Sap Tree Foraging Preference of Yellow-bellied Sapsuckers, *Sphyrapicus varius*.

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Abstract

Foraging preferences vary among avian species and multiple factors influence this preference including maximizing energy efficiency and utilizing the resources available over time (both seasonally and throughout successional periods). The Yellow-bellied Sapsucker, *Sphyrapicus varius*, is a woodpecker that forages by drilling wells into trees to obtain sap. The main objective of this study was to investigate if a relationship exists between foraging preference of Yellow-bellied Sapsuckers and the period of time in which foraging is observed. During Spring 2015, we examined and collected data on the foraging preference of sapsuckers at the University of Michigan Biological Station (UMBS). Our results indicated that foraging preference of sapsuckers differ significantly among tree species ($\chi^2_8 = 22.19$, $p = 0.005$). Upon comparing previous studies done at UMBS, a change in foraging preference of the Yellow-bellied Sapsucker appeared to correlate with the successional changes of the mixed hardwood forest. Previous studies have found that paper birch (*Betula papyrifera*), an early successional species was the primary foraged tree of the Yellow-bellied Sapsucker. However, based on our current results that were collected over 17 years later, their primary foraging preference has changed to red maple (*Acer rubrum*), a late successional species. Future analysis of sapsucker foraging preference could further investigate this trend.

Introduction

Foraging behaviors of organisms are selected to maximize energy intake while minimizing energy expended to obtain food resources. Some birds probe into the mud for invertebrates, some catch flying insects aerially, and some prey on other birds. Despite this diversity of foraging behaviors, mechanisms to maximize energy efficiency are still expected.

Woodpeckers, which are arboreal birds that drill into trees to find food and build nests, utilize resources efficiently (Elphick et al., 2001). For instance, the Yellow-bellied Sapsucker, *Sphyrapicus varius*, usually excavates nesting cavities in decaying trees to minimize the energy expenditures (Kilham, 1971). The sapsucker forages by drilling arrays of holes into the trees to obtain sap as one of its major food resources. We predicted sapsuckers would preferentially forage on tree species that provide a rich food supply relative to the cost of obtaining the food.

In addition to maximizing energy efficiency, foraging behaviors are influenced by many factors of the environment including seasonality and period of succession. For sapsuckers in particular, the seasonal changes of sap sucrose content could influence their foraging preferences and result in seasonal differences (Stanislawek et al., 1987). Availability of resources is also an influencing factor of foraging preference that changes over time. As a forest ecosystem undergoes succession, the abundance of tree species changes (Tester, 1995). In northern deciduous forests, successional patterns usually begin with paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), and bigtooth aspen (*Populus grandidentata*) as early-successional species followed by northern red oak (*Quercus rubra*) in mid-succession and finally red pine (*Pinus resinosa*), white pine (*Pinus strobus*) (Tester, 1995) and red maple (*Acer rubrum*) species as late successional tree species (Anonymous, 1923). As the tree species change

over time, the Yellow-bellied Sapsucker would be expected to adapt to utilize the resources available.

Previous studies at the University of Michigan Biological Station (UMBS) have shown that the Yellow-bellied Sapsucker shows a preference for foraging in certain tree species. Eberhardt (2000) observed their foraging preference to be paper birch and red maple in April and May of 1992-1993. On the other hand, in July 1997, McLenon found the majority of trees actively foraged on to be scots pine (*Pinus sylvestris*). Okoniewski (1998) observed foraging in mid-June to late-August of 1998 and found the foraging tree preference of the sapsuckers to be paper birch. More generally, Rushmore (1969) suggested that sapsucker foraging preference varies with season in the northeastern United States. Based on these studies, we therefore hypothesized that seasonality and successional period may affect sapsucker foraging preference. To further investigate the tree preference of Yellow-bellied Sapsucker at UMBS, we observed foraging behavior in late-May and early-June of 2015.

