

**The influence of red-naped sapsuckers on bird populations of riparian
willow communities**

Elizabeth Clark, REU
Chris Floyd, Mentor
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Abstract

In subalpine Colorado ecosystems, red-naped sapsuckers feed by excavating sap wells in shrubby willow branches. Many species of insects, birds, and mammals are known to feed from this sap. Previous studies on avian sap robbers suggest these sap wells may have a direct effect on bird communities. Furthermore, studies on the effects of yellow-bellied sapsucker sap wells on insect guilds suggest that sap wells may influence bird distribution indirectly through their influence on insect abundance. In this study, I investigated the relationship between sap wells and bird diversity. I found no effect of sap wells on bird diversity or on known avian sap robbers; however, other variables, such as drainage and proximity to a river, were found to affect bird diversity.

Introduction

In Intermountain western North America, woody riparian habitats sustain the highest avifaunal species richness (Dobkin 1994). Within these diverse and interrelated communities, the red-naped sapsucker (*Sphyrapicus nuchalis*) plays two distinct roles. First, *S. nuchalis* excavates nest cavities upon which several species of secondary cavity nesting birds depend (Daily et al 1993). In addition, the sapsuckers feed on sap by drilling small wells in shrubby willows located near the aspen nesting community; this sap is robbed by at least 40 other species, including warblers, hummingbirds, chipmunks, and many insects (Kilham 1953, Weigert 1959, Sutherland et al 1982, Miller et al 1983, Ehrlich et al 1988, Williams 1990). Because the secondary cavity nesters rely on, and sap robbers benefit from, the presence of sapsuckers in aspen and willow habitats, the system has been called a “double keystone complex” (Daily, et al 1993).

Sapsucker wells could influence bird diversity in willow communities indirectly by causing an increase in insect diversity or abundance. Extensive sapsucker wells may be an important nutrient source for the insects of these riparian willow communities because the sap of willows, like that of other deciduous trees, can be high in sucrose during the summer months when photosynthesis rates are elevated (Tate 1973). In

different ecosystems inhabited by yellow-bellied sapsuckers, sap wells in trees such as paper birch caused a significant increase in insect species richness and abundance (Rissler 1995). Furthermore, the sap wells eventually kill willow branches, altering the composition of dead plant material in a willow patch. Leaf litter in riparian communities often has significant effects on insect species richness, both positive and negative, depending on the relative amounts of litter. Therefore, an increase in dead willow branches due to sapsucker damage could also influence the composition of the insect community. It is possible that increases in insect abundance, resulting from running sap of new wells or from branch death after many seasons of damage, would in turn drive an increase in bird diversity and abundance in willow patches visited by sapsuckers.

It has been postulated that the removal of *S. nuchalis* would cause a cascade of biodiversity loss in the aspen and willow ecosystems (Daily, et al 1993); however, while Daily et al (1993) showed that secondary cavity nesters depend on sapsuckers, the specific contributions of sapsuckers to willow communities have not been measured. In the following study I investigated the relationship between both new and old *S. nuchalis* sap well density and bird diversity in riparian willow communities, predicting increases in avian diversity corresponding to the density of sapsucker wells.

Methods

This study was conducted in 25 willow patches of variable size, slope, edge, proximity to large water bodies, and drainage, located in the upper East River Valley near the Rocky Mountain Biological Laboratory (RMBL) in Gunnison County, Colorado.

Sites were selected to ensure full coverage of environmental conditions. I estimated sap well density using transects and estimated bird diversity using modified point counts.

Some willow patches were so large that it was impossible to observe the entire patch at once (because it is difficult to identify birds visually or by song at a distance of 50 meters or more); thus, several sites were subsampled. Of these samples, some were divided from the larger system by a physical boundary such as a road or river, while others were not physically separate from the larger system but were marked with tape as a separate section of study. The smaller sections of larger patches that were marked off with tape were chosen based on which section would most closely match the sizes and amount of edge of those smaller sections of larger systems that were physically separated from the larger patch.

To estimate sap well density in each willow patch, I measured the longest section of the patch and then randomly selected a location along that length to run a perpendicular transect through the patch. For example, if the patch was roughly rectangular, then I would measure the length of the rectangle and then walk the width of it at the chosen point. I chose the transect locations to be at 10-meter intervals within the length measurement; in sites with length measurements of greater than 69 meters, two transects were chosen. I walked these transects through the entire width of the willow patch at each location. Along each transect, the number of willow branches with new or old sapsucker damage within 0.5 m of the transect were counted. I used these measurements of width and length to estimate willow patch area and perimeter for analysis of edge and area effects.

