

# **Forest Songbird Communities in the Adirondacks: Investigating Effects of Calcium Availability and Field-Testing an Automated Monitoring System**

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## **INTRODUCTION**

Fossil fuel emissions have led to environmental degradation in the northeastern US through the deposition of sulfate and nitrate ions in precipitation. This acidic deposition affects the calcium content of forest soils by leaching calcium out of the system. The Adirondack Mountains of northern New York have experienced elevated levels of long-term acidic deposition and are particularly sensitive to chronic soil calcium depletion. The depletion of soil calcium, an important macronutrient, has been linked to changes in plant and invertebrate communities, as well as to reproductive declines in some bird species. Most food items do not sufficiently meet the calcium requirements of songbirds; instead, breeding birds must seek out supplemental sources of calcium, such as snails and calcareous grit to support eggshell formation and bone development in nestlings. My internship objective was to investigate the effects of calcium availability on overall avian abundance and diversity in the Adirondack Mountains.

An additional objective for my internship was to evaluate the efficacy of microphone-based automated digital recording systems (ADRS). Use of ADRS may increase the number, consistency, and efficiency of time- and labor-constrained avian survey efforts, but little information is available on the effectiveness of ADRS. My specific goal was to determine if the probability of detecting birds using a particular ADRS was higher or lower than the probability of detecting birds using conventional point count surveys with human observers.

My internship was sponsored by Dr. Michale Glennon, Adirondack Landscape Science Coordinator for the Wildlife Conservation Society (WCS). In addition to contributing to the WCS Adirondack Program's mission of conserving environmental quality and community well-

being in the region, the data collected during the summer of 2012 greatly enhanced my Master's degree research.

## **METHODS**

I conducted point count surveys of bird communities at 15 upland northern hardwood forest sites representing a soil calcium gradient in the Adirondack Park from the end of May to the beginning of July in 2011 and 2012 (Supplementary Material, Fig. 1). We selected the sites to capture the full range of soil calcium in the Adirondack region. Prior studies had assessed snail, salamander, and vegetation communities at 12 of the sites and I conducted vegetation community surveys at the remaining sites. We obtained estimates of acidic deposition at our sites using a geospatial model (Ito et al. 2002). For each of the 15 sites, I calculated Simpson's Diversity Index and corrected species richness for sample size. As a preliminary analysis, I used raw counts as an index for bird abundance within 50m at each point and used linear regression to determine what species may have higher population densities at higher calcium sites.

During each point count survey in 2011, I simultaneously recorded with an ADRS unit consisting of an SM2 Terrestrial Acoustic Platform (Wildlife Acoustics, Inc., Concord, MA). There were some sites with substantial background noise, so I was also able to test whether the presence of interfering background noise affects ADRS surveys any more than conventional point count surveys. To interpret the recordings, I simultaneously viewed a spectrogram while listening to the recording (Supplementary Material, Fig. 2).

Detection probability is a measure of the probability that an observer detects an individual bird. I compared ADRS detection probabilities with those from the more traditional point count surveys by fitting data to a Huggins closed capture model that estimated separate detection probabilities for the two survey methods (model  $M_m$ ), separate detection probabilities

for each of the ten most common species (model  $M_s$ ), separate detection probabilities for each species within each survey method (model  $M_{sm}$ ), and to a model that did not distinguish between methods or species (model  $M_0$ ). I also included a variation on all previously mentioned models that included background noise as a covariate (models  $M_n$ ,  $M_{mn}$ ,  $M_{smn}$ , and  $M_{sn}$ ). I then used Akaike's Information Criterion for small sample sizes ( $AIC_c$ ) to determine which of the eight models best fit the survey data, which would indicate whether detection probabilities of the two methods differed and whether either method may be more sensitive to the presence of background noise.

### **PRELIMINARY RESULTS**

I observed 31 species of bird during my conventional point count surveys and 33 species using ADRS survey recordings. There was no relationship between species diversity or richness and soil calcium concentration or acidic deposition levels. In 2011, corvids (American Crow, Common Raven, and Blue Jay), flycatchers (Eastern Wood-Pewee, Least Flycatcher, and Eastern Phoebe), and nuthatches (Red-Breasted Nuthatch and White-Breasted Nuthatch) appeared to have significantly higher densities at higher calcium sites (Supplementary Material, Fig. 3).

