Backyard conflict:

The effect of urban development on a population of Eastern box turtles

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Abstract

Eastern box turtles (*Terrapene carolina carolina*) are small terrestrial turtles, known for their domed shell and hermit-like tendencies. They roam around mature forests, thermoregulating or munching on fungi and worms. With a selective home range and long lifespan (30-40 years), box turtles are often threatened by changes to their habitat, such as timbering. Understanding how the population responds to reduction in habitat provides insight to preserve these populations when faced with urban development.

Alongside the Blackwater Creek trail, Lynchburg, VA, a small population of turtles in an undisturbed forest area has been monitored annually by Liberty students and professors since 1999 using a mark recapture method. The shell notch method was used to mark individuals, and several were monitored with radio telemetry. In 2020, a large portion of the previous study site was timbered for new residential housing, reducing available forest from 11 to 2.2 hectares.

Data collected Fall 2021 were compared to pre-development data and showed that the population of box turtles declined from 169 to 58 in response to the reduction in habitat, while other characteristics of the turtle population (turtle size, home range, fraction female) remained similar. Tracking turtle movements showed migration of some turtles into the remnant forest post-development.

While the study observed a decrease in the box turtle population, there is hope, and future studies will explore this, that remnant populations will be able to survive and continue within the remnant forest.

Introduction

When sin was first committed in the Garden of Eden, relationships between man and creation and between species within creation shifted drastically. Where there was once harmony, peace, unity, and unlimited flourishing there was now death, decay, limitation of resources, and hardship. While many aspects in this current phase still hold goodness and beauty, the consequences of sin remain evident within our daily lives. Just as a construction project brings homes, community, and economic opportunity, there is also the destruction of natural habitat and removal or reduction of plant and animal species. Our question as creation scientists is how to mitigate the consequences seen in our fallen world to better reflect the Lord's original design and that promised in His coming new earth. In the local area of Lynchburg, VA, a residential development project has been encroaching on the habitat of the Eastern box turtle (*Terrapene carolina carolina*). By monitoring the changes in this population, pre- and post-development, we can help reduce our impact on these "backyard neighbors".

Eastern box turtles are terrestrial turtles found from Maine to Florida. They prefer areas with forest cover, moderate temperatures, and humidity (Ernst, et.al., 1994). Home ranges between turtles often overlap; however, females will sometimes journey far outside their home range to nest in an open grassy field (Wilson and Ernst, 2008). As ground dwellers, box turtles can be opportunistic omnivores, feeding on insects, fungi, fruits, flowers, and sometimes carrion (Ernst, et.al., 1994). They have a steady growth rate until they near 20 years old, when growth almost halts until they typically die when 30-40 years old (Ernst, et.al, 1994). This long lifespan is linked to slow reproductive rates, resulting in slow recovery from adverse environmental changes (Dodd, 2001). Historically, most box turtles were threatened by conversion of woods to pasture lands, commercial pet trade, and industrialization. While these threats are still active today, many more are victims of automobile collisions, as well as mowing and construction equipment (Wilson and Ernst, 2008; Dodd, 2001).

In Fall 2021 we began monitoring the impact of an urban development project on an existing box turtle population, studied since 1999. Beginning in 2020, the area beside Blackwater Creek trail was reduced from 11 to 2.2 hectares, cleared for residential housing. Data collected on population size, sex ratios, carapace length, and home range sizes were compared to pre-development data.

Methods & Materials

In 1999 a mark-recapture study was initiated by Dr. Gordon Wilson within an 11 ha portion of the Odd Fellows Home property adjacent to the Blackwater Creek Nature area. The turtle population was monitored annually with varying levels of sampling frequency. In 2019, the Odd Fellows Home property was sold and a housing development began which impacted the 11 ha study site. Much of the forested property was cleared of trees between 2019 and 2020 and by fall 2021 there was 2 ha left of habitable forest from the original 11 ha site.

Turtles found throughout this study were found by the visual encounter method. Turtles were hand collected and given permanent, distinct markings for future identification. Shallow notches were ground into the marginal scutes of the carapace using a small triangular file. This method allowed for the individual identification of hundreds of turtles by making use of a numbering system first described in "A new coding system for hardshelled turtles" (Figs. 1&2, Ernst et al., 1974). In addition to using the shell notch method to mark turtles, the tradition of naming turtles, which Dr. Wilson initiated, was also maintained throughout the study. All turtles collected had their sex, carapace length, GPS coordinates, and date of capture recorded. A small number of turtles were equipped with radio transmitters so that they could be regularly located for several months in the fall using telemetry equipment. For telemetered turtles, prior to their release, a transmitter was epoxied onto the turtle's shell (Fig. 2). A directional antenna and receiver were then used to locate each turtle several times a week. UTM coordinates using a GPS were recorded upon locating the turtle.

