The Effects of Selective Tree Species Girdling on Breeding Bird Species in an Aspen-Dominated Forest: A Preliminary Assessment

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Abstract

Bird species richness and diversity in response to selective forest species modification was studied at two plots in Pellston, Emmet County, Michigan. In one plot, three deciduous tree species were girdled to accelerate forest succession, significantly altering canopy cover and tree species composition within the plot. The girdling of the tree species significantly reduced canopy cover of aspen and white birch compared to the reference plot. Though the total number of birds counted per plot did not differ significantly, coniferous gleaners were significantly more common at the treatment plot and relative abundance of two species that forage primarily in deciduous trees, American Redstart and Red-eyed Vireo, differed between the treatment and control plots. Reduced abundance of American Redstarts in the treatment plot may be related to loss of birch, a favored foraging substrate of this species, while the increased abundance of Red-eyed Vireo, a generalist in terms of tree use as a foraging substrate, in the treatment plot may reflect density compensation as a result of lower numbers of American Redstarts.

Introduction

Both bird species and relative abundance of breeding bird species change with forest composition and forest succession (Monkkonen and Helle 1989, Holmes and Sherry 2001, Keller et al. 2002). These changes may be attributable to factors such as foraging behavior (Holmes et al. 1979, Holmes and Robinson 1981) and nesting requirements (Holmes 1986). Few studies have focused on evaluating response of avian species composition to experimental, complete removal of selected tree species within a forest tract and are thus able to document how tree species composition may affect the composition and relative abundance of breeding bird communities. In this study, we describe differences in breeding bird species composition and relative abundance between a reference plot and an experimental plot in which primary succesional dominant tree species quaking aspen (*Populus tremuloides*), bigtooth aspen (*Populus grandidentata*), and paper birch (*Betula papyrifera*) were girdled. This is altering canopy coverage and the number of snags. Studies at the Hubbard Brook Experimental Forest in New Hampshire, USA, have shown that the abundance and diversity of select insectivorous bird species changed with differing tree species in the forest canopy (Holmes et al. 1979, Holmes and Robinson 1981). A study in central New York forests studied successional age in forest stands after clear cutting relative to the abundance of bird species foraging-guilds (Keller et al. 2002). Studying bird species preference for aspen and birch is relevant because these tree species are the typical species of many aspen-dominated forests of the upper Midwest Great Lakes region, where this forest is in decline as it succeeds to a mixed coniferous/deciduous forest (Peterson and Squire 1995).

The successional process from aspen-dominated to mixed coniferous/deciduous has been accelerated at a treatment plot (FASET) in consisting of bigtooth aspen, quaking aspen, paper birch, red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), white pine (*Pinus strobus*), and other species, by girdling paper birch, bigtooth aspen, and quaking aspen. This treatment provided an opportunity to test predictions regarding changes in bird species composition and relative abundance where forest succession is controlled by treatments that mimic accelerated successional transitions. In areas of the upper Midwest where similar forest succession is taking place, red maple, northern red oak, white pine, and American beech (*Fagus grandifolia*) are increasing in abundance (Peterson and Squires 1995, Kneeshaw and Bergeron 1998, Stearns and Likens 2002). White pine and red maple in particular are beginning to replace aspen as the major canopy species in this region (Curtis et al. 2006).

Forests succeeding to mixed coniferous-hardwoods in central New York showed increased abundance of breeding bird guilds associated with high canopy coniferous and deciduous foraging compared to forests at earlier successional stages, as well as increased numbers of bark-probers and bark-gleaners with the increase of tree snags (Keller et al. 2002). Deciduous-foraging species, such as the American Redstart (*Setophaga ruticilla)*, which have shown preference for birch species (Holmes and Robinson 1981), are expected to decrease within the treatment plot because of a decrease in aspen and birch foliage. The decrease in aspen and birch foliage may allow white pine and red maple trees to increase foliage in the canopy (Curtis et al. 2006), and with an increase of white pine foliage we expect to see an increase in coniferous-foraging bird species. Girdling in the treatment plot should create more forest gaps (Curtis et al. 2006), and thus favor an increasing number of aerial foragers such as flycatchers (De Graaf 1985). An increase in bark-probing and bark-gleaning species is expected with the increase of dead snags (Keller et al. 2002). We expect no significant change in the relative abundance of Red-eyed Vireos (*Vireo olivaceus*) between treatment and reference plots, as this species shows minimal preference for specific tree species while foraging (Holmes and Robinson 1981).

