COLLECTED DATA AND RESEARCH INTO TURTLE POPULATIONS IN THE FORT WORTH AREA

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COLLECTED DATA AND RESEARCH INTO TURTLE POPULATIONS IN THE FORT WORTH AREA

by

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ABSTRACT

COLLECTED DATA AND RESEARCH

INTO TURTLE POPULATIONS

IN THE FORT WORTH

AREA

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The turtle population within Fort Worth has been observed to be in danger. Turtles of all species were washing up on lakes and rivers deceased or incapacitated, often diseased and lacking any sense of innate self-preservation that would otherwise be present in the species.

The research conducted aimed to trap and track the turtle population using Passive Integrated Transponders, or PITs. These techniques were utilized to further solidify any potential new disease outbreak or trend in turtle deaths so that further action could be taken in the future. The turtles were each measured for circumference, weight, and sex while the total number of turtles captured were sorted through a table and

organized by species. The data was then applied and the total number of turtles per the three years of testing was compared.

The data, when reviewed, pointed towards a notable change in turtle population that could explain the reported sightings of mass turtle deaths. The mean of the first half of data was 37.4 turtles trapped and tracked while the final data points mean resulted in 33.2 turtles trapped and tracked. The research clearly shows a decline in turtle population in a short time span-pointing towards a possible new, devastating event that is targeting turtle species in the DFW area.

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CHAPTER 1

INTRODUCTION

The study on the population and tracking of the conservation of turtles first requires a thorough and complete understanding of not only the biology of turtles but the relationship turtles have with the environment. Turtles are not often thought of as a keystone species, however, due to their efforts on the sustainability of the environment, their position in the habitat is a vital one. The importance of the turtles to their environment places stress on the importance of study and conservation because a dwindling turtle population may also indicate other deadly events within an ecosystem that have farther reaching consequences.

1.1 Biology of Turtles

Turtles belong to an order of reptiles known as Testudines with genetic evidence placing them within the animal kingdom close to crocodilians and birds. Turtles are widely known for their unique structure and are typically characterized by a hard outer shell encompassing their body. The turtle is a general term describing reptiles with a bony shell. The turtle shell is divided into two parts, the top is known as the carapace while the bottom, the plastron. The turtle shell is a structural part of its body. The carapace and plastron are joined together as one, along the sides, to create a skeletal box. The shell itself is made of bone and cartilage and unlike typical animals that rotate their shells such as a hermit crab, the turtle's carapace is retained throughout the turtle's lifespan. Turtles are not able to exit their carapace, and the carapace cannot be shed much like other animals who outgrow their own shells (Carr, 2018). Nearly 300 species of turtles are found around the world including on most of the world's continents and within all oceans.

1.1.1 Turtle Reproduction

Turtles are similar to mammals in that they are able to breathe air and do not lay eggs underwater. This unique ability necessitates the practice for proper egg hatching grounds along the shore. Sea turtles commonly lay eggs along beaches-creating miles of potential egg laying sites on the world's coasts. The turtles found in residential areas or developed demographics, such as the turtle species researched, often utilize riverbanks or lake shores in a similar fashion to hide and protect their eggs until they hatch (Ernst Lovich, 2009). This behavior requires turtles to primarily live in or around water.

1.1.2 Turtle Thermoregulation

Turtles are ectotherms, known as cold-blooded. This means that every species of turtle has a unique internal temperature which varies with their external environment. Because of this, they are sensitive to environmental changes within their ecosystem. The cold-blooded nature of the turtle causes forms of internal thermoregulation to take place. Small pond turtles such as the ones observed in the project often leave the water to bask in the sun to regulate their internal temperatures (Dubois et al., 2009). Other species often rotate in and out of the sun and shade to regulate their body temperature while others still, such as sea turtles, utilize their own body mass and thermal inertia to control their temperatures (Dubois et al., 2009). It is important to note the impact the environment has on these forms of temperature regulation.