Methods

The study took place from 27 May to 12 June 2015 at the University of Michigan Biological Station campus located on Douglas Lake, Cheboygan Co., Michigan (45.55969°N, 84.67423°W). The mixed hardwood forest of the study area consists mainly of quaking aspen, red and white pine, northern red oak, paper birch, American beech (*Fagus grandifollia*), sugar maple (*Acer saccharum)*, and red maple. Using playback of the sapsucker call, we identified five territories where we observed foraging behavior by both male and female sapsuckers. We only began recording behavior once territorial drumming ceased and the sapsucker returned to

foraging. Foraging was determined using visual and audio cues accompanied by the presence of wells on the tree.

After a foraging tree was identified, we recorded the tree species, diameter at breast height (DBH), an estimate of the quantity of wells on an order of magnitude scale (0, 1-10, 11-100, 101-1000, 1001+ wells per tree), and the location of the wells on the tree. The height of the wells was estimated using a clinometer at a distance of 15 meters. To describe the relative abundance of other potential foraging trees, we then recorded the tree species and DBH within a five meter radius of the identified foraging tree. If another foraging tree occurred within the radius of the observed foraging tree, each tree was given a separate radius and the overlap was noted. When a surrounding tree contained wells but no foraging was observed, the number of wells was estimated but it was not considered a foraging tree. All statistical tests (ANOVA, χ^2, t-test) were conducted using Microsoft Excel and SPSS.

Results

Tree species foraging preference

A total of 83 trees were recorded and categorized into foraging and non-foraging trees. Tree species found included quaking aspen, American beech, paper birch, black cherry, northern red oak, red pine, white pine, sugar maple, and red maple (Fig. 1). Of the 21 trees on which we observed active foraging for sap, 11 (52%) were red maple, five (24%) were northern red oak, and five (24%) were paper birch (Fig. 2). A χ^2 contingency test revealed a foraging preference based on tree species ($\chi^2_8 = 22.19$, $p = 0.005$). In all foraging tree species we observed wells on both trunk and branches.

Tree foraging preference based on DBH

Using an independent *t*-test for each tree species foraged on (red maple, northern red oak, and paper birch), the DBH of all foraged trees was compared to the DBH of all non-foraged trees. Statistical analysis found no significant difference between the diameter of foraged and non-foraged trees (red maple: $t_{16} = -1.385$, $p > 0.05$; paper birch: $t_{10} = -0.752$, $p > 0.05$; northern red oak: $t_{11} = 0.086$, $p > 0.05$).

Tree foraging preference based on quantity of wells

To quantify the preference of the tree species, the number of wells was recorded as an order of magnitude. An analysis of variance did not show a significant difference in the number of holes by diameter for red maple ($F_{3,21} = 0.736$, $p > 0.05$), northern red oak ($F_{4,12} = 0.333$, $p > 0.05$), and paper birch ($F_{4,11} = 1.579$, $p > 0.05$).

Discussion

Tree Species Foraging Preference

The proportions of foraging preferences of Yellow-bellied Sapsucker varied significantly among different tree species. We only observed foraging on three tree species (red maple, paper birch, and northern red oak) in comparison to the nine tree species recorded. Assuming the energy expenditure of visiting a different tree within a five meter radius of the foraging tree is nearly negligible, this result supports the hypothesis that the Yellow-bellied Sapsucker is preferentially foraging on specific tree species. This is further supported by the Eberhardt (2000) study, which found that foraging was not influenced by a tree's distance from the nesting cavity. The majority of foraged trees that we observed were red maple, suggesting that this is the foraging tree preference of the Yellow-bellied Sapsucker. Multiple factors could influence this preference which is further discussed below.

Our study focused mainly on tree species preference of foraging Yellow-bellied Sapsucker and how it varies over time. Previous studies conducted at UMBS which differed temporally from ours differed in the preferences found. Including those studies, the foraging preference of the Yellow-bellied Sapsucker was primarily paper birch in April and May 1992-1993 (Eberhardt, 2000), red maple in late-May and early-June 2015, scots pine in July 1997 (McLenon, 1997), and paper birch in mid-June to August 1998 (Okoniewski, 1998). While these preferences seem to vary seasonally, the seasonality of preference may not be accurately measured due to the 17 years of succession that these forests have undergone since the most recent study of this kind. Therefore, the species available at each stage of succession and their relative age could influence the foraging preferences of the Yellow-bellied Sapsucker as discussed below.

