

Abstract-The American Redstart is a wood warbler that is in population decline in northern Michigan. This study investigates the effect understory vegetation density has on the distribution of American Redstarts in hardwood forests, in order to better understand how deforestation and forest regeneration will affect the population in the future. Transects were established to sample vegetation and to census the local American Redstart population. There is significant positive correlation between understory vegetation density and American Redstart distribution. There is no significant correlation between American Redstart distribution and canopy cover, presence of other bird species, or distance from a lakeshore. This study indicates that American Redstarts choose to inhabit areas of hardwood forests with denser understory.

Key Words-American Redstart, understory density, vegetation score.

INTRODUCTION

The American Redstart (*Setophaga ruticilla*) has maintained a viable population in Michigan over the past 40 years, but more specifically, in northern Michigan it has shown an overall decline in population (BBS Trend Map). American Redstarts prefer to breed in deciduous forests located near water (Williamson, 1971). Densities of American Redstarts are higher in early-successional forests than in late successional forests, and among late-successional forests, forests with lower percentages of conifers showed higher densities of American Redstarts (Hunt, 1996). Using this knowledge, one can begin to understand how deforestation and forest regeneration will affect the northern Michigan population of American Redstarts in the future. This study intends to deepen the knowledge of the effect forest vegetation characteristics have on American Redstarts by investigating how understory foliage density of a mid to late-successional hardwood forest influences American Redstart distribution. Based on what is known about American Redstart ecology, we expected to find that the distribution of American Redstarts is significantly and positively correlated to the density of the understory vegetation. Other factors that can influence American redstart distribution are presence of other bird species (Sherry and Holmes, 1988) and canopy cover (Crawford et al., 1981) and have been included in this study. Further knowledge of these interactions will contribute to a method of conservation that is sensitive to the currently declining American redstart population in northern Michigan.

METHODS AND MATERIALS

American Redstarts were counted and vegetation was sampled in the hardwood forest surrounding Grapevine Trail. The trail is located near the Douglas Lake shore at the University of Michigan Biological Station in Pellston, Michigan, USA. Five transects, spaced 100 m apart, were run perpendicular to the shore. Data was collected on each transect at two points, one 25 m from shore and another 85 m from

shore. At each data collection point, a 25 m radius was marked in the four cardinal directions and all data was collected inside these sites.

American Redstart Counting. American Redstarts were identified by song and sight on 12, 14, 16, and 17 July 2009 between 5:45 and 7:15 A.M. We counted Redstarts for ten minutes at each site and recorded the approximate location within the site of all Redstarts heard and/or seen.

Vegetation Sampling. Vegetation was sampled based on Nudds' density score (Nudds, 1977). A pole was used in place of the vegetation profile board. Vegetation samples were taken 1-3.44 m off the ground because the vegetation within this range was considered the understory. Samples were taken at the center point of each site and then at 12.5 and 25 m from the center point in each cardinal direction. The observer recorded the approximate percentage of each pole segment that was covered by vegetation. The observer stood 10 m away from the pole when recording the percent coverage, as this was determined to be the optimal distance.

Statistical Analyses. American Redstart distribution was compared separately with understory vegetation density, canopy cover, and other bird species using linear regression analysis in SPSS, in order to determine which of these factors significantly influenced American Redstart distribution. To determine if distance from shore had any significant effect American Redstart distribution, a *Mann-Whitney U test* was run between the average American Redstart density of sites 25 m away from the shore (sites 1-5) and sites 85 m away from the shore (sites 6-10).

RESULTS

The density of American Redstarts was variable among the ten different study sites, with average densities ranging from 0 to 3.5 birds per site. The average vegetation score per site ranged from 1.42 to 3.25 and the average density of other species of birds ranged from 1.25 to 3.25 birds per site. Average

canopy cover score was the least variable, ranging from 3.89 to 4.78 (Table 1). American Redstart distribution correlated positively with understory vegetation density (Fig. 1). Linear regression analysis showed that the correlation between American Redstart distribution and understory vegetation density is significant (R-squared = 0.76). Linear regression analysis showed positive correlation between American Redstart distribution and canopy cover, but the correlation was not significant (Fig. 2, R-squared = 0.184). There is no significant correlation between American Redstart distribution and the distribution of other bird species (Fig. 3, R-squared = 0.004). *Mann-Whitney U test* showed that distance from shore does not have a significant effect on American Redstart distribution (Table 2, $p = 0.113$).

DISCUSSION

The significant correlation between American Redstart distribution and understory vegetation density supports the original hypothesis. This supports the results of other studies that have shown that American Redstarts are associated with deciduous forest containing high percentages of shrub cover (Collins et al., 1982). The same study did find that American Redstarts were also associated with forest edges, which this study did not take into account because all but one of the study sites were located well within the forest edge. Part of site 6 was located very near a forest edge and no American Redstarts were found there during any of the four counts.

