Implications for tick-borne disease risk in New York City: A comparative study of wildlife diversity and tick abundance.

[Name redacted by Managing Editor]

1. Abstract

Context: Tick abundance has been on the upsurge in the Midwestern and Northeastern regions of the United States, leading to increased cases of tick-borne diseases such as Lyme disease. Many studies about tick disease hazards are done in suburban and rural areas, leaving a research gap in urban areas.

Objective: Our goal is to fill the gap in knowledge about tick borne hazards in urban areas. Additionally, we wanted to test the dilution effect theory to see if it applies in an urban setting.

Methods: We measured biodiversity by observing the Avian and Mammalian population. We sampled the tick abundance for both parks through tick dragging.

Results: We found similar patterns of biodiversity in both parks, but differing tick abundances. Wave Hill had a slightly higher Shannon diversity, but Van Cortlandt had a higher species richness, abundance, and evenness. We found an established tick population in Van Cortlandt, and zero ticks in Wave Hill.

Discussion: We did not find evidence to support whether or not the dilution effect applies in an urban area. Additionally, we found that species diversity may matter less than species identity. Further research is necessary to better understand the role of biodiversity on tick-borne disease hazards in urban areas. However, this study does indicate that Van Cortlandt needs to implement tick management to decrease tick disease hazards in highly used areas like trails and edges where ticks were found.

Keywords: Ixodes scapularis, tick disease hazards, land management, biodiversity, dilution effect theory.

2. Introduction

In recent years, cases of tick-borne diseases, especially Lyme disease, have been increasing in the Midwest and Northeast regions of the United States. In New York State, *Ixodes scapularis* is the main disease vector for the bacteria *Borrelia burgdorferi*, the causing agent for lyme disease (Piedmonte et al., 2018). Tick abundance, a proxy for tick-borne disease risk and hazard, in an area depends on the host species and several environmental factors (Lilly et al., 2025). *Ixodes Scapularis* feeds on hosts infected with *Borrelia burgdorferi* to become infected. As larvae and nymphs, *Ixodes scapularis* feed on a variety of mammalian, avian, and reptilian host species, some of which are believed or documented to have low reservoir competence (LoGiudice et al., 2003). Hosts with lower reservoir competence have an immune system that clears *Borrelia burgdorferi* faster than hosts with a high reservoir competence (Brunner et al., 2008).

Anthropogenic impacts such as land use change, climate change, and deforestation have increased tick abundances, thereby increasing the tick-borne disease risk (Diuk-Wasser et al., 2021). Urbanization creates a mosaic landscape which increases forest patches and decreases habitat patch size (Wilson et al., 1984). Although tick borne diseases in urban settings are studied thoroughly in Europe, there is a major gap in the U.S, in which most tick disease studies are done in rural and suburban areas (Kilpatrick et al. 2014). Urbanization creates highly fragmented forest patches, reducing the amount of suitable habitat for predators of important host species.

This results in a negative correlation between patch size and density of infected ticks (Allan et al., 2003). Active forest management may reduce the presence of nymphal and density of adult blacklegged ticks, and exposure to tick-borne pathogens in the landscape (Conte et al., 2021).

According to the dilution effect, increased biodiversity in an ecological community can lead to a decrease in the transmission of a pathogen (Schmidt and Ostfeld, 2001). The dilution effect theory remains ambiguous. Randolph and Dobson argued that the dilution effect theory applies only in certain, limited circumstances (Randolph and Dobson, 2012).

We sought to test the dilution effect with tick-borne hazards in urban greenspaces. We chose two study sites in the Bronx, New York City, New York that vary in patch size and land management practices.

This study aims to bridge this information gap and connect these learnings to already existing knowledge regarding the relationship between tick populations and land use. This study identifies how land management, whether highly manicured or completely unmanaged, impacts tick abundance. This study also examines the effect of host biodiversity on the abundance of ticks in urban greenspaces.

3. Methods

3.1 Study Area

We collected data in Riverdale, a residential neighborhood located in the northwest Bronx, during July 2025. Within Riverdale, two distinct urban green spaces were selected for comparison: Wave Hill and Van Cortlandt Park. Wave Hill is a 28-acre estate characterized by landscaped gardens and managed woodlands (Wave Hill, 2025), while Van Cortlandt Park is a 1,146-acre urban park characterized by largely unmanaged forest (NYC Parks, n.d.).

3.2 Wildlife Camera Trapping

Two motion-triggered Browning Strike Force wildlife cameras were deployed at each site for a collection period of two weeks. All photographs were reviewed and tagged in Wildlife Insights according to the species present.

3.3 Tick Collection

In the area surrounding each wildlife camera, tick drags were collected over 2 collection days for a total distance of 1000 meters squared. Using 1m x 1m corduroy drag cloths, the forest interior, forest/lawn edge, and trail were sampled by dragging the cloth in ten 10m increments for a total transect length of 100m. At the end of each 10m drag, the cloth was examined for ticks. Any ticks found within each 100m transect were collected with metal forceps and placed in 1.5mL preservation vials of 85% ethanol (Lilly et al. 2025). The number of ticks at each life stage (adult, nymph, larva) and the dominant habitat type (unmaintained herbaceous, leaf litter, maintained grass) of each 10m increment were recorded. The species of ticks present in each vial were identified under a microscope based on morphological characteristics using taxonomical keys and expert guidance.

3.4 Avian Point Counts

Thirty bird survey points within a polygon of each site were randomly generated using AI. Before each count, current weather conditions were recorded. Each count lasted 10 minutes, during which observers recorded the species, distance, minute after time start, number of birds seen if in a group, behavior, and any additional notes necessary (Ralph et al. 1995). Bird species were determined using visual observation and assistance from the Merlin Bird ID app (https://merlin.allaboutbirds.org/). To maintain spatial independence, points surveyed on the same day were separated by at least 100m.

3.5 Data Analysis

Camera trap data was filtered by removing avian species and photos of the same mammalian species identified within a 30 minute time frame to avoid pseudoreplication (Lawrence et al., 2018). Bird survey and camera trap data was summarized by species richness, abundance, evenness, and Shannon diversity (Shannon, 1948), which was calculated by site. Tick data was summarized into density of larva, nymphs, and adults by species per 1000m.

4. Results

We set camera traps for a duration of two weeks, capturing a total of 57 different mammalian individuals across Wave Hill and Van Cortlandt. We conducted 28 bird point counts for each site, observing 401 Avian individuals across both sites.

4.1 Species Richness

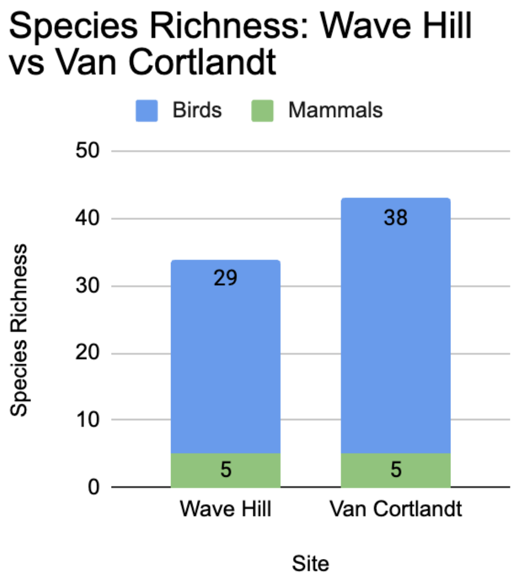

Figure 1. Avian and Mammalian species richness in Wave Hill vs Van Cortlandt Park.

There was a higher Avian species richness in Van Cortlandt than Wave Hill. In Wave Hill, we found 29 bird species. In Van Cortlandt, we found 38 bird species. The mammalian species richness is the same for both sites. We capture five different mammalian species in both parks. In Van Cortlandt, we recorded Coyote, Eastern Gray Squirrel, Northern Raccoon, Virginia Opossum, and White-tailed Deer. In Wave Hill, we recorded Eastern Chipmunk, Eastern Cottontail, Eastern Gray Squirrel, Virginia Opossum, Coyote. Although the species richness is the same for both sites, they differ in species identity slightly.

4.2 Wildlife Abundance

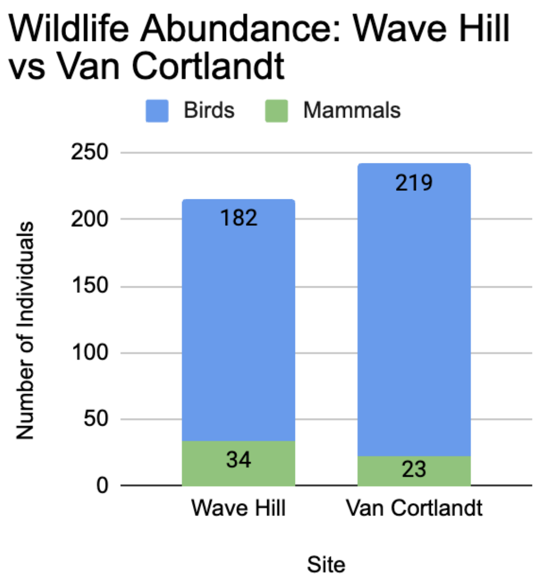

Figure 2. Numbers of Avian and Mammalian individuals between Wave Hill and Van Cortlandt.