Forest Succession

Throughout the study, we found a significant amount of sap wells on dead paper birch trees at the vicinity of the foraged trees. Based on these observations, we inferred that Yellow-bellied Sapsucker previously foraged on paper birch trees. However, although not statistically significant, currently red maple trees were most preferentially foraged on followed by paper birch and northern red oak trees. This potential change in foraging preference may be associated with forest succession. In this case, red maple tree is a late successional species while paper birch tree is an early successional species (Tester, 1995). Therefore, this infers that while the forest was in early successional stages and paper birch trees were abundant, Yellow-bellied Sapsuckers opportunistically used them as a foraging resource. However, in later successional stages once red maples have become more abundant, the birds alter their foraging preference to incorporate the changing abundance of tree species.

Tree foraging preference based on DBH

No significant difference in diameter was found between foraged and non-foraged trees within red maple, paper birch or northern red oak. However, all of the trees measured within a species seemed to be approximately the same age. The red maple trees in the sampled mixed hardwood forest were immature as the average DBH was 0.146 m and mature red maple trees are usually between 0.46 and 0.76 m in diameter (Hutnik and Yawney, 1961). Young trees have a higher amount of sapwood: the live, growing wood where the sap flows. Therefore, the sapsuckers would preferentially forage on younger trees with larger amounts of sapwood.

Similarly to red maple, the observed northern red oak trees were immature with an average diameter of 0.284 m while mature trees usually have diameters of 0.61 m to 0.91 m (Tirmenstein, 1991). On the other hand, the observed paper birch trees were mature with an average diameter of 0.24 m which is within the range of mature trees (0.2 m to 0.3 m, (Uchytil, 1991)). These patterns are consistent with the successional stages of this mixed hardwood forest as northern red oak and red maple are mid- and late-successional species, respectively and are therefore younger than the paper birch which is an early successional species (Tester, 1995).

Tree foraging preference based on quantity of wells

Using an analysis of variance we did not find a significant difference between the species of tree foraged on and the quantity of wells present. This could indicate that while Yellow-bellied Sapsuckers do have preference between foraged and non-foraged tree species, they do not have a preference among foraged tree species. Alternatively, while the majority of our diameter measurements for paper birch indicated maturity (Hutnik and Cunningham, 1965), all red maple (Hutnik and Yawney, 1961) and northern red oak diameters indicated immature trees (Tirmenstein, 1991). Therefore, this suggests that the mature paper birch trees have simply had

more years to accumulate wells while dominating earlier successional stages and if there was a preference for red maple or northern red oak, it would not appear upon quantitative analysis.

Conclusion

Statistical analysis revealed a difference in the foraged trees of Yellow-bellied Sapsuckers when compared by tree species. Though the diameter of foraged vs. non-foraged trees does not seem to influence sapsucker preference, we conclude that the differing age of tree species based on successional stage of the forest may have an effect. Future studies should aim to continue exploring the relationship between Yellow-bellied Sapsucker foraging preference and successional age of the forest. These should include dissecting the potentially differing influences of seasonality and successional stages and measuring seasonally varying physical characteristics of the tree species, such as sap flow. Additionally, though our study found no significant difference in the quantity of wells between foraged tree species, this could be due to the accumulation of wells over previous successional stages. This preference could be examined by measuring the accumulation of wells within a season on differing foraged tree species. In conclusion, it is clear that the foraged trees of Yellow-bellied Sapsuckers are not chosen arbitrarily. To more clearly understand this preference, more investigation on the confounding variables of seasonality and successional age of the forest would be beneficial.

Caveats

Due to time constraints on the study period, we obtained a limited sample size. Future results may be better supported with a larger sample size.

