Box Turtles in Texas:
A Review of Natural History and Call for Conservation Action

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Summary: Box turtles (genus *Terrapene*) are found throughout Texas but in recent years observers report seeing fewer of them. These turtles have evolved in such a way as to require high longevity and high population density in order to survive. As more roads cut through their habitat and as people continue to collect them for pets, box turtle longevity and population density would be expected to drop, perhaps to levels at which populations cannot sustain themselves. Since the Texas Parks & Wildlife Department (TPWD) began receiving data on the collection and sale of Texas box turtles, thousands of box turtles have been reported as purchased and sold. The commercial collection of box turtles thus may be a noteworthy threat to their continued survival in the wild. It is recommended that TPWD support further box turtle research, establish a citizen watch program, and prohibit commercial collection and sale of wild box turtles. A number of volunteer groups would likely help with efforts to gather data and educate the public.

Box turtles are a familiar and well-loved part of the herpetofauna of Texas. Their hinged shells and pretty patterns fascinate people, and their behavior as they chase a grasshopper or closely examine a strawberry is often interpreted as charming. Like the horned lizard, the box turtle is a rarity among reptiles: one that people often are drawn to and one that is missed when it becomes scarce. And box turtles appear to be increasingly scarce in many parts of Texas. As will be seen, the particulars of their natural history make them vulnerable to a number of threats. Many believe it is time to take urgent conservation action, as these turtles may be in serious trouble and may not, in practical terms, be able to recover once they are gone.

Two species of box turtles are found within Texas. One is *Terrapene carolina* (represented by one subspecies, *T. c. triunguis*, the three-toed box turtle) (Dixon, 2000). The other is *Terrapene ornata* (including *T. o. ornata*, the ornate box turtle, and *T. o. luteola*, the desert box turtle) (Dixon, 2000). Historically, box turtles have been considered common in Texas. However, this assumption is based on descriptive records and anecdotal reports, as there do not appear to be any studies of box turtle demographics or population trends within Texas. Many people can recall observations from years ago of numerous box turtles, particularly driving Texas roads on spring mornings. Anecdotal reports in Texas, as in other places, suggest declining populations of these turtles (Bartlett & Bartlett, 1999).

Without population studies in Texas, decisions about managing these species must draw upon studies and reports from other regions, as well as life history information relevant to how box turtles grow, reproduce, and survive. The available information paints an ominous picture of the future of box turtles. Their reproductive life history shows that high population densities are needed for reproductive success. Their low reproductive rate, high juvenile mortality, and high adult survivorship make them especially vulnerable to loss of adults. Their tendency to confine movements to a small home range and their site fidelity suggests that if turtles are lost in one area, nearby turtles may not readily move in to repatriate the area, nor is the release of box turtles for repatriation likely to be a successful conservation strategy.

In light of the apparent vulnerability of Texas box turtles, I review relevant life history traits and then offer suggestions for conserving these turtles for the future.

Home range and movement patterns

In general, box turtles tend to confine their activities to a small area, the home range, within which most activities occur. A relatively small area is utilized, about 1 to 5 hectares (1 hectare is approximately 2.5 acres) depending on whether the turtle is a juvenile or adult and depending upon habitat characteristics (Dodd, 2001). In a study of Missouri *T. c. triunguis*, home range size averaged from 1.2 to 4.7 hectares when captures were by dogs (Schwartz & Schwartz, 1974). In one Wisconsin study of *T. o. ornata*, the average home range of adults was 8.7 hectares (Doroff & Keith, 1990). Others have reported smaller home ranges for *T. ornata*, with an average radius of home range 83.5 meters or average long axis of the home range 94 to 111 meters (cited in Ernst, *et al.*, 1994).

