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The Birds and the Trees

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As the human population increases, we are faced with the loss of natural habitats for organisms. This loss of habitat is due to many human enterprises that result in land transformation, biotic additions and losses, loss of biological diversity, as well as climate change. The transformation of the Earth's land surface due to urbanization is estimated to be 10-15% (Vitousek et al. 1997). It has been shown that urban bird communities are strongly influenced by vegetation, with the volume of native vegetation being most closely correlated with native bird density and species richness (Mills et al. 1991). Like other organisms, the American Robin (*Turdus migratorius*) is losing native habitats. Common in both agricultural and suburban areas, American Robins, can be useful indicators of how anthropogenic activities alter wildlife habitats and sustainability of the ecological system (Vanderhoff et al. 2016) (Beaver 1980). Understanding which types of vegetation are found within their territories and how vegetation contributes to their nesting success (and by extension population levels) is essential. By doing so, we can better plan urban landscapes to supply the essential needs of avian populations and inform local urban planning organizations.

1. Background

American Robin Life History

American Robins are a common songbird found throughout North America. They are ecologically diverse and can thrive in a multitude of different habitats, including city parks, open prairies, grasslands, alpine forests, and tundra (Vanderhoff et al. 2016). American Robins are numerous and widespread, with their populations increasing over the last few decades (Vanderhoff et al. 2016). They eat a plethora of different invertebrates and fruits, with their primary source of food in the summer being earthworms (Vanderhoff et al. 2016). Female Robins choose nesting sites, which is usually found on horizontal branches of trees, gutters,

eaves, or even outdoor lighting fixtures (Vanderhoff et al. 2016). Females build nests of dead grass and twigs, as well as other materials (Vanderhoff et al. 2016). Mud from worm castings is used to reinforce the nest. Nests are generally 6-8 inches across and 3-6 inches high (Vanderhoff et al. 2016). American Robins raise anywhere from one to three broods per season, with each brood consisting of three to five eggs sky blue or blue-green unmarked eggs (Vanderhoff et al. 2016). Females incubate the eggs for 12-14 days before hatching, and nestlings will grow rapidly for 13 days before fledging from the nest (Vanderhoff et al. 2016). American Robins forage on the ground by running along and stopping abruptly to visually scan the surrounding area for insects and earthworms (Vanderhoff et al. 2016). During the breeding season, males attract females by singing, raising, and spreading their tails, shaking their wings, and inflating their white-striped throats (Vanderhoff et al. 2016). Thus, American Robins require a habitat that supplies nesting material, nesting sites, worms, and fruit in order to raise a brood of chicks successfully. We aimed to determine the level of interaction between trees and habitat needs and its effect on the survival rate of the American Robins.

Urban Landscapes

Urban landscapes are typically characterized as being highly developed, containing impervious land cover in the core enclosed by rings of decreasing development. Policy, as well as transportation routes, often regulate differences in how urban growth and development occur. During the expansion of urban locations, there may be deviances from the pattern mentioned due to the use of land for wildlife, parks, or future development (Francis & Chadwick, 2013). As a result, we often find an intermingling of both urban and non-urban characteristics as you move away from an urban center. Trees are implanted into this urban landscape at various densities and times, thus creating many different micro-habitats within urban locations.

The effects of urbanization are one of the most significant threats to biodiversity. In the United States, urbanization is responsible for the endangerment of more species and is more widespread than any other anthropogenic activity (Czech et al. 2000). Many urban centers are in areas with an abundance of biodiversity, but humans now monopolize the resources that were previously being used by flora and fauna. To better counteract the impacts of urbanization, we must understand how the environments that have been urbanized are affecting local organisms.

Study of Birds in Urban Spaces

Birds are the subject of many ecological studies because they serve as excellent indicators of ecosystem health. Ecological indicators are generally used in three ways: to reflect the biotic or abiotic conditions of the environments in which they are found, to provide evidence of environmental change and its impacts, and to serve as indicators of diversity in other species or communities within a given area (Lawton & Gaston, 2001) (Vanderhoff et al. 2016). Therefore, I chose to study birds to understand how human modification of landscapes affects the overall success of the ecosystem.

