

Winter Diet of the Northern Cardinal (*Cardinalis cardinalis*) in Central Virginia: A Comparison of a Rural and an Urban Site.

Ezra Staengl^{*1}

Piedmont Virginia Community College
501 College Dr, Charlottesville, VA 22902

Joanna Vondrasek

Piedmont Virginia Community College
501 College Dr, Charlottesville, VA 22902

*corresponding author: ezraperegrine@gmail.com

¹current address: 5030 Burnley Road, Barboursville, VA 22923

Abstract

Northern Cardinals (*Cardinalis cardinalis*) are generally more abundant in cities than surrounding rural areas. The causes of this discrepancy are unknown, but diet may be an important factor. Northern Cardinals are omnivorous but are known to consume mostly plant material during the winter, including the seeds of common native trees and shrubs. Differences in the abundance and prevalence of native compared to non-native plants are a possible explanation for differences in rural versus urban bird abundance. We investigated Northern Cardinal diet at an urban site (Greenbrier Park) and a rural site (Walnut Creek Park) in Central Virginia during the late winter period between February and March 2022. Diet observations were made in ten-minute intervals, during which Northern Cardinals were observed and every food item eaten was recorded. Ten-minute observation sessions were conducted at each site, split evenly between male and female birds. There was no significant difference in the proportion of non-native food items Northern Cardinals ate between the urban and rural locations. Diet consisted almost entirely of plants, most frequently Tuliptree (*Liriodendron tulipifera*) at both sites. Other than Tuliptree and Wild Grape (*Vitis* sp.), there was little overlap in diet composition between the sites. The results do not support the hypothesis that differences in diet (specifically non-native plants) are a factor contributing to urban populations of Northern Cardinals being larger than rural populations; however, more research is needed. This study corroborates previous findings about the importance of plant material to the winter diet of Northern Cardinals and provides a list of important local winter food sources, as well as information about potential urban versus rural diet differences.

Introduction

The Northern Cardinal (*Cardinalis cardinalis*) is a common songbird throughout much of eastern North America. Northern Cardinals have been found to be

more abundant in cities than surrounding rural areas in Ohio (Leston and Rodewald 2006). In general, birds are more abundant but less diverse in cities compared to less developed areas (Shochat et al. 2010, Gorosito and Cueto 2020). The effects of urban development on birds are not equivalent among species, with resident and short distance migrants generally having higher abundance than long distance migrants in urban habitats (Leston and Rodewald 2006). There are multiple reasons for greater abundance of certain bird species in cities, but greater food availability there is one commonly hypothesized factor (Shochat et al. 2010, Leston and Rodewald 2006).

Northern Cardinals are omnivores and eat both plant and animal food, but the exact composition of their diet varies by season (Halkin et al. 2021). In general, animal material makes up a greater proportion of the Northern Cardinal diet during the breeding season, while plant material, such as fruits and seeds, is most important during the winter (McAtee 1908). This is similar to the patterns displayed by many other omnivorous birds (Narango et al. 2017). McAtee (1908) documented 77 plant taxa in analyses of Northern Cardinal stomach contents, including notably large proportions of Wild Grape (*Vitis* sp.), Dogwood (*Cornus* sp.) and Smartweed (*Persicaria* sp.). Tuliptree (*Liriodendron tulipifera*) has also been shown to be an important component of Northern Cardinal diets (McAtee 1908, Martin et al. 1961).

Of the food available to birds in cities but not in more rural areas, seed from bird feeders, fruit from native and exotic ornamental plants, and human food waste are generally regarded as the most likely factors to support increased urban populations (Shochat et al. 2010). Because food items found in garbage do not make up a significant portion of the Northern Cardinal diet (McAtee 1908), any greater food availability for this species in urban areas would likely come either from bird feeders or from material from plant species that are more concentrated in cities. Previous

research suggests that more fruit is available to Northern Cardinals in cities, specifically the exotic invasive species Multiflora Rose (*Rosa multiflora*) and Amur Honeysuckle (*Lonicera mackii*) (Atchison and Rodewald 2006, Leston and Rodewald 2006). Northern Cardinals are known to eat the fruit of Multiflora Rose, as well as that of various invasive honeysuckle species (Linville and Breitwisch 1997), so it is possible that these plants could help support larger populations of these birds in cities.

In this study, we compared observations of Northern Cardinal diets at two sites in Central Virginia: one urban—Greenbrier Park in Charlottesville City, and one rural—Walnut Creek Park in Albemarle County. We hypothesized that diet composition would differ between the two sites. Specifically, because urban areas generally have a greater variety and higher density of non-native plant species, we predicted that non-native plant species would make up a greater proportion of the diet of Northern Cardinals in the urban park compared with the rural park.

