The urban ecology of Eastern box turtles: Examining demography and life history traits in New York with wildlife detection dogs

Executive Summary

This project aims to establish a long-term ecological monitoring program to investigate the effects of urbanization on Eastern box turtle (*Terrapene carolina*) populations in New York. Eastern box turtles are long-lived, terrestrial species facing population declines due to habitat loss, fragmentation, predation, and illegal collection. While some studies suggest that Eastern box turtles may persist in urban environments, there is a clear gap in understanding how urbanization influences their demographic and life history traits, especially in New York, which represents the most urbanized portion of their range, with populations in areas such as Staten Island, Queens, and Long Island.

This research will examine how urbanization affects the life history traits (e.g., growth rate, longevity, home range size) and demographic parameters (e.g., population size, survival rates) of Eastern box turtles along an urbanization gradient in New York. To improve detection probability and the accuracy of demographic estimates, wildlife detection dogs will assist with surveys. Surveys will be conducted at four sites—two urban (Staten Island and Queens) and two rural (Brookhaven National Labs and Long Pond Greenbelt)—with a team of volunteers and wildlife detection dogs. Local conservation organizations, including the Seatuck Environmental Association, Friends of the Long Pond Greenbelt, and the South Fork Natural History Museum, will assist with volunteer recruitment and outreach at these sites.

The primary goal of this project is to collect baseline data on how urbanization impacts Eastern box turtle populations, providing valuable ecological insights into the species' adaptability and response to urban environments. With the goal of continuing these surveys long-term, this research will help track population trends and demographic changes over time. This research will help further our understanding of the ecological dynamics of Eastern box turtles and contribute to the broader field of evolutionary ecology and the environmental influences on populations in urbanized landscapes.

Introduction

Eastern box turtles (*Terrapene carolina*) are a terrestrial turtle species, with six subspecies distributed throughout the eastern half of the United States and down into regions of Mexico (Kiester and Willey 2015). Like many turtle species, Eastern box turtles are long-lived and can live up to 80 years with some reports suggesting they may even reach 100 years (Kiester and Willey 2015). Despite widespread public interest in and support for Eastern box turtle conservation, their populations have been steadily declining across their range for many decades (Stickel 1978, Hall et al. 1999, Nazdrowicz et al. 2008, Kemp et al. 2022, Roberts et al. 2024). For example, Stickel (1978) documented a 50% decline in an Eastern box turtle population in Maryland over just a decade (1965–1975). Similarly, a long-term study at the Patuxent Wildlife Research Center in Maryland reported an even steeper decline of 77% between 1955 and 1995 (Hall et al. 1999). Similar population declines have been observed in other regions, with Nazdrowicz et al. (2008) reporting a 75% decrease in a Delaware population from 1968 to 2002, and Kemp et al. (2022) estimating a 71%–74% decline in a southeastern Pennsylvania population between 1978 and 2020. This decline is attributed to a variety of threats, including habitat loss, fragmentation, and degradation, as well as vehicle collisions, illegal collection for the pet trade, and increased predation from species such as raccoons, foxes, crows, and fire ants (Steen et al.

2006, van Dijk 2011). The IUCN Red List classifies the Eastern box turtle as Vulnerable, with a declining population trend (van Dijk 2011).

Urbanization in particular has taken a substantial tole on Eastern box turtle populations. Studies have found a range of impacts on the species due to urbanization, including declines in abundance (Graham et al. 2022), higher mortality (Gibbs and Shriver 2002, Budischak e al. 2006), reduced home range size (Iglay et al. 2007, Willey 2010), increased rates of shell damage (Thonis et al. 2023), and disruptions in movement patterns (Graham and Sasaki 2024). However, several studies have suggested that Eastern box turtles may fare relatively well in more urbanized landscapes (Brisbin et al. 2008, Cureton et al. 2014, Lamczyk et al. 2022). For example, Brisbin et al. (2008) found that survival rates of Eastern box turtles in urban habitats in South Carolina do not differ greatly from that of individuals in nearby natural habitats. In another study, researchers found that Eastern box turtles in both urban and rural sites in Missouri had similar corticosterone levels, indicating that urban turtles do not experience elevated stress levels (Lamczyk et al. 2022). Given the range of findings on how urbanization affects Eastern box turtles, there is a clear need for more systematic surveys that specifically account for the influence of urbanization (Erb and Roberts 2023). Moreover, the majority of studies examining the impact of urbanization on Eastern box turtles have not been conducted in the most heavily urbanized part of the species' range: New York (Fig. 1).

In New York, the woodland box turtle (*Terrapene carolina carolina*), a subspecies of the Eastern box turtle, is found throughout the state. Its range extends from the northeastern states down through the mid-Atlantic and southeastern U.S., reaching into parts of the central U.S. and across the Midwest, encompassing both the Appalachian and lower coastal regions (Fig. 1). Despite extensive urbanization in the New York metropolitan area, woodland box turtle populations persist on Staten Island, in Queens, and on Long Island, suggesting that these turtles can survive in highly urbanized environments. The New York State Department of Environmental Conservation recognizes the woodland box turtle as a species of Special Concern (NYDEC 2013). Although several populations on Long Island have been studied (Latham 1916; Nichols 1939; Burke and Capitano 2011a, 2011b; Figueras et al. 2021), the populations on Staten Island and Queens have received much less attention. At present, there are no active long-term ecological studies on woodland box turtles in any of these three areas (Long Island, Staten Island, and Queens), highlighting a significant gap in understanding the impact of urbanization on the Eastern box turtle species as a whole.

