemmys guttata*) (\$125.00) and Barbour’s map turtle (*Graptemys barbouri*) (\$100.00). Lowest mean prices were for the spiny softshell (\$8.00), map turtle (*Graptemys* spp.) (\$9.50), pond slider (\$9.69), and musk turtle (*Sternotherus* spp.) (\$21.50). Appearance was an important factor that increased the price of individual turtles, as was the case of an albino pond slider offered for \$225.00. Most turtles were sold as hatchlings or juveniles, and the only adult species observed were the red-footed tortoise and matamora, probably because it was a requirement by exposition organizers that only captive-bred animals be sold. Other than live animals, turtle shells (carapace and plastron) were offered as curios. We observed shells of eastern box turtles, black-knobbed map turtles (*Graptemys nigrinoda*), an African spurred tortoise, Russian tortoise, and a Burmese eyed turtle (*Morenia ocellata*) from Myanmar. Offered by catalog and through the Internet were parts of other species including snapping turtle (shell \$11.00, skull \$20.00) and alligator snapping turtle (shell \$105.00, skull \$65.00).

Of the 82 attendees at expos (n =5) who were approached, 65 answered a written questionnaire (response rate 79.3%). These individuals attended 1–10 reptile expositions a year (\bar{x} =2.57, SD=1.91, n =64). A total of 34 respondents (52.3%) had up to 22 different species of turtles as pets (\bar{x} =9.27, SD=17.82), reflecting the variety of species available at pet stores and expositions. The pond slider was the most popular species (16 owners), followed by the leopard tortoise (12 owners), the African spurred tortoise (11 owners), and the eastern box turtle (10 owners). Some species not offered by pet shops or at reptile shows were owned by the public, including snapping turtles (7 owners), musk turtles (4 owners), and the New Guinea snapping turtle (*Elseya novaguineae*) (1 owner).

Zoos and aquariums. Four of 12 zoos and 2 of 3 aquariums responded to the mail survey. A total of 231 turtles were reported, representing 38 land,

freshwater, and marine species. The most frequent species were bolson tortoises (*Gopherus flavo-marginatus*) ($n=62$), ornate box turtles ($n=16$), Berlandier's tortoises (*Gopherus berlandieri*) ($n=15$ in 3 zoos), alligator snapping turtles ($n=14$ in 3 zoos), and 4 sea turtle species including the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and Kemp's Ridley sea turtle (*Lepidochelys kempii*). The origin of these turtles varied. Some were born at a zoo (36.8%), donated (28.7%), purchased (19.5%), loaned from another zoo (3.9%), confiscated by USFWS (2.5%), and traded with another zoo (2.5%). The remaining 6.0% had an unclear origin, but at least 9 were born in the wild.

Texas herpetological societies. Of the 13 herpetological societies located in Texas, 2 were defunct and only 3 answered the mail survey (response rate of 27.3%). Because questionnaires were answered by individuals, answers did not necessarily represent the society positions. Respondents indicated that the most traded species in Texas were: pond sliders and spiny softshells as pets, food, and for research; snapping turtles for pets and food; and eastern box turtles, African spurred tortoises, and cooters for pets only. They also indicated that animals traded for pets were hatchlings or small juveniles, and animals traded for food were adults. The origin of traded turtles varied; some were wild-caught, as was the case for pond sliders (according to one respondent), softshells, snapping turtles, and eastern box turtles. Some pond sliders also were reported to be captive-born, as were African spurred tortoises and cooters.

International trade between Texas and other countries. Records of turtle shipments to and from Texas compiled by the LEMIS database indicated that the number of turtles traded between Texas and other countries increased during the 5-year-plus reporting period. Between August 1995 and December 2000, 377,534 turtles left Texas and 35,743 turtles entered Texas (Table 2). Some turtles were identified only to genus, but at least 37 species were exported and 24 imported. Four species made up 89% of the total number of turtles exported from Texas: pond sliders (73.3%), Florida red-bellied cooters (8.1%), Florida softshells (4.5%), and painted turtles (3.6%). A total of 14,779 individuals of 9 species of map turtles were exported during the reporting period. Pond sliders (84.4%), Malayan box turtles (7.6%), and red-footed tortoises

Table 2. Numbers of turtles exported from Texas to other countries and imported to Texas from other countries from August 1995–December 2000, and dollar value (U.S.), as reported in the USFWS LEMIS database.