Most box turtles attempt to return to their home range if displaced, and there are many reports in the literature of box turtles successfully returning from distances of about a kilometer (Dodd, 2001). Relocation to distances far beyond 1 km. tend to result in box turtles wandering for long periods without establishing new home ranges, and such turtles are more likely to come into contact with highways, predators, or unsuitable habitat. Doroff & Keith (1990) experimentally released several ornate box turtles at their study site, and found that one group did not tend to disperse while another did disperse. The groups were composed of only five and six turtles, respectively, and contact was lost with two and a third died. Schwartz & Schwartz (1974) released 40 turtles in their study area. Only 17 were recaptured, and only seven of those ultimately appeared to become established in the population. Belzer (2002) has been working on box turtle repatriation in Pennsylvania for a number of years, radio tracking and retrieving turtles that wander away following release in the area, and has found that over 60% of the displaced turtles fail to establish new home ranges. When repatriation efforts began at a different preserve, the

initial year's results showed that released box turtles wandered away from that site, despite the 200 hectare size of the preserve (Belzer, 2002).

The tendency for box turtles to stay within small home ranges may help account for the fact that box turtles may not repopulate an area from which they are extirpated. Even after a twenty-year period, box turtles in Maryland had not recovered after a 1972 flood despite the availability of protected habitat (cited in Dodd, 2001). There are records of the Iroquois in western New York making use of box turtles for various purposes such that the turtles were eventually depleted. In the intervening 200 years, box turtles have not repopulated the area (Belzer, 2002). The conservation implications of data on box turtle home range and movement are clear: it is urgently important to maintain existing viable populations, because once the turtles have disappeared from an area they may never recover, even with human assistance.

Courtship and reproduction

Delayed sexual maturity contributes to box turtles' inability to quickly rebound from losses and it places great importance on the reproductive output of those turtles that do make it to adulthood. It takes a number of years for box turtles to reach sexual maturity. Male ornate box turtles may be sexually mature at 7 to 9 years, while females may be mature at 8 to 11 years; similarly, *Terrapene carolina* is sexually mature in 5 to 10 years (Ernst, et al., 1994). A box turtle must make it through years of growth during which it is very vulnerable to predators before it can add to the population.

Dodd (2001) indicated that we do not know how adult turtles find each other, but he noted that box turtles have some ability to recognize neighbors and thus it might be possible for males to travel within his home range to places where they have encountered neighboring females. Box turtles' overlapping home ranges would facilitate this. However, recent work by Belzer (2002) showed that male box turtles locate females by using visual cues. He conducted a series of experiments showing the importance of visual cues in mating encounters. In one experiment, he placed a visual barrier between a nearby male and female. Males did not show recognition (e.g. by scent) of the nearby hidden female except in one case in which the female moved about, producing sounds. When the visual barrier was lifted, most males approached the female only when she began to move. In another experiment, one female and one male box turtle were hidden an equal distance from a male. The male approached whichever turtle moved, regardless of sex. Belzer also tested the importance of visual cues by moving a skeletal carapace or a wood or plastic decoy in front of males. A number of the males was enticed to chase and court these objects, although when they reached the object they stopped courting, evidently recognizing at close range that these were

not real turtles. The powerful argument emerging from these findings is that box turtle populations must maintain some critical density in order for mating encounters to occur.

If box turtles only find each other by chance encounter, do not usually travel beyond their home range, and do not seek females based on chemical cues, mating opportunities should drop as population density decreases. If a population is thinned, through highway mortality, habitat degradation, or collecting for the pet trade, the population may be reproductively dead even though increasingly geriatric specimens continue to be encountered. Historically there have been reports of box turtles occurring at great densities; Ditmars (1936) quotes a report of ornate box turtles in Kansas "so abundant as to become a nuisance as a cumberer of the ground" (p. 434). As reviewed by Dodd (2001), densities for *T. carolina* range from 2.7-26.9 per hectare and for *T. ornata* up to 13.9 per hectare. Belzer suggested that densities of more than 25 per hectare might be necessary for a population to be able to rebound from losses (Belzer, 2002). It seems possible that box turtles require a greater density than we have appreciated, and that the effects of gradual thinning of populations over the years (incompletely studied but increasingly remarked upon) is something whose importance we are only beginning to understand.