Further, the inherently low detection probability of many turtle species, including box turtles, has posed a significant challenge for long-term ecological studies. As a result, researchers have struggled to obtain reliable estimates of key demographic parameters—such as survival probability, growth rate, mortality rate, fecundity, and generation length—without encountering unacceptably wide confidence intervals. To improve detection probability and address this challenge, researchers across the Eastern box turtle's range have increasingly turned to wildlife detection dogs (Kapfer et al. 2012). Wildlife detection dogs are trained to locate specific species based on scent profiles, allowing them to efficiently identify individuals or signs of a species in areas where human detection would be challenging, ultimately enhancing survey accuracy and detection probabilities (Kapfer et al. 2012, Ballouard et al. 2019, McKeague et al. 2023). The University of Illinois Urbana-Champaign's Wildlife Epidemiology Lab, which frequently utilizes this method, reports that while a single person typically locates only 0.25 turtles per hour, a trained detection dog can find up to two turtles per hour (University of Illinois Urbana-Champaign Wildlife Epidemiology Lab).

To address the need for systematic, long-term ecological research on the impact of urbanization on Eastern box turtle demography and life history traits, we propose establishing a long-term ecological monitoring program along an urbanization gradient in New York. This project will focus on understanding how urbanization influences demographic (e.g., population size, survival rate) and life history traits (e.g., clutch size, growth rate) of Eastern box turtles. We will use wildlife detection dogs to enhance detection probabilities and improve the accuracy of our estimates. The Seatuck Environmental Association, the Friends of the Long Pond Greenbelt, and the South Fork Natural History Museum will serve as partners in this effort, assisting with site identification, surveys, and volunteer recruitment. We are seeking funding to initiate the first full set of surveys, with the goal of establishing annual surveys in subsequent years to create a long-term ecological study.

Objectives and Hypotheses

Objective 1.— Investigate the impact of urbanization on eastern box turtle life history traits.

hypothesis: Urbanization will lead to altered life history traits in Eastern box turtles, such as lower growth rates in urbanized environments compared to more natural habitats.

Objective 2.— Assess the effects of urbanization on Eastern box turtle demography.

Hypothesis: Eastern box turtle populations in urbanized areas will exhibit reduced population sizes and lower survival rates compared to populations in less urbanized or rural habitats.

Objective 3.— Examine the spatial distribution of Eastern box turtles across the urbanization gradient in New York

Hypothesis: The spatial distribution of Eastern box turtles will show a negative correlation with increasing urbanization, with higher densities in less urbanized areas and lower densities in highly urbanized regions.

Objective 4.— Evaluate the efficacy of wildlife detection dogs in improving detection probability and accuracy for Eastern box turtle surveys.

Hypothesis: The use of wildlife detection dogs will significantly enhance detection probabilities and improve the accuracy of demographic and life history estimates for Eastern box turtles compared to traditional survey methods.

Methods

Study Sites.— We will establish four 0.25 km^2 survey sites along an urbanization gradient in New York, extending from Staten Island and Queens eastward to the South Fork of Long Island (Fig. 1). Of these four sites, Queens has the highest human population density with ~8,322 people per square kilometer. Staten Island has the second highest, with a human population density of ~3,272 people per square kilometer. In comparison, Brookhaven, NY—home to the Brookhaven National Laboratory site—has a human population density of ~355 people per square kilometer, while Southampton, NY, where the Long Pond Greenbelt site is located, has an even lower human population density of around 13 people per square kilometer.

The westernmost site will be located in the Staten Island Greenbelt, a 3,000-acre forest preserve and the largest remaining contiguous woodland in New York City. Managed by the Greenbelt Conservancy in collaboration with NYC Parks, this area offers essential habitat for