Year	Exports		Imports	
	Individuals	US\$	Individuals	US\$
1995	25,240	27,001	672	1,340
1996	1,681	5,834	31,244	38,205
1997	16,030	11,245	1,119	10,964
1998	33,650	63,129	441	18,131
1999	184,641	213,775	1,124	13,382
2000	116,292	246,515	1,143	45,124
Total	377,534	567,499	35,743	127,146

(1.8%) together accounted for 94% of turtle imports into Texas. The number of wild-caught turtles exported from Texas also increased. From 1995–1997, monthly exports were less than 400 individuals, but in 1998 and 1999 more than 2,000 individuals per month were exported, especially during April and May. In 2000 exports were even higher, surpassing 4,000 turtles during April, August, and November (Figure 4).

Turtles imported to and exported from Texas had different origins and destinations. They were either wild-caught in the USA or another country, captive-born in the USA or other country, or produced from ranching operations in other countries. The pond slider was the most commonly exported turtle. Eighty percent of turtles exported from Texas went to 4 countries: Republic of Korea (44.6%), Japan (20%), Holland (9.6%), and France (6.2%). Turtle exports from Texas were driven by 2 companies that together accounted for 98.8% of all turtle exports from August 1996–December 2000. One firm exported 204,748 turtles and another exported 168,325 turtles. Countries that exported the most turtles to Texas were Singapore (83.4%) and Indonesia (10.3%).

The LEMIS database did not provide information on the specific state in the USA where turtles originated, or whether the shipment was an exportation or a re-exportation. This was the case with Florida red-bellied cooters and Florida softshells, which do not occur naturally in Texas but were reported as exported from Texas. Presuming the species were correctly identified, these turtles must have been imported into Texas or captive-bred in Texas, then re-exported from Texas. This lack of resolution in reporting systems made it difficult to ascertain trade patterns with certainty.

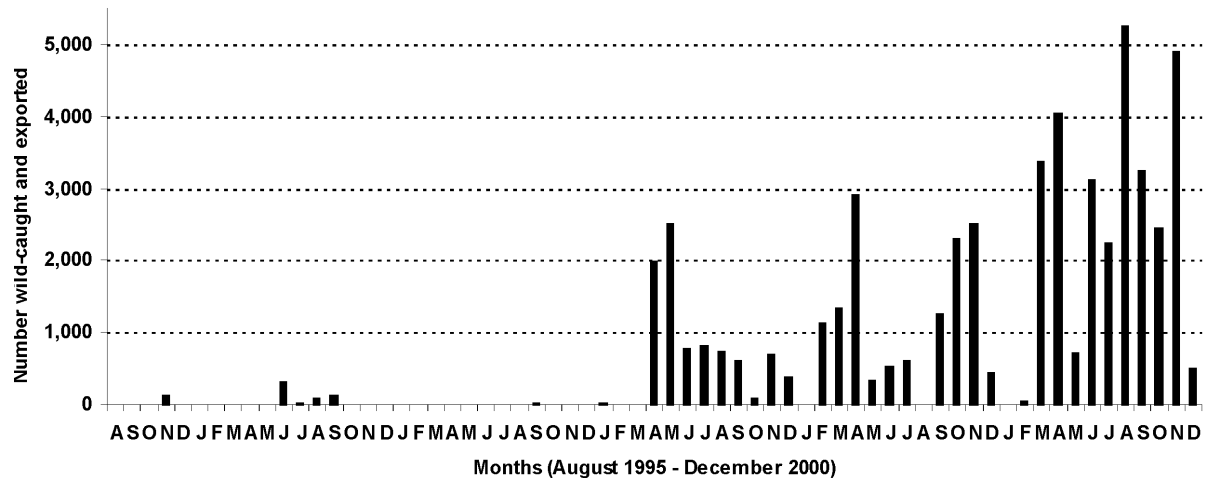


Figure 4. The number of wild-caught turtles exported from Texas by month between August 1995 and December 2000.