Observations of the bird communities were taken using 10-min point counts conducted at randomly chosen points on the periphery of the willow stand. I modified point counts from standard procedure by standing outside of the willow patch (to ensure a better view because willows can often reach 3 or 4 meters in height, making point counts from inside the patches impractical) and counting only those birds seen or heard in the willow patch. If the randomly chosen point count location provided a poor view of the willow patch, I moved randomly left or right of the original point until a better view of the patch was obtained. Three 10-minute point counts were taken at each site. Each of these three point counts was taken on a different day and during a different time of the morning: from 0.5 to 1.5 hours, from 1.5 to 2.5 hours, and from 2.5 to 3.5 hours after sunrise. I used the mean number of each bird species and mean total bird individuals counted from the three point counts at each site to determine bird diversity using the Simpson's Index of Diversity. In addition, species richness was calculated as total number of bird species observed in the patch over the three point counts.

I used Simpson's Index to calculate bird Diversity (D), and Index of Diversity (1-D). I used this to run a regression for old, new, and combined (old plus new) sapsucker well densities by bird Index of Diversity, species richness, and abundance. In addition, I ran a regression for the abundance of rufous and broad-tailed hummingbirds, *Selasphorus rufus* and *S. platycerus*, (two of the three known avian sap robbers; the third was not observed in this study) by new sap well density. I then used a *t*-test for the abundance of hummingbirds in the presence or absence of new sap well density. Next I used regressions and one-way analyses of variance (ANOVA) to test the effects of other recorded willow patch variables, such as size, amount of edge, slope (flat, moderate, or

steep), proximity to river (adjacent, near, or far), and drainage (wet or dry) on bird diversity. Finally, I used two-way analyses of variance to test the effects of slope, drainage, and their interaction on bird diversity. I had to exclude steep sites from analysis because I did not have sufficient replication of steep sites.

Results

Sapsucker sap wells

I found no significant effects of new, old, or a total of both new and old sapsucker wells on bird diversity, abundance, or species richness in the observed willow communities ($P > 0.15$ for all). I also found no significant effects of new sap well density or presence on abundance or presence of broad-tailed and rufous hummingbirds ($P > 0.15$)

Other willow patch variables

I found a significant positive relationship between willow patch area and bird abundance ($p=0.0138$). There was also a significant effect of drainage on bird diversity ($p=0.0137$), where patches categorized as wet (containing running or standing water within the patch) had significantly higher diversity than patches categorized as dry (containing neither running nor standing water) (Fig. 1a). The proximity of the willow patches to a river was significantly correlated to bird abundance ($P=0.0388$) and species richness ($P=0.0329$), where willow patches adjacent to a river (one side < 5 meters from river) had less abundance and species richness than patches near to (< 50 m) and far from (>50 m) (Fig. 1b). No significant correlations were found between drainage or proximity

to river and area. However, a significant relationship was found between proximity to river and trees present ($p=0.0186$). Those sites adjacent to the river all had either only conifers (spruce/fir) within 20 meters of the patch or a mix of conifers and aspen; none of the sites adjacent to the river had only aspens or no nearby trees. Those sites far from the river had mostly aspen or no nearby trees, while those near had an equal number of aspen, conifers, or a mix.

Other variables (slope, edge) were not found to significantly affect bird diversity, species richness, or abundance.

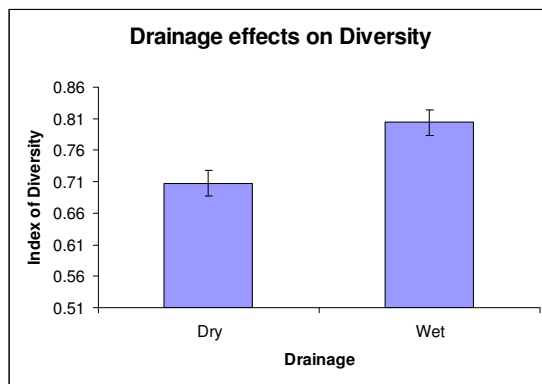


Figure 1a

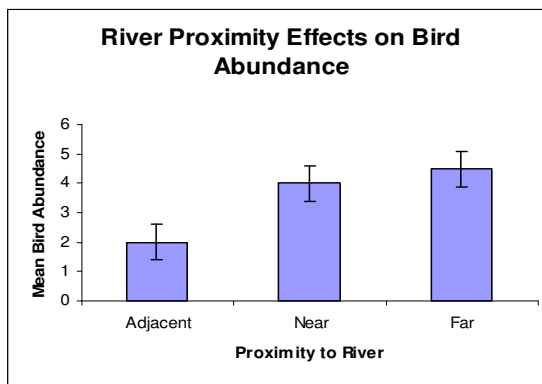


Figure 1b

Finally, one significant interaction was found between drainage and slope (two-way ANOVA), in which bird diversity was the dependent variable. Bird diversity in flat willow patches was high regardless of drainage; however, diversity in moderately sloped willow patches was significantly lower in dry patches than wet (see fig 2). No significant correlations were found between willow patch slope or drainage and proximity to river or area.

