Abundance of Red-eyed Vireos (*Vireo olivacea*) relative to foliage density and forest structure

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Abstract
We evaluated the relationship between Red-eyed Vireo (*Vireo olivaceus*) abundance and foliage density and forest structurein a northern hardwood forest on Douglas Lake, Michigan. We found no relationship between the abundance of Red-eyed Vireos and forest structure complexity. Although our results suggest that Red-eyed Vireo density does not increase with forest structure, as predicted, our sampling protocol and short period that we had for sampling may have been insufficient to identify Red-eyed Vireo distribution patterns relative to forest structure.

Introduction

Density of breeding foliage-gleaning birds varies spatially across the landscape and temporally at all scales. One likely factor that affects densities of these breeding birds is foliage volume, which in turn may be associated with availability of insects and other invertebrate prey consumed by foliage gleaning birds. One way to test the relationship between foliage volume and abundance of foliage gleaning birds is to compare the abundance of breeding birds with estimates of foliage volume. We predict that the density of a common inhabitant of northern hardwood forests, the Red-eyed Vireo (*Vireo olivaceus*), will increase with increased forest structure. Red-eyed Vireos prefer to nest and forage in northern hardwood forests composed of deciduous trees, including red maples (*Acer rubrum*) and aspens (*Populus grandidentata* and *P. tremuloides*) (Pettingill 1974, Kendeigh 1948). The Red-eyed Vireo gleans insects, mainly *Lepidoptera* larvae (Robinson and Holmes 1984) from foliage (Marshall et al. 2002), so we predict that increased density of forest structure provides more foliage, thus supporting increased insect abundance and therefore an increased abundance of Red-eyed Vireos. The purpose of this study is to compare areas of less structure to areas of greater structure to determine its effect on Red-eyed Vireo density, controlling for forest type. Because increased forest structure increased insect populations (Gray 1993), we expect forest structure to have a positive relationship with abundance of Red-eyed Vireos.

Materials and Methods

Data were collected in a northern hardwood forest along Douglas Lake, Pellston, Michigan (45˚ 33’ 45” N, 84˚ 40’ 38”, elevation 721 ft) at the University of Michigan’s Biological Station (Jurik 1986); the forest varied in canopy and understory density. We sampled vertical forest structure and abundance of Red-eyed Vireos at 12 circular plots, each with a 25-meter radius and located 18.3 m from the shoreline of Douglas Lake. Each site was separated by at least 200 meters to reduce the chance of recounting Red-eyed Vireos.

To measure foliage density and ultimately forest structure at the sites, the pole-touching method (Shemske and Brokaw 1981, Kennedy et. al. 2010) was used. Measurements were taken at the center of each site and at the four cardinal directions on a 25-meter radius. A seven-meter pole was held up and leaves contacting the pole at four height intervals (0-1 m, 1-2 m, 2-5 m, and 5-7 m) were counted. Above seven meters, the height of the tallest tree above the pole was estimated. The number of major branches (those connected to the trunk of a tree) directly above the seven-meter pole was also counted. The average number of leaf touches across the five sampled locations in each site was combined with the average number of major branches across the site to calculate a measure of Forest structure.

Point counts were performed to estimate abundance of Red-eyed Vireos. Observers were randomly assigned to a partner and sites were assigned randomly to each pair of observers. Each group located the center of each site, recorded the site number, time of day, date, current temperature, amount of wind, and sky condition. Point counts were not performed during rain, thunder or lightning. Point counts were 10 minutes long. All observations started were completed between 06:00-10:00 (Latta and Sondreal 1999). During the 10 minutes, all Red-eyed Vireos detected visually or acoustically within our 25-meter radius were recorded. To avoid double-counting birds we noted when birds were interacting, including countersinging, and mapped movement of birds within the sampled area.

Results

The number of Red-eyed Vireos observed at each point count site ranged from zero to three birds. The average amount of leaf touches in the understory (0-7 m) of each point count site ranged from 0.9 to 3.75. The average number of major branches above seven meters ranged from 2.2 to 5.4. We used linear regression (SPSS version XX) to describe the relationship between Red-eyed Vireo abundance and forest structure. There was a slightly negative, non-significant relationship ($R^2 = 0.06$, $p = 0.43$) between the number of Red-eyed Vireos and foliage density and structure (Figure 1). Canopy height was estimated and is being used here as descriptive data and not calculated into our forest structure measure.

