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MORBIDITY AND MORTALITY OF WILD TURTLES AT A NORTH CAROLINA WILDLIFE CLINIC: A 10-YEAR RETROSPECTIVE

Alexandra Sack, D.V.M., Eric Butler, Ph.D., Peter Cowen, D.V.M., Ph.D., Gregory A. Lewbart, MS, V.M.D., Dipl. A.C.Z.M.

Abstract: The medical records from 1,847 wild turtle patients seen between 2005 and 2014 by the Turtle Rescue Team at the North Carolina State University College of Veterinary Medicine were analyzed. Eastern box turtles (*Terrapene carolina carolina*; $n = 947$), yellow-bellied sliders (*Trachemys scripta scripta*; $n = 301$), cooters (*Pseudemys* spp.; $n = 235$), common snapping turtles (*Chelydra serpentina*; $n = 165$), and eastern painted turtles (*Chrysemys picta*; $n = 93$) made up 94.3% of all patients. Patient admissions peaked in May when 25.6% (473/1,847) of all turtles were admitted. Cooters were the most-likely species to be gravid, and the loss of gravid females may put this population at increased risk for decline. The majority of wild turtles presented for anthropogenic causes, primarily vehicular trauma (63.2%; 1,168/1,847), which also had the greatest mortality at 57.8% (675/1,168) of any presenting complaint. Coelomic breach was the presenting injury with greatest risk of dying, increasing the risk of dying by 4.8 times. Other factors that were associated with increased mortality included head injuries, myiasis, and cranial or caudal midline injuries. Of all turtle species, eastern box turtles most commonly presented for nontraumatic conditions including aural abscesses (8.2%; 78/947), upper respiratory infections (6.3%; 60/947), and both conditions concurrently (2.5%; 14/947). While many turtles presented with little to no chance for survival in the wild, 47.6% were eventually released and that number increased to 62.0% released for those that survived 24 hr or longer after presentation. This study adds to the knowledge about the treatment of injured and diseased wild turtles in order to potentially ameliorate the overall impact of humans, especially as a result of vehicular trauma.

Key words: Anthropogenic, mortality, rehabilitation, reptile, turtle, wildlife.

INTRODUCTION

Anthropogenic causes of morbidity and mortality are the major reasons that animals are brought to wildlife clinics.¹³ Anthropogenic causes of adult mortality have the potential to severely impact populations of turtles, as most turtle species have a life history with very low natural mortality as adults and, consequently, a long period of reproduction postmaturity.⁶ A model of the effects of road mortality on turtle populations concluded that very low levels of mortality could cause local extinctions in most species of large-bodied, freshwater turtles.⁴ This study's conclusions are sensitive to estimates of mortality in turtles that cross roads, but a study in Florida found that more than two thirds of all turtles that attempted to cross a road were killed, with mortality rising to as high as 98% on high-traffic, four-lane highways.¹ As urbanization increases traffic in previously rural areas, the risk of

vehicular trauma and mortality rises. The eastern box turtle (*Terrapene carolina carolina*) is considered especially at risk for vehicular trauma and mortality due to terrestrial behavior patterns.³ Male-biased populations have been recorded in eastern painted turtles (*Chrysemys picta*) and common snapping turtles (*Chelydra serpentina*).¹⁵ The male bias may be from female road mortality due to migration of females looking for nesting sites.¹⁵ Injured turtles presenting to wildlife clinics offer opportunities to both heal these animals, providing a partial offset to anthropogenically caused mortality, and to better understand the risks for injury and disease. Understanding risks may allow the development of preventive and public education strategies while an increased understanding of outcomes may help guide treatment decisions and the use of resources.

The North Carolina State University's College of Veterinary Medicine's (NCSU-CVM) Turtle Rescue Team (TRT) is a wildlife clinic that treats wild reptiles and amphibians. The TRT is a nonprofit organization run by veterinary students under the supervision of a faculty member at the NCSU-CVM.⁹ The team started in 1996 and has seen >3,800 cases since its inception. While TRT is certified to provide wildlife rehabilitation to all wild reptiles and amphibians, over 95% of pa-

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tients are wild turtles. Adding to other wildlife clinics' data on reptile admission and mortality statistics, the TRT provides a unique opportunity to examine turtle admission and mortality with an unusually large annual patient load. Through an examination of the 1,847 turtle medical records from 2005–2014, this paper adds to existing knowledge by describing the risks for presentation and outcomes of various presenting conditions and injuries for multiple species of wild turtles.