My overall objective in this research is to understand how the American Robin, a potential ecological indicator, is affected by urbanization, with a focus on the role of trees. I surveyed the habitat of American Robins at sites classified as urban and non-urban, compare tree features between sites, examine landscape characteristics, and relate them to the reproductive success of American Robins. To achieve this goal, I had the following objectives and corresponding predictions:

1. Monitor nests in urban and non-urban nesting sites to determine the survival rate of nestlings.
2. Collect data on tree characteristics in a 0.2 Hectare plot around American Robin Nests: diameter at breast height, canopy cover, tree number, tree height.
3. Determine if the differences in tree characteristics between Urban and Non-urban nesting sites correlate with the survival rate of American Robins.

Predictions:

1. The survival rate of nestlings will be higher in non-urban habitats than in urban habitats.
2. Non-urban nesting sites will have more trees within the habitat. Additionally, these trees are predicted to be taller and have a larger diameter than those found in urban nesting sites.
3. The survival rate of American Robins will be lower in urban nesting sites than the survival rate in non-urban nesting sites.

In addition to understanding which types of vegetation are found within American Robin habitats and how trees contribute to their nesting success, and by extension population levels, outcomes will help us to better plan urban landscapes to supply the essential needs of avian populations.

2. Methods

Study area

The study area of this research took place at twelve nesting sites in Weld County, Colorado. Sites were chosen using online reporting of nests by citizens (https://www.urbanbirdnerd.com/) as well as nest searching. When nest searching, I observed American Robins for various behaviors that indicate a nest is nearby. Sites were designated as either urban or non-urban based on the distance from the city center of Greeley, Colorado. Nests were monitored for the duration of incubation and the period in which nestlings were present. We surveyed a 0.2-hectare plot around each nest after the nests were fledged or abandoned. We collected measurements of canopy cover, the number of trees, the height of trees, and the diameter of the trees at breast height for all trees within that plot (see below for more detail).

Timeline

Data collection took place during the 2019 breeding season (May-August). During the initial stages of collection, the primary focus was nest searching, trapping, and banding of a minimum of one adult American Robin for each nest observed. Nest monitoring took place from the clutch initiation until the nest fledged.

Capture and Nest monitoring

We captured and banded American Robins using standard mist nets and playback of male songs. We banded each of these Robins with a unique identification aluminum band as well as colored bands to allow for future identification. We banded a minimum of one parent for all nests. Once these birds were banded, we made behavioral observations to see where they were carrying nesting material to find their nests. Once nests were found, we marked the nesting sites with UTM coordinates using a hand-held Global Positioning System unit. We checked each nest a minimum of once weekly. During each monitoring session, the nest was accessed by either a

member of the Urban Bird Nerd research team or me. A nest was considered successful if it hatched at least one chick (Hovick et al. 2015), and there was no evidence of predation (e.g., disturbed nest lining) (Frey et al. 2008). Capture and handling of American Robins were approved by the University of Northern Colorado IACUC Protocol 1807B-LB-Birds-21, federal BBL banding permit 23741, and Colorado DOW permit 19TRb3273.

Plot Layout

The plot center was set directly under the nest at each nesting site. If the plot center fell into an area that was not suitable for sampling, the plot center was moved to the nearest location suitable for sampling. Transects of twenty-five meters in the cardinal directions (0˚, 90 ˚, 180 ˚, and 270 ˚) using a declinate compass set for nine degrees to the east. At five-meter intervals along with each transect, data was collected on canopy cover using a convex crown densitometer. Trees that fell within the plot quadrants had their vertical height measured using a Nikon Forestry Pro. Tree height was measured from the center of the plot to ensure consistency. The diameter at breast height recorded using a standard forestry fabric tape measure. We collected measurements at six urban and six non-urban nest sites.