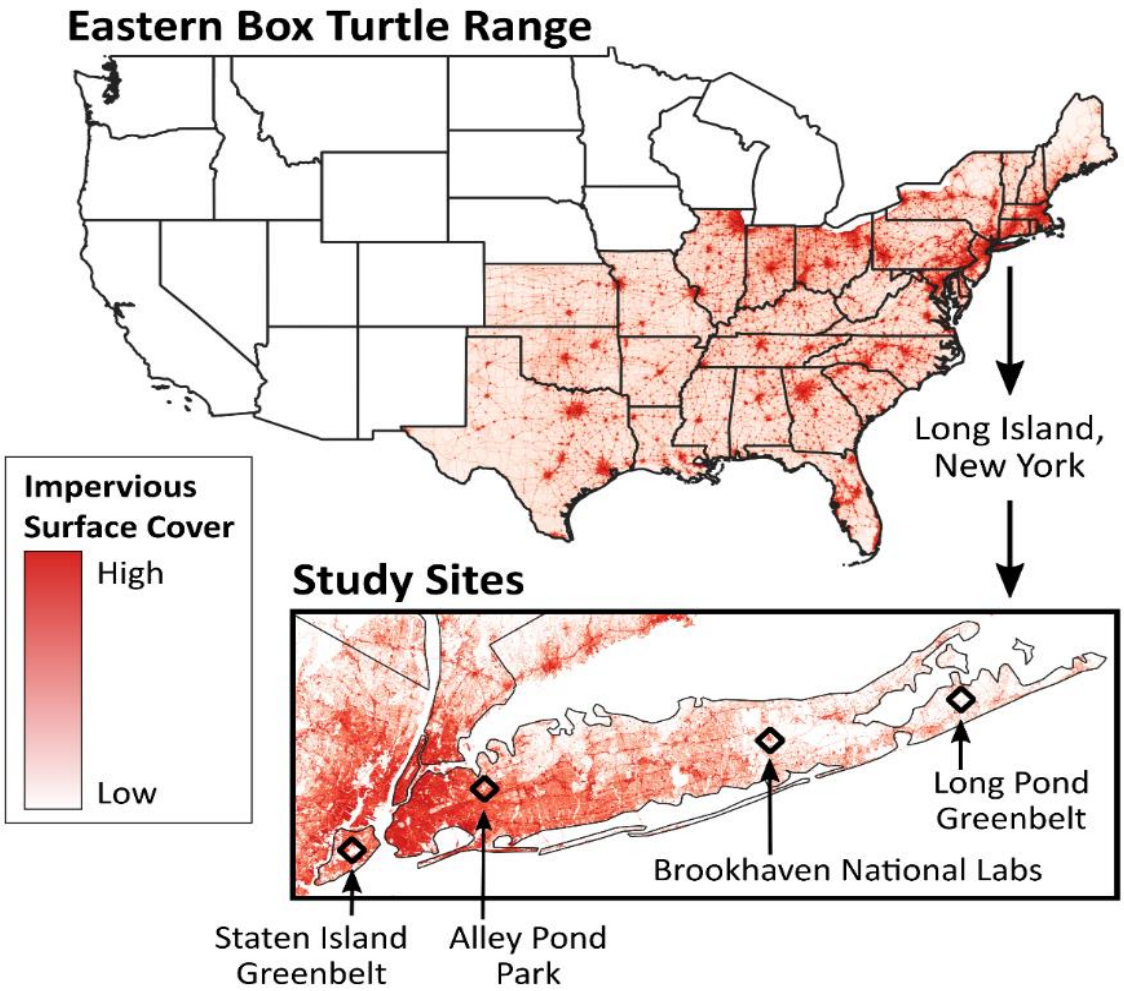

Figure 1. A map depicting the range of the Eastern box turtle in the contiguous United States, overlaid with impervious surface cover. The four proposed study sites are highlighted, illustrating the urbanization gradient from Staten Island eastward to the South Fork of Long Island. (Source of impervious surface cover: NASA Earthdata)

wildlife (Greenebelt Conservancy, Fig. 2). Our Staten Island Greenbelt site will be one of two situated in heavily urbanized areas, with the second urban site at Alley Pond Park in Queens. Managed by NYC Parks, Alley Pond Park is the second-largest public park in Queens, spanning 655 acres (Fig. 2). Eastern box turtles have been observed at both sites, but to our knowledge, no formal surveys have been conducted.

Our two rural sites are located at Brookhaven National Labs (BNL) in Brookhaven, NY, and on privately owned land managed by Friends of the Long Pond Greenbelt (FLPG) in Southampton, NY, on the South Fork of Long Island (Fig. 2). Both sites are within pine barrens—fire-dependent ecosystems defined by sandy, nutrient-poor soils, open-canopy forests, and drought-adapted vegetation. Although no formal ecological studies of Eastern box turtles have been conducted at either site, more than 700 individuals have been tagged and released on BNL property, and FLPG volunteers have carried out informal turtle surveys at the Long Pond Greenbelt site. Our collaborators at BNL have provided us with their box turtle data, allowing us

to avoid reusing the same turtle IDs and integrate their data into the expanding dataset we aim to develop.

Survey Schedule.— Surveys will be conducted over eight days in June 2025, with two non-consecutive days at each study site. Following Erb and Roberts (2023), surveys will begin at 7:00 am. In the days leading up to each survey, we will carefully monitor weather conditions to select days that are most favorable for box turtle movement, thereby enhancing detection opportunities.

Survey Procedure.— A team of volunteers, along with 1-2 wildlife detection dogs and their handler(s), will assist in the surveys. Volunteers will walk antiparallel transect lines through each site to ensure a more thorough visual survey. This approach is crucial, as turtles may be hidden on the far side of logs or other obstacles, making them difficult to spot from a single direction. Simultaneously, wildlife detection dogs will survey each site, working alongside volunteers. Each

