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Morbidity and mortality in reptiles presented to a wildlife care facility in Central Illinois

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Abstract: We examined morbidity and mortality of 200 reptiles, representing 13 different species that were presented to the University of Illinois Wildlife Medical Clinic (WMC) from 2003 to 2010. Snapping turtles (*Chelydra serpentine*; *n* = 46), box turtles (*Terrapene* sp.; *n* = 43), painted turtles (*Chrysemys picta*; *n* = 37), and red-eared slider turtles (*Trachemys scripta elegans*; *n* = 33) were the most frequently seen species. Turtles were significantly more likely to be presented to the WMC following collision with a motor vehicle (*n* = 73) than any other reason, including idiopathic trauma (i.e., trauma of unknown origin; *n* = 25) or infectious disease (*n* =18). The findings from this cross-sectional study suggest a potential for community education in limiting reptile traumas resulting in presentations to a wildlife hospital.

Key words: anthropogenic, human–wildlife conflicts, morbidity, mortality, reptile, trauma

Reptile populations are in decline worldwide (Gibbons et al. 2000), and many of the declines are attributed to human encroachment on natural habitat along with other anthropogenic activities (Gardner et al. 2007). However, there are likely regional differences for reptile population declines, too, and studies are required to characterize morbidity and mortality of local reptile populations and their effect on biodiversity to effectively develop management plans to protect these animals. One means of monitoring local causes of morbidity and mortality of native wildlife, including reptiles, is using case information obtained from wildlife rehabilitation facilities (Brown et al. 2003, Joyner et al. 2006).

The Wildlife Medical Clinic (WMC; Urbana, Il.) at the University of Illinois College of Veterinary Medicine is a wildlife hospital that provides medical care to free-living wildlife species in east central Illinois. Although WMC will accept native wildlife from anywhere within the state of Illinois, most wildlife patients originated in Champaign County, with the surrounding counties serving as the second most common source of animals (Figure 1). This region encompasses 1,307,892 ha, divided into cropland (1,048,316 ha), grassland (157,974 ha), forest (40,154 ha), urban and built-up areas (34,055 ha), open water (15,338 ha), wetland (10,790 ha), and barren land (454 ha; Illinois Department of Natural Resources 2004). The most recent census reported the population of these counties as 521,644 (U.S. Census Bureau 2010).

As a point-of-care facility for sick or injured wildlife, the WMC serves as an investigative source for wildlife pathologies in this region. A few previous investigations have evaluated trends in morbidity and mortality among reptiles presented to wildlife hospitals (Hartup 1996, Brown and Sleeman 2002, Schrader et al. 2010). However, these studies have been in regions with different habitats, species distributions, and land-use breakdowns. To our knowledge, morbidity and mortality trends in reptiles from central Illinois have not been evaluated.

This study reviews medical records of reptiles presented to the WMC. Our goal was to determine causes of morbidity and mortality to assess risk factors that can be used to guide future case management and preventive measures against anthropogenic injury of reptiles in Illinois.

Methods

This cross-sectional study was conducted using data from reptile cases presented to the WMC from 2003 to 2010. All cases were presented by good Samaritans who presumed that the animals were in need of assistance. We examined original medical records from 249 reptiles admitted to the WMC within this time period. Exclusion criteria consisted of non-native species, previously owned animals, animals that were presented for research transmitter implantation, and those with incomplete medical records. Based on these criteria, 200 of these cases were included for analysis.

Diagnosis was assigned with the following criteria: hit by car = trauma due to known automobile collision or after being found traumatized in the vicinity of a roadway (n = 73); lawn equipment = trauma due to lawn mower or plastic fencing (n = 9); animal attack = trauma inflicted by another animal as indicated by bite wounds (n = 7); fish hook = imbedded fish hook (n = 16); idiopathic trauma = trauma of unknown origin (n = 25); infectious = pneumonia and aural abscesses (n = 18); disturbed hibernation = reptiles collected by finders during hibernation (n = 14); healthy = no discernible medical problem (n = 30); idiopathic = conditions of unknown etiology (n = 5); and miscellaneous trauma = trauma from being closed in a door and entrapped in a glue trap (n = 3). Diagnoses of hit by car, lawn equipment, fish hook, disturbed hibernation, and miscellaneous trauma were collectively considered as human-related problems (n = 115). Only the primary problems were interpreted for diagnosis. The medical diagnoses were determined by the original attending clinician and were based on case history, physical examination findings, and any ancillary diagnostic tests.