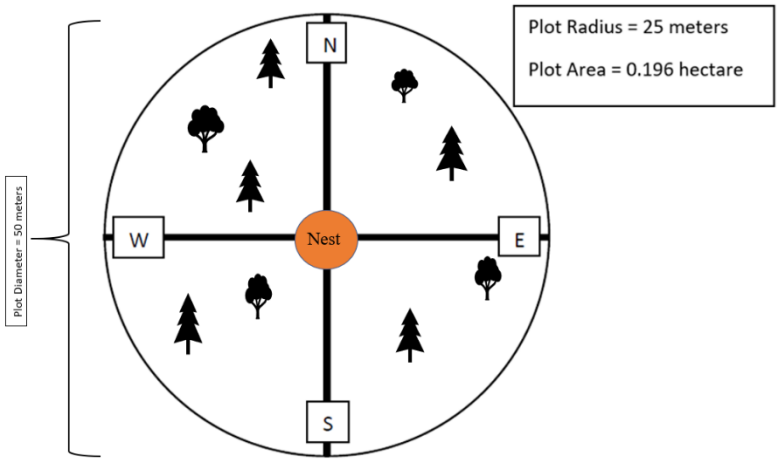

Figure 1: Plot configuration

3.Results

We divided the twelve nest habitat surveys into two groups, urban and non-urban, and calculated the survival rate for each (Table one). We calculated the survival rate as Clutch Size / Number of Fledglings. We found survival rates in *urban nesting sites* at 45.67% and *non-urban nesting sites* at 66.67%. These rates were not significantly different, $p > 0.05$ (Wilcoxon Rank-Sum test: $Z = -0.32$, $p = 0.75$).

Nest ID	Habitat Type	Survival Rate
KS01	Non-Urban	0.00
BL03	Non-Urban	0.75
KS08	Non-Urban	0.50
KS03	Non-Urban	1.00
KS13	Non-Urban	0.75
KS14	Non-Urban	1.00
FE01	Urban	0.75
SB01	Urban	1.00
KS07	Urban	0.00
GM01	Urban	0.33
KS09	Urban	0.00
KA01	Urban	0.66

Table 1: The survival rate of each nest.

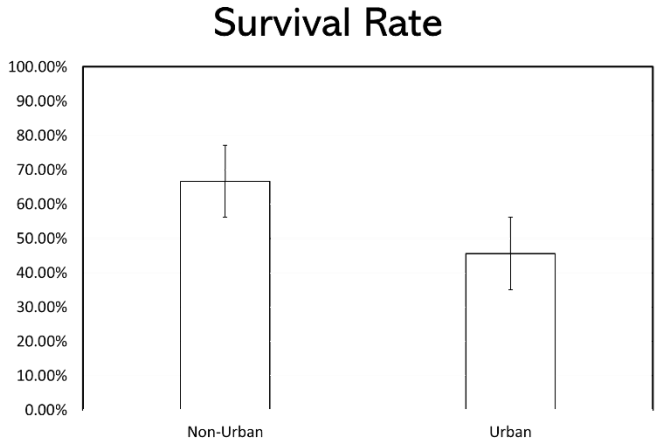

Figure 2: The survival rate of urban and non-urban study groups.

We used a principal component analysis (PCA) to determine that as the number of trees within a plot increases, so does the average cover within the plot. Additionally, as the average height of trees increases, so does the average diameter at breast height. Urban and non-urban study sites do not group separately on a plot of principal component one (PC1) versus principal component two (PC2). We found that PC1 explained 55.22% of the variation found within our nesting sites. We found there to be no clustering of urban and non-urban sites as expected.

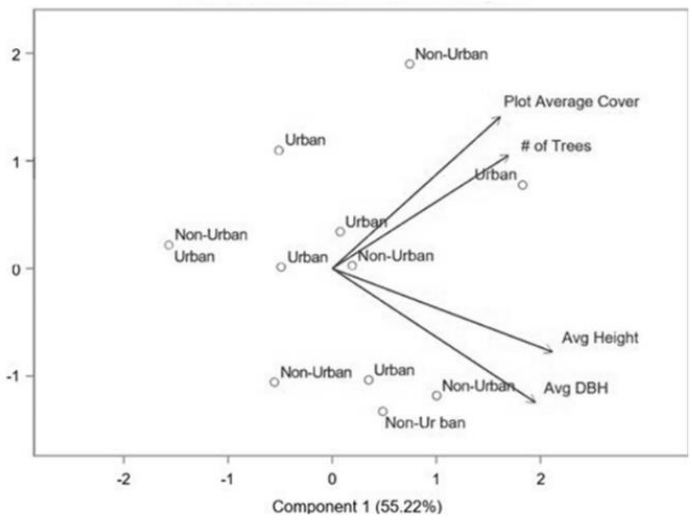

Figure 3: Principal component analysis of urban and non-urban nesting sites.