Materials and Methods

We sampled breeding bird populations and canopy cover at two paired study sites in a mid-successional forest at the University of Michigan Biological Station near Pellston, Emmet County, Michigan (45˚33'30.27", 84˚40'27.51"). We observed breeding bird populations at 21 sites in each of the treatment and reference plots: all 21 sites in the treatment (FASET) plot and 21 randomly selected sites within the reference (AmeriFlux) plot. Each point count station was located 100 meters from other point stations. We used ten-minute point counts to document all birds seen or heard within a twenty-five meter radius, selecting the distance of 25m to ensure proper identification of each bird. Two counts were conducted at each of the 42 plots from 9-11 July 2010. The bird population data were collected between 05:30 and 10:00, with the sites sampled in opposite directions during the second sampling period to ensure that each point was visited during the time in the morning when bird are most active and thus detectable. Testing for normal distribution was done using Mann-Whitney tests.

To estimate canopy cover for each site, we used ocular tubes at twenty locations at each site. We sampled every five meters up to 25m in each of the cardinal directions, at each site sampled for bird populations. The canopy cover was recorded using percent cover by each tree or shrub species present. Canopy cover data was collected July 25, 30, and 31, 2010.

In order to analyze the differences in canopy cover between the AmeriFlux and FASET sites, we grouped tree species into deciduous and coniferous tree types. Deciduous trees included sugar maple (*Acer saccharum*), red maple, northern red oak, paper birch, quaking and bigtooth aspen, and American beech. Red pine (*Pinus resinosa)* and white pine were the only coniferous trees. We then used Mann-Whitney tests to evaluate the significance of the differences in canopy cover.

In order to analyze the differences in bird abundances between the sites, we divided the observed birds into four different guilds based on feeding habits: (1) deciduous-foraging, (2) coniferous-foraging, (3) flycatching, (4) bark-gleaning and bark-probing. Deciduous-foraging birds included the American Redstart, Black-capped Chickadee (*Poecile atricapillus*), Red-eyed Vireo, Scarlet Tanager (*Piranga olivacea*), Mourning Warbler (*Oporornis philadelphia*), and Rose-breasted Grosbeak (*Pheucticus ludovicianus*). Coniferous-foraging birds included the Blackburnian Warbler (*Dendroica fusca*), Nashville Warbler (*Vermivora ruficapilla*), Blue-headed Vireo (*Vireo solitarius*), Black-throated Green Warbler (*Dendroica virens*), and Yellow-rumped Warbler (*Dendroica coronata*). Flycatchers included the Eastern Wood-Pewee (*Contopus virens*), Least Flycatcher (*Empidonax minimus*), and Great Crested Flycatcher (*Myiarchus crinitus*). Bark-gleaning/-probing birds included the Downy Woodpecker (*Picoides pubescens*), Hairy Woodpecker (*Picoides villosus*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), Northern Flicker (*Colaptes auratus*), Red-breasted Nuthatch (*Sitta canadensis*), and White-breasted Nuthatch (*Sitta carolinensis*). We used Mann-Whitney tests to analyze the differences in abundance of total birds, abundances of each guild, as well as the differences in abundance of American Redstart and Red-eyed Vireo between the treatment and reference plots.

Results

Canopy Cover

The percentage of total canopy cover was significantly lower in the treatment plot than the reference site (83.1%, 71.5%, $U = 75$, $p < 0.001$,). The canopy in the treatment plot was composed of significantly less (28.7%, 6.1%, U = 28, $p < 0.001$) of the girdled tree species, quaking and bigtooth aspen and birch. At the treatment plot, deciduous canopy cover was significantly lower (76.9%, 61.6%, U = 85.5, p = 0.001), while coniferous canopy cover was significantly higher (6.2%, 9.9%, U = 133.5, p = 0.012). Maple canopy cover did not differ significantly (28.6%, 29.4%, U = 203.5, p = .334) between the two sites. (Table 1, Appendix 1).