1.1.3 Turtle Diet

A turtle's diet often depends heavily on the age, population, environment, and species of the turtle. In general, turtles can be seen as opportunistic omnivores. This means that turtles often feed on both plant material and animals based on availability. Sea turtles feed on small shellfish such as mollusks or clams, but often consume fish and birds as well. The varying diet even includes small mammals or other turtles (Ernst and Lovich, 2009). There are other turtles, such as the ones observed in the study, that feed on plant material as a regular part of their diets (Carr, 2018). These smaller turtles often consume grass or fruits and small insects or worms varying their diet. This uneven diet often subjects the turtles to their environment. The ecosystem where they reside heavily influences on what they eat and a consistent eating habit cannot be determined from one single turtle. A collective population within an area needs to be observed to make a diet observation.

1.2 Turtles on the Ecosystem

Turtles are an important part of an ecosystem and their role within the food chain helps bring about stability to their environment. Turtles are a keystone species within the ecosystem and a loss in population or shift in behavior could be interpreted as a sign of the deteriorating health of an ecosystem as a whole due to the turtles importance (Lovich et al. 2018). If a keystone species, such as the turtle, is removed or reduced in a habitat the natural order is effectively ruined impacting other wildlife from predators to producers in many ways. Turtles contribute greatly to the world around them.

1.2.1 Food Chain Placement

A turtle is not just a single species residing within an ecosystem but an integral part of the food chain that each level of the ecosystem relies on. Firstly, they are sources of food for predators. Sea turtles are relied on by sharks, shellfish, dolphins, and large fish as a source of food. Pond turtles are preyed on by lake or river fish, other reptiles, dogs, and even wild pigs. Hatchlings themselves are an important part of the food chain with insects and birds using the young turtles or eggs as a critical part of their diet. The absence of these sources of nutrition will no doubt put a severe damper on other populations (Lovich et al., 2018). Secondly, turtle species of all types are consumers. Pond turtles keep local vegetation along rivers, streams, and lakes at a manageable level which is especially important for maintaining balance within the environment (Carr, 2018). Sea turtles also do this to an extent. The management of sea grass is directly attributed to the presence of this species. Pond turtles also keep insect populations down and turtles of all types prey on fish and fish spawn as well as various types of crawfish. The loss of the turtle population could skyrocket these otherwise balanced populations which would throw the entire ecosystem off balance and result in masses of uncontrolled populations destroying the habitat and fighting for limited resources (Lovich et al., 2018).

1.2.2 Endozoochory

One way that turtles contribute to their environment is a process known as endozoochory. Turtles are omnivores and, in particular, the range of species studied were often herbivores. These turtles consumed plants and leaves often. This diet means an opportunity for seed-dispersal. Endozoochory refers to the mutual relationship where plants surround seeds with nutritious and inviting plant material, such as fruits, to entice animals, such as turtles, to consume and spread through their droppings (Pakeman et al., 2002). After consuming the seeds of the plants, turtles excrete the seeds in a new location. It would otherwise be impossible for the plant to disperse its seeds in this location without the turtle. The relationship and endozoochory helps diversify plant species and populations, an important part of the producer's survival (Pakeman et al. 2002).

1.2.3 Mineral Support

Turtles also contribute to the environment in other surprising ways. Sea turtles and pond turtles alike lay eggs along the shores of bodies of water. The natural movement of the waves breaks down the eggshells, which contain vital minerals and create great carriers to erosion in their physical composition. This breakdown of eggshells boosts local vegetation (Lovich et al., 2018). The turtle offspring that do not survive to adulthood also contribute to the local environment. As their bodies decompose, it affects the levels of pH in the soil and provides scavengers or decomposers an opportunity for a meal (Lovich et al., 2018).

CHAPTER 2

LITERATURE REVIEW

2.1 Turtle Conservation

Prior studies have identified a link between population decline and the declining health of an ecosystem. These studies suggested that the loss of turtles over a year coincided with various events happening within an ecosystem, suggesting a possible link (Hall et al., 1999). One study found that an increase in human development and recreation within an area ran parallel to the decline of turtles within the same area in a linear decline over a 20-year time span (Garber and Burger, 1995). Another study suggested that flooding and an overall theme of climate change were possible causes of the decline of box turtles in Maryland (Hall et al., 1999). Yet another study localized the turtle population within an area, suggesting that a Southern Québec Wood Turtle's population decline was credited to human development including a recently paved road (Daigle and Jutras, 2005).