MATERIALS AND METHODS

From 2005–2014, 1,906 medical records were created for patients seen by the TRT, and of these 1,847 were wild turtles. All 1,847 wild turtle patients were included in this study. The patients chosen for this review were native turtles and nonnative red-eared sliders (*Trachemys scripta*), as the TRT treats all wild, free-range turtles brought to it by the public. Ten years was chosen because it covers about half of the lifetime of the TRT and because medical records across this period follow a consistent format that was developed in the earlier years of the TRT.

Information from the entire medical file was used including the intake physical examination form, the finder's intake form, progress notes, and daily treatment sheets. The physical examination form included presenting condition, descriptions of presenting injuries, and other pre-existing conditions such as gravid or existing–healed injuries. The progress notes and daily treatment sheets recorded length of clinic stay, case outcome, and any treatments–surgeries received. Turtles euthanized upon presentation (for wounds such as severe central nervous system trauma) are included in this study to prevent introducing bias into the data against the most-severe injuries. Of patients that were euthanized–died on arrival (EOA–DOA), many were not given full medical records because no continuing medical treatment was to be given. However, 408 of the EOA–DOA cases had a full physical exam form in their patient record. Patients with an unknown outcome were lost to follow-up (3.8%, 70/1,847).

Veterinary students made and recorded physical examination and medical decisions in the hand-written notes or treatment sheets. Faculty or technical staff was consulted on complex or nonroutine cases. All turtles were identified to the species level except river cooters (*Pseudemys concinna*) and Florida cooters (*Pseudemys floridana*), which were grouped as cooters (*Pseudemys* spp.) due to inconsistent differentiation in the medical records.

The veterinary student used the history provided by the finder, and the physical exam findings to assign the appropriate presenting complaint, using the following definitions. Vehicular trauma was defined as a turtle that was seen hit by a vehicle or was found in the road with injuries consistent with vehicular trauma. Trauma from lawnmowers and gardening tools were reported by the finder. Fishing hooks were reported by the finder or found on physical examination. Turtles found with traumatic injuries away from roads were recorded as unspecified trauma. Upper respiratory infection (URI) was defined as discharge, plaques, or swelling (eyes only) for two of the following three systems: eyes, mouth, nares, as well as respiratory distress. Because it only affected one system, conjunctivitis was a separate presenting condition from URI. Aural abscessation was diagnosed on physical exam as a unilateral or bilateral mass medial to the tympanum and was confirmed by the presence of necrotic material. Animal attacks were divided into dog and other or unknown, where bite marks implicated an unknown animal. "Healthy" indicated turtles that were taken from the wild immediately before presentation due to perceived injuries or illness by the finder. These were hatchlings or turtles with healed injuries or non-pathologic shell variations. Surrendered pets were native turtles taken from the wild as pets, then later surrendered, and were considered as a separate presenting condition because these patients often presented with nutritional deficiencies. URI and aural abscesses were the only presenting complaints that occurred concurrently or as a second complaint to another presenting condition. Turtles with another presenting complaint and URI–aural abscess are categorized under the initial complaint.

Examination findings were diagnosed grossly and were supplemented as needed with radiographs. Species, sex, and weight were recorded at intake. The veterinary student filled the appropriate boxes on the physical exam form for external injuries and drew any shell or leg fractures on a diagram of a turtle. Head injuries encompassed any injury to the mouth, tomia, nares, or skull. Leg injuries were also drawn on the diagram of the turtle. Location of the carapace or plastron fracture was drawn on the diagram including cranial and caudal midline injuries. There was a separate box for neurologic behavior and room to note the specific behavior. Coelomic breach(es) and myiasis were diagnosed visually. Patients were diagnosed as gravid by radiographs, palpation, or from egg laying. Healed injuries were also marked

Table 1. Turtles by species and sex presented to North Carolina State University College of Veterinary Medicine's Turtle Rescue Team from 2005–2014 ($n = 1,847$).