In my analysis of detection probabilities for the two survey methods, there was strong support for the top model  $M_{sm}$ . Model  $M_{sm}$  estimated separate detection probabilities for each species within each survey method. In model  $M_{sm}$ , the detection probability using ADRS was 0.70, which is higher than the detection probability of 0.60 using point count surveys. For seven of the ten most common species,  $M_{sm}$  estimated a higher detection probability during ADRS surveys than during conventional point count surveys (Supplementary Material, Fig. 4). There was no support for models containing the background noise covariate.

## CONCLUSIONS

There was no significant relationship between songbird species richness or diversity and soil calcium concentration or acidic deposition levels. There are two potential explanations for the lack of relationship: 1) calcium availability and acidic deposition levels do not strongly affect the species composition for a particular site, or 2) some species may be highly tolerant of low-calcium availability while others are sensitive. Although species richness at a high calcium site may be the same as the richness at a very low calcium site, the actual species composition at those sites may be very different. There are some preliminary indications that certain groups of species may be more sensitive to calcium availability, such as flycatchers, corvids, and nuthatches. These groups have higher population densities at sites with higher levels of soil calcium.

There is evidence that ADRS may actually provide higher detection capabilities than traditional point count surveys, which may be due to the ability to re-listen to recordings without time constraints and to double-check identifications with visual and auditory resources such as birdsong databases. Background noise does not seem to affect the ADRS any more than conventional point count surveys. Conventional point count surveys have their advantages for particular species that call infrequently or locations where auditory detections are less important. But, especially in forested environments, ADRS may provide an opportunity to improve the number, consistency, and efficiency of survey efforts.

## ONGOING ANALYSIS

I will continue to analyze relationships between calcium availability and the abundance of specific species. Additionally, each species will be designated to one of four guilds to analyze differences among sites in guild abundance and diversity. The guild assignments will be based

on foraging strategy and dietary preferences. Knowing which groups of birds may be most sensitive to calcium availability may help determine potential mechanisms linking bird abundance to soil calcium availability.

Thus far, the comparison of bird survey methods has relied on a direct comparison of simultaneous recordings and point counts, but I also recorded four hours of birdsong two mornings at each site during the summer of 2011. I plan to investigate whether the presence of human observers may affect bird surveys and whether repeated, independent samples of ADRS may provide a different snapshot of bird communities than that provided by our repeated point counts.

#### **ACKNOWLEDGMENTS**

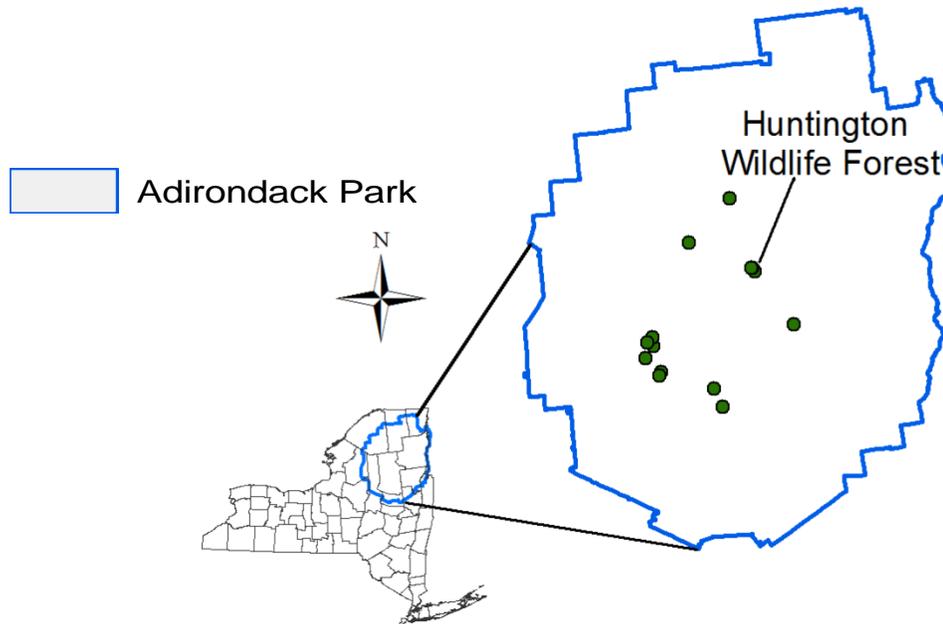
Valuable data collection and audio analysis during the summer of 2012 greatly enhanced the project and would not have been possible without the generous support of the Edna Bailey Sussman Foundation. The project also received essential funding from the Joseph and Joan Cullman Foundation, the Randolph G. Pack Environmental Institute, SUNY College of Environmental Science and Forestry, the SUNY-ESF Graduate Student Association, the Betty Moore Chamberlain Memorial Fund, and the USDA Forest Service Northeastern States Research Cooperative. I would especially like to thank my advisor, Dr. Colin Beier, my committee member Dr. James Gibbs, and my committee member and Wildlife Conservation Society sponsor Dr. Michale Glennon for their support and guidance.