Assuming that mating has occurred, the female lays only a few eggs per clutch. In a study of *T. carolina bauri* in Florida, Dodd (1997) found that the most common clutch size was two. Although this southern population could produce multiple egg clutches annually, such factors as smaller clutch size resulted in no greater egg production than more northern populations of box turtles. For the species (*Terrapene carolina*, of which the three-toed box turtle is a subspecies), the normal clutch size is reported as 4 to 5 eggs (Ernst, *et al*., 1994). The ornate box turtle lays a similar average number of eggs, 4 to 6 (Ernst, *et al*., 1994). Therefore, the picture of box turtle reproductive potential that emerges is of an animal that takes a long time to reach sexual maturity, probably cannot seek out mates across distances if populations are thinned, and then produces relatively few eggs. Further, many box turtle eggs are infertile (Dodd, 2001). To compensate for these factors, box turtles rely on adults surviving a long time and having many opportunities to reproduce.

Demography and survivorship

Box turtles share with many other turtles a set of life history traits that make them unusually vulnerable to loss of adults. It is for this reason that harvesting adults from the wild for pets is a concern, even when the reported take seems relatively low. Box turtle populations have been studied in some localities, but more studies are clearly needed. Multi-year studies have been done, for example, on *T. c. triunguis* in Missouri (Schwartz & Schwartz, 1974) and on *T. ornata* in Wisconsin (Doroff & Keith, 1990) and

Kansas (Legler, 1960). While replications and extensions are needed, we have a fair amount of life history information. We know that box turtles have low reproductive output, that nest and juvenile predation is high, that they have delayed sexual maturity, and that they live a long time. What we know at this point allows us to make general inferences about how box turtle populations change and how much they will be affected by loss of adults.

Where sufficient data are available, life tables can be constructed that can predict how changes on certain variables (such as increased adult mortality) produce changes in populations. Doroff & Keith (1990), using information about the rates at which hatchlings were produced and the annual survivorship of adults, were able to look at what level of juvenile survivorship would be necessary in order for the population to be sustained. Given a relatively low reproductive output, and an adult survivorship of 81% per year, they found that juveniles would require survivorship rates of 90% or better in order to keep the population from dwindling. They noted that such rates of juvenile survivorship were very improbable. Therefore, they predicted that their study population would decline in subsequent years. Their prediction apparently turned out to be true (based on communication with the second author cited in Curtin, 1997). They concluded that the survivorship of adults was, at 81%, too low for the study population to remain viable. When reproductive output is low, females need to remain in the reproductive population for many years in order to replace themselves.

Dodd (2001) has commented that no complete life history tables have yet been assembled for box turtles, and so it is helpful to look at life tables constructed for turtles whose life histories are similar to those of box turtles. Congdon, et al. (1994) reported on a population of common snapping turtles (*Chelydra serpentina*) in Michigan that had been studied over a period of 18 years. They constructed a life table for those turtles based on what was known of clutch size, turtles leaving the population, and survivorship of juveniles and adults. As a result of delayed sexual maturity and extended longevity of adults, they found that loss of adults would have significant effects on the population, such that an increase in annual mortality of 10% among adults would halve the number of adults in less than 20 years. In other words, small decreases in adult survivorship could doom the population. The authors noted that the life history traits of these turtles (largely shared by box turtles) “argues strongly against justifying sustained harvests of populations of long-lived organisms with arguments based on the concept of sustained yield” (p.406).

Reed, et al. (2002) gathered life history information on the alligator snapping turtle (*Macrochelys temminckii*), another long-lived chelonian. Their report to U.S. Fish & Wildlife found “no support for the sustainability of harvest of adult alligator snapping turtles” (p. 13). Again, the delayed maturation and

high adult survivorship of this species made them extremely sensitive to loss of adults from the population. They concluded that an annual harvest of less than 2% of adult females would result in population declines.

These studies demonstrate that with long-lived species such as box turtles and snapping turtles, removal of relatively few adults can severely harm a population. Taking away a few individuals removes many years of reproductive potential. With relatively few young produced, and with low odds of a juvenile surviving to join the adult population, adults are not easily replaced.