Species	Female (%)	Male (%)	Unknown (%)	Total (%)
Eastern box turtle (<i>Terrapene carolina carolina</i>)	381 (40.2)	454 (47.9)	112 (11.8)	947 (51.3)
Yellow-bellied slider (<i>Trachemys scripta scripta</i>)	159 (52.8)	111 (36.9)	31 (10.3)	301 (16.3)
Cooter (<i>Pseudemys</i> spp.)	137 (58.3)	82 (34.9)	16 (6.8)	235 (12.7)
Common snapping turtle (<i>Chelydra serpentina</i>)	49 (29.7)	67 (40.6)	49 (29.7)	165 (8.9)
Eastern painted turtle (<i>Chrysemys picta</i>)	39 (41.9)	46 (49.5)	8 (8.6)	93 (5.0)
Eastern mud turtle (<i>Kinosternon subrubrum</i>)	12 (35.3)	17 (50.0)	5 (14.7)	34 (1.8)
Common musk turtle (<i>Sternotherus odoratus</i>)	6 (22.2)	16 (59.2)	5 (18.5)	27 (1.5)
Red-eared slider (<i>Trachemys scripta elegans</i>)	16 (61.5)	7 (26.9)	3 (11.5)	26 (1.4)
Spotted turtle (<i>Clemmys guttata</i>)	4 (44.4)	5 (55.5)	0	9 (0.5)
Diamondback terrapin (<i>Malaclemys terrapin</i>)	3 (50.0)	1 (16.7)	2 (33.3)	6 (0.3)
Spiny softshell turtles (<i>Apalone spinifera</i>)	0	0	3 (100)	3 (0.2)
Chicken turtle (<i>Deirochelys reticularia</i>)	1 (100)	0	0	1 (0.1)
Total	807 (43.7)	806 (43.6)	234 (12.7)	1,847

and drawn on the diagram to differentiate them from the current presenting complaint. Turtles were confirmed dead by Doppler ultrasound. For location-specific injuries (eg, new or healed leg trauma, shell fractures), only turtles with full physical examinations were compared. This was done to prevent turtles from being included that may have an injury that was not recognized.

Descriptive statistics were developed using R 2013 (R Core Team, Vienna, Austria), and Excel 2016 (Microsoft, Redmond, Washington 98052, USA) and Epi Info 7.1.5.2 (Centers for Disease Control, Atlanta, Georgia 30333, USA) were used to determine chi-square values, P -values, odds ratios, and 95% confidence intervals (CI) for 2 × 2 tables. For parametric tests, data were evaluated for normality and a $P < 0.05$ was considered significant. Signalment and outcome differences by species, as well as risk of dying or being euthanized by presenting complaint and injuries, were evaluated with odds-ratios and a 95% CI. Chi-squared tests were used to evaluate the ratios of males and females across species as well as patterns of intake across time (grouped by month). Linear regression was used to determine if the length of treatment of turtles changed across the study period. The effect of the weight of a turtle on its odds of surviving was evaluated using two-tailed t -tests. The effect of past injuries on the odds of surviving current presenting conditions was analyzed using an analysis of variance (ANOVA).

RESULTS

Overall

From 2005–2014, 1,847 wild turtles presented to TRT. Of all turtle patients, 51.3% were eastern

box turtles. The five most-prevalent species, eastern box turtles (947/1,847), yellow-bellied sliders (*Trachemys scripta scripta*; 301/1,847), cooters (*Pseudemys* sp.; 235/1,847), common snapping turtles (165/1,847), and eastern painted turtles (93/1,847), made up 94.3% of all turtle patients (Table 1). Approximately equal numbers of males (43.6%; 806/1,847) and females (43.7%; 807/1,847) were presented to the TRT during the study period (Table 1). For eastern box turtles, there was a significantly greater proportion of male patients ($P < 0.001$) while cooters and yellow-bellied sliders both had a significantly greater proportion of female patients ($P < 0.005$ and $P = 0.001$, respectively; Table 1). Of these female turtles, 28.7% (232/807) were gravid. Cooters had the greatest percentage of females and were 2.5 times more likely (CI = 1.7, 3.7) to be gravid than were other species. The majority of gravid turtles arrived in May or June (83.2%; 193/232).

Patients were received throughout the year, with 53.9% (996/1,847) of patients arriving from April–June (Fig. 1). Patient admissions peaked in May, in which 25.6% (473/1,847) of all turtle patients arrived. Eastern box turtles continued to arrive through the summer and fall, and their seasonal pattern of presentation was significantly different than the other turtle species when presentations were grouped by month ($P < 0.001$; Fig. 2).