We found more birds and mammals in Van Cortlandt than we did in Wave Hill. There were 216 individuals across all species in Wave Hill, and 242 individuals across all species in Van Cortlandt. The number of birds in Van Cortlandt was more than the number of birds in Wave Hill. We recorded 182 Avian individuals in Wave Hill, and 219 Avian individuals in Van Cortlandt. The number of individual mammals was more in Wave Hill than in Van Cortlandt. There were 34 mammalian individuals in Wave Hill, and 23 mammalian individuals in Van Cortlandt.

4.3 Shannon Diversity Index

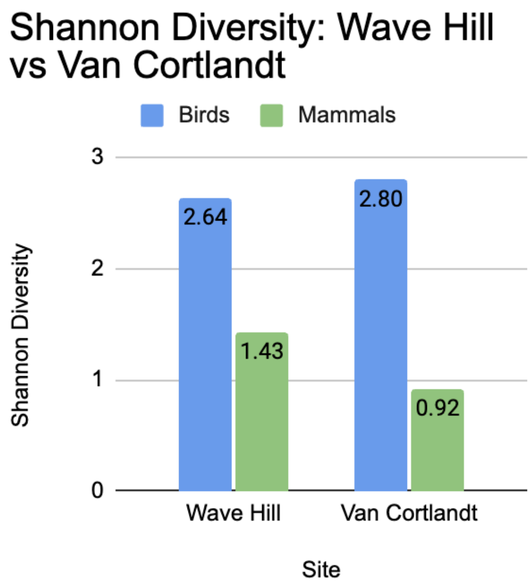

Figure 3. Avian and Mammalian Shannon Diversity Index between Wave Hill and Van Cortlandt.

The Shannon Diversity Index slightly varied between the sites. Wave Hill had a higher mammalian Shannon diversity index value–1.43, than Van Cortlandt's mammalian Shannon diversity index value–0.92. Van Cortlandt had a higher avian Shannon Diversity Index value–2.80, than Wave Hill's Avian Index value–2.64. T

4.4 Species Evenness

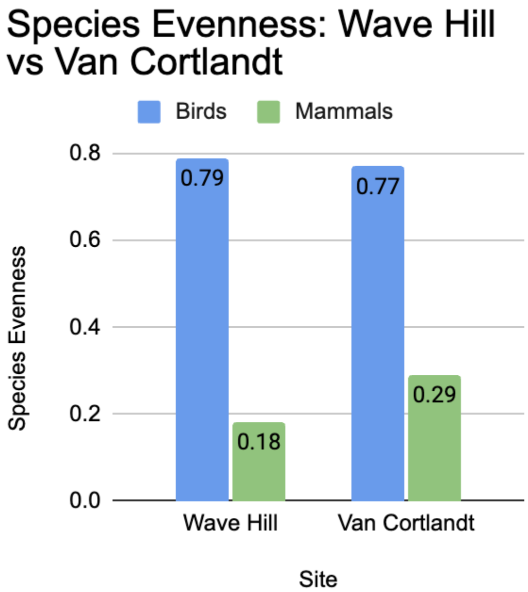

Figure 4. Avian and Mammalian Species Evenness between Wave Hill and Van Cortlandt.

Avian species evenness was slightly higher in Wave Hill than Van Cortland with values of 0.79 and 0.77, respectively. Although, the avian species evenness was very similar in both parks.

The mammalian species evenness was higher in Van Cortlandt than Wave Hill with values 0.29 and 0.18, respectively.

4.5 Tick Abundance

Site	**Black-legged Tick Larvae**	**Black-legged Tick Nymphs**	**Dog Tick Adults**
Van Cortlandt	104	5	2
Wave Hill	0	0	0

Grand Total	104	5	2

Table 1. The number of ticks and tick species.

In Van Cortlandt, we collected 104 *I. Scapularis* larvae, five *I. Scapularis* nymphs, and two *Dermacentor variabilis* adults. In Wave Hill, we recorded zero ticks across the 1000m transect.

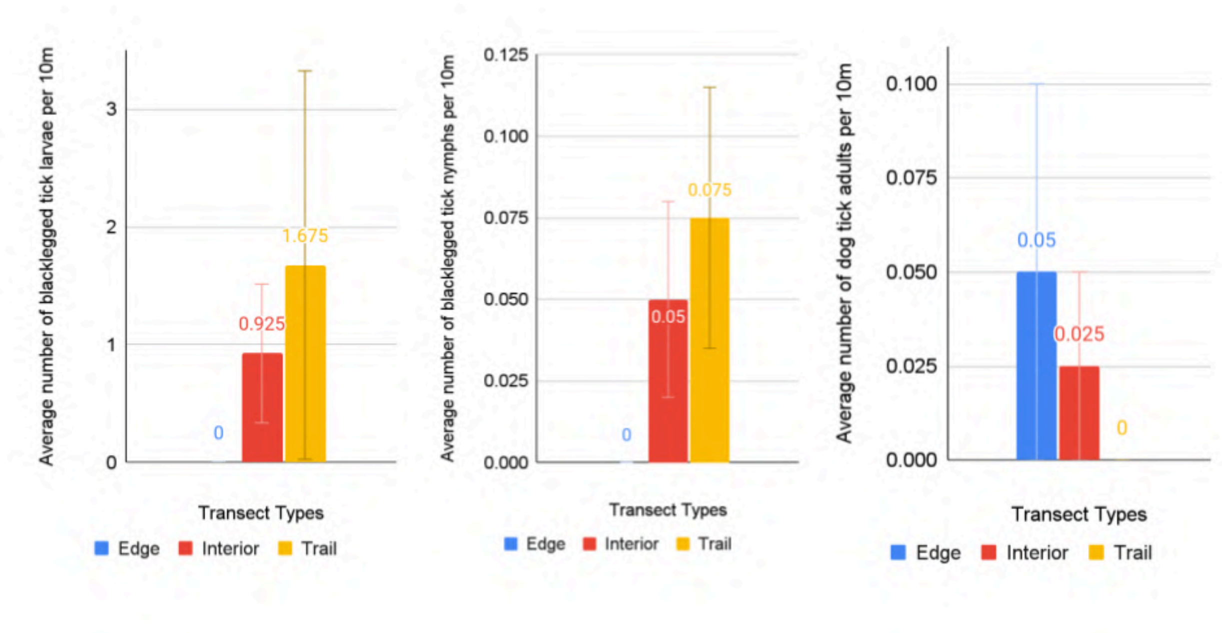

Figure 5. Average number ticks by life stage and species collected by each transect type at Van Cortlandt Park.

At Van Cortlandt Park, we summarized the tick species and life stage by transect types. For blacklegged tick larvae, we found an average of 1.675 (SE 1.65) per 10m along trails, 0.925 (SE 0.59) per 10m within the interior, and 0 on the edge. For blacklegged ticks nymphs, we found an average of 0.075 (SE 0.04) per 10m along the trail, 0.05 (SE 0.03) per 10m within the interior, and 0 on the edge. For adult dog tick adults, we found an average of 0 per 10m along the trail, 0.025 (SE 0.025) within the interior, and 0.05 (SE 0.05) on the edge.

5. Discussion

5.1 Land Management

I. Scapularis populations prefer forested habitat over habitat composed of ornamental vegetation or manicured lawn (Maupin et al. 1991). This is consistent with our findings, as a total of 109 *I. Scapularis* were found in Van Cortlandt Park, which contains a larger amount of forested habitat than Wave Hill, where none were found (Fig. 5).

5.2 Species Identity

Although both sites had similar species richness, the identity of those species differed slightly. Based on our findings, species identity may matter more than species richness when it comes to tick abundance. White-tail deer, a major host for *I. Scapularis* (Wilson et al., 1985), was present in Van Cortlandt but not in Wave Hill, which could explain the large tick abundance in Van Cortlandt that was not there in Wave Hill. Recent research in New York City has shown that white-tailed deer occupancy in urban parks is the most important driver of nymphal blacklegged tick abundance (Lilly et al. 2025) which supports our results. Wave Hill has a fence gating off larger mammals, preventing deer from entering Wave Hill. Van Cortlandt is a larger park that is not gated, allowing white tailed deer to pass through and bring or host ticks. The presence of coyotes, a keystone predator species, in both urban parks could indicate a healthy ecosystem and predation of rodent tick hosts (Weckel & Wincorn, 2016). Interestingly, we found a relatively high abundance of American Robin at both of our sites, which is a host of *I. Scapularis* (Richter et al 2000), underscoring the need for further research in urban tick-borne diseases relating to birds.

5.3 Dilution Effect

We did not find evidence to support the dilution effect. Van Cortlandt and Wave Hill had similar Shannon diversity index values, and we found 111 ticks in Van Cortlandt park and zero in Wave Hill (Fig. 5). The dilution effect theory was developed in suburban and rural areas (Schmidt and Ostfeld 2001), this study was done in an urban area. There have been fewer tick ecology studies done in urban areas, so further research needs to be done to test ecological theories since our results suggest there may be differing ecological processes contributing to tick hazard.