Methods

Greenbrier Park in Charlottesville City (38.0641, -78.4756; Fig. 1) and Walnut Creek Park in Albemarle County (37.9291, -78.5903; Fig. 1) were chosen as the study locations. Both



Figure 1. Satellite views of the urban, Greenbrier Park (above) and the rural, Walnut Creek Park (below) sampled in this study.

parks are primarily forested, contain small streams, and have similar geology (Lynchburg Group metasedimentary rocks crosscut by a mafic dike). Greenbrier Park is surrounded by forested but densely populated residential areas and a commercial strip along Route 29 to the west. In contrast, Walnut Creek Park is surrounded by undeveloped forest and farmland. Additionally, Walnut Creek Park contains a large lake. Although a detailed quantitative vegetation survey was not undertaken, casual observation of the flora indicated that Greenbrier was characterized by a relatively higher abundance and diversity of non-native species than Walnut Creek.

Diet observations were made between 8 February and 15 March 2022, between the times of 7:00 AM and 11:30 AM EST. For a single diet observation session, one observer (EJS) watched an individual Northern Cardinal with binoculars (Vortex Viper HD 8 x 42) for 10 minutes, and identified and recorded everything the bird ate to species, if possible. If the focal bird flew out of view during the 10-minute block, another individual of the same sex was observed to complete the 10-minute block. Only observation sessions during which the focal bird consumed something were included in the final data analysis. Sixteen of these observation sessions were conducted at each of the two parks, split evenly between male and female Northern Cardinals. These methods are similar to those employed in other studies utilizing field-based observational methods for monitoring the diets of passerine songbirds (Price 1987, Nazaro and Blendinger 2017). Effort was made to survey a large area in each park to minimize repeated observations of the same birds; however, the assumption that individual birds were never observed more than once could not be verified because focal birds were not individually marked.

We categorized food items as native versus non-native and then calculated the proportion of non-native plants consumed during each observation session. We compared median proportion of non-native plants consumed between Greenbrier Park ($n = 15$) and Walnut Creek Park ($n = 16$) with a Mann-Whitney U test. Because food items not identified to species could not be categorized as native or non-native, we excluded these 'unknown seeds' from the ratio calculations, assuming that they represented native and non-native plants equally. In one instance, no seeds consumed by a focal bird could be reliably identified; thus, the sample size was reduced to 15 observation sessions at Greenbrier Park.

Results

The Northern Cardinals observed for this study consumed 12 species of plants, as well as two individuals of an unidentified pill bug species (Isoptera: Armadillidiidae) (Table 1). The pill bugs were the only non-plant material consumed. When focal birds were foraging on the ground

Table 1. Comparison of food items consumed by Northern Cardinals between an urban park (Greenbrier Park, Charlottesville) and a rural park (Walnut Creek Park, Albemarle County).

Native plant species	Number consumed (Number obs. sessions)	
	Urban park	Rural park
Tuliptree seeds (<i>Liriodendron tulipifera</i>)	27 (9)	92 (9)
Ash sp. seeds (<i>Fraxinus sp.</i>)	9 (1)	0 (0)
American Sycamore seeds (<i>Platanus occidentalis</i>)	5 (1)	0 (0)
Wild Grape seeds (<i>Vitis sp.</i>)	2 (1)	22 (5)
Poison Ivy berries (<i>Toxicodendron radicans</i>)	2 (2)	0 (0)
Red Maple buds (<i>Acer rubrum</i>)	0 (0)	4 (1)
Eastern Redcedar berries (<i>Juniperus virginiana</i>)	0 (0)	41 (2)
Non-native plant species		
Leatherleaf Mahonia flowers (<i>Berberis bealei</i>)	14 (1)	0 (0)
Oriental Bittersweet (<i>Celastrus orbiculatus</i>)	9 (2)	0 (0)
Joint-head Grass seeds (<i>Arthraxon hispidus</i>)	5 (1)	0 (0)
Kudzu seedpods (<i>Pueraria montana</i>)	3 (2)	0 (0)
Multiflora Rose fruits (<i>Rosa multiflora</i>)	0 (0)	21 (6)
Other food items		
Pill bug sp. (<i>Armadillidiidae sp.</i>)	2 (1)	0 (0)
unidentified seeds	23 (8)	29 (9)

