Owen Howard

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EXAMINING BIODIVERSITY OF MAMMALIAN SPECIES IN THE CHICAGOLAND AREA

ABSTRACT

Urban biodiversity of mammalian species were examined using motion-detecting camera to document appearances over a period of 14-40 days in the Chicagoland area. The 91 camera sites were divided into 10 subgroups based on their distance from the center of urban Chicago (with 1 representing 0-5 km from the center, 10 representing 45-50 km from the center). The differences in species richness from sections 1-10 were analyzed, finding a slightly significant (significance factor = 1.8223E-06) direct correlation (trendline: $y = .33x + 3.12$) between distance from urbanization and wildlife biodiversity. Furthermore, Shannon's diversity index was used for sections 1 and 10 to determine both species richness and evenness. A slightly significant difference was found in biodiversity using the means of Shannon's diversity index of section 1 ($.80 \pm 0.256$) and section 10 (1.36 ± 0.433). In order to promote biodiversity in urban ecosystems, it is recommended that more natural green spaces are implemented into city architecture.

INTRODUCTION

Anthropocentrism is the belief that humans are the most important species on Earth. Attitudes of anthropocentrism and greed by powerful and/or wealthy people allow for environmentally destructive practices for economic profit. Researchers estimate the extinction of 200 vertebrate species over the past 100 years. Through a human perspective, this may not seem significant, but with "normal" extinction patterns, a loss of 200 vertebrate species would likely take 10,000 years, not a century (Ceballos et al., 2017). Seeing as the powerful and wealthy typically do not care about the rapid extinction of non-human species (otherwise rehabilitative action would be taken already), it is difficult to caution against environmentally damaging processes using only anthropocentric arguments.

To much of the general population, the actions of deforestation or off-shore fracking seem distant, but one environmentally questionable process hits much closer to home: urbanization. The rise of urbanization has been generally unfriendly to non-human animal species. Urban spaces often have a high concentration of paved areas, whether for roads or for sidewalks, which decrease green space that native fauna would otherwise use for feeding. Buildings are known to be a significant danger to bird species, killing an estimated 1 billion birds in North America alone; the taller height of urban buildings only exacerbates this (though, tall buildings in low-urbanization areas pose the greatest threat) (Hager et al., 2017). Cities with lacking public transport systems indirectly encourage the usage of more cars, increasing the likelihood of roadkill. The sheer number of people who live in cities is enough to scare wild animals off, decreasing their possibilities for nesting. Moreover, community dynamics must also be taken into consideration along with the features of urbanization themselves. Dominant species in urban environments will sometimes outcompete subordinate species entirely, reducing species diversity (Martin & Bonier 2018). Based on this information, it was hypothesized that the distance from the center of Chicago would significantly change the level of species diversity. The null hypothesis, however, stated that there would be no significant change in the level of species diversity across different distances from the city. It was predicted that species diversity would be the highest furthest from the center of Chicago.

Still, there are questions that remain concerning urban biodiversity. What kind of green spaces are beneficial to wildlife? There are certainly types of green spaces that provide little or no benefit to native fauna, like city parks, due to high human activity and frequent landscaping (Gallo et al., 2017). Is there such a thing as a "healthy" urbanization or is ceasing urban lifestyles necessary to maintain appropriate levels of biodiversity? Is environmental reform enough to rehabilitate vulnerable species and protect currently thriving species? Questions such as these can be answered through field research within and around urban communities concerning native species, in hopes to better inform public opinion and policy surrounding environmental rehabilitation and biodiversity maintenance.

METHODS

Within the Chicagoland area during autumn of 2018, motion-detecting cameras were affixed for periods ranging between 14 and 40 days (27 days on average). These camera locations were either in parks (n=41), golf courses (n=8), cemeteries (n=11), and forest preserves (n=30) with one unknown site across four 50 kilometer transects. Camera sites were assigned a section from

1-10, depending on the distance from the center of Chicago (where urbanization was the highest), 1 as the closest section and 10 as the furthest section. Every time motion was detected by a camera, a picture was taken. After the detection period was over, the pictures were evaluated and tagged for the presence of mammalian species (and the Virginia opossum), for a total of 13 possible species.