5.4 Human Disease Risk Implication

We did not test the ticks for tick borne pathogens, but tick density is often used as a metric for human hazard (Lilly et al. 2025). Our study shows that there was an established tick population in Van Cortlandt: more than six *I. Scapularis* of one life stage and two different life stages (CDC, 2025). We found ticks on the trails, edges, and interior of Van Cortlandt park. Our results strongly suggest that there are more blacklegged ticks nymphs and larvae in forest trails and interior than forest/lawn edges. Areas that are highly used by people, such as the trail, can be hazardous. Increased tick management should be added in these areas. For example, we suggest adding signage about taking precautions and checking for ticks.

5.5 Limitation

We made an effort to sample the entire tick and wildlife host community at both of our collection sites. However, our data collection period was relatively short: only two weeks. The low mammalian species richness in Van Cortlandt could be due to this short sampling period. One of our cameras in Van Cortlandt only picked up an Eastern Grey Squirrel, while the other camera picked up 5 different mammalian species indicating that other cameras could also be missing species observations due to camera placement or the limited time period. Extending our research period could have given us more precise mammalian species data for both Van Cortlandt and Wave Hill. Additionally, our camera trapping method was unable to capture the entire small mammal population, which are important hosts for ticks and tick-borne pathogens that are missing from our dataset (LoGiudice et al., 2003). Lastly, we were only able to collect data at two different urban greenspaces. Future studies should add additional sites for comparison.

6. Conclusion

Our findings show the importance of tick-borne disease studies in urban areas. Through this study, we did not find evidence to support the dilution effect, which usually applies for rural and suburban conditions. We found a relatively high abundance of American Robin, indicating further research is needed relating to birds and tick borne hazards. Our data indicates that Van Cortlandt has an established tick population, potentially due to presence of the White-tailed Deer, and could benefit from increased tick management in areas with high human activity.

7. Acknowledgement

[Redacted by Managing Editor]

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REVIEW FOR:

Implications for tick-borne disease risk in New York City: A comparative study of wildlife diversity and tick abundance.

ACCEPT WITH MINOR REVISIONS

Revisions needed

The paper presents an interesting narrative and novel findings regarding the prevalence of tick species across two distinct green spaces. No revisions are needed in the Methods or Results sections. The Methods section is excellent—each method is described in detail, and appropriate references are provided. The Introduction offers a brief background on the topic and makes some connections to relevant research. However, as noted below, please add more details and supporting evidence to the Introduction and Abstract to strengthen the rationale for the research question. Additionally, the Discussion section would benefit from further synthesis of existing research on tick populations in urban areas.

Originality and Significance

The paper presents original findings and insights into the prevalence of common tick species in two natural areas in the Bronx. The data discovered is highly relevant both ecologically and for public health, as the project resulted in posted warnings regarding tick exposure.

Clarity and Structure

The argument is relatively well-organized. I suggest checking the flow of ideas and presentation of information in the introduction- be sure that a clear claim is presented at the beginning of each paragraph and that detailed evidence is provided to support that claim within the body of the paragraph. Some paragraphs would benefit from smoother transitions. Further, covering the current research in tick prevalence in urban areas would strengthen the rationale and arguments of the paper.

Use of Evidence and Research Methods

The methods section is excellent- well-written and the methods are cited and explained in detail. The results are presented clearly- results are explained and major statistical findings and comparisons are stated in the text.

Engagement with Literatur

The introduction and conclusions need more references and discussion of currently published studies on tick prevalence and biodiversity in urban areas.

Grammar and Language

The grammar and language use is clear and professional. I don't see any major issues or need for revision in this area

Specific Feedback

- *Nice job introducing the topic and identifying the research gap early on in the abstract. Please state the location of the study in the abstract.*

- *The introduction does a great job of covering the variety of tick species. I suggest including more details regarding the different species and the hosts that are affected. For example, which species have lower reservoir competence and what is the significance of this?*
- *The anthropogenic impacts on forest density is highly relevant, can the author expand on evidence related to the influence of urbanization? For example, details on urbanization in New York City and the Bronx could help connect the claims made regarding urbanization and tick abundance to the thesis of the paper. In addition, the level of land management in Bronx greenspaces.*

- *I wonder what is known about tick-related diseases in New York City and the Bronx- in humans and wildlife? This information could potentially strengthen the rationale of the paper.*

- *Could the research question be better defined in the abstract and introduction? The question is stated as:*

"Our goal is to fill the gap in knowledge about tick borne hazards in urban areas. Additionally, we wanted to test the dilution effect theory to see if it applies in an urban setting."
I suggest explicitly stating the independent and dependent variable in the research question- for example - what is the effect of land management on tick biodiversity and prevalence?

- *The discussion connects the findings to relevant literature regarding forest density, tick abundance as it relates to host species, and the dilution effect. The discussion (and introduction) would benefit from a discussion of already published studies documenting tick populations and prevalence in other urban areas. For example, after a quick search, I was able to find this study: https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-022-05416-2.*

- *Make sure to comment on the most striking findings from the paper in the conclusions- that the forested areas have more tick abundance than well-manicured spaces. This has major implications for human disease risk implications as mentioned, so restating this in the conclusions will leave the reader with an understanding of the most important take-aways.*

- *I wonder what is known about tick-related diseases in New York City and the Bronx- in humans and wildlife? This information could potentially strengthen the rationale of the paper.*

Review Report

Submission ID: 100041

Paper title- Implications for tick-borne disease risk in New York City: A comparative study of wildlife diversity and tick abundance.

Final recommendation- Minor revisions

This study offers significant strengths, including addressing a critical research gap by focusing on tick-borne disease hazards in urban areas and testing the dilution effect theory. It provides baseline data on biodiversity and tick abundance, with practical implications for public health interventions such as targeted tick management in high-use parks.

However, limitations include the small sample size of only two parks, seasonal constraints that may affect tick abundance, and inconclusive findings regarding the dilution effect, partly due to species identity playing a larger role than diversity. Additionally, potential confounding factors such as human activity and microclimate differences may influence results, highlighting the need for broader and longer-term studies.

Following suggestions will improve manuscript in terms of concept and clarity.

For Title:

- Comparative Analysis of Tick Abundance and Wildlife Diversity in NYC Parks: Implications for Public Health
- Urban Biodiversity and Tick Presence: Insights into Tick-Borne Disease Hazards in NYC.

This is just suggestion; I would prefer having 'urban' in the title because that the novelty of study.

1. Abstract: The abstract is informative and follow a clearer structure.

2. Introduction: The introduction needs following changes:

- Line 28: add hard bodied tick or deer tick in paragraph with the scientific name *Ixodes scapularis* as these are commonly used names.
- Authors have used quite old references for setting the context; I would suggest using recent studies, like line 41, 1984, similarly 2001, 2003…
- Replace "We sought to test" with "This study tests" for an academic, more formal tone.
- Line 43 and 44, is repetition of already explained concept.
- Currently, the introduction jumps between disease trends, ecology, anthropogenic impacts, and theory. Open with the rise of tick-borne diseases and why urban areas matter, before diving into details about vectors and ecology.

Follow the scheme to improve introduction broadly:

- **Global and regional trends**
- **Ecological and anthropogenic drivers**
- **Research gap**
- **Theory (dilution effect) or what other options are there?**
- **Study aim**

Lines 58–62 focus heavily on land use and land management, but your study is based on observations rather than GIS or land-use mapping. I suggest revising this paragraph to emphasize your observational approach and clearly mentioning your objectives and study rationale here.

3. Methodology

- It would be helpful to add a study area map (e.g., a simple Google Earth image) and include photos of the wildlife camera setup as figures for Section 3.2.
- Additionally, clarify why July was chosen, emphasizing its seasonal relevance for tick activity, and specify whether sampling occurred at consistent times of day.
- Replace "1000 meters squared" with "1,000 m^2" for clarity, and ensure consistent terminology throughout, particularly for "transect" and "increment."
- **Please provide Shannon diversity index in methodology**, you can provide its formula/equation which you have used to calculate values.
- Provide reference for line 88.

4.Results

- The results are well-presented and supported by figures and tables.
- Line 108: You said **"28 bird point counts for each site"**, which means:
    - Wave Hill: 28 counts
    - Van Cortlandt: 28 counts
      Total = 56 point counts across both sites.
- But then you reported **"401 Avian individuals across both sites"** without clarifying the effort per site. That part is fine, but the potential issue is whether the effort (56 counts) matches the interpretation of your results. Please check.

- Figures: please remove the caption within all figures, as the title you provided is same.
- Also, please remove **vs'** from the title like Figure 1. Avian and Mammalian species

  richness in Wave Hill **vs** Van Cortlandt Park.

- For mentioning name of species, please follow alphabetical order. Line 119 to 121

- Remove T .. line 144

5. **Discussion-**

Line 180: In that sentence, **"amount"** isn't ideal because *forested habitat* is not something you measure in discrete units like quantity—it's more about **extent** or **area**.

Use *italicized* genus and species names throughout (e.g., *I. scapularis*, *Odocoileus virginianus* for white-tailed deer).

- Clarify the role of deer:

"White-tailed deer (*Odocoileus virginianus*), a major reproductive host for *I. scapularis* adults…"

- Improve sentence structure for readability:

"Van Cortlandt's lack of fencing allows deer movement, likely increasing tick abundance, whereas Wave Hill's fencing excludes large mammals."