Age classes were assigned to each animal based on subjective criteria that included mass and length. Sex was determined based on plastron morphology (chelonians), cloaca position (chelonians), radiographic evidence of eggs (chelonians), or cloacal probing (serpentes). Final dispositions were classified as released, died, or euthanized.

Frequencies were determined for species, age, sex, diagnosis, and final disposition. Associations between each outcome variable (diagnosis and final disposition) and each independent variable (species, age, and sex) were initially evaluated using Fisher's exact test and Pearson's Chi-square. Categorical variables were assessed for equal probabilities using the 1 sample Chi-square test. We used a Chi-square test to determine associations between month animals were presented to the WMC and the 4 most commonly presented species: box turtles (*Terrapene* sp.), painted turtles (*Chrysemys picta*), snapping turtles (*Chelydra serpentina*), and red-eared slider turtles (*Trachemys scripta elegans*). Ordinal regression modeling was then done to evaluate these independent variables (species, age, sex) simultaneously by each dependent variable (final disposition and diagnosis). A $P < 0.05$ was used to determine statistical significance. We used SPSS 19.0 (SPSS Inc., Chicago, Ill.) to analyze the data.

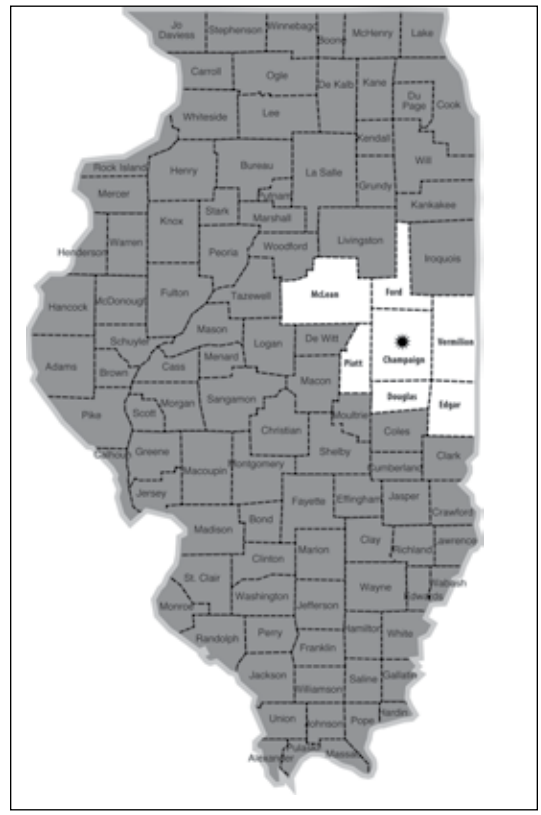

Figure 1. Map of Illinois with the study area consisting of Champaign and its surrounding counties shaded gray. The approximate location of the Wildlife Medical Clinic is indicated with an asterisk.