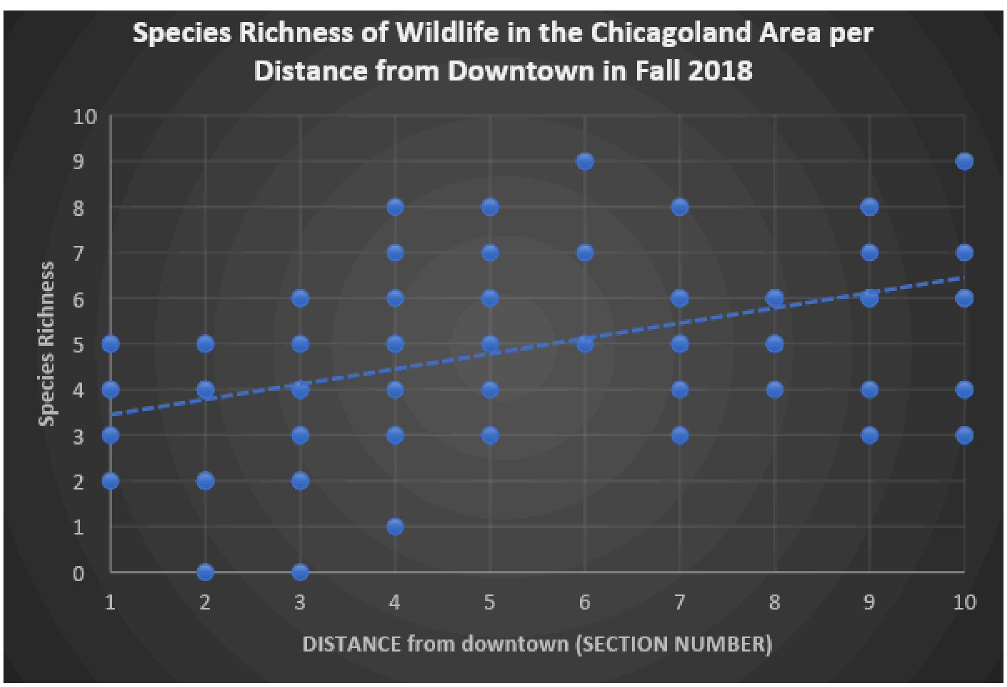
Data of whether an animal was seen or not and the proportion of days said animal was seen for both sections 1 (6 sites) and 10 (11 sites) were used for calculations of species richness, gamma diversity, community similarity, and Shannon's diversity index. Furthermore, statistical tests (two-sample t-test and regression analysis) were performed to evaluate the significance of the results. These techniques ultimately presented the relationship between wildlife diversity and urbanization.

RESULTS

Between the 91 sites, a total of 13 species were recorded. These species included *Sylvilagus floridanus* (Eastern cottontail), *Canis latrans* (coyote), *Tamias striatus* (Eastern chipmunk), *Glaucomys sabrinus* (Northern flying squirrel), *Sciurus niger* (fox squirrel), *Urocyon cinereoargenteus* (gray fox), *Sciurus carolinensis* (Eastern gray squirrel), *Neovison vison* (American mink), *Procyon lotor* (raccoon), *Vulpes vulpes* (red fox), *Mephitis mephitis* (striped skunk), *Didelphis virginiana* (Virginia opossum), and *Odocoileus virginianus* (white-tailed deer).

Species richness was calculated for each site, categorized into their respective sections. For every species that appeared, a value of 1 was added to the site. If a site never showed any wildlife, it would be given a species richness value of 0 and if it showed an occurrence of each species at least once, it would be given a species richness value of 13. Sections 2 and 3 both had sites with species richness values of 0, the lowest, and sections 6 and 10 both had sites with species richness values of 9, the highest. A graph was derived from the species richness values, with a trendline with the equation y = .33x + 3.12.

Figure 1. Graph depicting species richness of wildlife in the Chicagoland area per distance from downtown in fall 2018



The trendline was calculated using regression analysis, where m = the x coefficient (SE = 0.4078) and b = the intercept coefficient (SE = 0.0653). The R square value of the regression analysis was 0.2268. Using ANOVA, the significance factor was determined to be 1.822×10^{-6}. There were 1 regression degree of freedom and 89 residual degrees of freedom.