- For coyotes:

"The presence of coyotes (*Canis latrans*), a keystone predator, in both parks suggests potential regulation of rodent populations, which are key tick hosts."

- Strengthen interpretation:

"Despite similar Shannon diversity values, tick abundance differed markedly, suggesting that species composition, rather than diversity alone, influences tick hazard in urban settings."

- Make recommendations more formal:

"We recommend targeted tick management strategies along high-use trails, including signage promoting tick checks and personal protective measures."

"Our two-week sampling period may have underestimated mammalian richness, as evidenced by variation between camera traps. Additionally, our methods did not capture small mammals, which are critical hosts for immature ticks. Future studies should extend sampling duration and include additional urban greenspaces."

6**. Conclusion**

- Replace informal phrases like *"Through this study"* with more precise wording:
- "Our findings highlight the importance of investigating tick-borne disease dynamics in urban environments." Instead of *"which usually applies for rural and suburban conditions"*, make it more formal: "…a pattern typically observed in rural and suburban landscapes.
- Connect ideas logically: "Despite similar diversity metrics, we did not find evidence supporting the dilution effect, suggesting that different ecological processes may operate in urban settings.
- Instead of *"could benefit from increased tick management"*, specify what that means: "…indicating a need for targeted tick management strategies, such as signage, public awareness campaigns, and habitat modification in high-use areas."

- Expand on why American Robins matter:
  "The relatively high abundance of American Robins, known hosts for *I. scapularis*, underscores the need for further research on avian contributions to urban tick-borne disease risk."

7. References

- Consistent formatting; spacing, punctuation
- Ensure all references are formatted uniformly (e.g., "Lilly et al., 2025" vs. "Ralph et al. 1995").

Overall, there are minor grammatical issues and formatting inconsistencies (e.g., spacing, punctuation), a thorough proofreading would improve readability.

Recommendation

Minor Revision

The work is conceptually sound and provides important findings. With minor revisions focused on clarity and detail, it will be well-positioned for publication.

Comparative Analysis of Tick Abundance and Wildlife Biodiversity in NYC Urban Greenspaces: Implications for Tick-Borne Diseases.

Hoa Van, Diego Benitez, Audrey Effros, Marie Lilly*

*Supervisory author

1. Abstract

Context: Tick abundance has been on the upsurge in the Midwestern and Northeastern regions of the United States, leading to increased cases of tick-borne diseases such as Lyme disease. Many studies about tick disease hazards are done in suburban and rural areas, leaving a research gap in urban areas.

Objective: Our goal is to fill the gap in knowledge about urban biodiversity and greenspace management on tick-borne hazards in urban areas. Additionally, we wanted to test the dilution effect theory to see if it applies in an urban setting.

Methods: We selected two urban greenspaces, Wave Hill and Van Cortlandt Park, in the Bronx, New York City, NY, for our data collection. We measured biodiversity by observing the Avian and Mammalian populations. We sampled the tick abundance for both parks through tick dragging.

Results: We found similar patterns of biodiversity in both parks, but differing tick abundances. Wave Hill had a slightly higher Shannon diversity, but Van Cortlandt had a higher species richness, abundance, and evenness. We found an established tick population in Van Cortlandt and zero ticks in Wave Hill.

Discussion: We did not find evidence to support whether or not the dilution effect applies in an urban area. Additionally, we found that species diversity may matter less than species identity.

Further research is necessary to better understand the role of biodiversity on tick-borne disease hazards in urban areas. However, this study does indicate that Van Cortlandt needs to implement tick management to decrease tick disease hazards in highly used areas like trails and edges where ticks were found.

Keywords: Ixodes scapularis, tick disease hazards, land management, biodiversity, dilution effect theory.

2. Introduction

In recent years, cases of tick-borne diseases, especially Lyme disease, have been increasing in the Midwest and Northeast regions of the United States. In New York State, *Ixodes scapularis* (commonly called the blacklegged tick or deer tick) is the main disease vector for the bacteria *Borrelia burgdorferi*, the causing agent for Lyme disease (Piedmonte et al. 2018). Anthropogenic impacts such as land use change, climate change, and deforestation have increased tick abundances, thereby increasing the tick-borne disease risk (Diuk-Wasser et al. 2021). Urbanization creates a mosaic landscape, which increases forest patches and decreases habitat patch size (Wilson et al. 1984). This results in a negative correlation between patch size and density of infected ticks (Allan et al. 2003). Lastly, active forest management may reduce the presence of nymphal and density of adult blacklegged ticks, and exposure to tick-borne pathogens in the landscape (Conte et al. 2021). Nevertheless, less research has been conducted in urban areas, leaving a gap in knowledge about the role of wildlife hosts on tick-borne disease risk in urban contexts (Diuk-Wasser et al. 2025). Although tick-borne diseases in urban settings are studied thoroughly in Europe, there is a major gap in the U.S, in which most tick disease studies are done in rural and suburban areas (Kilpatrick et al. 2014, Diuk-Wasser et al. 2025).

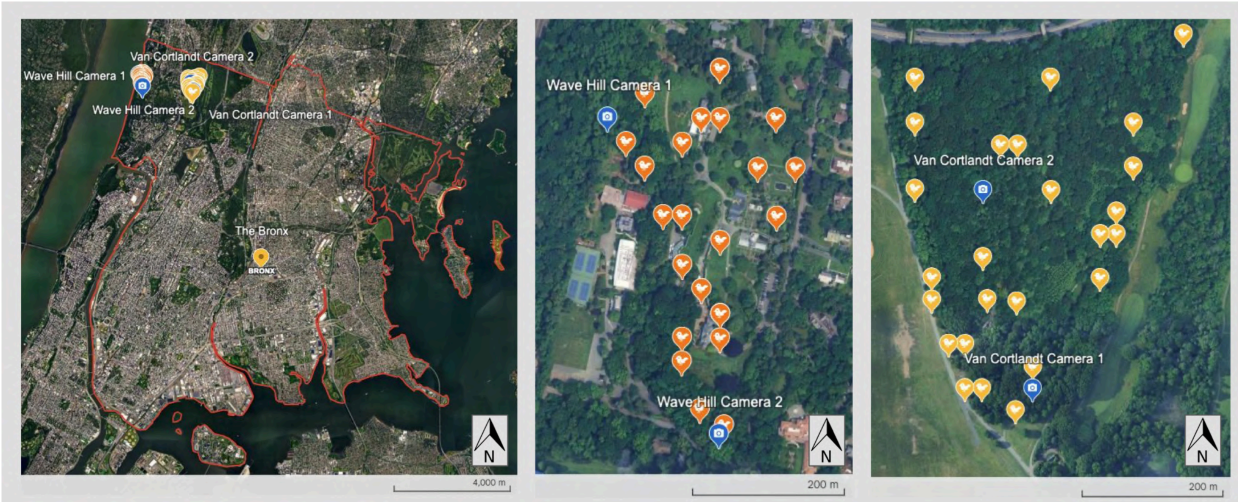
Tick abundance, a proxy for tick-borne disease risk and hazard, in an area depends on the host species and several environmental factors (Lilly et al. 2025). *I. scapularis* feeds on hosts infected with *B. burgdorferi* to become infected. As larvae and nymphs, *I. scapularis* feed on a variety of mammalian, avian, and reptilian host species, some of which are believed or documented to have low reservoir competence (LoGiudice et al. 2003). Hosts with lower reservoir competence have an immune system that clears *B. burgdorferi* faster than hosts with high reservoir competence (Brunner et al. 2008). For example, the *Odocoileus virginianus*, white-tailed deer, is the key reproductive host for *I. scapularis* but is not a competent host for *B. burgdorferi* (Wilson et al. 1985). Other mammalian host species that can host *I. scapularis* ticks, such as Raccoons and Opossums, have a low reservoir competence for *B. burgdorferi*, while several small mammals, such as the white-footed mouse and eastern chipmunk, have a higher reservoir competence (LoGiudice et al. 2003). On the other hand, there has not been as much research on the relationship between avian species as hosts for *I. scapularis* ticks and *B. burgdorferi* (Brinkerhoff et al. 2009, Loss et al. 2016). However, the American Robin has been implicated as a potentially important host for *I. scapularis* ticks and *B. burgdorferi* (Richter et al. 2000). These host species are present across the Northeast, and their role in Lyme disease transmission is well documented in rural and suburban areas but less so in urban environments (LoGiudice et al. 2003, Kilpatrick et al. 2017, Diuk-Wasser et al. 2025).

Additionally, according to the dilution effect, increased biodiversity in an ecological community can lead to a decrease in the transmission of a pathogen due to differences in predation and reservoir competence of host species in a more diverse community (Schmidt and Ostfeld, 2001). However, the dilution effect theory remains ambiguous with mixed evidence in urban environments, including highly urban New York City, where ticks and hosts are also present (Bastard et al. 2024). Randolph and Dobson argued that the dilution effect theory applies only in certain, limited circumstances (Randolph and Dobson, 2012).

This study tests the dilution effect with tick-borne hazards in urban greenspaces. We chose two study sites in the Bronx, New York City, New York, that vary in patch size and land management practices. This study aims to bridge the information gap regarding urban biodiversity and greenspace management on tick-borne hazards and connect these learnings to already existing knowledge regarding the relationship between tick populations and urban land management. This study identifies whether a highly manicured or a low managed greenspace impacts the tick abundance. This study also examines the effect of host biodiversity on the abundance of ticks in urban greenspaces.