Figure 1. Students measuring carapace length and marking turtles with a file.

Figure 2. Box turtle displaying shell notch marking on outer scute.

Figure 3. Adhering a transmitter with epoxy to the carapace of a box turtle.

Figure 4. Left figure from 2017. Right figure from 2021. Red outline showing 11 hectare pre-development study site. Blue outline showing current, post-development, 2.2 hectare study site.

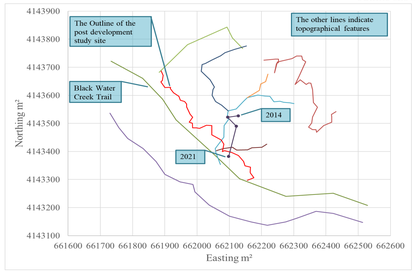

Figure 5. Bilbo, a named box turtle initially found in 2014, was found two other years in what is now the construction site. In 2021, Bilbo was found in the remnant forest distant from the original three sightings.

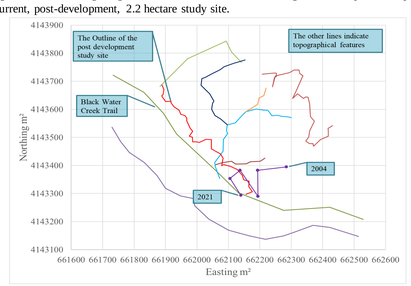

Figure 6. Stevie Y, a named box turtle initially found in 2004, was found three other years in what is now the construction site. In 2020 and 2021, Stevie Y was found in the remnant forest.

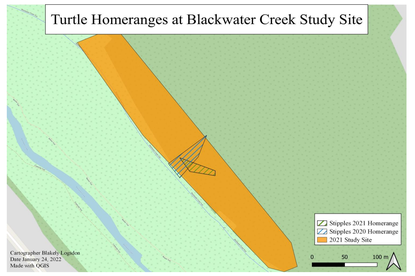

Figure 7. Stipples was found in the remnant forest before construction began, as seen by historic telemetry data from 2020, and after the construction began his home range shrank, but stayed in a similar location.

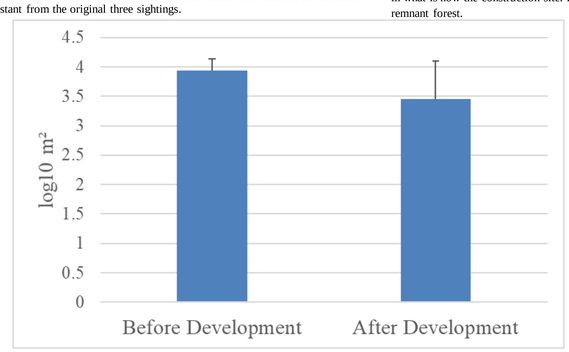

Figure 8. Home ranges (log_{10} m²) for telemetered box turtle found during pre- and post-development times.

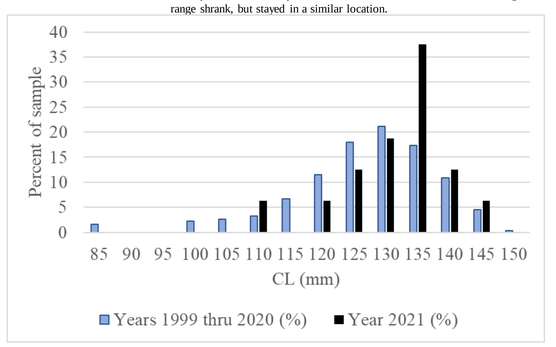

Figure 9. Box turtle carapace lengths comparing those found historically in the pre-development site compared to those found in the remnant forest of the post-development site.