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Figures

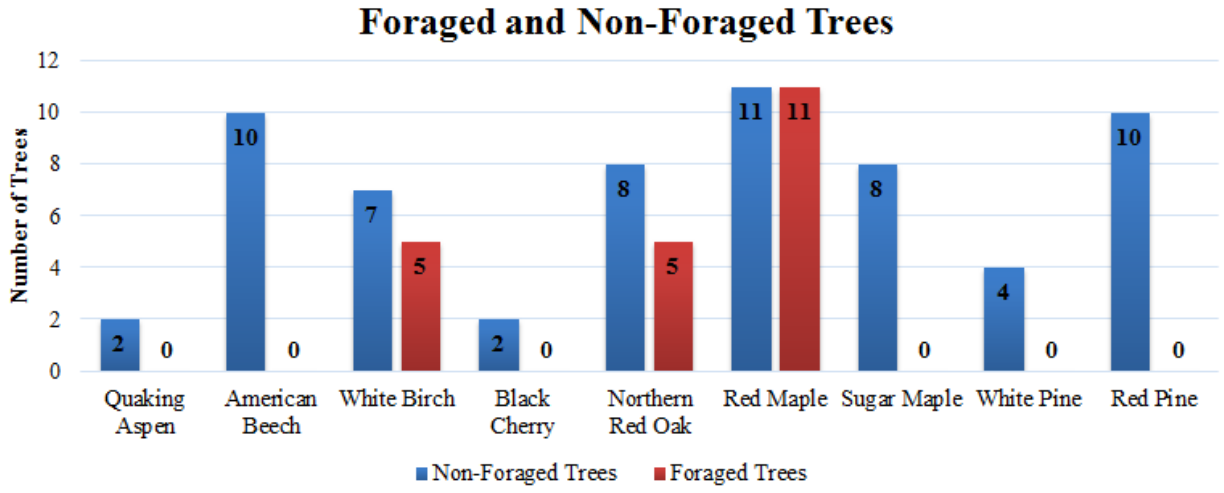

Figure 1: Number of foraged and non-foraged trees within each species: quaking aspen (*Populus tremuloides*), American beech (*Fagus grandifolia*), white birch (*Betula papyrifera*), black cherry (*Prunus serotina*), northern red oak (*Quercus rubra*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), white pine (*Pinus strobus*) and red pine (*Pinus resinosa*).

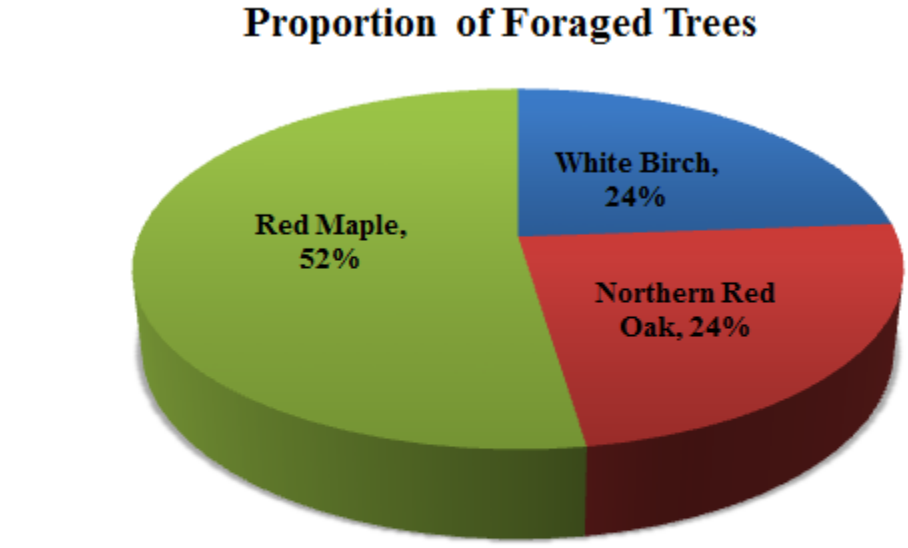

Figure 2: Proportion of foraged tree species: red maple, white birch and northern red oak.

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