Results

Seventeen reptile species were presented

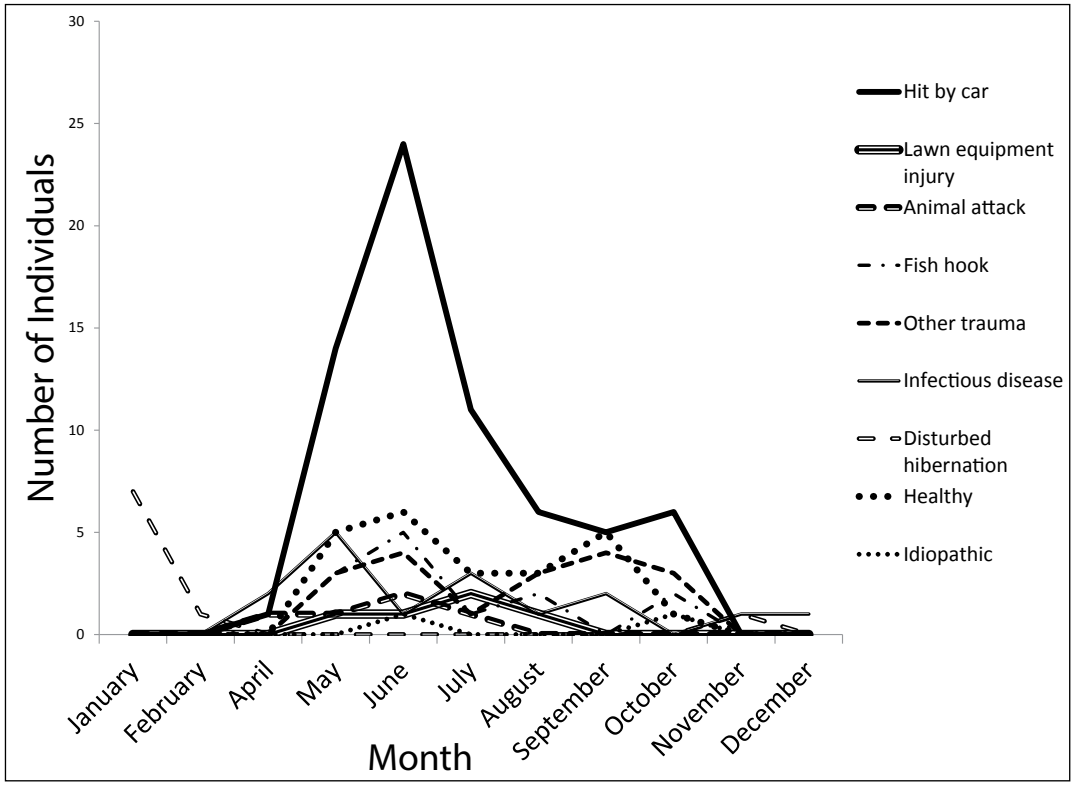

Figure 2. Number of individuals presented by month of the 4 most common reptile species (eastern box turtle, painted turtle, snapping turtle, slider turtle) seen at the Wildlife Medical Clinic, 2003 to 2010.

to the WMC for care. However, due to inconsistent classification in the records, box turtles (*Terrapene carolina* and *T. ornata*), garter snakes (*Thamnophis radix* and *T. sirtalis*), king snakes (*Lampropeltis calligaster* and *L. getula*), and softshell turtles (*Apolone multica* and *A. spinifera*) were each reported as a single species for the purposes of this study (Table 1).

All animals that were not classified as healthy received appropriate medical treatment (fracture repair, wound care, antimicrobial therapy, analgesia, fluid therapy, supplemental feedings, or euthanasia). The majority of patients were released or transferred to a licensed wildlife rehabilitator for ongoing care prior to release (n = 114). The others were euthanized (n = 58) or died while in captivity (n = 27). Final disposition varied significantly ($P < 0.001$) based on diagnosis and is presented in Table 2.

Table 1: Reptiles presented to the Wildlife Medical Clinic at the University of Illinois College of Veterinary Medicine, 2003 to 2010.

Species	Number of animals
Snapping turtle (*Chelydra serpentina*)	46
Box turtle (*Terrapene carolina, T. ornata*)	43
Painted turtle (*Chrysemys picta)*	37
Slider turtle (*Trachemys scripta*)	33
Garter snake (*Thamnophis radix, T. sirtalis*)	17
Fox snake (*Elaphe vulpina*)	6
Softshell turtle (*Apolone mutica, A. spinifera*)	6
King snake (*Lampropeltis calligaster, L. getula*)	4
Eastern massasauga rattlesnake (*Sistrurus catenatus*)	2
Black rat snake (*Elaphe obsoleta*)	2
Bullsnake (*Pituophis melanoleucus*)	2
Brown snake (*Storeria dekayi*)	1
Eastern hognose snake (*Heterodon platirhinos*)	1
Total	200