3. Methods

3.1 Study Area



Map 1. Study area in the Bronx, NYC, NY at Wave Hill and Van Cortlandt Park. The camera icons indicate the location where the camera traps were placed. The birds icon represents the randomly generated bird point counts, with the orange icons for Wave Hill and yellow for Van Cortlandt Park. Satellite image basemap from GoogleEarth.

We collected data in Riverdale, a residential neighborhood located in the northwest Bronx, during July 2025. Within Riverdale, two distinct urban green spaces were selected for comparison: Wave Hill and Van Cortlandt Park. Wave Hill is a 28-acre estate characterized by landscaped gardens and managed woodlands (Wave Hill, 2025), while Van Cortlandt Park is a 1,146-acre urban park characterized by largely unmanaged forest (NYC Parks, n.d.).

3.2 Wildlife Camera Trapping

Two motion-triggered Browning Strike Force wildlife cameras were deployed at each site for a collection period of two weeks. All photographs were reviewed and tagged in Wildlife Insights according to the species present.

Figure 1. This image demonstrates the wildlife camera setup in the study.

3.3 Tick Collection

Tick data collection took place in July, because *I. scapularis* are actively looking for hosts during the warmer seasons (Levi et al. 2015). In the area surrounding each wildlife camera, tick drags were collected over 2 collection days for a total distance of 1000 m^2. Using 1m x 1m corduroy drag cloths, the forest interior, forest/lawn edge, and trail were sampled by dragging the cloth in ten 10m^2 transects for a total transect length of 100m. At the end of each 10m drag, the cloth was examined for ticks. Any ticks found within each 100m transect were collected with metal forceps and placed in 1.5mL preservation vials of 85% ethanol (Lilly et al. 2025). The number of ticks at each life stage (adult, nymph, larva) and the dominant habitat type (unmaintained herbaceous, leaf litter, maintained grass) of each 10m transect were recorded. The species of ticks present in each vial were identified under a microscope based on morphological characteristics using taxonomical keys and expert guidance (Madder et al. 2014)

3.4 Avian Point Counts

Thirty bird survey points within a polygon of each site were randomly generated using AI. Before each count, current weather conditions were recorded. Each count lasted 10 minutes, during which observers recorded the species, distance, minute after time start, number of birds seen if in a group, behavior, and any additional notes necessary (Ralph et al. 1995). Bird species were determined using visual observation and assistance from the Merlin Bird ID app (https://merlin.allaboutbirds.org/). To maintain spatial independence, points surveyed on the same day were separated by at least 100m.

3.5 Data Analysis

Tick data were summarized into the density of larvae, nymphs, and adults by species per 1000m. Camera trap data were filtered by removing avian species and photos of the same mammalian species identified within a 30-minute time frame to avoid pseudoreplication (Lawrence et al. 2018). Bird survey and camera trap data were summarized by species richness, abundance, evenness, and Shannon diversity (Shannon, 1948), which was calculated by site.

Shannon's diversity formula is as follows:

$$H= -\sum_{i=1}^{s} p_{i} \ln p_{i}$$

The variable H is the Shannon diversity index value. Pi represents the number of individuals of a specific species divided by the total number of all individuals in the community.

4. Results

We set camera traps for a duration of two weeks, capturing a total of 57 different mammalian individuals across Wave Hill and Van Cortlandt. We conducted 28 bird point counts for each site, totaling 56 bird point counts. Through our observation, we recorded 182 avian individuals in Wave Hill and 219 avian individuals in Van Cortlandt, totaling 401 avian individuals in both sites.

4.1 Species Richness

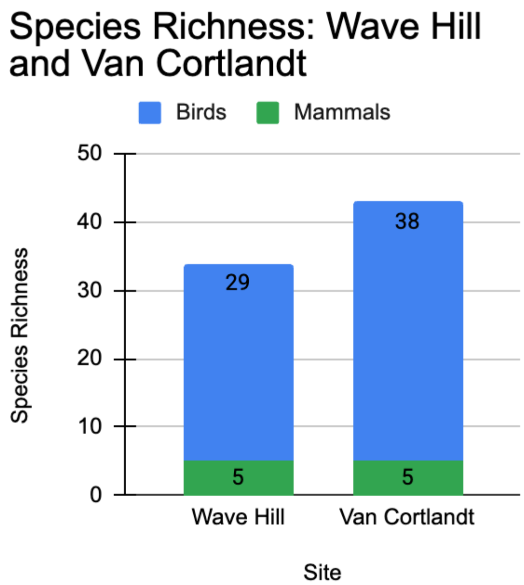


Figure 2.

There was a higher Avian species richness in Van Cortlandt than in Wave Hill. In Wave Hill, we found 29 bird species. In Van Cortlandt, we found 38 bird species. The mammalian species richness is the same for both sites. We capture five different mammalian species in both parks. In Van Cortlandt, we recorded Coyote, Eastern Gray Squirrel, Northern Raccoon, Virginia Opossum, and White-tailed deer. In Wave Hill, we recorded Coyote, Eastern Chipmunk, Eastern Cottontail, Eastern Gray Squirrel, and Virginia Opossum. Although the species richness is the same for both sites, they differ slightly in species identity.

4.2 Wildlife Abundance

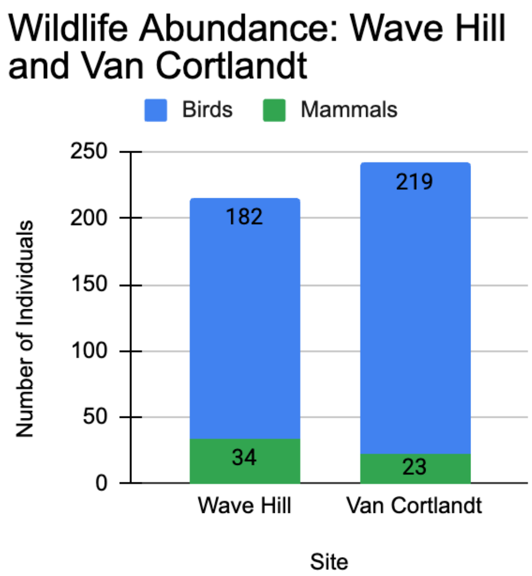


Figure 3.

We found more birds and mammals in Van Cortlandt than we did in Wave Hill. There were 216 individuals across all species in Wave Hill, and 242 individuals across all species in Van Cortlandt. The number of birds in Van Cortlandt was more than the number of birds in Wave Hill. We recorded 182 Avian individuals in Wave Hill and 219 Avian individuals in Van Cortlandt. The number of individual mammals was more in Wave Hill than in Van Cortlandt. There were 34 mammalian individuals in Wave Hill, and 23 mammalian individuals in Van Cortlandt.

4.3 Shannon Diversity Index

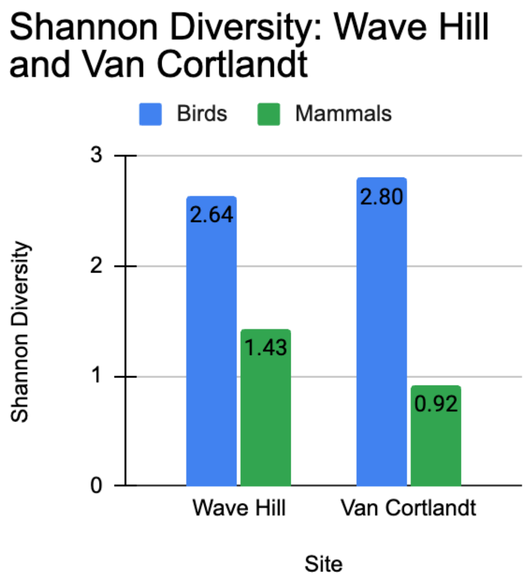


Figure 4.

The Shannon Diversity Index slightly varied between the sites. Wave Hill had a higher mammalian Shannon diversity index value–1.43, than Van Cortlandt's mammalian Shannon diversity index value–0.92. Van Cortlandt had a higher avian Shannon Diversity Index value–2.80, than Wave Hill's Avian Index value–2.64.

4.4 Species Evenness

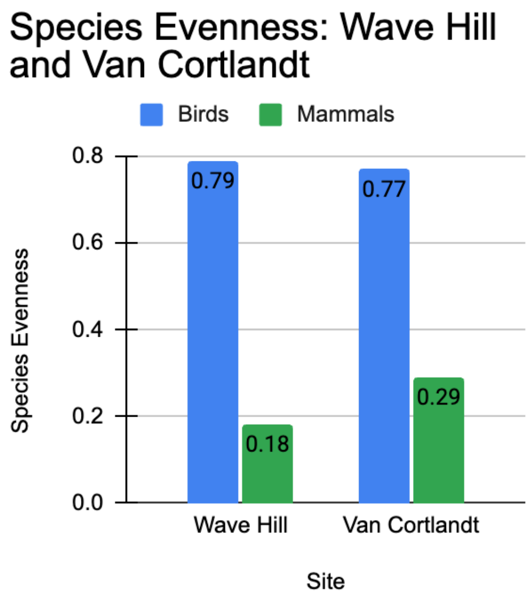


Figure 5.