In these studies, and related research, the death of turtles was linked to a change in habitat or a shift within an ecosystem (Garber and Burger, 1995). The data collection was performed similarly to our own experiment. This study of turtles around a recreation area involved the tagging of over 130 turtles. The turtles were then tracked using a similar mark-and-recapture study on a protected watershed in south-central Connecticut (Garber and Burger, 1995). This characterized the catch and track method as the most popular method of which to understand a population within a selected habitat. Other researchers, however, observed turtles over a much longer time period, with researchers setting out to count individual turtles over a selected time period in a long-term study of the population (Hall et al. 1999). These studies not only tracked the turtle population but also drew a link between environmental factors that could have affected their decline. One study on the decline of Wood Turtles pointed towards road mortality as a major cause of some turtle population decline, citing a recently paved road and previous work. (Wood and Herlands, 1997). The same study also pointed towards farming machinery during ploughing and harvest, common in that specific area (Daigle and Jutras, 2005). These types of studies give insight into how turtle populations are tracked around the world and how connections on causes to the turtle declines are created.

The studies and data collected by these researchers offer valuable information on how a proper experiment involving a turtle population should be accomplished. The researchers all asked a similar question; were turtle populations declining and did it mean something bigger for the ecosystem as a whole? The work of these studies helps paint a bigger picture of the state of turtles as a whole and not just as a single sample of a selected area. The methods and information observed help form the base for other researchers' experiments. Turtle populations are declining nationwide, and they must be studied. Causes of this decline must be deduced to mitigate any more potential declines that would cause an extinction of such an important keystone species further degrading the world we live in.

CHAPTER 3

METHODOLOGY

The population of turtles within an area should be measured over a long period of time, such as the maturity period of turtle species expected to be encountered, and consistently tracked to mitigate a sampling bias. It is imperative that the methods utilized to conduct the data collection are reviewed extensively and researched from previous studies to maintain the validity of the study. The factors that come with methodology include a look into the field site itself, the organisms expected to be encountered, the methods of tracking, and the methods by which the data was analyzed and reviewed.

3.1 Field Site

The area selected for study was a man-made lake located in Candleridge Park in Fort Worth, Texas. This site was known to serve as a habitat for a variety of species of turtles and was one of the main locations for the sightings of dead or dying turtle species. These deaths could be attributed to the high foot traffic around the area which also meant the lake was easily accessible along the four-week testing period. The lake, known locally as French Lake for the roads running adjacent to the site, is characterized by individual trees shading a field that separates walking paths for visitors from the shoreline. The north end of the lake has an artificial fountain which was avoided. The north end of the lake also has a small sea wall composed of individual stones as a form of erosion control. The south side of the lake was utilized primarily as the shoreline sloped into the water rather than at an abrupt angle like the sea walls, providing better habitats for the turtles. French Lake also feeds small tributaries and streams that branch off across the lake. There was no turtle activity along these bodies of water and the water level was observed as relatively low during the time period collected. The easy access to the site as a public park meant that the data collected could be made on consistent dates and with permission from a public source rather than a private owner. It should also be noted that the Fort Worth area serves as a prime location for the ecosystem of the turtles observed with warm, long summer months and a mild winter. This increased the suitability of the park and French Lake as a source of data collection.