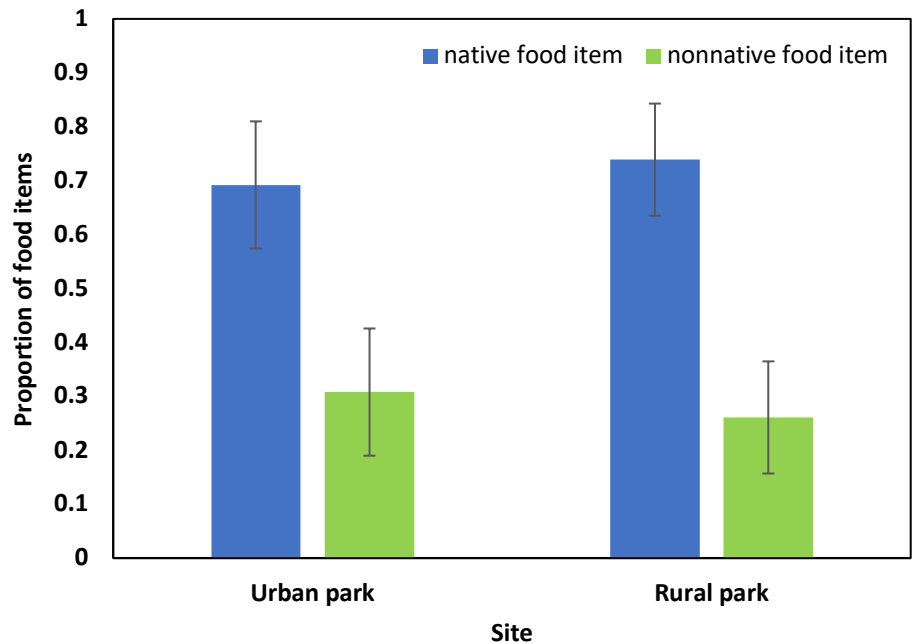


Figure 2. Mean (+/- 1 SE) proportion of identifiable native and non-native food items consumed by Northern Cardinals in an urban park (Greenbrier Park, Charlottesville) and in a rural park (Walnut Creek Park, Albemarle County) in February and March 2022.

and not eating large or otherwise easily distinguishable seeds, some food items could not be identified. Such instances where it appeared that a bird ate something, but the identity of the food item could not be determined were recorded as 'unknown seed', under the assumption that we would have at least been able to distinguish between plant material and an arthropod. Unknown seeds represented 14% of the total at Walnut Creek, and 23% of the total at Greenbrier. The results presented here, therefore, should be interpreted only as documentation of certain diet components, and not an exhaustive inventory.

Qualitatively, the species composition of the food items consumed by Northern Cardinals differed between the two parks, with only two species observed being consumed at both locations: Wild Grape and Tuliptree (the latter species also being the most frequently consumed food at both locations) (Table 1). Multiflora Rose was the only non-native plant consumed at the rural park (Walnut Creek), whereas Northern Cardinals at the urban park (Greenbrier) fed on several other non-native species (Leatherleaf Mahonia, Oriental Bittersweet, Joint-head Grass, and Kudzu), but not Multiflora Rose (Table 1).

Of the food items that could be identified, native plant materials comprised a greater proportion of Northern Cardinal diets than did non-native plant materials in both the urban and rural parks (Fig. 2). As predicted, the mean proportion of non-native food items consumed per observation session was higher at the urban park than at the rural park (0.31 and 0.26, respectively, Fig. 2). The results of the Mann-Whitney U test, however, show that the median difference between the parks in the proportion of non-native food items consumed was not statistically significant ($U_{15,16} = 118.5, p = 0.97$).

Discussion

The analysis did not provide sufficient evidence to support the hypothesis that Northern Cardinals in the urban park ate proportionally more non-native plant material than those in the rural park. This finding also does not support the broader idea that non-native plant food is a factor that allows for larger Northern Cardinal populations in cities. However, future research may be necessary to clarify the issue, given this study's low sample size and limited statistical power.

One non-native species that Northern Cardinals used as a food source at Greenbrier Park was Leatherleaf Mahonia (*Berberis bealei*). One male ate 14 flowers. This is a notable finding because Leatherleaf Mahonia is a relatively new invasive species in the southeastern U.S. and little is known about its interactions with native species in southeastern ecosystems. Previous studies have suggested that the seeds of Leatherleaf Mahonia are dispersed by birds

(Bartuszevige and Gorchoff 2006, Greim and Kiage 2021, Allen et al. 2006). Although the observation of Northern Cardinals eating Leatherleaf Mahonia flowers is insufficient to confirm this, it does provide evidence that Northern Cardinals may be an agent of dispersal. If Leatherleaf Mahonia is being dispersed by a bird as ubiquitous as the Northern Cardinal, it suggests that this plant is likely to continue its rapid spread and should be taken seriously as an invasive species.