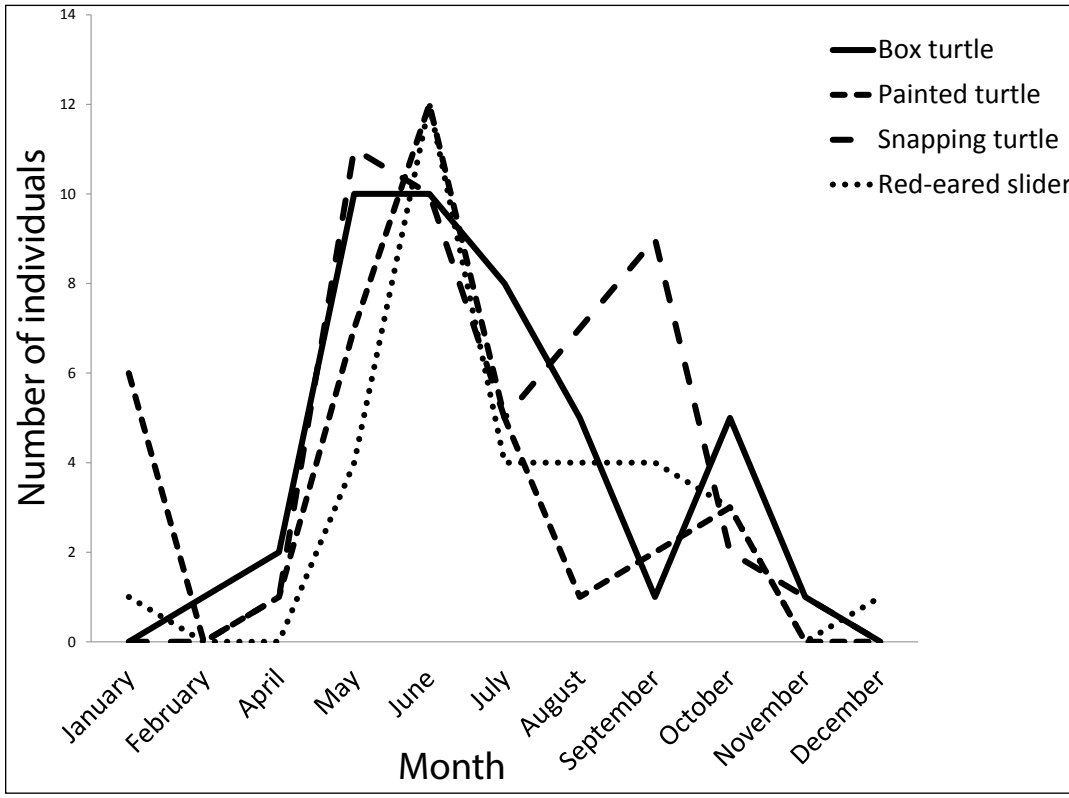

Figure 3. Morbidity and mortality category by month of the 4 most common reptile species (eastern box turtle, painted turtle, snapping turtle, slider) presented to the Wildlife Medical Clinic, 2003 to 2010.

Patients were significantly more likely to be adult animals (n = 149) than juveniles (n = 35) or unknown age (n = 16) animals. Eighteen animals were female, 17 animals were male, and 165 animals had sex listed as unknown.

Human-related problems predominated among causes of morbidity and mortality (n = 115; Table 3). Hit-by-car was both the most frequently encountered human-related problem and most frequently encountered problem overall (n = 73). The next most common diagnosis was healthy (n = 30).

Causes of morbidity and mortality varied significantly ($P < 0.001$) among species (Table 4). Hit-by-car was the most frequent diagnosis among the 4 most commonly encountered species: common snapping turtles, box turtles, painted turtles, and red-eared slider turtles. Box turtles constituted nine of the 18 infectious disease cases. The most commonly recorded species was the snapping turtle (n = 46), of which animals were healthy with no medical problems.

The 4 most common species were not presented to the WMC with equal probabilities throughout the year ($P < 0.001$), but animals

Table 2: Final disposition of reptiles by diagnosis presented to the Wildlife Medical Clinic at the University of Illinois College of Veterinary Medicine, 2003 to 2010.

Diagnosis	Released	Died	Euthanized
Hit by car	25	12	35
Lawn equipment	4	0	5
Animal attack	4	0	3
Fish hook	14	1	1
Idiopathic trauma	11	6	8
Infectious	11	5	2
Disturbed hibernation	13	0	1
Healthy	30	0	0
Idiopathic	1	1	3
Miscellaneous trauma	1	2	0
Total	114	27	58

were seen each month (Figure 2). Hit-by-car was the most common ($P < 0.001$) presented in every month except from November through February (Figure 3). There were significant differences in the diagnosis of infectious disease by month ($P = 0.003$). There was no significant association in month presented and disposition ($P = 0.399$).

Discussion

Compared to previous studies conducted at other wildlife health centers, the results of this cross-sectional study were unique in identifying snapping turtles as the most frequently encountered species (Hartup 1996, Brown and Sleeman 2002). There are a few reasons that could account for this. The WMC is located in the Wabash River Watershed, where snapping turtles are the most abundant aquatic turtle species (Rizkalla and Swihart 2006). Snapping turtles also are known to be more vagrant than other species (Christens and Bider 1987) when searching for suitable hibernation sites and bodies of water (Brown and Brooks 1994, Burke et al. 1995). Galbraith (2008) speculated that snapping turtles' limited carapace and plastron allow for greater mobility, enabling them to migrate greater distances in comparison to other aquatic turtles. In our 1,307,892-ha study area, 1,082,372 ha are dedicated to agriculture or urban and built-up use (Illinois Department of Natural Resources 2004). The limited amount of natural habitat that remains, combined with snapping turtles' tendency to travel greater distances, could result in an increased likelihood that these turtles would encounter humans, leading to both the high number of

Table 3: Morbidity and mortality of reptiles presented to the Wildlife Medical Clinic at the University of Illinois College of Veterinary Medicine, 2003 to 2010.