Human-induced mortality

The box turtle life history scheme worked well for them as long as the adults had few predators and were almost guaranteed to live long lives. However, human activities are a significant contributor to box turtle mortality. Removing top-level predators allows mid-level predators of nests and juveniles to artificially flourish. We degrade box turtle habitat by developing it or turning it into farmland. Remaining suitable habitat is crisscrossed with highways where many box turtles are run over. And a sort of "predation" occurs when we collect them for the pet trade (a box turtle taken as a pet is just as lost to the population as if it were killed and eaten). In a Wisconsin study of ornate box turtles, the only known deaths in the study population over a ten year period were from cars, farm machinery, and lawn mowers (Doroff & Keith, 1990). There is no appreciable trade in box turtles for food; the significant threats posed by the Asian turtle trade affect primarily freshwater turtles. However, there has been a substantial trade in box turtles as pets. When CITES export permits were still being issued, in 1995 Louisiana alone exported 13,300 *T. carolina* (Boundy, 1998). No export permits have been issued since 1996, but Dodd (2001) cites an example in 1997 of arrests made of people attempting to sell more than a thousand box turtles.

In response to a request for information, Texas Parks & Wildlife provided information about numbers of box turtles collected from the wild, purchased, and sold over the four year period from 1999-2002 (Herron, pers. comm..). For each subspecies, the summary data are as follows:

	Three-toed box turtle	Ornate box turtle	Desert box turtle
Collected from the wild	399	624	1150
Purchased	1619	7478	1022
Sold	1878	7333	2005

No clear interpretation was provided regarding why numbers purchased and sold were higher than numbers collected. These data are said to be from the reports turned in by individuals with permits, and so the data did not allow for tracking of sources of purchased or sold turtles. One plausible interpretation is as follows: Texas' nongame permits may in many cases be ignored by those who gather the turtles from the wild, as such persons' visibility is low and their role in the collection of turtles (e.g., by one report, ranchers picking them up and putting them in tubs to await a middleman) is informal and may only be a source of a little supplementary income. Those buying from collectors and selling to pet stores or distributors may be more visible and have more motivation to get the permit. This could result in the kinds of numbers reported. Another possible interpretation is that some of the "purchased" and "sold" turtles could be brought in from out of the state. It is sometimes remarked upon that Texas, as a state that does not limit numbers of box turtles that can be taken with a permit, is used for laundering illegally-traded turtles. Alternately, some of the turtles in such a scenario might be legally obtained, and if so it suggests that populations in other states may be harmed to satisfy the trade in Texas. A different interpretation of the numbers is that they reflect multiple sales (i.e. the same turtles are being reported more than once as they are sold among middlemen and vendors). A final point is that an unknown number of box turtles may be sold in flea markets, pet stores, and expos without ever being reported. What all of this suggests is that the number of box turtles annually harvested from the wild in Texas is currently unknown.

Could some of the numbers of box turtles purchased and sold in Texas reflect captive-bred individuals? Sale of captive-bred juveniles might account for some of the "purchased" and "sold" data. There is no appreciable trade in captive-bred adult box turtles. Those who breed box turtles virtually always sell them as juveniles, with the purchaser agreeing (per USDA regulation) that they are for scientific or educational purposes. Given that it takes years to raise a box turtle to adulthood, it is not practical or financially feasible to raise box turtles to adulthood and then sell them. And yet, adult box turtles can be found in flea markets, pet stores, reptile expos, and ads on the Internet have offered "Texas box turtles" in lots by the hundreds.

What happens when box turtles from an area are harvested over a period of time? Boundy (1998) reported on areas where the gulf coast box turtle (*T. c. major*) had been harvested and areas that had been protected from harvest. The mean number of turtles found per hour was over twice as high at protected sites than at harvested sites, a finding that was statistically significant. Effects of harvest have been examined for other species, again finding that populations can be adversely affected. Close & Seigel (1997) examined carapace lengths of red-eared sliders (*Trachemys scripta elegans*) in harvested,

protected, and public areas in Louisiana and Mississippi. They found that turtles from protected sites and public sites not being harvested had greater mean carapace lengths than those found at harvested sites, indicated that harvests were reducing turtles in larger size classes. Local groceries and fish markets commented to the authors that "the turtles are all fished out here" (p.565).

Harvest by humans is not the only source of box turtle mortality. Other sources of increased box turtle mortality include those run over on Texas' highways. While there do not appear to be any data on box turtle road mortality in Texas, Dodd states that "the most serious direct threat to box turtles comes from the automobile. Literally thousands are killed each year on highways…." (2001, p. 156). A further threat, perhaps the most significant of all, is habitat loss and degradation (Gibbons, et al., 2000). Box turtles may not be able to make use of highly altered habitats. For example, in the study by Doroff & Keith (1990) radio tracked box turtles never made use of agricultural land. In later work with ornate box turtles in Wisconsin, Curtin (1997) showed that degraded habitat affected the temperature of microclimates and limited the seasonal activity period, home range size, and incubation period. The ongoing loss of suitable box turtle habitat makes it all the more important to preserve existing populations wherever suitable habitat remains. Based on their life history traits, preserving existing populations means protecting them from any but the most inconsequential loss of adults.