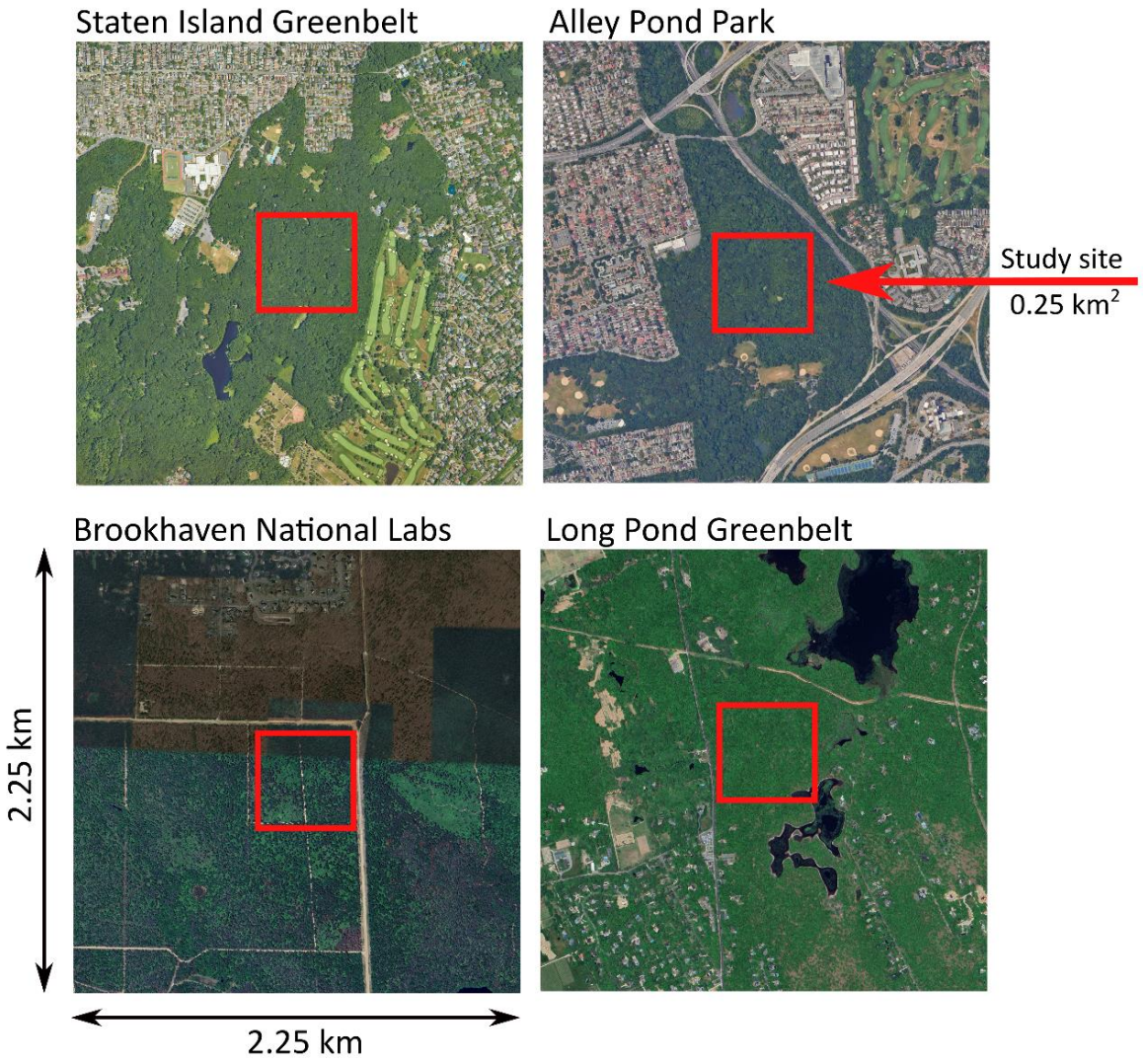

Figure 2. Aerial views of each of the four 0.25 km² study sites, zoomed in within a 5 km² surrounding area, highlighting the degree of urbanization around each site.

site will be surveyed for 4-6 hours on a given day, with the possibility of extending the duration if more turtles are encountered, which may slow the pace of the surveys.

Wildlife Detection Dog Collaboration.— We will collaborate with the Conservation Dogs Program, operated by the New York-New Jersey Trail Conference, to include wildlife detection dogs and their handler(s) in our surveys. We will also collaborate with independent wildlife detection dog handler Dr. Kristine (Kris) Hoffman and her dog, Newt, for these surveys. Dr. Hoffman teaches a course at St. Lawrence University, where she trains students and their dogs to detect and locate wildlife. She has trained several turtle detection dogs and their handlers in the Northeast and is an active member of the Conservation Dog Alliance.

These collaborations will ensure that experienced handlers and trained detection dogs are incorporated into our surveys, maximizing detection probability of the box turtles. This first year of data collection will establish baseline detection probabilities using wildlife detection dogs. In future years, alternating survey designs with and without dogs will allow for direct comparisons of detection probabilities across different methods, further refining estimates of survey efficacy.

Pilot Survey with Wildlife Detection Dog.— To better understand how wildlife detection dogs can assist with Eastern box turtle surveys, we conducted a pilot survey at our BNL site in September 2024. Before beginning this pilot survey, we recognized that it was quite late in the season for box turtles on Long Island, NY, and there was a chance we might not find any. Nevertheless, we considered it a valuable opportunity to assess how much area a single wildlife detection dog can cover within a 4–6-hour window, as well as to observe how the handler directs the dog during the search. For this survey, we worked with Dr. Hoffman and Newt. To our surprise, Newt was able to locate a single Eastern box turtle buried under a significant amount of leaf litter, as well as two other potential individuals that were already hibernating (we chose not to disturb them for confirmation). When Newt located the turtles, he laid down next to them (or near the spot where he detected their scent) with his front paws pointed in the direction of the supposed turtle (Fig. 3). While some wildlife detection dogs are trained to pick up and retrieve turtles in their mouths, Dr. Hoffman

Figure 3. Photos of Newt, the turtle detection dog, signaling an Eastern box turtle, alongside other images from our pilot survey at Brookhaven National Laboratory.

and the Conservation Dogs Program discourage this method due to the risk of disease transmission between turtles.