Avian species evenness was slightly higher in Wave Hill than in Van Cortland, with values of 0.79 and 0.77, respectively. Although the avian species evenness was very similar in both parks.

The mammalian species evenness was higher in Van Cortlandt than in Wave Hill, with values of 0.29 and 0.18, respectively.

4.5 Tick Abundance

Site	**Black-legged Tick Larvae**	**Black-legged Tick Nymphs**	**Dog Tick Adults**
Van Cortlandt	104	5	2
Wave Hill	0	0	0

Grand Total	104	5	2

Table 1. The number of ticks and tick species.

In Van Cortlandt, we collected 104 *I. scapularis* larvae, five *I. scapularis* nymphs, and two *Dermacentor variabilis* adults. In Wave Hill, we recorded zero ticks across the 1000m transect.

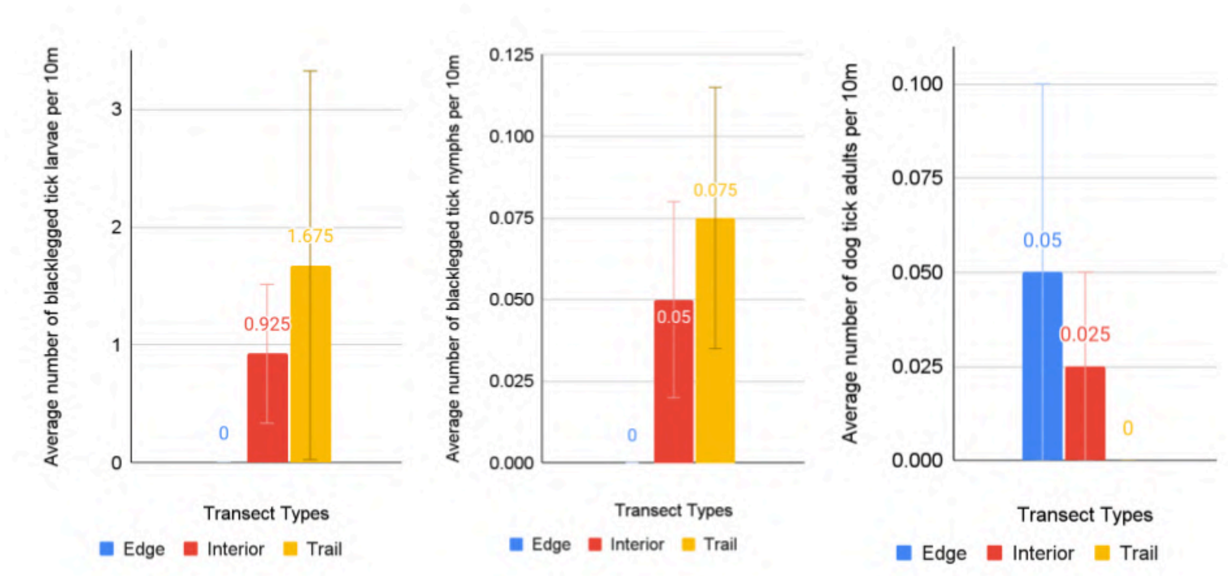


Figure 6. Average number of ticks by life stage and species collected by each transect type at Van Cortlandt Park.

At Van Cortlandt Park, we summarized the tick species and life stage by transect types. For blacklegged tick larvae, we found an average of 1.675 (SE 1.65) per 10m along trails, 0.925 (SE 0.59) per 10m within the interior, and 0 on the edge. For blacklegged ticks nymphs, we found an average of 0.075 (SE 0.04) per 10m along the trail, 0.05 (SE 0.03) per 10m within the interior, and 0 on the edge. For adult dog ticks, we found an average of 0 per 10m along the trail, 0.025 (SE 0.025) within the interior, and 0.05 (SE 0.05) on the edge.

4.6 Camera Traps Highlights

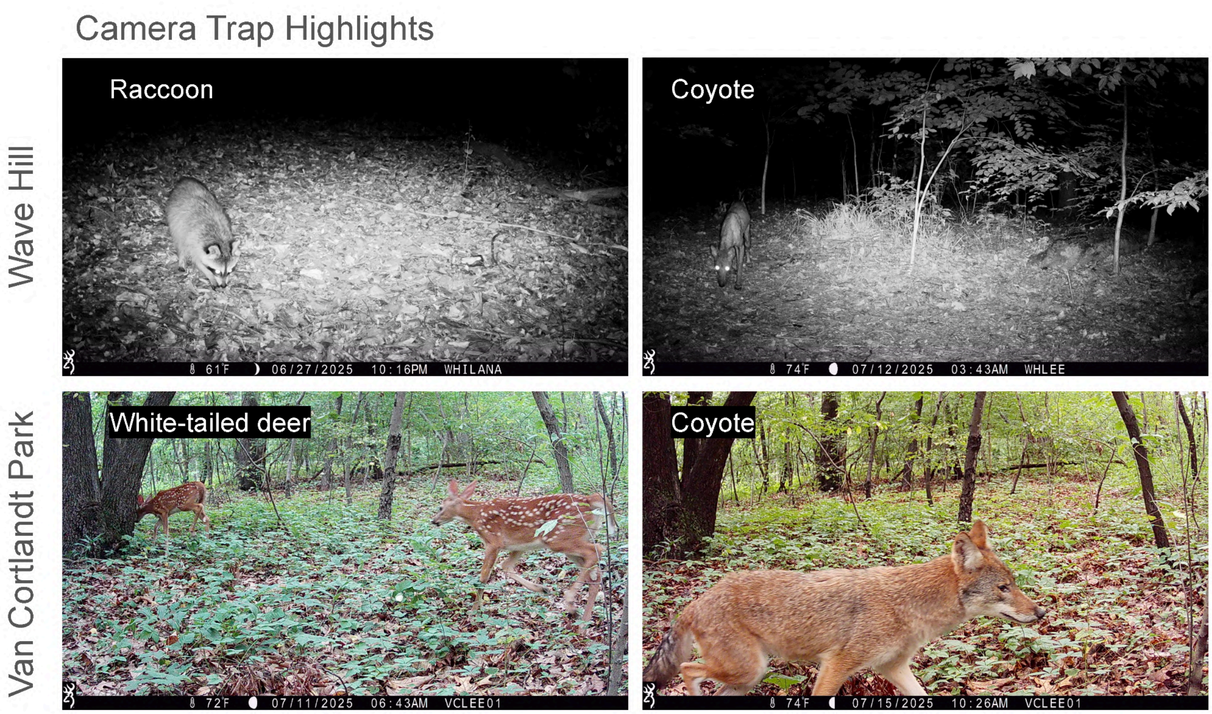


Figure 7. Highlight photos from the camera traps at Wave Hill and Van Cortlandt Park.

Some camera trap highlights of the mammalian species within the two urban parks are shown in figure 7. In Wave Hill, a coyote and raccoon were captured at night. In Van Cortlandt Park, there a coyote and two white-tail deer are shown active in the morning.

5. Discussion

5.1 Land Management

I. scapularis populations prefer forested habitat over habitat composed of ornamental vegetation or manicured lawn (Maupin et al. 1991). This is consistent with our findings, as a total of 109 *I. scapularis* were found in Van Cortlandt Park, which contains a larger area of forested habitat than Wave Hill, where none were found (Fig. 5). Our results highlight that urban forested areas had a higher tick abundance than well-manicured spaces, which is consistent with other studies of tick-borne hazards in New York City (Gregory et al. 2022, Lilly et al. 2025).

5.2 Species Identity

Although both sites had similar species richness, the identity of those species differed slightly. Based on our findings, species identity may matter more than species richness when it comes to tick abundance. *O. virginianus*, a major reproductive host for *I. scapularis* adults (Wilson et al. 1985), was present in Van Cortlandt but not in Wave Hill, which could explain the large tick abundance in Van Cortlandt that was not there in Wave Hill. Recent research in New York City has shown that *O. virginianus* occupancy in urban parks is the most important driver of nymphal blacklegged tick abundance (Lilly et al. 2025), which supports our results. Wave Hill has a fence that gates off larger mammals, preventing deer from entering Wave Hill. The absence of fencing in Van Cortlandt Park allows deer movement, which likely increases the tick abundance; in contrast, the fencing around Wave Hill prevents the entry of larger mammals. The presence of coyotes, a keystone predator species, in both urban parks potentially indicates a regulation of rodent populations, which are a key host for ticks and a reservoir species for *B. burgdoferi*

(Weckel & Wincorn, 2016). Interestingly, we found a relatively high abundance of American Robin at both of our sites, which is a host of *I. scapularis* (Richter et al. 2000), underscoring the need for further research in urban tick-borne diseases relating to birds.

5.3 Dilution Effect

We did not find evidence to support the dilution effect. Van Cortlandt and Wave Hill had similar Shannon diversity index values, and we found 111 ticks in Van Cortlandt Park and zero in Wave Hill (Fig. 5). Even with similar Shannon diversity values, tick numbers differed greatly, implying that the makeup of species—not just overall diversity—influences tick hazard in urban settings. The dilution effect theory was developed in suburban and rural areas (Schmidt and Ostfeld 2001); this study was done in an urban area. There have been fewer tick ecology studies done in urban areas, so further research needs to be done to test ecological theories since our results suggest there may be differing ecological processes contributing to tick hazard.