When examining all patient cases, the median length of stay was 10 days with a range of 0–210 days. The majority of patients (73.6%; 1,360/1,847) spent less than 25 days in the clinic. There was no statistically significant change in stay duration across the years ($P > 0.05$). When

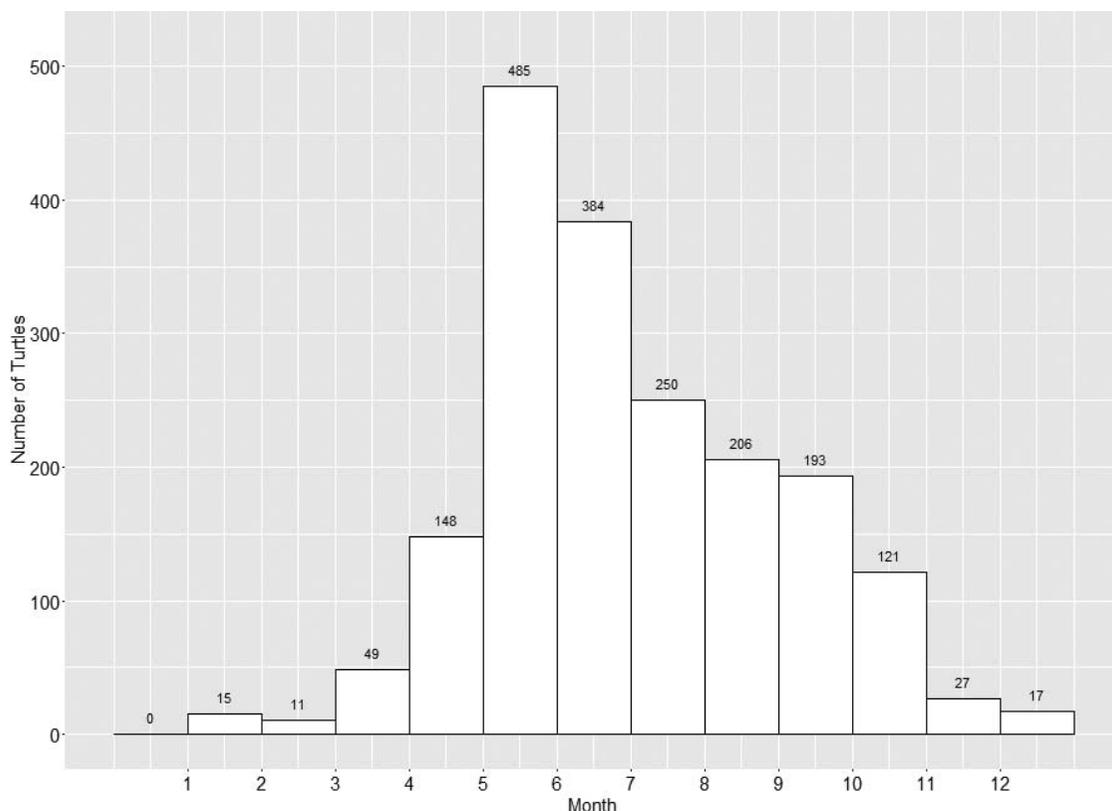


Figure 1. Patients presented to North Carolina State University College of Veterinary Medicine's Turtle Rescue Team from 2005–2014 by month ($n = 1,906$).

EOA–DOA patients were excluded from analysis, the median treatment length became 17 days. For all patients, 48.8% survived, with 47.6% released (879/1,847) and 1.2% adopted (23/1,847), and 47.4% did not survive with 17.9% dying (331/1,847) and 29.5% euthanized (544/1,847). Another 3.8% of outcomes were unknown (70/1,847). Of patients at the clinic after 1 day, 62.0% (856/1,380) were released and 1.6% (22/1,380) were adopted. Another 10.4% (143/1,380) were euthanized and 20.9% (289/1,380) died, with 5.1% (70/1,380) unknown.

Presenting conditions

The majority of patients presented for vehicular trauma (63.2%; 1,168/1,847). Unspecified trauma (140/1,847) and animal attack by dog (93/1,847) were the only other condition that accounted for at least 5.0% (Table 2). The greatest percentage of EOA–DOAs was vehicular traumas (87.6%; 388/443). This fatality rate represents 33.2% (388/1,168) of all patients presenting for vehicular trauma. Animal attack by an animal other than a dog, and trauma from a lawnmower or garden

tool, also had greater than 15% EOA–DOA (Table 2).