Data Collection.— Each turtle that is located either by a volunteer or a wildlife detection dog will be captured for data collection. Upon capture, photos will be taken of each individual (carapace, plastron, side views) and we will record whether a human or a dog first located the individual turtle. We will use measuring tape to record carapace length and width, and plastron length and width. Weight will be measured with a hanging scale. Additionally, we will record an individual's sex, age/life stage, and any signs of injury or damage (photos will also be taken of any specific injuries/damage observed). Since box turtles are sexually dimorphic, we will differentiate between males and females using secondary sexual characteristics, such as eye color, plastron and carapace shape, rear claw shape, and tail morphology. To estimate age, we will count the annuli (growth lines on the scutes of the carapace). However, it is important to note that after about 15 years of age, the annuli become too closely spaced to accurately determine age, and only the life stage will be reported. Turtles ≤ 10 years old will be classified as juveniles, while those ≥ 11 years old will be considered adults. If a turtle's age cannot be determined due to many annuli, we will report it as an adult.

We will also collect a variety of habitat data at each turtle's location. In addition to recording the GPS coordinates and time of observation, we will use a Kestrel 3000 Weather Meter to record the air temperature, humidity and wind speed at the observation site, and a Temtop Air Quality Monitor to record air pollution (i.e., particulate matter). We will also record the precipitation likelihood, and days since the last rainfall. We will note the substrate the turtle was on or interacting with and its behavior at the time of initial observation (e.g., burrowing, nesting, walking). Canopy cover photos will be taken using a fisheye lens adapter for a smartphone, capturing photos from the ground, while leaf litter will be photographed with a smartphone held approximately 1 meter above the ground.

Additionally, each turtle will be given a unique notch code (i.e., a unique ID) using a metal file (Fig. 4). Notch codes will consist of three notches. For example, the code 2L4R8L would indicate that the turtle will have one notch on its 2nd marginal scute on the left side of its carapace, one notch on its 4th marginal scute on the right side of its carapace, and one notch on its 8th marginal scute on the left side of its carapace.

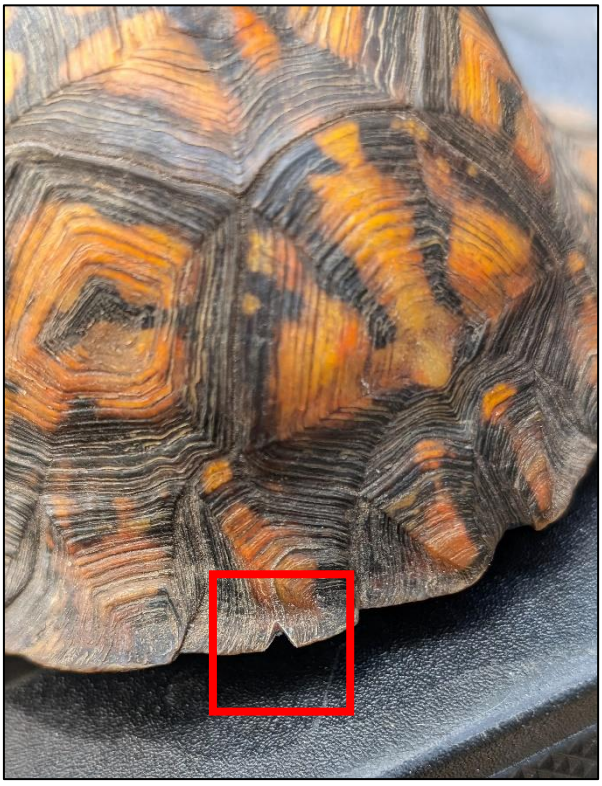

Figure 4. An example of a notch on a marginal scute of a box turtle's carapace.

Data Analysis.— Data analysis will focus on examining how urbanization affects Eastern box turtle demographics and life history traits using capture-mark-recapture (CMR) models, regression techniques, and spatial analysis, with the

understanding that this first year of data will establish a foundation for a long-term ecological study. Data analysis methods below are organized by objective to address each research question specifically.

Objective 1: Investigate the impact of urbanization on Eastern box turtle life history traits

To assess how urbanization influences life history traits of Eastern box turtles, we will focus on key metrics such as growth rate and longevity. Growth rates will be estimated by measuring changes in carapace length over time, comparing growth patterns between turtles in urbanized and rural sites. We will use linear mixed-effects models to account for individual variation and urbanization status, treating growth rate as a dependent variable and site type (urban vs. rural) as a fixed effect. We will also extract other environmental data (e.g., climatic data, distance to the nearest road, impervious surface cover) for each site using available satellite imagery. These models will help us evaluate whether turtles in more urbanized habitats exhibit slower growth or other altered life history traits compared to those in rural habitats.

Objective 2: Assess the effects of urbanization on Eastern box turtle demographic parameters

To estimate demographic parameters such as population size, survival rates, and age distribution, we will apply capture-mark-recapture (CMR) methods. In the first year, we will use a closed population model to estimate population size. However, CMR models require multiple years of data, particularly for long-lived species like Eastern box turtles, so the first year of data will serve as a starting point. Over time, additional data will make these models more informative. Survival rates will be estimated using CMR models that account for individual recapture histories. By tracking age distribution over time, we aim to assess how urbanization may affect demographic trends and the survival of Eastern box turtles in urban versus rural environments.