Table 1. Percent cover of tree types in the AmeriFlux and FASET sites, and Mann-Whitney test results.

	AmeriFlux	FASET	U	p-value
Total Canopy Cover	83.1%	71.5%	75	<0.001
Deciduous	76.9%	61.6%	85.5	0.001
Coniferous	6.2%	9.9%	133.5	0.012
Aspen and Birch	28.7%	6.1%	28	<0.001
Maple	28.6%	29.4%	203.5	0.334

Point Counts

The total number of birds counted did not differ significantly between the treatment and reference plots (U = 193, p = 0.243). Coniferous gleaners were significantly more abundant (U = 91.5, $p < 0.001$) at the treatment plot, while there was no significant difference between the sites for deciduous gleaners (U = 206, p = 0.356), foliage gleaners (coniferous and deciduous combined; U = 161, p = 0.065), flycatchers (U = 205, p = 0.329) or bark foragers (gleaners and probers combined; U = 211.5, p = 0.405). Between sites only Red-eyed Vireo and American Redstart were sufficiently common to perform individual species statistical analysis. At the treatment plot, Red-eyed Vireos were significantly more (U = 96, $p < .001$), while American Redstarts were significantly less (U = 123, p = 0.004). (Table 2, Appendix 2).

Table 2. Bird counts by guild /species in AmeriFlux and FASET plots, and Mann-Whitney test results.

Guild or species	AmeriFlux	FASET	U	p-value
Total birds	177	202	193	0.243
Coniferous gleaners	4	27	91.5	<0.001
Deciduous gleaners	83	95	206	0.356
Foliage gleaners	87	122	161	0.065
Flycatchers	13	13	205	0.329
Bark foragers	23	22	211.5	0.405
American Redstart	37	9	123	0.004
Red-eyed Vireo	39	64	96	<0.001

Discussion

Tree and bird community-level response to girdling treatment

Differences in canopy cover between treatment and reference plots were associated with some differences in the bird community. Although there were no significant differences in total number of birds or the abundance of foliage-gleaning species between the treatment and reference plots or the number of individuals in the flycatcher guild, there were more conifer dependent species in the reference plot where canopy coverage was greater than in the treatment plot. These results suggest that in response to openings in the canopy, white pine is starting to replace aspen and birch, which is consistent with the predictions of Curtis et al. (2006). As was expected, the population of the conifer-gleaning guild was significantly higher in the treatment plot. Overall there was significantly higher cover of deciduous trees in the canopy of the reference plot, where we therefore predicted to find more birds in the deciduous guild. No significant difference in occurrence of the deciduous guild was observed, but this could be a result of interspecific interactions.

Individual species response to the treatment and interpretation

We predicted that the abundance of flycatchers would increase in the treatment plot due to a more open canopy that favors aerial foraging. Observations from a Holmes (1981) study state that Least Flycatchers have a preference to forage on birch while avoiding beech, sugar maple and conifers. De Graaf et al. (1985) placed Least Flycatchers and our other observed flycatchers (Eastern Wood-Pewee, Great Crested Flycatcher) into an “air sallier insectivore” guild. Our results suggest that the reference and treatment plots provide similar habitat quality, but based on different attributes for flycatcher needs: the reference plot has preferred species-specific substrate while the treatment plot has preferred structure, more open space for foraging.

Although the abundance of the community of deciduous foliage gleaning species was similar in both plots, American Redstarts were more abundant in the reference plot and Red-eyed Vireos had a higher population in the treatment plot. We predicted that American Redstart abundance would be greater in the reference plot where birch, a preferred foraging substrate (Holmes and Robinson 1981), remains in the canopy. The lack of their preferred tree species and interspecific competition with Red-eyed Vireos in the treatment plot might explain the change in distribution between sites. Based on Robinson and Holmes (1982) it appears that prey species of both American Redstarts and Red-eyed Vireos overlap: moth caterpillars, flies, leafhoppers, planthoppers, beetles, wasps and spiders. These arthropods constitute about 75% of the Redstart and 57% of Red-eyed Vireo diet. We expected no significant difference in Red-eyed Vireo population between plots based on the finding of Holmes and Robinson (1981) that Red-eyed Vireos showed the lowest tree species preference of the ten birds surveyed. They did, however, find a slight preference for maple and pine, which is consistent with our findings in the treatment plot. Thus, the higher abundance of Red-eyed Vireos in the treatment plot may reflect a response to differences in tree species composition between the plots or density compensation as a result of decreased numbers of the American Redstart in the treatment plot.