5.4 Human Disease Risk Implication

We did not test the ticks for tick-borne pathogens, but tick density is often used as a metric for human hazard (Lilly et al. 2025). Our study shows that there was an established tick population in Van Cortlandt: more than six *I. scapularis* of one life stage and two different life stages (CDC, 2025). We found ticks on the trails, edges, and interior of Van Cortlandt Park. Our results strongly suggest that there are more blacklegged tick nymphs and larvae in forest trails and interior than in forest/lawn edges. Areas that are highly used by people, such as the trail, can be hazardous. We recommend implementing tick management along high-use trails, such as signage encouraging visitors to perform tick checks and other personal protective measures.

5.5 Limitation

We made an effort to sample the entire tick and wildlife host community at both of our collection sites. Our two-week sampling period may have underestimated mammalian richness, as shown by the variation between the camera trap data. For example, one of our cameras in Van Cortlandt only picked up an Eastern Grey Squirrel, while the other camera picked up 5 different mammalian species, indicating that other cameras could also be missing species observations due to camera placement or the limited time period. Additionally, our methods did not capture small mammals, which are critical hosts for immature ticks and tick-borne pathogens (LoGiudice et al. 2003). Future studies should extend the sampling period and include additional urban greenspaces.

6. Conclusion

Our findings highlight the importance of tick-borne disease dynamics in urban environments. Despite possessing similar diversity metrics, we did not find evidence to support the dilution effect, indicating that different ecological processes may operate in urban settings. We did not find evidence to support a pattern typically observed in both rural and suburban landscapes for the dilution effect. The relatively high numbers of American Robins—key hosts for *I.*

scapularis—underscore the need for additional research on avian roles in urban tick-borne disease risk. Our data indicate that Van Cortlandt has an established tick population, potentially due to the presence of the *O. virginianus*, suggesting the need for targeted tick management strategies, such as signage, raising public awareness, and habitat modification in high-use areas.

7. Acknowledgement

We would like to thank Lee Renshaw, Ilana Weinstein, and Wave Hill for their continued support in the WERM program. Lastly, we thank the Eco-Epidemiology lab at Columbia University for supplying us with tick collection equipment and identification resources.

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Dear Jonas Katona,

Thank you for the opportunity to revise and resubmit the manuscript. We appreciate the feedback and provided the point by point responses below.

Review 1
REVIEW FOR:

Implications for tick-borne disease risk in New York City: A comparative study of wildlife diversity and tick abundance.

ACCEPT WITH MINOR REVISIONS

Revisions needed

The paper presents an interesting narrative and novel findings regarding the prevalence of tick species across two distinct green spaces. No revisions are needed in the Methods or Results sections. The Methods section is excellent—each method is described in detail, and appropriate references are provided. The Introduction offers a brief background on the topic and makes some connections to relevant research. However, as noted below, please add more details and supporting evidence to the Introduction and Abstract to strengthen the rationale for the research question. Additionally, the Discussion section would benefit from further synthesis of existing research on tick populations in urban areas.

> Response: Thank you for your kind words about the paper, we have addressed your comments on the manuscript.

Originality and Significance

The paper presents original findings and insights into the prevalence of common tick species in two natural areas in the Bronx. The data discovered is highly relevant both ecologically and for public health, as the project resulted in posted warnings regarding tick exposure.

> Response: Thank you!

Clarity and Structure

The argument is relatively well-organized. I suggest checking the flow of ideas and presentation of information in the introduction- be sure that a clear claim is presented at the beginning of each paragraph and that detailed evidence is provided to support that claim within the body of the paragraph. Some paragraphs would benefit from smoother transitions. Further, covering the current research in tick prevalence in urban areas would strengthen the rationale and arguments of the paper.

> *Response:* Great suggestions, we have added additional background information about urban tick research, clarified the aims, and have tried to add smoother transitions between

paragraphs.

Use of Evidence and Research Methods

The methods section is excellent- well-written and the methods are cited and explained in detail. The results are presented clearly- results are explained and major statistical findings and comparisons are stated in the text.

>Response: Thank you!

Engagement with Literatur

The introduction and conclusions need more references and discussion of currently published studies on tick prevalence and biodiversity in urban areas.

>Response: We have added more references and discussion of currently published studies on tick prevalence and biodiversity in urban areas to the introduction and conclusion.

Grammar and Language

The grammar and language use is clear and professional. I don't see any major issues or need for revision in this area

>Response: Thank you!

Specific Feedback

- *Nice job introducing the topic and identifying the research gap early on in the abstract. Please state the location of the study in the abstract.*

  > *Response: We have added a sentence to the methods section of the abstract with the study location that now reads, "*We selected two urban greenspaces, Wave Hill and Van Cortlandt Park, in the Bronx, New York City, NY for our data collection."

- *The introduction does a great job of covering the variety of tick species. I suggest including more details regarding the different species and the hosts that are affected. For example, which species have lower reservoir competence and what is the significance of this?*

  > *Response:* Thank you for your comments and suggestions. We have added more details regarding the tick hosts species and significance to our study in lines 39-52.

- The anthropogenic impacts on forest density is highly relevant, can the author expand on evidence related to the influence of urbanization? For example, details on urbanization in New York City and the Bronx could help connect the claims made regarding urbanization and tick abundance to the thesis of the paper. In addition, the level of land management in Bronx greenspaces.

>Response: Thank you for your comments, we have added additional information about urbanization effects on tick hosts in NYC in lines 50-70.

- I wonder what is known about tick-related diseases in New York City and the Bronx- in humans and wildlife? This information could potentially strengthen the rationale of the paper.

>Response: We have added reference to research studies about tick-related diseases in New York City in humans and wildlife.

- Could the research question be better defined in the abstract and introduction? The question is stated as:

"Our goal is to fill the gap in knowledge about tick borne hazards in urban areas. Additionally, we wanted to test the dilution effect theory to see if it applies in an urban setting." I suggest explicitly stating the independent and dependent variable in the research question- for example - what is the effect of land management on tick biodiversity and prevalence?

> Response: Thank you for your suggestion. The abstract now reads, "Objective: Our goal is to fill the gap in knowledge about urban biodiversity and greenspace management on tick borne hazards in urban areas. Additionally, we wanted to test the dilution effect theory to see if it applies in an urban setting." We have also tightened the aims in the body of the text.

- The discussion connects the findings to relevant literature regarding forest density, tick abundance as it relates to host species, and the dilution effect. The discussion (and introduction) would benefit from a discussion of already published studies documenting tick populations and prevalence in other urban areas. For example, after a quick search, I was able to find this study: https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-022-05416-2.

- Make sure to comment on the most striking findings from the paper in the conclusions that the forested areas have more tick abundance than well-manicured spaces. This has major implications for human disease risk implications as mentioned, so restating this in the conclusions will leave the reader with an understanding of the most important take-aways.

*> Response to previous two comments: Thank you for your suggestions. We have added to the land management discussion an additional sentence that now reads, "*Our results highlight urban forested areas had a higher tick abundance than well-manicured spaces,

which is consistent with other studies of tick-borne hazards in New York City (Gregory et al. 2022, Lilly et al. 2025)."

- I wonder what is known about tick-related diseases in New York City and the Bronx- in humans and wildlife? This information could potentially strengthen the rationale of the paper.

>Responses: Thank you! We have added more information about tick hosts in NYC in the introduction.

Review 2

Submission ID: 100041

Paper title- Implications for tick-borne disease risk in New York City: A comparative study of wildlife diversity and tick abundance.

Final recommendation- Minor revisions

This study offers significant strengths, including addressing a critical research gap by focusing on tick-borne disease hazards in urban areas and testing the dilution effect theory. It provides baseline data on biodiversity and tick abundance, with practical implications for public health interventions such as targeted tick management in high-use parks.

However, limitations include the small sample size of only two parks, seasonal constraints that may affect tick abundance, and inconclusive findings regarding the dilution effect, partly due to species identity playing a larger role than diversity. Additionally, potential confounding factors such as human activity and microclimate differences may influence results, highlighting the need for broader and longer-term studies.

Following suggestions will improve manuscript in terms of concept and clarity.

For Title:

- Comparative Analysis of Tick Abundance and Wildlife Diversity in NYC Parks: Implications for Public Health
- Urban Biodiversity and Tick Presence: Insights into Tick-Borne Disease Hazards in NYC.

This is just suggestion; I would prefer having 'urban' in the title because that the novelty of study.

>Response: Thank you for the feedback. We have changed the title to “Comparative Analysis of Tick Abundance and Wildlife Biodiversity in NYC Urban Greenspaces: Implications for Tick-Borne Diseases”

1. Abstract: The abstract is informative and follow a clearer structure.

>Response: Thank you!

2. Introduction: The introduction needs following changes:

- Line 28: add hard bodied tick or deer tick in paragraph with the scientific name *Ixodes scapularis* as these are commonly used names.

>Response: Thank you for your suggestion, we have added the common names after first reference to the scientific name, “In New York State, *Ixodes scapularis* (commonly called the blacklegged tick or deer tick) is the main disease…”

- Authors have used quite old references for setting the context; I would suggest using recent studies, like line 41, 1984, similarly 2001, 2003…
- Replace “We sought to test” with “This study tests” for an academic, more formal tone.