A study conducted by Crawford (et al., 1981) found that in hardwood forests American Redstarts were obligate canopy dwellers. The lack of variation in canopy cover in this study over the ten study sites does neither support nor reject this finding. However, the lack of significant correlation between American Redstart distribution and canopy cover suggests that canopy cover does not affect American Redstart distribution in this population.

The finding that the other bird species present, which consisted mostly of Red-eyed Vireos (*Vireo olivaceus*), do not affect the distribution of American Redstarts is consistent with other studies.

Williamson (1971) and Maurer and Whitmore (1981) both found that American Redstarts and Red-eyed Vireos forage at different heights of the vegetation structure. Robinson and Holmes (1982) found that American Redstarts eat less larval insects, forage at a different rate, and use different foraging maneuvers than do Red-eyed Vireos. All of these findings suggest that American Redstarts and Red-eyed Vireos do not exhibit a high degree of interspecific competition. Other bird species counted in this study were the Eastern Wood-pewee (*Cantopus virens*), Eastern Phoebe (*Sayornis phoebe*), Black-capped Chickadee (*Poecile atricapilla*), and Hairy Woodpecker (*Picoides villosus*), but none of these were found with enough consistency to allow for data analysis to be conducted.

The insignificant effect of distance from shore on American Redstart distribution implies that there are other factors than food resources determining the way in which American Redstarts choose habitats in deciduous forests. American Redstarts primarily feed on insects and insect density is expected to be greater closer to the shore because of the water-borne insects emerging from the shore. This might be explained through the cold summer that occurred when this study was being conducted, which might cause lower hatching rates.

To further investigate why understory vegetation density correlates positively with American Redstart distribution, a study involving the distribution of insects with respect to vegetation density may be useful. American Redstart density is positively correlated with arthropod biomass (Johnson and Sherry, 2001). Lesser rates of predation may also affect American Redstart habitat choice (Hunt, 1996). Merlins (*Falco columbarius*) were sighted in the same forest, although none were sighted inside of any of the ten study sites. An investigation into the affect of understory vegetation density on Merlin predation rates of forest songbirds could more thoroughly explain why more American Redstarts are found in denser understory.

Further studies could be conducted earlier in the breeding season. By the time the bird counting was started, the song rate had already begun to decline. Since sound was the most common method used to identify birds, due to the high difficulty of location by sight, this factor may have confounded the data collected. Many studies have shown there to be strong interactions between the American Redstart and the Least Flycatcher (*Empidonax minimus*). No Least Flycatchers were seen or heard in the study forest, but because of declining song rate, Least Flycatchers present in the forest may have been overlooked. Least Flycatchers share the same habitat as American Redstarts and have been found to influence their distribution (Sherry and Holmes, 1988). Another confounding factor affecting American Redstart distribution may have been flocking of birds. During the last day of counting, one instance of flocking behavior was observed. Five adult American Redstarts were sighted within the same 10 x 10 m area. Observer bias was involved in the bird counting. The observer had to determine if songs at different locations within a site were the same bird moving to a different location or a different bird at a different location. Consistent guidelines on how determine this were not used.

The vegetation profile pole used to conduct vegetation sampling was 2.44 m (8 ft) long. This may not have been sufficient length to conduct a more detailed study of vegetation density at different heights. Analysis of American Redstart distribution using a larger vertical range of the understory may have been able to yield more detailed results of the affect vegetation density has on American Redstart distribution.

The forest in which this study was conducted did contain a dirt path, approximately 2 m wide and 10-15 m away from the shore, that was included in study sites 1-5. This may have created edge effects that affected American redstart distribution (Collins et al., 1982).