More broadly, this study largely corroborates previous findings about Northern Cardinal diets. The only two plant species eaten at both the urban and rural locations were Tuliptree and Wild Grape, both of which were previously documented to be important components of Northern Cardinal diets (McAtee 1908, Martin et al. 1961). Tuliptree in particular seems to make up a large percentage of Northern Cardinal winter diet in the Central Virginia region. Previous research also reported that Northern Cardinals eat mostly plant rather than animal material during the winter months (McAtee 1908), a finding also corroborated in this study.

An interesting finding of this study is that Northern Cardinals appeared to eat more frequently at the rural site than the urban site. Individual birds consumed nearly twice as many food items at the rural site, even though they were observed for the same amount of time and at similar times of day at each site (see Table 1). It is unclear if Northern Cardinals actually ate more frequently at the rural site or if birds at the two sites forage at different times of day. It is possible that Northern Cardinals at the urban site supplemented their diet at bird feeders and so were simply less hungry during the observation sessions in the park. This could be considered in future research.

Acknowledgements

We would like to thank the students and faculty of the spring 2022 Science 299 course at Piedmont Virginia Community College (PVCC) for their encouragement, suggestions, and guidance regarding the development and execution of this study. We would also like to thank Dr. Irina Liskey, professor of mathematics at PVCC, for her help with the statistical methods used in this paper.

Literature Cited

- Allen, C.R., A.S. Garmestani, J.A. LaBram, A.E. Peck, and L.B. Prevost. 2006. When landscaping goes bad: the incipient invasion of *Mahonia bealei* in the Southeastern United States. *Biological Invasions* 8:169-176. doi.org/10.1007/s10530-004-2896-4
- Atchison, K.A. and A.D. Rodewald. 2006. The value of urban forests to wintering birds. *Natural Areas Journal* 26:280-288. [doi.org/10.3375/0885-8608\(2006\)26\[280:TVOUFT\]2.0.CO;2](https://doi.org/10.3375/0885-8608(2006)26[280:TVOUFT]2.0.CO;2)

- Bartuszevige, A. and D. Gorchov. 2006. Avian seed dispersal of an invasive shrub. *Biological Invasions* 8:1013-1022. doi.org/10.1007/s10530-005-3634-2
- Gorosito, C.A. and V.R. Cueto. 2020. Do small cities affect bird assemblages? An evaluation from Patagonia. *Urban Ecosystems* 23:289-300. doi.org/10.1007/s11252-019-00915-0
- Greim, A. and L. Kiage. 2021. Abundance and distribution of invasive woody shrub, *Mahonia bealei*, in the urban forest fragments of the southern Piedmont, USA. *Urban Ecosystems* 24:1317-1326. doi.org/10.1007/s11252-020-01090-3
- Halkin, S.L., D.P. Shustack, M.S. DeVries, J.M. Jawor, and S.U. Linville. 2021. Northern Cardinal (*Cardinals cardinalis*), version 2.0. In: P. G. Rodewald and B. K. Keeney, Editors. *Birds of the World*. Cornell Lab of Ornithology, Ithaca, NY, USA. doi.org/10.2173/bow.norcar.02
- Leston, L.F.V. and A.D. Rodewald. 2006. Are urban forests ecological traps for understory birds? An examination using Northern Cardinals. *Biological Conservation* 4:566-574. doi.org/10.1016/j.biocon.2006.03.003
- Linville, S.U. and R. Breitwisch. 1997. Carotenoid availability and plumage coloration in a wild population of Northern Cardinals. *The Auk* 114:796-800. doi.org/10.2307/4089305
- Martin, A.C., H.S. Zim, and A.L. Nelson. 1961. *American Wildlife & Plants: a Guide to Wildlife Food Habits*. Dover Publications, New York, U.S.A. <http://archive.org/details/americanwildlife00mart>
- McAtee W.L. 1908. *Food Habits of the Grosbeaks*. U.S. Department of Agriculture, Biological Survey, Washington, U.S.A. <http://archive.org/details/foodhabitsofgros32mcat>
- Narango, D.L., D.W. Tallamy, and P.P. Marra. 2017. Native plants improve breeding and foraging habitat for an insectivorous bird. *Biological Conservation* 213:42-50. doi.org/10.1016/j.biocon.2017.06.029
- Nazaro, M.G. and P.G. Blendinger. 2017. How important are arthropods in the diet of fruit-eating birds? *The Wilson Journal of Ornithology* 129:520-528. doi.org/10.1676/16-083.1
- Price, T. 1987. Diet variation in a population of Darwin's Finches. *Ecology* 69:1015-1028. doi.org/10.2307/1938373
- Shochat, E., S. Lerman, and E. Fernández-Juricic. 2010. Birds in urban ecosystems: population dynamics, community structure, biodiversity, and conservation. *Urban Ecosystem Ecology* 55:75-86. doi.org/10.2134/agronmonogr55.c4