Recommended conservation actions

Partners in Amphibian and Reptile Conservation (PARC, 2000) has published a position statement on the sustainable use of reptiles and amphibians. One of its principles states: "Population trends, natural or human-influenced, should be monitored and considered in harvest management decisions. Species should not be harvested unless the agency's monitoring efforts or best biological opinion demonstrate there is a harvestable surplus." It goes on to state, "In the face of uncertainty or conflicting data, reptile and amphibian populations and their habitats and ecosystems should be managed conservatively." Texas Parks & Wildlife Department (TPWD) should embrace these principles, and accordingly take the following actions:

1. As called for by Dodd (2001), actively encourage and support research to study local populations of box turtles, gathering information on population size, demographics, and ecology. Among the practical topics in urgent need of study are: the effects of the size of habitat patch on populations (and what is the minimum size habitat patch for long-term viability); the effects of nearby highways (comparing population density and structure in areas adjacent to highways and far removed from

highways); and the viability of repatriation efforts (whether it is possible to reintroduce box turtles into areas from which they have declined or disappeared).

2. Develop a citizen watch program, among the watch programs for amphibians, horned lizards, and other species, to monitor sightings of box turtles. Such a program might contribute data for understanding population status and would be an excellent vehicle for public education and awareness of box turtles' conservation needs.

3. Provide legal protection for box turtles in Texas. Texas Parks & Wildlife Department should consider other states' efforts and develop regulations that take into account the particular vulnerabilities of box turtles. Louisiana's regulation might serve as a model. The regulation states, "Box turtles (genus Terrapene) may not be sold commercially, and recreational take and possession shall not exceed 4" and "No more than 4 box turtles of the genus *Terrapene* may be possessed at any time" (Louisiana Dept. of Wildlife & Fisheries, website). Whatever form the regulation takes, it should strive to do the following:

   A. Stop the commercial collection of wild box turtles. Bag limits and seasons would allow a continued level of take that cannot be shown to be sustainable and is probably, in view of the information reviewed earlier, unsustainable. This is particularly the case if there is reason to believe that collection from the wild takes place to an appreciable degree by people who may not be aware of regulations or be predisposed to abide by them.
   B. Stop the sale of wild box turtles. In pet stores, flea markets, and on the Internet, the sale of wild box turtles provides most of the incentive for continued collection from the wild. Additionally, the commercial trade is inhumane. Most of these box turtles suffer significant debilitation during stockpiling and transit and often end up in the hands of people who are not prepared to care for them adequately. It is estimated that as many as 50% of box turtles die prior to sale (Franke & Telecky, 2001) and it is widely believed that most of the rest die after being sold.
   C. Allow continued possession and use by educational and research institutions. Zoos, museums, and universities, for example, are unlikely to contribute significantly to the take from the wild.
   D. Allow only a small number of turtles to be possessed for personal use. Those might be collected from the wild, given, or traded, but the number in any case should be small. With widely distributed subspecies (*T. ornata ornata* and *T. carolina triunguis*) Texas might follow Louisiana's lead and allow no more than four individuals per subspecies. In the case of *T. ornata luteola*, the Department should review the best available data regarding population status and

microhabitat requirements before deciding whether personal possession ought to be allowed. This subspecies has a limited range in Texas and may be confined to more mesic conditions in a part of the state that is very arid.

The Texas Parks & Wildlife Department is encouraged to take these actions and to promote working partnerships with universities, land preservation groups, and interested citizens. With necessary scientific guidance, citizen groups (including herpetological societies, the Texas Master Naturalist program, and local Sierra Clubs) might provide considerable time and energy into box turtle conservation efforts. Making available land access and extra volunteer help might encourage university faculty and their graduate students to work on projects that, while requiring long term commitment, urgently need to be done.

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