A vehicular trauma patient was 3.3 times more likely to die or be euthanized compared to all other presenting conditions (CI = 2.7, 4.0), as 57.8% (675/1,168) died or were euthanized. Of the five most-prevalent species, eastern box turtles had the best chance of survival overall with a 25% lower chance of death or euthanasia compared to all other patients (CI = 0.62, 0.90). While only 50.6% of eastern box turtles (479/947) presented with vehicular trauma as compared to ~75–80% for the other four most-prevalent turtle species (Table 3), 60.3% (289/479) of eastern box turtles that presented for vehicular trauma either died or were euthanized. For vehicular trauma, released eastern box turtles were significantly heavier (mean = 345.5 g; SD = 97.6) compared to those who died or were euthanized (mean = 313.7 g; SD = 114.6; $P = 0.004$).

Another presenting complaint, URI, including those concurrently presenting with aural abscesses, accounted for 4.2% (77/1,847) of all presenting turtles, with the overwhelming majority being

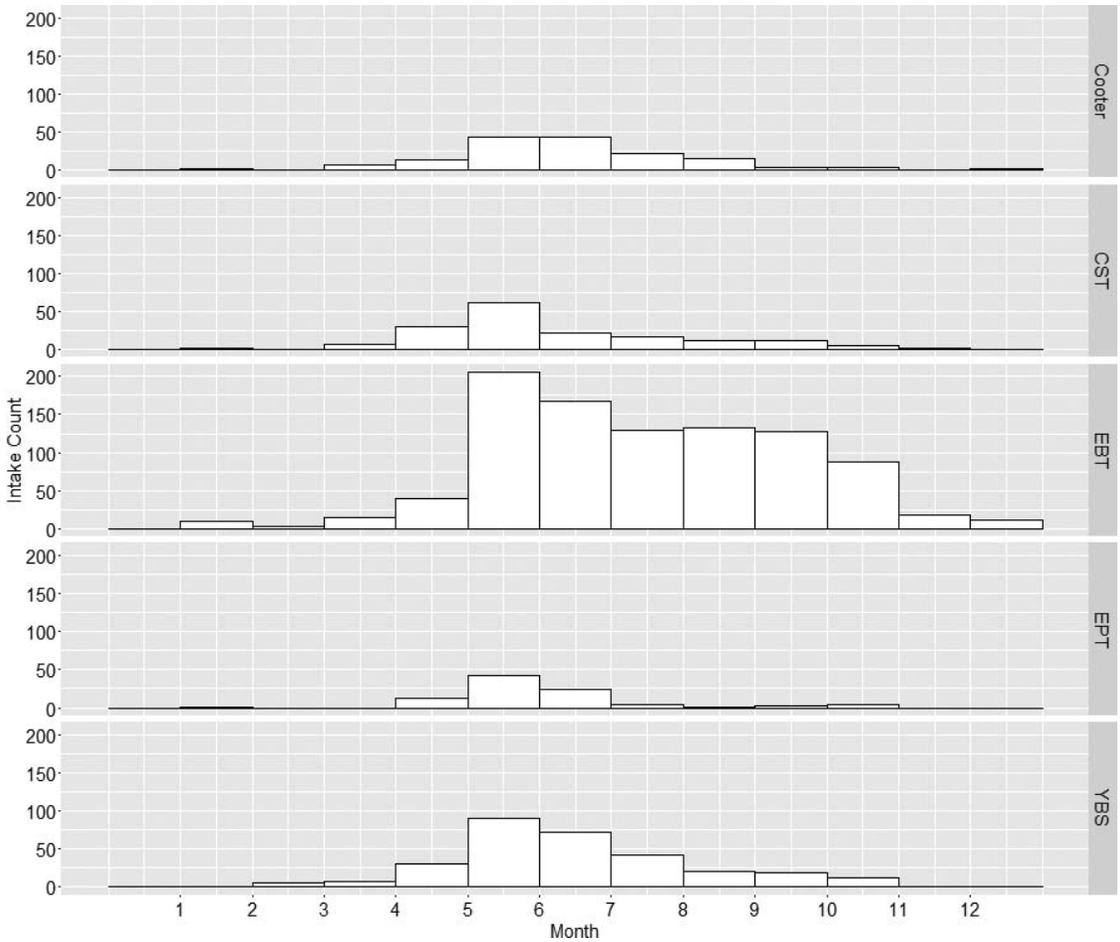


Figure 2. Most-prevalent species of turtles presented to North Carolina State University College of Veterinary Medicine's Turtle Rescue Team from 2005–2014 by month ($n = 1,506$).