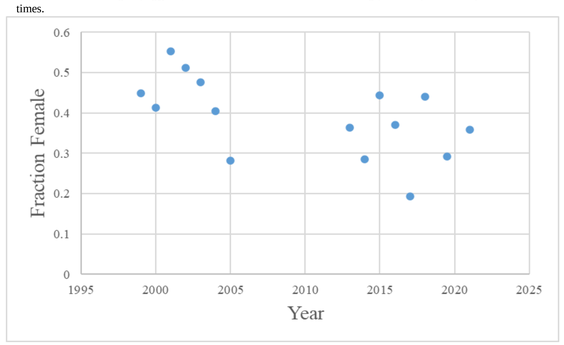

Figure 10. The fraction of females in the box turtle population showing a decline over time (r=-0.56, n=15, P=0.03). In more recent years (2013-2021), there was no temporal trend (r=-0.066, n=8, p=0.88).

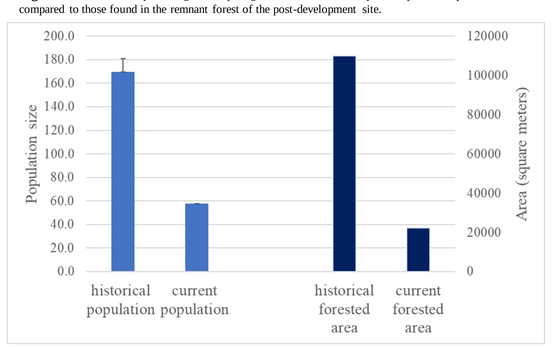

Figure 11. Eastern Box turtle population estimates from years before development occurred in the 11 ha (110,000 m²) pre-development site compared to the one for the remnant forest of the 2.2 ha (110,000 m²) post-development site.

Data collected on turtles during pre-development years were compared to those collected, post-development (Fall 2021). UTM coordinates were input into Biotas (Ecological Software solutions) to estimate home range size using the minimum convex polygon method. Population size was estimated using the Jolly-Seber method for pre-development years and for the shorter, post-development fall season, the Schnabel method was used. Home range size was log_{10} transformed to normalize them, before comparing pre- to post-development data using a t-test. Carapace lengths were compared using chi-square test and Pearson's correlation was used to assess trends over time for fraction of the population that were female. Alpha was set at 0.05 for all statistical tests.

Results and Conclusions

- The pre-development study site was partially cleared for a housing development in 2020, reducing the study area from 11 ha to 2.2 ha (Fig. 4).
- Pre-development (2014-2016), Bilbo was found in what is now the construction site, until 2021, where he was found in the post-development remnant forest far from his original home range (Fig. 5).
- Pre-development (2004-2019), Stevie Y was found in what is now the construction site, and then he moved to the post-development remnant forest in 2020 (Fig. 6).
- Stipples was found in the post-development remnant forest before construction began, as seen by historical telemetry data from 2020 and after the construction began, his home range declined from 0.13 hectares to 0.06 hectares, but he stayed in the same general area (Fig. 7).
- Post-development there was a decline in the mean home range of telemetered turtles (mean = 2879 m²) as compared to turtles tracked pre-development (mean = 8622 m²), but this difference was not significant due to the large variance (t=1.9, d.f.=19, P=0.08)(Fig. 8).
- Post-development, the range of box turtle carapace total lengths (range =110-145 mm) was similar to pre-development data (range = 85-150 mm) (x^2=6.52, d.f.=11, p=0.84; Fig. 9). In future years, it will be important to monitor the sharp post-development increase in turtles with carapace lengths around 135 mm. If the frequency of turtles found with smaller carapace lengths declines, this may indicate an aging population.
- The fraction of females in the overall population has historically decreased over time in the box turtle population from 0.55 to 0.19 (r=-0.56, n=15, p=0.03).
- When focusing on data from the most recent years (2013-2021), there was no temporal trend for fraction female in the box turtle population (r=-0.066, n=8, p=0.88; Fig. 10) indicating that post-development fraction female is similar to that seen in the more recent years.
- As the total forested area decreased due to construction from 11 ha to 2.2 ha, there was a similar observed decrease in population size of the Eastern box turtle from 169 to 58 (Fig. 11).

Future Work

In future studies, it will be important to continue monitoring the population size of the Eastern box turtles in the post-development area, especially with continued construction of residential housing, and an increase in urban activity. In the future, we will be able to estimate survival rates, and we will continue to characterize the population based on features of sex ratios and carapace lengths along with overall population size estimates. Our goal is to assist in the management of this post-development forest remnant beside the Blackwater Creek Trail so that the box turtle population in this area remains stable and viable.

Acknowledgements

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