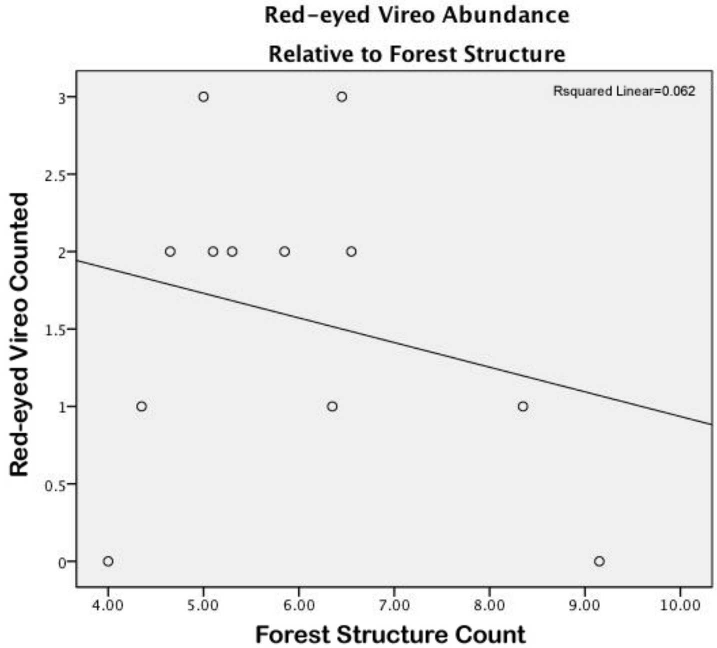
Table 1: SPSS linear regression output comparing Red-eyed Vireo abundance to forest structure count. With a p-value of 0.434, our results were insignificant. Also, there was a slightly negative (-.159) trend in our regression.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.526	1.193		2.118	.060
	ForestStructureCount	-.159	.195	-.250	-.815	.434

a. Dependent Variable: Red-eyed Vireos Counted

Figure 1. A linear regression of Red-eyed Vireo abundance relative to forest structure. No correlation is observed, although there is a negative slope which is opposite from our prediction.



Discussion

Our hypothesis of a positive relationship between Red-eyed Vireos and foliage density was not supported. The Red-eyed Vireo abundance varied among our 12 sites and had little relationship to forest structure. The site with the lowest abundance of Red-eyed Vireos during our point counts also had the highest foliage density. Robinson and Holmes (1984) concluded that Red-eyed Vireos feed primarily on caterpillars (*Lepidoptera*) and other insects. While thicker density of foliage offers more habitats for insects, it did not seem to be affect abundance of Red-eyed Vireos at Grapevine Point during our sampling period.

Our ability to interpret results from this work was likely constrained by several factors: small sample size, observer bias, and possibly weather conditions. Due to the 200-meter distance between plot centers we could place no more than 12 point count stations in deciduous forest before encountering coniferous forest. The northern edge of all 12 sample sites included approximately seven meters of lake water, which reduced the area of deciduous foliage observed in each site. Each site was only observed once, so the specific time of day that each point was sampled could be a source of bias. Due to storms, including high winds, our observations took place over two days, making weather conditions and day sampled potential confounding variable Observer biases possibly affected the canopy coverage estimates and bird observations, even though observers were paired in order to reduce the potential for error. Also, more dense sites may have been more difficult to observe birds in during point counts because of limited sight and sound perception.

A previous study of Red-eyed Vireo foraging behavior observed that from April to June the majority of Red-eyed Vireos forage by gleaning insects from leaves (Williams 1971). This suggests that the amount of leaves in a given area (foliage density) would have a positive relationship with the abundance of Red-eyed Vireos. Although our observations do not support this finding, we do not reject this interpretation given the methodological constraints associated with this r study.

Because our hypothesis was not supported by our results, further studies to test additional hypotheses are desired. Expanding our study to include more sites and observational periods for point counts as well as developing other criteria for collecting forest structure data would improve our ability to evaluate how Red-eyed Vireos respond to forests with different structure. The majority of Red-eyed Vireos that we found were either sighted or located by sound in the canopy of Grapevine Point. Although our densities of our 12 sites were very diverse, the canopies were very similar. We would like to measure the canopies more accurately, controlling for understory characteristics, to determine if differences in canopy cover are associated with differences in the number of Red-eyed Vireos at our site.

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Appendix 1

Site	Average Leaf Touches	Average Major Branch Above 7m	Average Canopy Height (m)	Forest Structure Count	Red-eyed Vireos Counted
1	0.9	4.4	16.6	5.3	2
2	2.85	3.6	19.8	6.45	3
3	3.75	5.4	20.2	9.15	0
4	2.15	2.2	18.8	4.35	1
5	1.05	3.6	13.8	4.65	2
6	2.95	3.6	17.4	6.55	2
7	1.3	3.8	16.4	5.10	2
8	2.1	3	16.6	5.00	3
9	2.35	4	26	6.35	1
10	2.95	5.4	20.4	8.35	1
11	1.25	4.6	16.8	5.85	2
12	1.8	2.2	19.6	4.00	0