3.2 Experimental Organism

A variety of turtles were expected to be encountered during data collection. These turtles are found in the southern region of North America, thriving in the environment expected from the Dallas-Fort Worth area. One example, the Slider Turtle or *Trachemys* are so prevalent throughout the North American region that in some circles of environmental specialists, they are seen as an invasive species. Slider Turtles are also some of the most popular pet turtles and are a very sustainable species making them some of the most commonly found turtle species in environments such as the one in French Lake. (Gibbon and Lovich, 2002). The Red-eared sliders that have a signature reddish or orange stripe along their heads starting from the ear to the back of the eyes. The Red-Eared slider can also be identified as their top shell has a yellow and black line pattern while their bellies are primarily yellow. The Cumberland slider turtle has an olive green or a brownish shell with yellow streaks. The yellow-bellied slider like the name suggests has a nearly completely yellow plastron. The red eared slider has a red streak as previously described from the ear to behind the eye.

Another commonly found species of turtle is the River Cooter, or *Pseudemys Concinna*. They are another freshwater turtle whose behavior includes basking on shores or logs and rocks. These turtles feature yellow and white stripes along the neck and head of the turtle. Another subspecies of the Cooter is the eastern river cooter, these species of turtles feature a green and brown feature towards the rear of the turtle along with stripes along its head and neck. The belly is often red or orange (Eckert et al., 1999). Yet another species that may appear is the Coastal Plain Cooter. These turtles feature stripes along the head and neck with a plain yellow belly without any patterns.

Apalone spinifera or the Spiny Softshell Turtle is the third unique turtle commonly found in freshwater bodies. They are easily recognized by their pointy beaks and uniquely structured shells (Eckert et al., 1999). Soft shell turtles are rare in the region surveyed but are not unexpected. The shells lack horny scutes or scales. The shell, or carapace, is instead a leathery and pliable to the touch, softer along the sides. It should be noted that these turtles developed these lighter and flexible shells to allow greater freedom of movement in water (Sánchez-Villagra, 2009). They are also able to move much faster on land than hard shelled turtles. Finally, the least common turtle observed, but expected in the environment, was the Common snapping turtle, or *Chelydra Serpentina*. This species of turtle is characterized by their large snapping jaws and prevalent beak used to crush and consume prey. They are generally the largest turtles observed in man-made lakes such as French Lake. These can be differentiated from regular turtles by their small cross shaped plastron on their belly (Gibbon and Lovich, 1990). A turtle that has a larger plastron on their belly with a short tail is not a snapping turtle. It should be noted that nearly all species of snapping turtles have a saw-like tail and are generally larger than all other freshwater turtle species (Roman, 1999).

These turtles were all expected to be found in the ecosystem and were easily identifiable between the species. These techniques and background research will greatly assist in aiding the study of turtles in the area.

3.3 Tracking

The selected method of capturing the turtles for study was through the use of specialized traps. These traps were chosen specifically for fit, the material, and survivability of the captured species. They were streamlined traps with little to no appendages that would snare or poke the captured turtles. The traps were constructed with a fine, mesh, non-stretched net that would not cause the turtle's limbs or head to be caught and cause possible drowning. It was equally important that the traps remain above water to some extent because a turtle requires air to survive. The traps were therefore suspended in the water rather than anchored to the lakebed where the turtles may have been trapped and drowned. The canned sardines placed inside the mesh net as bait owed to the omnivore nature of the pond turtle species. This bait catered to all species of turtle's diets. Once captured, the turtles were tracked using Passive Integrated Transponders, or PIT tags. These tags are used to injecting the upper left leg via a needle. PIT tags were selected because they did not require any external batteries and therefore limited the amount of trauma and weight experienced by the individual turtle (Gibbons and Andrews, 2004). The lack of batteries allowed the tags to last throughout the entire study. Moreover, the PIT tags are light and small in size. Tagging the turtles rather than counting them individually streamlined the data collecting process while also granting researchers the ability to track turtles even when the turtle was no longer alive. This way, dead turtles could also be tracked and potentially found if they were to drift within a certain range.

3.4 Data Processing

The raw data was collected and put into tables for easier organization. In addition, data such as circumference, sex, and size were inputted into Program Mark. The program provides parameter estimates from each marked animal when they are re-encountered at a later date. The program was also utilized because it included data from re-encounters from both living specimens and dead turtles. The time intervals between re-encounters did not have to be equal, meaning turtles that drifted out of range were not omitted from the data collection and were able to be included. The benefits of Program Mark continue, with more than one characteristic of a specimen able to be collected including circumference, sex, and size. The use of parameter programs such as Program Mark help researchers provide estimates of population size of a selected sample modeled as a function of time (White & Burnham, 1999). The data collected was saved and viewable in the results window.