Objective 3: Examine the spatial distribution of Eastern box turtles across the urbanization gradient in New York

To analyze the spatial distribution of Eastern box turtles along the urbanization gradient, we will use spatial autocorrelation and kernel density estimation techniques. These methods will help us understand how urbanization influences turtle density, with the hypothesis that turtle densities will be higher in less urbanized areas and decrease in more urbanized regions. We will incorporate environmental variables such as air temperature, humidity, substrate type, and canopy cover into generalized linear models to determine how these factors influence turtle distribution. This approach will allow us to evaluate the relative importance of environmental variables in shaping turtle distribution across different levels of urbanization.

Objective 4: Evaluate the efficacy of wildlife detection dogs in improving detection probability and accuracy

To assess the effectiveness of wildlife detection dogs in improving detection probability, we will compare survey results across years with and without the use of detection dogs. In this first year, all surveys will incorporate wildlife detection dogs to establish baseline detection probabilities. In subsequent years, alternating survey designs—using detection dogs in some years and relying solely on human searchers in others—will allow for direct comparisons of detection probabilities across methods. We will use Program MARK to estimate detection probabilities and assess whether dog-assisted surveys yield higher detection rates and more reliable demographic estimates

compared to traditional methods. This long-term approach will provide a robust evaluation of how detection dogs influence survey efficacy over time.

Student and Outreach Opportunities

Eastern box turtle surveys provide an excellent opportunity to engage students and the public in hands-on ecological research while fostering enthusiasm for wildlife and conservation. With my connections to Stony Brook University, where I earned my Ph.D., and New York University (NYU), where I am a Postdoctoral Researcher, I have a strong network for involving students in local fieldwork. While Stony Brook University's Ecology and Evolution Department offers numerous opportunities for undergraduate and graduate students interested in the field, NYU has relatively few field-based research opportunities in ecology and evolutionary biology. This was exemplified during our two-day test run at BNL, where an NYU undergraduate enthusiastically joined me in the field on short notice. My goal is to recruit Stony Brook University undergraduate students for surveys at Brookhaven National Labs and the Long Pond Greenbelt, as these sites are closer to their campus, and to recruit NYU students for the more urban sites on Staten Island and in Queens. While students from both universities will be welcome to participate in surveys at any of the sites, I believe emphasizing the proximity of certain locations will encourage more local students to volunteer.

In addition to engaging local undergraduate and graduate students, I am excited to involve members of the public as volunteers in box turtle surveys. To facilitate this, I will utilize the presence of science and nature centers at each of our study sites to connect with the public and raise awareness. Staten Island's Greenbelt is home to the Greenbelt Nature Center, Alley Pond Park in Queens has the Alley Pond Environmental Center, and the Long Pond Greenbelt boasts the Long Pond Greenbelt Nature Center. While not a nature center, Brookhaven National Labs is a renowned research facility that frequently hosts scientific events and talks, providing another avenue for public engagement. I have already had the opportunity to give a public talk for the Friends of the Long Pond Greenbelt at their nature center. Following the presentation, many attendees expressed interest in how they could become involved with the research we are proposing in this project. Seatuck Environmental Association, Friends of the Long Pond Greenbelt, and the South Fork Natural History Museum will all serve as key outreach partners, helping recruit volunteers, promote public involvement, and connect this research to their broader community education initiatives.

Expected Significance

This research will provide critical insights into how urbanization influences both the life history traits and demographic patterns of Eastern box turtles across a gradient of urbanization in New York. Specifically, it will help us understand how urban landscapes affect key aspects of turtle biology, including survival rates, reproductive success, and movement patterns. By comparing populations from urbanized, suburban, and more rural areas, the study will reveal how different levels of urbanization shape the ecological and demographic characteristics of this species. This gradient approach will provide a more nuanced understanding of the effects of urbanization on species that rely on specific habitat features and undisturbed landscapes for critical life functions.

While this proposal only pertains to the first year of data collection, the study will lay the groundwork for understanding how urban landscapes impact survival, reproduction, movement patterns, and overall population dynamics of this species. Through long-term data collection, this study will contribute to more accurate demographic models that can predict population dynamics

in urban and rural environments. Understanding how these environments influence turtle populations will enhance our ability to forecast future trends in species' populations.

In addition, this study will refine and strengthen wildlife monitoring tools, particularly the use of wildlife detection dogs to survey Eastern box turtles. While detection dog use is well-established in wildlife studies, its application here will allow for more efficient and accurate detection of turtles in challenging environments. This will enhance the reliability of the data collected and improve our ability to assess population sizes and demographic trends across the study area.

The research will also address understudied aspects of Eastern box turtle ecology, particularly regarding how urbanization impacts their demographic structure. Much of the current knowledge about this species focuses on rural or protected environments, and the effects of urbanization on its life history and population dynamics remain poorly understood. By filling this gap, the study will provide broader ecological insights into how species adapt to urban environments, how different landscape features affect their survival and reproduction, and how such insights can inform future research on species that live in urbanized landscapes.

Relevance to Conservation

While this study primarily focuses on advancing our understanding of Eastern box turtle ecology in urbanized environments, the findings could have broader implications for conservation efforts. This research will provide a detailed examination of how urbanization affects demographic patterns, potentially uncovering specific challenges and adaptive traits within turtle populations. These findings could inform future conservation strategies, particularly in urban areas where species like the Eastern box turtle face unique challenges.