Morbidity and mortality category	Number
Human-related problem	115
Hit by car	73
Fish hook	16
Disturbed hibernation	14
Lawn equipment	9
Miscellaneous trauma	3
Healthy	30
Idiopathic trauma	25
Infectious	18
Animal attack	7
Idiopathic	5
Total	200

Table 4: Morbidity and mortality in most frequently presented reptile species at the Wildlife Medical Clinic at the University of Illinois College of Veterinary Medicine, 2003 to 2010.

	Box turtle (*Terrapene carolina, T. ornata*)	Painted turtle (*Chrysemys picta*)	Slider turtle (*Trachemys scripta*)	Snapping turtle (*Chelydra serpentina*)
Human related problem	23	29	18	24
Hit by car	18	19	12	18
Fish hook	0	3	5	5
Disturbed hibernation	1	6	1	1
Lawn equipment	4	1	0	0
Miscellaneous trauma	0	0	0	0
Healthy	4	1	3	16
Idiopathic trauma	4	4	5	5
Infectious	9	1	5	1
Animal attack	2	2	1	0
Idiopathic	1	0	1	0
Total	43	37	33	46

vehicular traumas and collection by people who found healthy animals that were assumed to be in need of care.

Overall, most of the reptiles seen were adults, although there was a potential for misclassification bias in age characterization because morphometrics on these patients was not recorded. Adult wild turtles tend to be more vagrant than juveniles (Sexton 1959, Browne et al. 2006), possibly due to the greater physiologic costs and predation risks faced by juvenile turtles during migration (Lefevre and Brooks 1995, Finkler 2001). As with the snapping turtles, increased terrestrial exposure both makes adult wild reptiles more susceptible to vehicular trauma and collection of healthy animals by humans, the 2 most frequently recorded diagnoses of animals in this study.

Trauma after being hit by a car was the most common reason reptiles were presented to the WMC. Subjectively, these findings follow trends seen in similar studies, but, due to differences in data reporting, there are limitations to comparing findings (Hartup 1996, Brown and Sleeman 2002, Schrader et al. 2010). This high prevalence of vehicular trauma is not surprising. Regions with increased road density are known to have higher mortality and subsequent alterations in population structure for wild reptiles (Steen and Gibbs 2004, Patrick and Gibbs 2010). In addition to a higher likelihood of encountering roads during terrestrial migrations, increased vehicular trauma in such habitats may be due to reptiles spending more time basking on paved roads. Herpetofauna in distressed habitats are subject to sublethal environmental stressors that may suppress their immune systems (Carey 1993, Amo et al. 2007). Once ill, some reptiles combat some pathogens by behaviorally selecting and maintaining higher than normal body temperatures (Mongas and Gatten 1983, Burns et al. 1996).

Infectious etiologies were the second leading diagnosis for box turtles, which comprised the majority of the infectious disease cases. This was also the case among box turtles in another study (Schrader et al. 2010). There were seasonal trends in the number of infectious disease cases of animals presented to the WMC (Figure 3). All cases in December and half of the cases in November and April were infectious, while there were no infectious disease cases in October and few in all other months. The high number of infectious disease cases seen in these months may be related to decreased immune function during hibernation periods. Immune data from reptiles suggests that immune function is generally depressed during hibernation, though heightened in autumn just prior to hibernation (Muñoz and de la Fuente 2004, Nelson and Demas 1996, and Schwanz et al. 2011).

Despite the frequent occurrence of infectious etiologies in box turtles, the true prevalence of infectious disease among reptiles presented to WMC is difficult to ascertain given that many trauma cases are allotted only a brief physical exam prior to euthanasia. Ancillary testing may have shown that reptiles suffering trauma were impacted by underlying infectious disease etiologies. Limited funding prohibits advanced testing in many instances, but the importance of testing for infectious disease pathogens should not be overlooked. Infections with herpes virus, *Mycoplasma* or ranavirus, are without cure in reptiles, and animals harboring these pathogens could spread them upon release back to wild populations (Schumacher 2006, Johnson et al. 2008). To prevent introduction and propagation of pathogens in wild populations, it is recommended to release reptiles only that have been shown to be disease-free through appropriate screening protocols (Jacobson et al. 1999).