CHAPTER 4

DISCUSSION

The information collected over a four-week time period shows a very clear decline in turtle population throughout all species. The average total number of collected and tracked species of turtle dropped by nearly half in the span of two weeks. The drop was nearly consistent with all species of turtles.

Table 4.1: Turtles Tracked During Time Period

	9/26 2019	10/3 2019	10/17 2019	10/24 2019	10/1 2020	10/8 2020	10/22 2020	9/23 2021	9/30 2021	10/7 2021
Trachemys Scripta	48	41	22	9	38	27	42	22	31	33
Chelydra Serpentina	4	4	1	0	0	1	0	1	0	1
Pseudemys Concinna	2	3	2	0	1	0	0	1	0	0
Apalone Spinifera	6	6	0	0	0	4	0	3	1	4
Total	60	54	25	9	39	27	42	27	32	38

The data was interpreted by finding the mean for the total number of turtles per each data collecting section. The first two weeks, five sets of data, were added together and divided by five. The same was done for the second half of the data collection period. The result was an average mean of 37.4 turtles observed for the first half of the data point collection and 33.2 turtles for the second half. The difference between the two data points was nearly 4.2 turtles from each other. The data is consistent with each turtle species as well, with *Chelydra Serpentina*, *Pseudemys Concinna*, and *Apalone Spinnifera* showing remarkably lower numbers as the weeks progressed. The biggest note is the nine turtles tracked in the fourth data collection date, compared to the 60 data points collected in the beginning of the cycle. The common slider turtle also shows a slight downward trend in the four data points alone.

Figure 4.1 Capture and Recapture Events

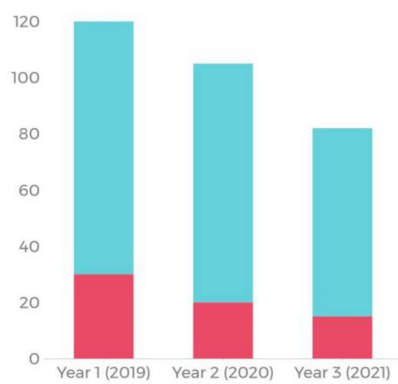

Figure 4.1 above represents the number of slider turtles captured and recaptured based on raw data collected. The comparison between the three bars is the turtles that were found between the data points within the year. The blue represents capture events while the red represents a failure in locating the turtle. The data suggests that the number of turtles captured and found again is a dramatic difference, suggesting even more evidence of a die-off between the data collection points. A healthy turtle population would result in turtles being tracked and recaptured alive within similar parameters and not such a large difference as shown in Figure 4.1. Turtles are not migratory animals and therefore should be easier to locate in a healthy ecosystem using the PIT tags.

Table 4.2: Program Mark on Turtle Data

p(t), phi (t), pent (t)