Prices were higher for exotics in general than for native species. The highest average price was for the giant musk turtle (*Staurotypus triporcatus*) (\$224.00), followed by the Parker's snake-necked turtle (*Chelodina parkeri*) (\$204.00), spider tortoise (*Pyxis arachnoides*) (\$175.00), and the Madagascar flatshelled (*Pyxis planicauda*) (\$160.60). The lowest prices were for pond sliders (\$0.79), Florida softshells (\$1.26), Florida red-bellied cooters (\$2.41), spiny softshells (\$2.43), and false map turtles (\$2.73). Exceptions to this pattern were the fat-headed turtle (*Siebenrockiella crassicollis*) imported from Indonesia, at \$2.37 each, and the Malayan box turtle at \$2.67. Additionally, prices varied within the same species. For example, prices for alligator snapping turtles ranged from \$1.83–1,200.00.

Discussion

Collection and trade

Information on the extent of wild-turtle collection reported by TPWD and international trade reported by USFWS revealed several general patterns of turtle trade in the USA. Turtle exports from Texas increased from 1996–2000, with recent numbers of turtles exported from Texas surpassing 100,000 individuals/year. This result reflected concurrent increases in turtle trade at the national level, from 3,485,136 in 1989 to 8,990,699 in 1997 (Franke and Telecky 2001). During this time period, turtle exports from Texas accounted for less than 1% of national exports (0.50% in 1995, 0.02% in 1996, and 0.18% in 1997; Franke and Telecky 2001).

The locations where turtles were collected were distinct from where they were sold. Counties with the highest number of turtles collected during 1999 were located primarily in south Texas along the Rio Grande River. In contrast, commercial trade occurred near the large population centers of Texas. This pattern reflected the movement of turtles from areas where a few professional collectors concentrated their activity to urban centers. Pet stores, and presumably demand for wild-caught reptile pets, were concentrated in the urban areas of Texas. The spiny softshell was the species most collected from the wild in Texas, but it was not exported from Texas in large numbers. Apparently, most collected spiny softshells stayed in Texas or elsewhere in the USA. Spiny softshell turtles collected in the wild consist mostly of medium-size and large individuals; hatchling turtles are difficult to find and trap in nature in large numbers. Based on our combined analyses of collecting reports and meat and seafood establishments, it appeared that spiny softshell turtles were transported from collecting areas to urban centers, where they were sold for food.

Unfortunately, we found no means of assessing the extent of the turtle trade from Texas to other states because the LEMIS system did not compile information on re-export or include information on the state of origin. Several examples from our datasets illustrated the need for more detailed reporting information on interstate wildlife trade, in particular the need for data on re-exports. The pond slider was the second most collected species from the wild, for example, and the most exported from Texas. However, not all exported

pond sliders were collected from the wild: It appeared that 216,890 pond sliders were captive-bred according to the LEMIS database. Hatchling turtles were popular as pets, and commercial turtle farms produced yearling and subadult turtles of several species for the pet trade. Indeed, one importer-exporter we interviewed by phone said some hatchling pond sliders were produced on turtle farms in Florida, Arkansas, and Louisiana and sold in Texas for the pet trade. An Internet search also identified several commercial turtle farms in Arkansas, Louisiana, and Texas. Thus, it is not possible to know with certainty how many turtles traded in Texas were produced in Texas or purchased by dealers in Texas and re-exported.

Florida softshell turtles do not occur naturally in Texas but were reported as exported from Texas in the LEMIS database. These exported Florida softshells were apparently either raised in Texas, wild-caught in Florida, or captive-bred somewhere, then imported to Texas and finally re-exported from Texas. A similar explanation applied to the export of painted turtles from Texas. The painted turtle occurred in only 7 of 254 counties in Texas, but 13,416 painted turtles appeared in the trade statistics. Considering the narrow geographic distribution of painted turtles in Texas and the distance of these counties from counties in south Texas where the majority of turtles were collected, it was likely that wild-caught painted turtles were imported into Texas from other states and then re-exported to other countries. It was possible that species were misidentified, but there was no way to assess the accuracy of species identifications reported in the LEMIS database.

We registered a total of 54 exotic species, either imported or re-exported, in pet shops and reptile expositions or kept at zoos or aquariums. Some exotic species at pet shops and zoos were not reported in the 1995–2000 LEMIS database. These may have entered the country before 1995, never been reported, or hatched from parents previously imported. To better assess the potential for introductions of exotic species into the wild, natural resource agencies should be aware of the variety of exotic species and estimated numbers of exotics available for sale and in private collections.