We used a regression analysis to determine the relationship between the survival rate based on (PC1). We found that the survival rate of American Robins and PC1 to be a negatively correlated relationship (R = -0.12). As the average cover, diameter at breast height, the height of trees, and the number of trees increases, there is a decrease in survival. However, this relationship is not significant, $p > 0.05$ ($t = -1.16$, $p = 0.27$).

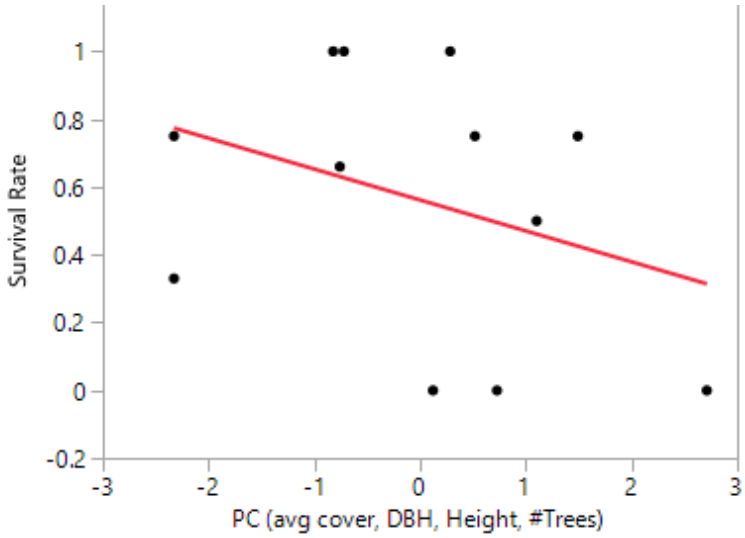

Figure 3: Regression Analysis

4. Discussion

We found the survival rate of the American Robin to be higher in urban nest sites than in non-urban nest sites. We found a negatively correlated relationship between the survival rate of the American Robin and principal component one.

We monitored nests in urban and non-urban habitat to determine the survival rate of nestlings (Table 1). We found that the American Robin survival rate to be higher in urban settings than in non-urban settings. We believe that the survival rate is higher in urban locations because American Robins are exploiting the habitat that has been created by humans at a higher rate than that of non-urban locations. With the development of urban locations, including the

installment of large swaths of green spaces, Weld County has provided a more suitable breeding habitat for the American Robin than that found in the surrounding grasslands.

We collected data on tree characteristics in a 0.2 Hectare plot around American Robin Nests: diameter at breast height, canopy cover, tree number, tree height. We predicted that non-urban nesting sites would have more trees within the habitat and that the trees would be taller and have a larger diameter than those found in urban nesting sites. We found that in urban nesting sites contained larger trees overall. It is believed that this is the case due to trees being brought into the urban locations during development. Additionally, the sites in urban locations are often irrigated to maintain these trees, resulting in larger trees overall.

Determine if the differences in tree characteristics between Urban and Non-urban nesting sites correlate with the survival rate of American Robins. The survival rate of American Robins will be lower in urban nesting sites than the survival rate in non-urban nesting sites.

The extent of the study limits these findings. The extent, Weld County, Colorado, is believed not to be a diverse enough landscape to answer confidently provide us with supporting evidence for our specific questions about the landscape and the role it plays on the survival of American Robins. With the use of more nests over multiple seasons could result in a different finding as the literature currently supports a positive correlation between vegetation and the survival of wildlife. We also believe that the findings could be altered based on the urban and non-urban nesting locations.

Continued research focusing on the relationship between landscape structure and the effects it plays on the survival of organisms is needed. Future studies should focus on locating nests that are in various stages of urban development to determine which characteristics of

landscapes alter survival rate. Population levels across taxa will continue to be affected by anthropogenic activity as the human enterprise continues to expand. To ensure the continued survival of native wildlife populations as this development continues, we must first know what features best support wildlife.

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