>Response: Done!

- Line 43 and 44, is repetition of already explained concept.
-

>Response: Thank you for your suggestion, we have removed “Urbanization creates highly fragmented forest patches, reducing the amount of suitable habitat for predators of important host species.”

- Currently, the introduction jumps between disease trends, ecology, anthropogenic impacts, and theory. Open with the rise of tick-borne diseases and why urban areas matter, before diving into details about vectors and ecology.

Follow the scheme to improve introduction broadly:

- **Global and regional trends**
- **Ecological and anthropogenic drivers**
- **Research gap**
- **Theory (dilution effect) or what other options are there?**
- **Study aim**

  >Response: Thank you so much! We have rearranged the scheme of our introduction from lines 30-82.

Lines 58–62 focus heavily on land use and land management, but your study is based on observations rather than GIS or land-use mapping. I suggest revising this paragraph to emphasize your observational approach and clearly mentioning your objectives and study rationale here.

>Response: Thank you for your feedback. We have edited our study’s aim on line 71-78.

3. Methodology

- It would be helpful to add a study area map (e.g., a simple Google Earth image) and include photos of the wildlife camera setup as figures for Section 3.2.
  >Response: Thank you! We have added a study map and an image of the general idea of a wildlife camera setup on lines 83-104.
- Additionally, clarify why July was chosen, emphasizing its seasonal relevance for tick activity, and specify whether sampling occurred at consistent times of day.

  >Response: Thank you for your feedback. We have added "Tick data collection took place in July, because *I. scapularis* are actively looking for hosts during the warmer seasons (Levi et al. 2015)" to 3.3 Tick Collection.

- Replace "1000 meters squared" with "1,000 m^2" for clarity, and ensure consistent terminology throughout, particularly for "transect" and "increment."

  >Response: Thank you. We made the adjustment to exclusively transects and m^2 to 3.2.

- **Please provide Shannon diversity index in methodology**, you can provide its formula/equation which you have used to calculate values.
  >Response: Thank you for your feedback. I have added the equation on line 133-136.

  "The Shannon's diversity formula is as follow:

$$H = -\sum_{i=1}^{s} p_{i} \ln p_{i}$$

The variable H is the Shannon diversity index value. Pi represents the number of individuals of a specific species divided by the total number of all individuals in the community."

- Provide reference for line 88.

  >Response: Thank you! We have added a reference.

  Madder, M., Horak, I., & Stoltsz, H. (2014). Tick identification. Pretoria: Faculty of veterinary Science University of Pretoria, 58. https://afrivip.org/sites/default/files/identification_complete_1.pdf

4.Results

- The results are well-presented and supported by figures and tables.
  >Response: Thank you!
- Line 108: You said **"28 bird point counts for each site"**, which means:

    - Wave Hill: 28 counts
    - Van Cortlandt: 28 counts
      Total = 56 point counts across both sites.

- But then you reported **“401 Avian individuals across both sites”** without clarifying the effort per site. That part is fine, but the potential issue is whether the effort (56 counts) matches the interpretation of your results. Please check.

  >Response: Thank you! We have fixed the wording by clarifying that the 28 bird point counts total to 56: “ We conducted 28 bird point counts for each site, totaling 56 bird point counts. Through our observation, we recorded 182 avian individuals in Wave Hill and 219 avian individuals in Van Cortlandt, totaling 401 avian individuals in both sites.”

- Figures: please remove the caption within all figures, as the title you provided is the same

  >Response: Thank you! We have removed all the captions on the figures, except for table 1 and figure 5.

- Also, please remove **vs’** from the title like Figure 1. Avian and Mammalian species richness in Wave Hill **vs** Van Cortlandt Park.

  >Response: Thank you so much! We have replace all “vs” with “and” in the titles of the figures.

- For mentioning name of species, please follow alphabetical order. Line 119 to 121

  >Response: Thank you, we have organized the species alphabetically.

- Remove T .. line 144

  >Response: Thank you!

5. **Discussion-**

Line 180: In that sentence, **“amount”** isn’t ideal because *forested habitat* is not something you measure in discrete units like quantity—it’s more about **extent** or **area**.

>Response: Thank you, we have adopted area.

Use *italicized* genus and species names throughout (e.g., *I. scapularis*, *Odocoileus virginianus* for white-tailed deer).

>Response: Thank you, all the scientific names for the species are now italicized.

- Clarify the role of deer:

"White-tailed deer (*Odocoileus virginianus*), a major reproductive host for *I. scapularis* adults…"

>Response: Thank you! We have indicated that the white tailed deer is a reproductive host for *I scapularis*: "*O. virginianus*, a major reproductive host for *I. scapularis* adults (Wilson et al., 1985), was present in Van Cortlandt but not in Wave Hill, which could explain the large tick abundance in Van Cortlandt that was not there in Wave Hill."

- Improve sentence structure for readability:

"Van Cortlandt's lack of fencing allows deer movement, likely increasing tick abundance, whereas Wave Hill's fencing excludes large mammals."

>Response: Thank you! We have added "The absence of fencing in Van Cortlandt Park allows deer movement, which likely increases the tick abundance; in contrast, the fencing around Wave Hill prevents the entry of larger mammals," in 5.2 Species Identity.

- For coyotes:

"The presence of coyotes (*Canis latrans*), a keystone predator, in both parks suggests potential regulation of rodent populations, which are key tick hosts."

>Response: Thank you! We have clarified it "The presence of coyotes, a keystone predator species, in both urban parks potentially indicates a regulation of rodent populations, which are a key host for ticks and a reservoir species for *B. burgdoferi* (Weckel & Wincorn, 2016)."

- Strengthen interpretation:

"Despite similar Shannon diversity values, tick abundance differed markedly, suggesting that species composition, rather than diversity alone, influences tick hazard in urban settings."

>Response: Thank you for your suggestions we have added to 5.3 Dilution Effects: "Even with similar Shannon diversity values, tick numbers differed greatly, implying that the makeup of species—not just overall diversity—influences tick hazard in urban settings."

- Make recommendations more formal:

"We recommend targeted tick management strategies along high-use trails, including signage promoting tick checks and personal protective measures."

> Response: Thank you! We have reworded our recommendation, "We recommend implementing tick management along high-use trails, such as signage encouraging visitors to perform tick checks and other personal protective measures. "

“Our two-week sampling period may have underestimated mammalian richness, as evidenced by variation between camera traps. Additionally, our methods did not capture small mammals, which are critical hosts for immature ticks. Future studies should extend sampling duration and include additional urban greenspaces.”

> Response: Thank you! The limitation now reads “We made an effort to sample the entire tick and wildlife host community at both of our collection sites. Our two-week sampling period may have underestimated mammalian richness, shown by variation between the camera traps data. For example, one of our cameras in Van Cortlandt only picked up an Eastern Grey Squirrel, while the other camera picked up 5 different mammalian species indicating that other cameras could also be missing species observations due to camera placement or the limited time period. Additionally, our methods did not capture small mammals, which are critical hosts for immature ticks and tick-borne pathogens (LoGiudice et al., 2003). Future studies should extend the sampling period and include additional urban greenspaces.”

6**. Conclusion**

- Replace informal phrases like *“Through this study”* with more precise wording:

  >Response: Thank you! We have removed that.

- “Our findings highlight the importance of investigating tick-borne disease dynamics in urban environments.”

  >Response: Thank you!

- Instead of *“which usually applies for rural and suburban conditions”*, make it more formal: “…a pattern typically observed in rural and suburban landscapes.

  >Response: Thank you! We have fixed it “We did not find evidence to support a pattern typically observed in both rural and suburban landscapes for the dilution effect.”

- Connect ideas logically: “Despite similar diversity metrics, we did not find evidence supporting the dilution effect, suggesting that different ecological processes may operate in urban settings.

  >Response: Thank you! We have added that line 272-273.

- Instead of *“could benefit from increased tick management”*, specify what that means: “…indicating a need for targeted tick management strategies, such as signage, public awareness campaigns, and habitat modification in high-use areas.”

  >Response: Thank you! We have reworded out suggestion “Our data indicates that Van Cortlandt has an established tick population, potentially due to presence of the *O. virginianus*, suggesting the need for targeted tick management strategies, such as signage, raising public awareness, and habitat modification in high use areas.”

- Expand on why American Robins matter:
  "The relatively high abundance of American Robins, known hosts for *I. scapularis*, underscores the need for further research on avian contributions to urban tick-borne disease risk."

  >Response: Great! We have added more to why American Robins matter "The relatively high numbers of American Robins—key hosts for *I. scapularis*—underscore the need for additional research on avian roles in urban tick-borne disease risk."

7. References

- Consistent formatting; spacing, punctuation
- Ensure all references are formatted uniformly (e.g., "Lilly et al., 2025" vs. "Ralph et al. 1995").

  >Response: Thank you! We have fixed the references.

Overall, there are minor grammatical issues and formatting inconsistencies (e.g., spacing, punctuation), a thorough proofreading would improve readability.

Recommendation

Minor Revision

The work is conceptually sound and provides important findings. With minor revisions focused on clarity and detail, it will be well-positioned for publication.