Real Function Parameters of {p(t),phi(t),pent(t)}

Parameter	Estimate	Standard Error	95% Confidence Interval Lower	Upper
1:Phi	1.0000000	0.0000000	1.0000000	1.0000000
2:p	0.3806141	2.5101275	0.5310651E-09	1.0000000
3:p	0.2557003	0.0478798	0.1734271	0.3600045
4:p	0.2346418	0.0536011	0.1458799	0.3549665
5:p	0.1066583	0.0348443	0.0550910	0.1964588
6:Phi	0.5546233	0.0500565	0.4556631	0.6494340
7:p	0.1787963	0.0367074	0.1176859	0.2622089
8:p	0.4471413	0.0675967	0.3212189	0.5802307
9:p	0.1361926	0.0393763	0.0756267	0.2330347
10:p	0.2042772	0.0528473	0.1195178	0.3268334
11:p	0.2179051	0.0554879	0.1283001	0.3453009
12:pent	0.1001764	2.7461290	0.1301550E-26	1.0000000
13:pent	0.3620917E-08	0.9282828E-05	-0.1819072E-04	0.1819796E-04
14:pent	0.4481507E-07	0.3548605E-04	0.2492921E-315	1.0000000
15:pent	0.1060110	0.0444049	0.0451963	0.2290275
16:pent	0.1702011	0.0541622	0.0881967	0.3031062
17:pent	0.5306651E-10	0.1674686E-06	-0.3281854E-06	0.3282915E-06
18:pent	0.2071051	0.0533697	0.1213752	0.3306034
19:pent	0.4326198E-07	0.5236390E-04	0.2406527E-315	1.0000000
20:pent	0.2690668E-06	0.1478407E-03	0.1496734E-314	1.0000000
21:N	302.76800	23.439828	265.09274	358.38961
22:Phi	0.8958507	0.2081750	0.0978641	0.9985359
23:Phi	0.7187049	0.1059921	0.4776310	0.8771409

The results of Figure 4.3 suggest a slight decline in turtle populations within the Fort Worth area across all species studied. The results are of immediate concern because the dates tested cover a relatively short time period in comparison to similar, contemporary studies over a long time frame. The drop in population is evident in the data collected.

4.1 Implications

The data points towards an event or external factor that is perhaps unnaturally affecting the turtles in a negative way. The role of turtles as a keystone species means that the results are inevitably a sign of the decline of the environment as a whole. The loss of turtles within the ecosystem would negatively affect predators and producers alike as food scarcity and competition of resources would increase substantially.

4.2 Limitations

The limitations of this study are clear however, that no one source of the turtle's demise can be deduced by the data collected. The data represents only figures regarding the turtle population and not an overall cause for the population decline. This initial study must be developed further into long term research that also represents specific dates that may have occurred to coincide with the decline in turtles. The data only suggests that there is an overwhelming event impacting the turtles rather than stating concrete evidence that the turtles are dying off due to one single event. The study opens the results up to interpretation and suggestion of the larger topic at hand and invites speculation towards the decrease in turtles.

The physical limitations of the study are also clear. There may have been turtles that actively avoided the traps after running into them more than once in the first few weeks of the data collection. A change in bait from canned sardines to another fish would have mitigated this, however. Another limitation of the study is due to the nature of a shorter-term experiment, the data points could not be considered absolutely consistent because there were only 10 data points collected over the course of three years. A form of sampling bias is inherent in this type of study and further research is required to solidify the findings.

4.3 Recommendations

The researchers of this study recommend that further research be conducted to not only confirm the preliminary findings of this research but also to pinpoint a specific cause for the turtle population's demise. Testing of the deceased turtles should also be conducted within a lab to compare against living specimens. This comparison can determine any potential disease or affliction that impacts the turtles which could be traced back to the environment. There should also be further studies into the composition of the lake to rule out the lake water itself as a culprit of the Turtle's demise. Another step that could be taken if the turtle population is indeed confirmed to be in a decline is to study all aspects of the food chain for any variations that affect both producers and consumers. Weather patterns could be observed and noted for any sharp changes coinciding with the decreasing population and finally, steps should be taken to remedy the situation if any cause is found. The turtle species within a healthy ecosystem is a vital one and should be protected to ensure the tranquility of that specific ecosystem. This preliminary study only opens the door as an invitation for further research which could unveil deeper results and consequences.

CHAPTER 5

CONCLUSION

The data collected within this study clearly presents a picture of some form of decline in the turtle population within French Lake. The data represents four weeks of data collection that, when organized into a table, demonstrates a clear linear decline as the weeks progress. The comparison between the first half of the study and second half of the study shows a difference of 4.2 data points representing a decline in population. The implications of this population drop include a loss of sustainable habitat for not only turtles but all members of the ecosystem including plants, scavengers, decomposers and to the predators that rely on turtles as a source of food. The health of the ecosystem is in danger if the data points are to be withheld.