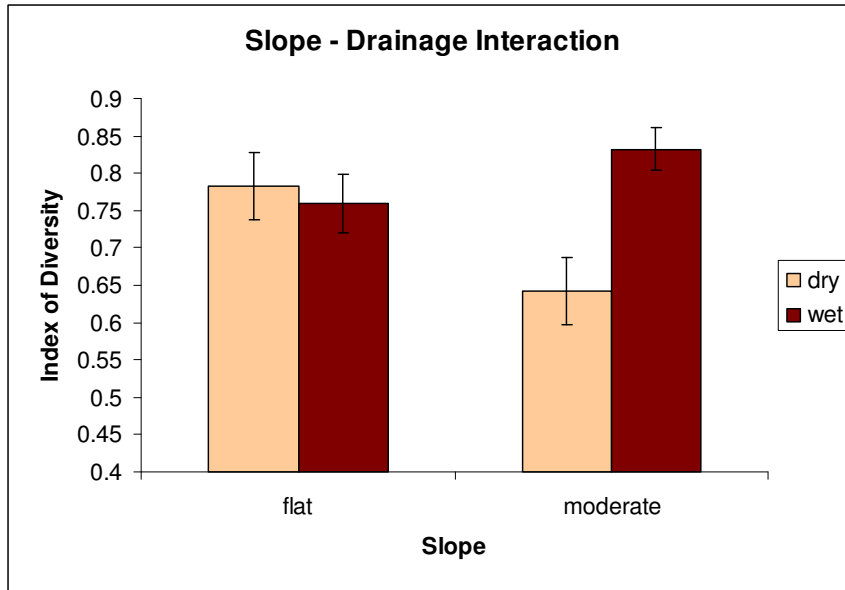


Figure 2

Discussion

Sapsucker sap wells

I find that neither new nor old *S. nuchalis* sap wells had a measurable effect on bird diversity, abundance, or species richness in riparian willow patches. Of the previously known avian sap robbers, the orange-crowned warbler, broad-tailed hummingbird and rufus hummingbird (Daily et al 1989), only the two hummingbird species were observed in this study. The presence or abundance of either species was unaffected by the presence or density of new sapsucker wells, indicating that other factors, such as nearby wildflowers, may have a greater effect on hummingbird distribution than the availability of another source of sugar. Furthermore, I observed the main mammalian sap robber, the least chipmunk (*Tamias minimus*), procuring sap from wells but also obtaining food from many other sources, such as willow flowers. Like the birds, chipmunks seem to benefit from sap wells as one of many food sources. My

findings suggest that avian sap robbers benefit from, but do not depend on, *S. nuchalis* sap wells.

New sap well density also had no effect on bird diversity as a whole, indicating that, if insect abundance or species richness was altered by the running sap, it was not enough to bring about changes in the bird community. However, the research on insect guilds near yellow-bellied sapsucker (*S. varius*) wells (Rissler et al 1995) provides good evidence that running sap wells influence the distribution of insects, making the investigation of insects near *S. nuchalis* sap wells a compelling question for future research.

Old sap well density also had no effect on bird diversity. This indicates that, if the abundance or diversity of litter-feeding insects was influenced by branch death from old sap wells, it was also not enough of an increase to drive an increase in bird diversity. While conducting transects through the willow patches, I observed that the majority of branch deaths occurred by other factors, such as avalanche damage or location at the base of the willow, and that compared to these other factors, the number of branch deaths due to sapsucker damage was insignificant. Further study on the relative abundance of branch deaths due to sapsucker damage may provide further insight into this interaction.

This study did not find a significant effect of *S. nuchalis* sap wells on bird diversity, making the possibility that these sap wells affect bird communities doubtful. However, because of the highly variable nature of the observed willow patches in this study, it is possible that other variables exerting greater influence over bird distribution drowned out any smaller effects of *S. nuchalis* wells. Further studies eliminating these variables by choosing willow patch sites of similar or identical size, proximity to river,

drainage, and nearby tree species may find a significant effect of sapsucker wells. More importantly, it is still possible that insect guilds are influenced by sap wells, particularly new wells with running sap.

Other willow patch variables

The relationship between drainage and bird diversity indicates that water conditions may be more important to the distribution of insects and birds than sap wells. It is likely that the higher bird diversity in wet willow patches than in dry patches is due to the abundance of insects that spawn in these water sources. It is possible that insect distribution within these wetter willow patches is determined by food sources such as sap wells, making a more detailed analysis of insect distributions within willow patches an interesting question for future research.

It is unclear why the willow patches adjacent to the river had lower abundance and species richness than others. Perhaps this is a function not of the river but of the nearby or adjacent conifers, which are home to many birds that may compete with willow birds for resources. Also, smaller birds of prey might hunt from conifers, making birds in these nearby willow patches more susceptible to predation.

It is also unclear why bird diversity in moderately sloped willow patches depends on drainage, while in flat patches diversity is high regardless of drainage. One possibility is that flatter patches provide a safer nesting environment for willow-nesting birds, making the higher abundance of insect food in wet, moderately sloped patches a factor that would cause more birds to nest in spite of non-ideal slope conditions. Any other

characteristics of sloped patches making them less desirable could be outweighed by the better food and water conditions in a wet, sloped patch.

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