The long-term data collected through this study will contribute to refining population models, essential for assessing species' vulnerability to habitat fragmentation, urban sprawl, and other anthropogenic pressures. Understanding how urban landscapes affect survival, reproduction, and movement can guide conservation practitioners in identifying priority areas for habitat protection or restoration, even in highly developed regions.

In addition to scientific insights, this research will foster community engagement and promote conservation awareness through outreach activities. Involving local students, community members, and conservation practitioners in fieldwork and data collection will offer opportunities for hands-on learning and increase public understanding of wildlife conservation. This involvement can help build a sense of stewardship, fostering a connection to the local environment and species. Engaging students, especially those from urban areas, in research on Eastern box turtle ecology will also inspire the next generation of conservationists, scientists, and environmental advocates. By partnering with organizations deeply rooted in local conservation—such as Seatuck, FLPG, and the South Fork Natural History Museum—this project builds bridges between scientific research and ongoing community-based efforts to protect native species in rapidly urbanizing landscapes. In doing so, it also has the potential to raise public awareness and galvanize broader support for protecting vulnerable species and restoring habitats in cities and suburbs..

Budget

Quote from NY-NJ Trail Conference's Conservation Dogs Program

Item	Cost
Staff time	$5,200
Travel	$1,246
Dog care for two wildlife detection dogs	$400
Supplies	$0
Indirect costs	$362
TOTAL	**$7,208**

Equipment

Item	Quantity	Unit Cost	Total Cost
File for notching turtle IDs	2	$10	$20
Hanging scale (Pensola)	2	$50	$100
Kestrel 3000 Weather Meter	1	$169	$169
Temtop M2000 Air Quality Meter	1	$190	$190
Measuring tape	2	$2.50	$5.00
Insect Shield lightweight cotton insect repellant coveralls (in a range of sizes)	10	$74.00	$740.00
Lint rollers	10	$2.50	$25.00
TOTAL			**$1,249**

TOTAL ESTIMATED PROJECT BUDGET: $8,457

For year 1 – subsequent years will require additional funding

Budget Justification

The quote from the NY-NJ Trail Conference's Conservation Dogs Program outlines the costs for 8 days of surveys assisted by one handler and two wildlife detection dogs. This quote, provided in October 2024, remains valid for 2025.

I am requesting funds for two turtle ID notching files, two Pensola hanging scales for weighing turtles, and two measuring tape rolls. I am requesting two of each of these items as they are relatively inexpensive and having backup field equipment is generally recommended. Additionally, I am requesting funds for a Kestrel 3000 weather meter to record air temperature, humidity, and wind speed, as well as a Temtop M2000 Air Quality Meter to measure PM2.5 and PM10 (Particulate Matter) levels, which will help assess pollution at different sites.

I am also requesting funds to purchase ten Insect Shield insect-repellent coveralls (in a range of sizes) and ten lint rollers. Insect Shield coveralls are pre-treated with permethrin and are designed to repel mosquitoes, ticks, ants, flies, chiggers, and midges. Given the high abundance and diversity of tick species on Long Island, it is essential to protect volunteers from insect bites and minimize the risk of exposure to vector-borne diseases such as Lyme disease. In addition, lint rollers offer a simple and cost-effective method for removing ticks from clothing during and after fieldwork.

Timeline

Pending funding, we are planning to conduct all eight surveys in June 2025 with the assistance of wildlife detection dogs from the Conservation Dogs Program. Given this short timeframe, funds would be used in May to purchase any necessary equipment and to pay the NY-NJ Trail Conference for using their Conservation Dogs Program. This means funds would be used in May 2025 (potentially June, depending on when the Conservation Dogs Program processes payment).

Literature Cited

Ballouard, J-M., Gayraud, R., Rozec, F., Besnard, A., Caron, S., Bech, N., and Bonnet, X. 2019. Excellent performances of dogs to detect cryptic tortoises in Mediterranean scrublands. *Biodiversity and Conservation* 28:4027–4045.

Brisbin Jr., I.L., Kennamer, R.A., Peters, E.L., and Karapatakis, D.J. 2008. A long-term study of Eastern box turtles (*Terrapene C. carolina*) in a suburban neighborhood: Survival characteristics and interactions with humans and conspecifics. *Herpetological Conservation* 3:xx–xx.

Budischak, S.A., Hester, J.M., Price, S.J., and Dorcas, M.E. 2006. Natural history of *Terrapene carolina* (box turtles) in an urbanized landscape. *Southeastern Naturalist* 5(2):191–204.

Burke, R.L. And Capitano, W. 2011a. Eastern box turtle, *Terrapene carolina*, neonate overwintering ecology on Long Island, New York. *Chelonian Conservation and Biology* 10:256–259.

Burke, R.L. And Capitano, W. 2011b. Nesting ecology and hatching success of the eastern box turtle, *Terrapene carolina*, on Long Island, New York. *American Midland Naturalist* 165:137–142

Cureton II, J.C., Janis, M., Lutterschmidt, W.I., Randle, C.P., Ruthven III, D.C., and Deaton, R. 2014. Effects of urbanization on genetic diversity, gene flow, and population structure in the ornate box turtle (*Terrpene ornata*). *Amphibia-Reptilia* 35:87–97.

Erb, L.A. and H.P. Roberts. 2023. Status assessment for the eastern box turtle in the northeastern United States. Final report to the Northeast Association of Fish and Wildlife Agencies (NEAFWA) for a Regional Conservation Needs (RCN) award.