There were temporal trends in the presentation of the 4 most common species (Figure 2), which correlated with the reproductive behavior of these species. May and June were the most common months for snapping turtles and box turtles to be brought to the WMC. Illinois populations of snapping turtles are known to nest mid-May to mid-June, and box turtles nest in June (Phillips et al. 1999). Slider turtles and painted turtles, which nest in Illinois during May to July (Phillips et al. 1999), were most commonly seen at the WMC during these same months. It is likely that the increase in number of animals seen during these months is due to increased migration by female turtles in search of nesting sites. Previous studies suggest that there is disproportionate road mortality of aquatic turtle females on nesting migrations in areas with increased road density (Patrick

and Gibbs 2010; Steen and Gibbs 2004). This coincides with our findings, which show a peak number of animal presentation during nesting months, as well as the highest number of hit-by-car diagnoses in May and June (Figure 3).

Overall, most (57%) animals were released or transferred to a licensed wildlife rehabilitator in preparation for release. Of the healthy animals, 49% of the patients were released or transferred to a wildlife rehabilitator. In the same time period at the WMC, the overall release rate for all species including reptiles was 41.2%. The higher release rate of reptile species may be due to reptiles being better able to withstand and recover from severe traumatic events than free-living avian and mammalian species.

The effects of human activities on the reptile patients in this study were not limited to vehicular trauma. Overall, human-related problems constituted >50% of all cases seen. Admittedly, the disease frequencies seen in the patient population at this clinic may not be representative of the entire disease scope of the natural population, as patient presentation is dependent on good Samaritans in the community. There is a suspected bias toward human-related problems in the animals presented to the clinic, and an underrepresentation of infectious disease compared with the natural population. Similar results have been found in other retrospectives assessing morbidity and mortality of reptiles presented to wildlife centers (Spalding and Forrester 1993, Hartup 1996, Brown and Sleeman 2002).

The reliance on good Samaritans may also contribute to a bias in the types of species that present. Chelonians appear over-represented, whereas snakes appear under-represented. This may be due to differences in natural history, with chelonians being less secretive or more likely to travel greater distances. Due to the protective nature of their shells, chelonians are also more likely to survive a traumatic impact when compared with snakes, resulting in a greater chance of being recovered by good Samaritans. This is supported by reptile road mortality surveys from another region of central Illinois that found snakes greatly outnumbered chelonians among vehicular fatalities (Shepard et al. 2008*a*). Additionally, greater species charisma might make chelonians more likely to encounter people willing to transport these animals for care. How the patient demographics compare to actual species abundance in the area is difficult to ascertain due to a lack of recent fieldwork on wild reptile populations in the region (Phillips et al. 1999).

In summary, most of known causes of morbidity and mortality among reptiles during the study period resulted from human activities. Many more healthy animals were relocated to new populations when insufficient information on their origin was available. This indicates that human activities are having an adverse effect on wild reptiles, though the true ramifications for the wild populations cannot be determined without prospective study. However, such studies for reptiles tend to be rare given the time and cost constraints in following these long-lived animals. As a result, retrospective evaluations of medical records provide valuable insight to possible trends in population health.

Although more study is required to comprehend the scope of human impacts on wild reptile populations, what is known is that reptiles are one of the most threatened taxonomic groups worldwide (International Union for the Conservation of Nature [IUCN] Red List 2011). In Illinois alone, 18 reptile species are listed as threatened or endangered (Illinois Endangered Species Protection Board 2011). Community education offers a potential to mitigate the impact of human activities that contribute to reptile population decline. Education may also limit the number of healthy animals that are unnecessarily relocated. Information from this study has been incorporated in the WMC community education programs. Future analysis will hopefully indicate that these education efforts are having an effect to reduce the number of reptiles presented to the WMC for human-related morbidity and mortality.

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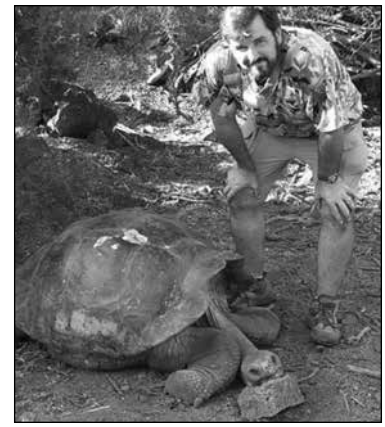

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