Table 2. Patient numbers divided by presenting complaint, including those turtles that were euthanized or died on arrival, at North Carolina State University College of Veterinary Medicine's Turtle Rescue Team from 2005–2014 ($n = 1,847$).

Presenting complaint	No. patients (%)	Dead or euthanized on arrival (% of total by complaint)
Vehicular trauma	1,168 (63.2)	388 (33.2)
Unspecified trauma	140 (7.6)	14 (10.0)
Animal attack–dog	93 (5.0)	8 (8.6)
Aural abscess	80 (4.3)	1 (1.3)
Upper respiratory infection (URI)	63 (3.4)	2 (3.2)
Trauma from lawnmowers and gardening tools	53 (2.9)	8 (15.1)
Healthy	47 (2.5)	0
Fishing hook	42 (2.3)	0
Conjunctivitis	31 (1.7)	0
Animal attack–other	22 (1.2)	4 (18.2)
Surrendered pets	19 (1.0)	2 (10.5)
Concurrent URI and aural abscess	14 (0.8)	0
All other conditions	75 (4.1)	16 (21.3)
Total	1,847	443 (24.0)

Table 3. Most-prevalent presenting conditions of the predominant turtle species at North Carolina State University College of Veterinary Medicine's Turtle Rescue Team from 2005–2014 ($n = 1,468$).

Species	Vehicular trauma (%)	Unspecified trauma (%)	Animal attack-dog (%)	Aural abscess (%)	Upper respiratory infection (%)	Concurrent upper respiratory infection and aural abscess (%)
Eastern box turtle (<i>Terrapene carolina carolina</i>)	479 (50.6)	74 (7.8)	73 (7.7)	78 (8.2)	60 (6.3)	14 (1.5)
Yellow-bellied slider (<i>Trachemys scripta scripta</i>)	232 (77.1)	14 (4.7)	4 (1.3)	1 (0.3)	1 (0.3)	0
Cooter (<i>Pseudemys</i> sp.)	191 (81.3)	14 (6.0)	2 (0.9)	0	1 (0.4)	0
Common snapping turtle (<i>Chelydra serpentina</i>)	123 (74.5)	16 (9.7)	2 (1.2)	0	0	0
Eastern painted turtle (<i>Chrysemys picta</i>)	77 (82.8)	6 (6.5)	6 (6.5)	0	0	0

eastern box turtles (96%; 74/77). URIs represented 7.8% of all eastern box turtles patients. Aural abscesses, including those concurrently presenting with an URI, accounted for 5.1% (94/1,847) of all patients and were also overwhelmingly found in eastern box turtles (98%; 92/94). This diagnosis represented 9.7% of all eastern box turtles patients (Table 3).

Fishing hooks were the presenting complaint for 2.3% (42/1,847) of patients and were most commonly seen in yellow-bellied sliders (8.0%; 24/301). This species was 2.8 times more likely to present with a fishing hook than were all other wild turtles, excluding eastern box turtles (CI = 1.5, 5.3). However, two less-prevalent species, red-eared sliders (19%; 5/26) and common musk turtles (15%; 4/27), also commonly presented with fishing hooks. Red-eared sliders were 5.4 times more likely to present with a fishing hook (CI = 1.9, 15.2), and common musk turtles were 3.8 times more likely to present with a fishing hook (CI = 1.3, 11.6) than were all other wild turtles, excluding eastern box turtles. The only other species to present with fishing hooks were common snapping turtles (1.2%; 2/165) and cooters (3.0%; 7/235). Eastern box turtles were excluded from the odds ratio due to their terrestrial lifestyle.

Injury location and severity

Head injuries occurred in 18.2% (336/1,847) of patients, and the survival rate was 29.5% (99/336). A patient with a head injury was 2.9 times more likely to die or be euthanized than all other injuries (CI = 2.2, 3.7). Compared to all turtles with head injuries, eastern box turtles were 2.1 times more likely to die with a head injury (CI = 1.3, 3.4). While common snapping turtles were 3.0 times more likely to have a head injury (CI = 2.1,

4.2), common snapping turtles were 0.25 times less likely to die or be euthanized with a head injury than were all other species (CI = 0.15, 0.46). Coelomic breach(es) were found in 16.1% (298/1,847) of patients and were associated with a 4.8 greater chance of dying or being euthanized than were all other injuries (CI = 3.5, 6.4). Myiasis was found in 4.5% (83/1,847) of all patients and was associated with a 2.0-times increased chance of dying or being euthanized (CI = 1.3, 3.3).