Table 1. Regression statistics for species richness of wildlife in the Chicagoland area

Regression Statistics	
Multiple R	0.4763
R Square	0.2269
Adjusted R Square	0.2182
Standard Error	1.8260
Observations	91

Table 2. ANOVA for species richness of wildlife in the Chicagoland area

	Degrees of Freedom	**Significance F**		
Regression	1	1.8223E-06		
Residual	89			
Total	90			
	Coefficients	**Standard Error**	**t-Statistic**	**p-Value**
Intercept	3.1161	0.4078	7.6419	2.344E-11
Section	0.3335	0.0653	5.1103	1.822E-06

The gamma diversity, the overall diversity between all sites, was 13. Gamma diversity for section 1 and 10 were 9 and 11, respectively. Both sections had appearances of Eastern cottontails, coyotes, fox squirrels, gray foxes, Eastern gray squirrels, raccoons, striped skunks, Virginia opossums, and white-tailed deer. Section 10 also had appearances of the Eastern chipmunk and Northern flying squirrel, which was absent in section 1. Therefore, the community similarity value between sections 1 and 10 was 0.9 and a beta diversity value of 2. The most common species observed in section 1 were the Eastern cottontail, Eastern grey squirrel, and raccoon; similarly, the most common species observed in section 10 were the Eastern grey squirrel, fox squirrel, and raccoon.

Using the proportions of days that a species was seen at a site, Shannon's diversity index was calculated for each site in both sections 1 and 10. The mean and standard deviation of the Shannon's diversity index for sections 1 (0.80 ± 0.2561) and 10 (1.36 ± 0.4330) were calculated and recorded. A two-sample t-test statistical analysis was performed, giving 15 degrees of freedom and a p-value of .0122.

Table 3. Community diversity calculations performed on sections 1 and 10

	Section #	
	1	**10**
γ – diversity	9	11
Species present	Eastern cottontail, coyote, fox squirrel, gray fox, Eastern gray squirrel, raccoon, striped skunk, Virginia opossum, white-tailed deer	Eastern cottontail, coyote, fox squirrel, gray fox, Eastern gray squirrel, raccoon, striped skunk, Virginia opossum, white-tailed deer, Eastern chipmunk, flying squirrel
Community similarity	0.9	
β – diversity	2	
Species not in common	Eastern chipmunk, Northern flying squirrel	
Shannon's Index (mean ± SD)	$.80 \pm .256$	$1.36 \pm .433$

Table 4. Two-sample t-test analysis on Shannon's diversity index for sections 1 and 10

	Section 1	Section 10
Mean	0.80	1.36
Variance	0.07	0.19
Observations	6.00	11.00
Degrees of Freedom	15.00	
t Statistic	-2.85	
p-Value	0.0122	
Standard Deviation	0.2561	0.4330

DISCUSSION

Based on the data and the calculations performed, there is sufficient evidence to reject the null hypothesis and suggest a statistically significant correlation between wildlife biodiversity and urbanization. Between all 10 sections, the graph (Fig. 1) contains a trendline with a positive slope. This positive slope indicates a direct relation between distance *from* urbanization and species richness. It should be noted that the r-square value states that only 22.69% of the points put on the graph fit on the trend line, which is rather small. However, regression analysis also indicated that these data were statistically significant, due to a very small significance factor of under .05 (1.8223E-06).

Species richness is not the only calculation relevant in determining biodiversity, though. Species richness merely records if a species was documented at least once, with no insight into how often a species appears. Using Shannon's diversity index provides information about both species richness and evenness. The mean values of species 1 and 10 are rather different than one another, though, when standard deviation is taken into account, these values do begin to overlap.

However, again, statistical analysis of Shannon's diversity index shows that the data were still statistically significant with a p-value of well under .05 (0.0122).

The data indicate that there is a difference in biodiversity of wildlife between area with differing levels of urbanization, but one may question why 2/3 of the most common mammals are the same between populations over 40 km away from one another. This is to be expected however, as some animals dominate in undisturbed environments and urbanized locations because of their ability to exploit urban resources or outcompete subordinate species. Mesopredators, like the Virginia opossum and the raccoon, both benefit from urban resources like increased availability of roadkill (due to the abundance of roads) and trash receptacles left outside (Beatty et al., 2016). Similarly, bird species that have begun to adapt to high buildings in urban settings will have little problem surviving in non-urban environments (Martin & Bonier, 2018).

However, the ability for some species to thrive in disturbed ecosystems is not an indication that most species are able to do so. As made clear by the numbers of vertebrate species declining rapidly, many species are not equipped to make a change to urban lifestyle. Still, certain urban green spaces can provide a type of sanctuary for wildlife facing decline otherwise. It is necessary for the benefit of heterogeneity and biodiversity that green spaces continue to be researched; in particular, which green spaces allow for the most biodiversity. Green spaces that encourage the colonization of a singular species, like the Eastern cottontail in public parks (Gallo et al., 2017), do little for the benefit of biodiversity as a whole. Humans in urban spaces must continue to ask themselves what can be done to benefit native species in their areas.

CITATIONS

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