Figueras, M.P., Green, T.M., and Burke, R.L. 2021. Consumption patterns of a generalist omnivore: eastern box turtle diets in the Long Island Pine Barrens. *Diversity* 13:345.

Gibbs, J.P. and Shriver, G. 2002. Estimating the effects of road mortality on turtle populations. *Conservation Biology* 16(6):1647–1652.

Graham, A., Nguyen, J., and Sasaki, K. 2022. Woodland box turtle (*Terrapene carolina carolina*) abundance declines with increasing urban land use in the Piedmont. *Ichthyology & Herpetology* 110(4):705–713.

Graham, A. and Sasaki, K. 2024. Urban land cover associated with space use in woodland box turtle (*Terrapene carolina carolina*). *Herpetological Conservation and Biology* 19(1):84–95.

Greenbelt Conservancy. *The Greenbelt Conservancy*. https://sigreenbelt.org/. Accessed 25 February 2025.

Hall, R.J., Henry, P.F.P., and Bunck, C.M. 1999. Fifty-year trends in a box turtle population in Maryland. *Biological Conservation* 88:165–172.

Iglay, R.B., Bowman, J.L., and Nazdrowicz, N.H. 2007. Eastern box turtle (*Terrapene carolina carolina*) movements in a fragmented landscape. *Journal of Herpetology* 41(1):102–106.

Kapfer, J.M., Muñoz, D.J., and Tomasek, T. 2012. Use of wildlife detector dogs to study Eastern box turtle (*Terrapene carolina carolina*) populations. *Herpetological Conservation and Biology* 7(2):169–175.

Kemp, S.J., Kemp, M.J., and Guers, C. 2022. Decline of woodland box turtle (*Terrapene carolina carolina*) over 40 years in southeastern Pennsylvania, USA. *Herpetological Conservation and Biology* 17(1):196–203.

Kiester, A., and Willey, I. 2015. *Terrapene carolina* (Linnaeus1758) — eastern box turtle, common box turtle. *Chelonian Research Monographs* 5:85.1–85.25. DOI:10.3854/crm.5.085.carolina.v1.2015.

Lamczyk, B.A., Palmber, J.L., Kozlowski, C.P., Blake, S., and Deem, S.L. 2022. No difference in corticosterone concentrations between Missouri three-toed box turtles living in an urban and a rural site. *Human-Wildlife Interactions* 16(1):108–116.

Latham, R. 1916. Notes on *Cistudo carolina* from Orient, Long Island. *Copeia* 34:65–67.

McKeague, B., Finlay, C., and Rooney, N. 2023. Conservation detection dogs: A critical review of efficacy and methodology. *Ecology and Evolution* 14:e10866.

Nazdrowicz, N.H., Bowman, J.L., and Roth, R.R. 2008. Population ecology of the eastern box turtle in a fragmented landscape. *Journal of Wildlife Management* 72:745–753.

New York Department of Environmental Conservation. 2013. New York Department of Environmental Conservation species status assessment: *Terrapene carolina carolina*. https:// www.dec.ny.gov/docs/wildlife_pdf/sgcnwoodlandboxturtl.pdf.

Nichols, J.T. 1939. Data on size, growth, and age in the box turtle, *Terrapene carolina*. *Copeia* 1939:14–20.

Roberts, H.P., Erb, L., Willey, L., Buchanan, S., Jones, M.T., Nazdrowicz, N., Oxenrider, K., Zarate, B., King, D.I., Ravesi, M., and Kleoper, J. 2024. Regional analysis estimates extensive habitat impairment for the widespread, but vulnerable eastern box turtle. *Global Ecology and Conservation* 50:e02842.

Steen, D. A., Aresco, M.J., Beilke, S.G., Compton, B.W., Condon, E.P., Dodd, C.K., Jr., Forrester, H., Gibbons, J.W., Greene, J.L., Johnson, G., Langen, T.A., Oldham, M.J., Oxier, D.N., Saumure, R.A., Schueler, F.W., Sleeman, J.M., Smith, L.L., Tucker, J.K.,

and Gibbs, J.P. 2006. Relative vulnerability of female turtles to road mortality. *Animal Conservation* 9:269–273.

Stickel, L.F. 1978. Changes in a box turtle population during three decades. *Copeia* 1978:221–225

Thonis, A., Werni, C., Ozcelik, C., Pan, Z.Y., Fung, K., Ford, B., Hunter, M., and Prowant, L. 2023. Eastern box turtle (*Terapene carolina carolina*) shell damage and health in an urban landscape. *Chelonian Conservation and Biology* 22(2):165–174.

University of Illinois Urbana-Champaign Wildlife Epidemiology Lab. "Meet the Dogs." University of Illinois College of Veterinary Medicine. Accessed 20 February 2025. https://vetmed.illinois.edu/wel/meet-the-dogs/.

Willey, L. (2010): Spatial ecology of eastern box turtles (Terrapene c. carolina) in central Massachusetts. Unpublished PhD dissertation, University of Massachusetts, Amherst, Massachusetts.

van Dijk, P.P. 2011. *Terrapene carolina* (errata version published in 2016). The IUCN Red List of Threatened Species 2011: e.T21641A97428179. https://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T21641A9303747.en. Accessed on 26 February 2025.