Traumatic leg injuries were found in 15.3% (282/1,847) of all patients. Pre-existing leg injuries were not associated with an increased risk of dying or being euthanized after accounting for presenting condition (ANOVA; $P = 0.31$). However, pre-existing healed shell injuries were associated with a decreased risk of dying or being euthanized after accounting for presenting condition (ANOVA; $P = 0.03$). These patients had a 0.5-times decreased chance of dying or being euthanized when compared with all turtles that survived and obtained a full physical examination (CI = 0.28, 0.86). When only analyzing turtles that underwent a full physical examination, a carapace injury on the cranial midline was associated with a 1.9-times increase in mortality (CI = 1.4, 2.6) while the caudal midline was associated with a 2.2-times increase (CI = 1.6, 3.0).

DISCUSSION

Overall

Patients were brought in all 12 mo, with 25.6% arriving in May. Most patients arrived between April–June (53.9%). This time period was similar to turtles who were presented to an Illinois wildlife clinic but earlier than to a geographically closer Tennessee clinic where June and July were the busiest months for turtles.^{11,14} May and June was the time period when >80% of gravid females

arrived. This was further supported by the female bias in presenting yellow-bellied sliders and cooters. Loss of females of reproductive age presents a great threat to the long-term viability of turtle populations. Reduction in mortality amongst this population is an important conservation priority.

The majority of patients (63.2%) presented for vehicular trauma. The main presenting complaint was the same for all three wildlife clinics with published data on turtles.^{2,5,11,14} Animal and dog attacks, infectious and aural abscesses, and fishing injuries were also common at these three clinics. These commonalities suggest that patterns of morbidity are consistent across the eastern United States and are largely anthropogenic in origin. At 2.5%, the percentage of healthy turtles was lower than the 45–50% seen by another clinic;⁵ this difference may be because the TRT usually speaks to finders on the phone before the public brings a turtle to the clinic. Moving healthy turtles to a clinic and then returning them creates additional opportunities for disease spread, and measures that avoid the unnecessary transport of healthy turtles should be adopted.

The duration of hospitalization for >70% of patients was <25 days, and many were transferred to rehabilitation facilities prior to release. The average length of stay has been consistent through the years. This stay duration is very different from the Tennessee clinic, which only had a median stay of 2 days.¹⁴ A more-specific knowledge of the other clinics' policies would be necessary to understand this difference.

Turtles with vehicular trauma had the highest mortality rate of all presenting conditions and were 3.3 times more likely to die or be euthanized. One third of turtles with vehicular trauma died or were euthanized on day zero, indicating a poor prognosis at presentation. Coelomic breach was the physical exam finding with the greatest risk, with a 4.8-fold greater chance of being euthanized or dying. A breach theoretically increased the chance of abdominal organ compromise, as the membrane protecting these organs was no longer intact. Head injuries were the next greatest threat with 2.9-fold greater chance of dying or being euthanized. Myiasis and cranial and caudal midline injuries also doubled the chance of being euthanized or dying. Cranial and caudal midline injuries suggest spinal damage. In most cases the veterinary student made euthanasia decisions at presentation, which may have biased the results against certain injuries considered nonsurvivable. However, having a large number of students over

a 10-yr period should have overcome any specific student's personal bias. At TRT, 47.6% of patients were released. This release rate is similar to another clinic with a 52% release rate.¹⁴ The TRT's release rate increased to 62.0% if the patient survived the first day.

Old shell injuries decreased by half the chance of dying or being euthanized compared with turtles without old shell injuries among all patients that received a full physical examination. It is unknown why pre-existing shell injuries would decrease mortality, as old leg injuries were not associated with either mortality or release.