Price patterns

Prices for turtles appeared to correlate with their availability and uniqueness. The pond slider is commonly raised in captivity, and natural populations

were widely distributed in the USA, Central America, and South America. Not surprisingly, pond sliders had among the lowest prices of all turtles. The African spurred tortoise, which is bred in captivity and offered for sale at several reptile expositions as hatchlings, also had a relatively low price. In his international reptile trade report to Traffic North America, Hoover (1998) also found that price was directly tied to the species' availability on the market. There also was a relationship between age and price of turtles. Hatchlings were relatively inexpensive, while high-priced specimens, such as tortoises of the genus *Geochelone*, often were adults. Prices of Texas native species were lower when exported to other countries but higher at local pet shops. For example, spiny softshell turtles were exported at an average price of \$2.50 but were \$20.00 at local pet shops; painted turtles were exported for \$3.00 on average but were offered locally for \$10.80; river cooters were exported for \$3.50 but sold locally for \$12.50. Differences in prices between local and international markets also were known for other reptile trades, particularly when the declared export value was lower than the retail value in the USA (Franke and Telecky 2001).

Export prices of Texas turtle species decreased during the last 2 decades. Hoover (1998) presented a list of average prices paid in the USA for selected wild-caught live reptile species from 1980–1996. The prices during 1980–1995 were higher than the mean prices of turtles exported during the last 5 years (1996–2000). For example, prices of snapping turtles ranged from \$19.00–95.00 during 1980–1995, but averaged \$4.00 since 1996. Spiny softshell ranged from \$11.00–67.00 and dropped to \$3.00. However, it was difficult to fully interpret these market changes because they may be due to many factors including demand, or the inclusion of traded individuals of different sex, size, or age in the datasets through time.

Seasonal patterns

Season played an important role in the collection of turtles from the wild. Most turtles were collected during April–July, when turtles are more active. In contrast, the lowest numbers of turtles collected in Texas occurred September–January. The trade in live turtles contained a significant number of hatchlings; hence, it makes sense that trade peaked during summer when hatchlings were produced in farms. Exports of wild-caught turtles also were

higher during the summer. This indicated that collectors sold their turtles soon after they were collected.

Conclusions and recommendations

Information available on turtle collection and trade reflected trade patterns of animals within the USA that cannot be tracked with current reporting systems. This lack of information regarding the origin of traded turtles needs to be addressed nationally to evaluate the extent to which wild populations are actually being harvested. It is important to point out that although assessing long-term trends in the trade of wild-caught turtles in Texas was beyond the scope of our study, large numbers of turtles were being collected and the turtle trade appears to be increasing based on published historical data (Salzberg 1995). It was clear that some turtle populations were bearing added mortality from hunting, and hunting was concentrated primarily in a few areas. Because turtle life histories are characterized by delayed onset of reproduction, high adult survivorship, and high hatchling mortality, population growth in turtles generally is sensitive to changes in adult survivorship. Turtle populations are unlikely to endure sustained levels of additional adult mortality from hunting, but the other side of the coin is also true—declining populations should stabilize when adult mortality is decreased (Heppell 1998). Therefore, it makes sense to implement precautionary management measures for populations of turtles subject to commercial collecting, and these populations should be monitored to build the datasets required for establishing sustained-yield management programs.

Collection from the wild and commercial trade in turtles were mostly limited to a few individuals and in a few counties. Data collected in this survey did not include clandestine markets; thus we should be aware that real numbers of turtles traded must be higher than our numbers reported here. Although great progress is being made in record-keeping and permitting, information available on the origin of traded turtles was poor, limiting our understanding of the impact of the turtle trade on natural populations and on our ability to assess trade. This is a general problem for all domestically traded wildlife in the USA, and the limitations we faced with data for Texas probably pertain to most states in the USA. Therefore we recommend that data on origin, export, and re-export be tabulated in

trade statistics at both state and national levels.

This is one of only a few attempts to quantitatively assess the turtle trade at a state level in the USA, and we suggest that our methodology could be used by other states to assess their trade in turtles or other traded wildlife. The different user groups involved in our study were a source of valuable data to understand the local collection and trade. International trade data from USFWS can be retrieved for any state, but data regarding collection must be recorded by each state wildlife agency.

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