Since girdled aspens take approximately four to six years to completely die (Aulén 1991) and the trees were girdled in 2008, additional changes in bird population compositions are likely to occur. Gunn and Hagan (1999) found no difference in the abundance of the bark-gleaning guild in managed and unmanaged Maine forests due to the guild's preference for either living or recently dead trees. Our findings paralleled these results as we found no significant difference in abundance of bark-gleaners between plots.

Confounding factors, caveats and future explorations

Possible sources of error include but are not limited to a small sample size and possible observer bias. The study was also preformed late in the breeding season when song rates were not at their peak. Different species may have had much lower singing rates than others. In order to minimize error based on time of day, the order in which point counts were taken was reversed on the second day, but this does not account for plots taken in the middle of the point count. Observer biases likely included differential detection of birds and canopy coverage estimates. Although each of these factors introduced variation in the data set, we reduced these potential sources of error by pairing observers during sampling. The two towers are 1.25 kilometers apart. The treatment stand of trees was specifically chosen because it was a dominant aspen forest while the reference plot was not necessarily chosen based on species composition. Since the reference site was larger than the treatment plot, it may be more heterogeneous than the treatment plot.

This study should provide a basis for assessing future trends in breeding bird populations in the treatment plot as aspen abundance continues to decline. Later in succession, as the aspen canopy is replaced with white pine, maple, and oak, it would be of interest to observe differences in bird and tree species occurrence. Studies done in later years should also document avian response to snags and presence of bark probers. In a study performed by Greene (2008) in the reference and treatment plots she found that bird communities responded to differences in vegetation structure including a positive relationship with increasing basal area and a smaller number of trees. These results suggest that higher densities of breeding birds are associated with more later successional forests. The study did not consider species composition, but we could expect based on these findings that the treatment plot may decrease in bird densities as large aspens and birches die in the canopy and forest structure is diminished.

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Appendix 1

Percent canopy cover by tree species in the AmeriFlux and FASET sites.

Tree Species	AmeriFlux	FASET
Red Maple	26.9	21.6
Sugar Maple	0	6.6
Striped Maple	1.7	1.1
Northern Red Oak	11.4	16.3
Paper Birch	6.5	0.1
Quaking Aspen	7.0	3.6
Bigtooth Aspen	15.2	2.4
American Beech	7.3	9.9
Red Pine	0	4.9
White Pine	6.2	5.0

Appendix 2

Number of each bird species in the AmeriFlux and FASET sites.

Bird Species	AmeriFlux	FASET
American Crow	0	14
American Redstart	37	9
American Robin	0	1
Blackburnian Warbler	0	5
Black-capped Chickadee	5	15
Black-throated Green Warbler	1	8
Blue-headed Vireo	3	12
Caspian Tern	0	2
Common Grackle	1	2
Common Raven	1	4
Cooper's Hawk	1	0
Downy Woodpecker	0	9
Eastern Phoebe	0	0
Eastern Wood-Pewee	12	12
Great Crested Flycatcher	1	1
Hairy Woodpecker	3	1
Hermit Thrush	13	3
Least Flycatcher	3	0
Mourning Warbler	2	0
Nashville Warbler	0	1

Northern Flicker	5	1
Ovenbird	30	16
Red-breasted Nuthatch	1	3
Red-eyed Vireo	39	64
Rose-breasted Grosbeak	0	1
Scarlet Tanager	0	6
Veery	5	3
White-breasted Nuthatch	2	2
Yellow-bellied Sapsucker	11	5
Yellow-rumped Warbler	0	1
Unknown Woodpecker	1	1

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