The limitations of the study are inherent to the nature of the experiment. The short time frame selected for the preliminary study means that results may not have been consistent and suffer from forms of sampling bias that a longer-term study would mitigate. The study also had some physical limitations such as inconsistent data collecting dates and loss of tracking tags from turtles drifting beyond the range of the sensor. The solution to these problems would be follow up studies on the population of turtles within the lake to confirm the findings of the study and for further follow up research to be conducted to determine potential causes for the sharp decline. It is important to learn from the limitations of this study and improve the methodology for further research to ensure that the loss of a keystone species is dealt with swiftly and with confidence. The loss of turtles within an ecosystem is devastating and could be a sign of larger issues to come.

REFERENCES

Carr, A. (2018). Handbook of turtles: the turtles of the United States, Canada, and Baja California. Cornell University Press.

Daigle, C., & Jutras, J. (2005). Quantitative evidence of decline in a southern Quebec wood turtle (Glyptemys insculpta) population. Journal of Herpetology, 39(1), 130-132.

Dubois, Y., Blouin-Demers, G., Shipley, B., & Thomas, D. (2009). Thermoregulation and habitat selection in wood turtles Glyptemys insculpta: chasing the sun slowly. Journal of Animal Ecology, 78(5), 1023-1032.

Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A., & Donnelly, M. (1999). Taxonomy, external morphology, and species identification. Research and management techniques for the conservation of sea turtles, 21, 11-13.

Ernst, C. H., & Lovich, J. E. (2009). Turtles of the united states and Canada. JHU Press.

Garber, S. D., & Burger, J. (1995). A 20-yr study documenting the relationship between turtle decline and human recreation. Ecological Applications, 5(4), 1151-1162.Gibbon, J. Whitfield, and Jeffrey E. Lovich. "On the Slider Turtle (Trachemys Scripta)." Herpetological monographs 4 (1990): 1-29.

Gibbons, W. J., & Andrews, K. M. (2004). PIT tagging: simple technology at its best. Bioscience, 54(5), 447-454.

Hall, R. J., Henry, P. F., & Bunck, C. M. (1999). Fifty-year trends in a box turtle population in Maryland. Biological Conservation, 88(2), 165-172.

Lovich, J. E., Ennen, J. R., Agha, M., & Gibbons, J. W. (2018). Where have all the turtles gone, and why does it matter?. BioScience, 68(10), 771-781.

Pakeman, R. J., Digneffe, G., & Small, J. L. (2002). Ecological correlates of endozoochory by herbivores. Functional Ecology, 296-304.

Roman, J., Santhuff, S. D., Moler, P. E., & Bowen, B. W. (1999). Population structure and cryptic evolutionary units in the alligator snapping turtle. Conservation Biology, 13(1), 135-142.

Sánchez-Villagra, M. R., Müller, H., Sheil, C. A., Scheyer, T. M., Nagashima, H., & Kuratani, S. (2009). Skeletal development in the Chinese soft-shelled turtle Pelodiscus sinensis (Testudines: Trionychidae). Journal of Morphology, 270(11), 1381-1399.

White, G. C., & Burnham, K. P. (1999). Program MARK: survival estimation from populations of marked animals. Bird study, 46(sup1), S120-S139.

BIOGRAPHICAL INFORMATION

Dung Nguyen arrived in the United States in 2003 from Hanoi, Vietnam with a passion for biology and wildlife. She was inspired by the blend of nature and the local community in her hometown, with a diverse ecosystem and relationships between the people and the world around them. She is currently enrolled at the University of Texas at Arlington and will graduate in 2022 with an Honors Bachelor of Science in Biology. She has taken part in numerous undergraduate and Honors programs all aimed at preserving wildlife and studying the relationships between humans and nature. Dung Nguyen plans to further her career in studying the impact of humans on the ecosystem to better the world around her, especially in regard to climate change. She plans to graduate with a masters from the University of Texas at Arlington and continue in her field helping animals and providing invaluable research to the scientific community to better the Earth.