REFERENCES

- BBS TREND MAP, 1996-2003. American Redstart (*Setophaga ruticilla*). <http://www.mbr-pwrc.usgs.gov/bbs/htm03/trn2003/tr06870.htm>
- COLLINS, F.L., JAMES F.C., and RISSER P.G. 1982. Habitat Relationships of Wood Warblers (Parulidae) in Northern Central Minnesota. *Oikos* 39:50-58.
- CRAWFORD, H.S., HOOPER, R.G., and TITTERINGTON, R.W. 1981. Songbird Population Response to Silvicultural Practices in Central Appalachian Hardwoods. *The Journal of Wildlife Management* 45:680-692.
- HUNT, P.D. 1996. Selection by American Redstarts along a Successional Gradient in Northern Hardwoods Forest: Evaluation of Habitat Quality. *The Auk* 113:875-888.
- JOHNSON, M.D. and SHERRY T.W. 2001. Effects of Food Availability on the Distribution of Migratory Warblers among Habitats in Jamaica. *Journal of Animal Ecology* 70:546-560.
- MAURER, B.A. and WHITMORE, R.C. 1981. Foraging of Five Bird Species in Two Forests with Different Vegetation Structure. *The Wilson Bulletin* 93:478-490.
- NUDDS, T.D. 1977. Quantifying the Vegetative Structure of Wildlife Cover. *Wildlife Society Bulletin* 5:113-117.
- ROBINSON, S.K. and HOLMES, R.T. 1982. Foraging Behavior of Forest Birds: The Relationships Among Search Tactics, Diet, and Habitat Structure. *Ecology* 63:1918-1931.
- SHERRY, T.W. and HOLMES R.T. 1988. Habitat Selection by Breeding American Redstarts in Response to a Dominant Competitor, the Least Flycatcher. *The Auk* 105:350-364.
- WILLIAMSON, P. 1971. Feeding Ecology of the Red-eyed Vireo (*Vireo olivaceus*) and Associated Foliage-Gleaning Birds. *Ecological Monographs* 41:129-152.

TABLES AND FIGURES

Table 1. SUMMARY OF AMERICAN REDSTART, UNDERSTORY VEGETATION, OTHER BIRD SPECIES, AND CANOPY COVER DATA Variation in the average density of American Redstarts, average vegetation density, average density of other birds, and average canopy cover at 10 different sites. American Redstart and other bird species averages were compiled from 4 counts at each site. Vegetation and canopy cover averages were compiled using data collected from 9 different points within each site. Vegetation and canopy cover score values are 1 = 0-20%, 2 = 21-40%, 3 = 41-60%, 4 = 61-80%, 5 = 81-100%.

Site	Average American Redstart Density	Average Vegetation Score at all Heights	Average Density of Other Birds	Average Canopy Cover Score
1	1.25	2.08	1.5	4.22
2	2.75	2.97	2.75	4.22
3	3.5	3.25	1.25	4.67
4	2.25	3.19	2.25	4.11
5	1.5	2.06	3.25	3.89
6	0	1.42	1.75	4.11
7	1.0	1.81	2.5	4.0
8	2	2.31	2.5	4.33
9	1.5	1.83	2.25	4.78
10	1.5	1.44	2.0	4.33

Table 2. THE EFFECT OF DISTANCE FROM SHORE ON AMERICAN REDSTART DISTRIBUTION The average number of American Redstarts per site 25 m away from shore (sites 1-5) and 85 m away from shore (sites 6-10). Averages were calculated from 4 counts done at each site ($p = 0.113$).

Average Number of American Redstarts 25 m from Shore	Average Number of American Redstarts 85 m from Shore
2.25	1.20

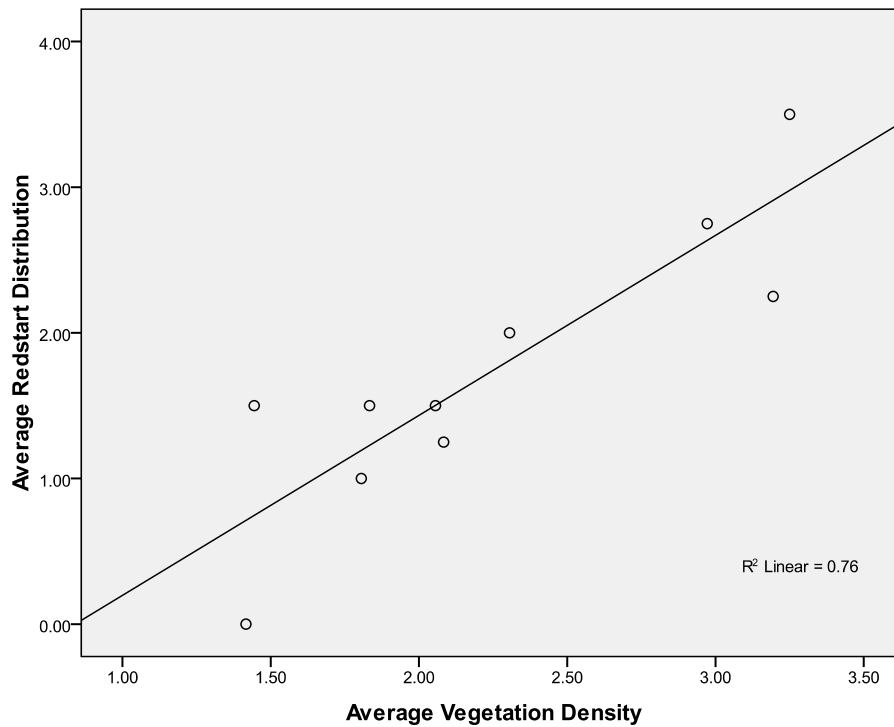


Figure 1. AMERICAN REDSTART DISTRIBUTION AS A FUNCTION OF UNDERSTORY VEGETATION DENSITY Average Redstart distribution was taken from 4 different counts at each site. Average understory vegetation density was taken from 9 vegetation scores collected at each site.