Eastern box turtles

The predominant presenting species was eastern box turtles, representing 51.3% of all patients. Unlike all other species in this study, which move on to land in significant numbers only during the breeding season, eastern box turtles in this study are present on land year-round and are therefore exposed to vehicles and other land-based anthropogenic threats all year. The large number of eastern box turtles may have been due to this factor or to a larger population, or to both. A study of eastern box turtles in North Carolina captured the majority of them between June and September,³ demonstrating continued activity throughout the summer and into fall. While eastern box turtles presented for a greater variety of complaints, including animal attack by a dog and over 90% of all URI and aural abscesses, eastern box turtles still presented for approximately half of all cases and half of all vehicular traumas, implying equal risk for vehicular trauma as the other species. The incidences of dog attack were most-likely driven by the terrestrial habits of eastern box turtles. Aural abscesses and URI may have been more common in eastern box turtles, or these conditions were more easily noticed in the terrestrial eastern box turtles, which were thus brought to the TRT.

When examining just survival rate for vehicular traumas, eastern box turtles no longer had a significantly higher survival rate. This suggested that presenting condition and not species was driving the survival rate. Furthermore, eastern box turtles were 2.1 times as likely to die from a head injury compared to all other species of turtles. This increased mortality rate is likely related to anatomic features because the eastern box turtles hinged plastron can easily crush the head between the carapace, as was recorded in multiple patient files of eastern box turtles with vehicular trauma.

Common snapping turtles

Common snapping turtles had the highest amount of unspecified trauma, which may have been due to common snapping turtles' aggressive, attack-centered behavior,⁸ directly or indirectly, such as a delayed vehicular trauma presentation due to reluctance of the public to transport a common snapping turtles. Common snapping turtles are known to use several kilometers as part of their home range, potentially increasing their risk of vehicular trauma.¹² Common snapping turtle behavior may have also put them at greater risk for minor head injuries, as common snapping turtles were three times more likely to have a head injury than were all other species. However, common snapping turtles were 4-fold less likely to die or be euthanized with a head injury. Many of these head injuries were fractured mandibles and not damage to the skull around the eyes and brain. Common snapping turtles have increased musculature protecting the brain and sensory structures on their skulls, as compared to other turtle species, which may have reduced the mortality associated with head injuries for this species.^{10,18}

Yellow-bellied sliders and cooters

Yellow-bellied sliders and cooters arrived with similar seasonality and presenting complaints. Both species presented primarily for vehicular trauma in May and June. Furthermore, there were more females than males for both species. Cooters were 2.5 times more likely to be gravid than were other wild turtles. One study¹⁶ found that over half of *Trachemys* sp. (yellow-bellied sliders and red-eared sliders) moved at least 800 m from the nearest wetland to nest while 95% of cooters (*Pseudemys* spp.) moved less than 150 m. The shorter distance traveled should thus reduce the chance of cooters being hit by a vehicle while gravid, which was not the case in the current study. It is possible that nongravid cooters move even less than gravid females or that prime nesting habitat in the study area is located exceptionally close to roads.

Yellow-bellied sliders more frequently presented for fishing hooks. Yellow-bellied sliders were 2.8 times more likely to present for a fishing hook injury and another *Trachemys* species, red-eared sliders, presented with an even greater chance (5.4-fold increase) of having a fishing hook compared to all wild turtles (terrestrial eastern box turtles excluded). Previously, common snapping turtles and yellow-bellied sliders were reported as being more likely to have ingested

fishing hooks,¹⁷ so TRT may be overlooking internal hooks in some common snapping turtles and yellow-bellied sliders.

Eastern painted turtles

Eastern painted turtles accounted for the fewest cases of the five most-prevalent species and presented in the narrowest period of time. Eastern painted turtles also had a higher percentage of attack by a dog (6.5%), although not significant, than did the other primarily freshwater turtles. In one study, eastern painted turtles used small home ranges and stayed close to shore in water less than 1 m deep.⁷ This habitat, along with their small size, may have made them more vulnerable to dogs than were common snapping turtles, yellow-bellied sliders, and cooters.

CONCLUSIONS

The majority of wild turtles died or was euthanized from anthropogenic causes, primarily vehicular trauma. Vehicular trauma was still the greatest threat to the eastern box turtles, but this species presented for a greater variety of conditions that were less-directly caused by humans such as animal attack by a dog, URI, and aural abscess. Cooter populations may be at special risk of decline due to the large number of gravid females received. While many turtles presented with little chance for survival, 47.6% were eventually released, and that number increased to 63.6% when looking at turtles that survived for 24 hr or longer. Through an examination of 1,847 turtle patient files from 2005–2014, this study adds to the knowledge about the risks of injury and diseases, and the resulting outcomes, for multiple species of wild turtles in an attempt to further characterize and potentially ameliorate the overall impact of humans, especially as a result of vehicular trauma.

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