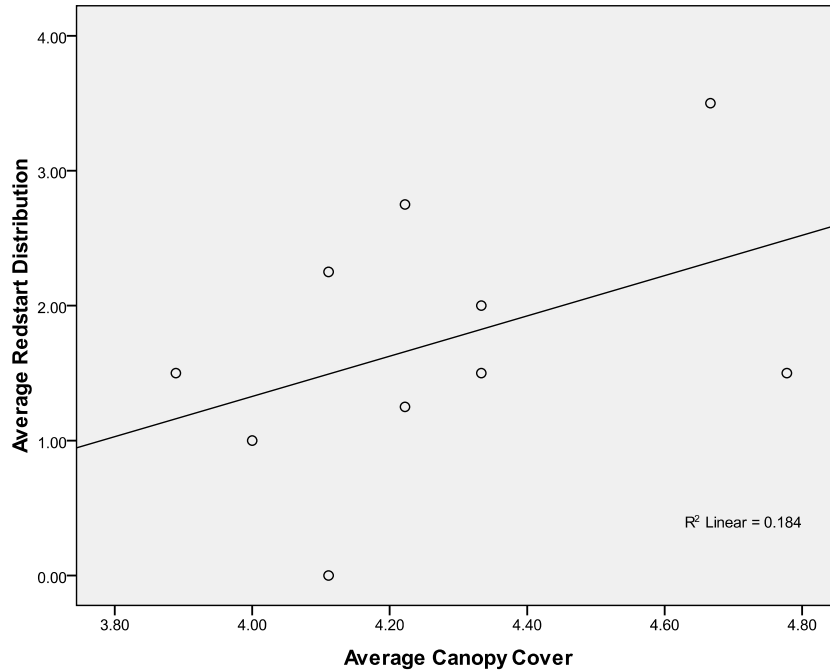


Figure 2. AMERICAN REDSTART DISTRIBUTION AS A FUNCTION OF CANOPY COVER Average canopy cover was taken from 9 vegetation scores collected at each site.

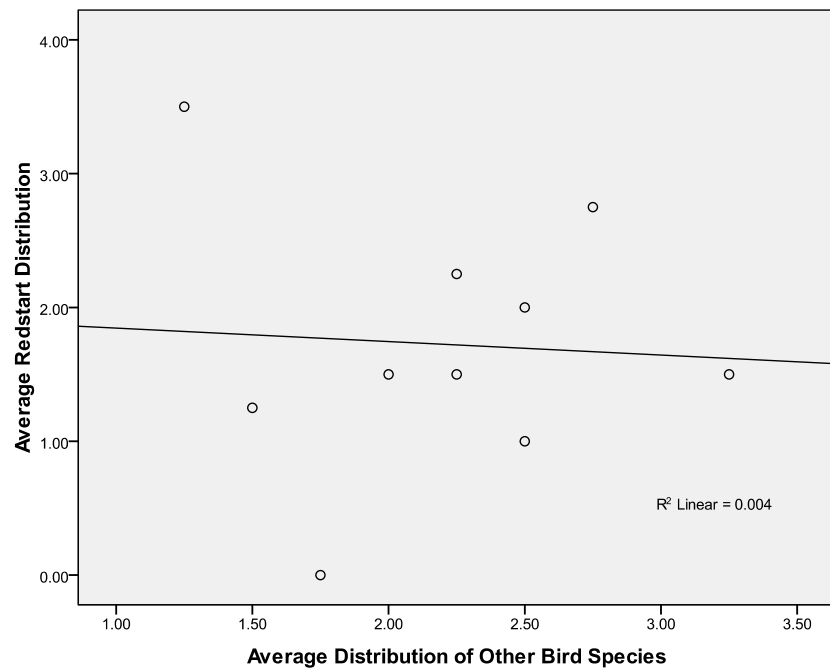


Figure 3. AMERICAN REDSTART DISTRIBUTION AS A FUNCTION OF THE DISTRIBUTION OF OTHER BIRD SPECIES Average distribution of other birds was taken from 4 different counts at each site.

THE EFFECT OF UNDERSTORY VEGETATION DENSITY ON THE DISTRIBUTION OF AMERICAN REDSTARTS
(*Setophaga ruticilla*) IN A HARDWOOD FOREST

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