#### **LITERATURE CITED**

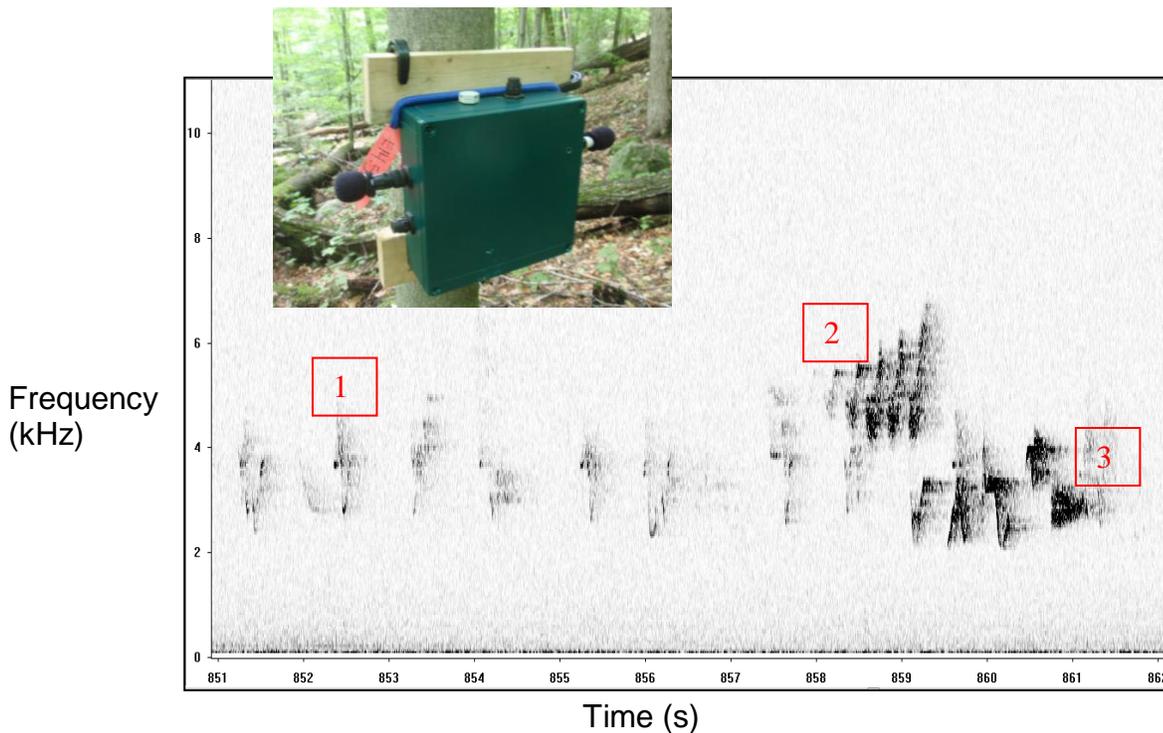
Ito M., M. J. Mitchell, and C. T. Driscoll. 2002. Spatial patterns of precipitation quantity and chemistry and air temperature in the Adirondack region of New York. *Atmospheric Environment* 36:1051-1062.

**SUPPLEMENTARY MATERIAL**

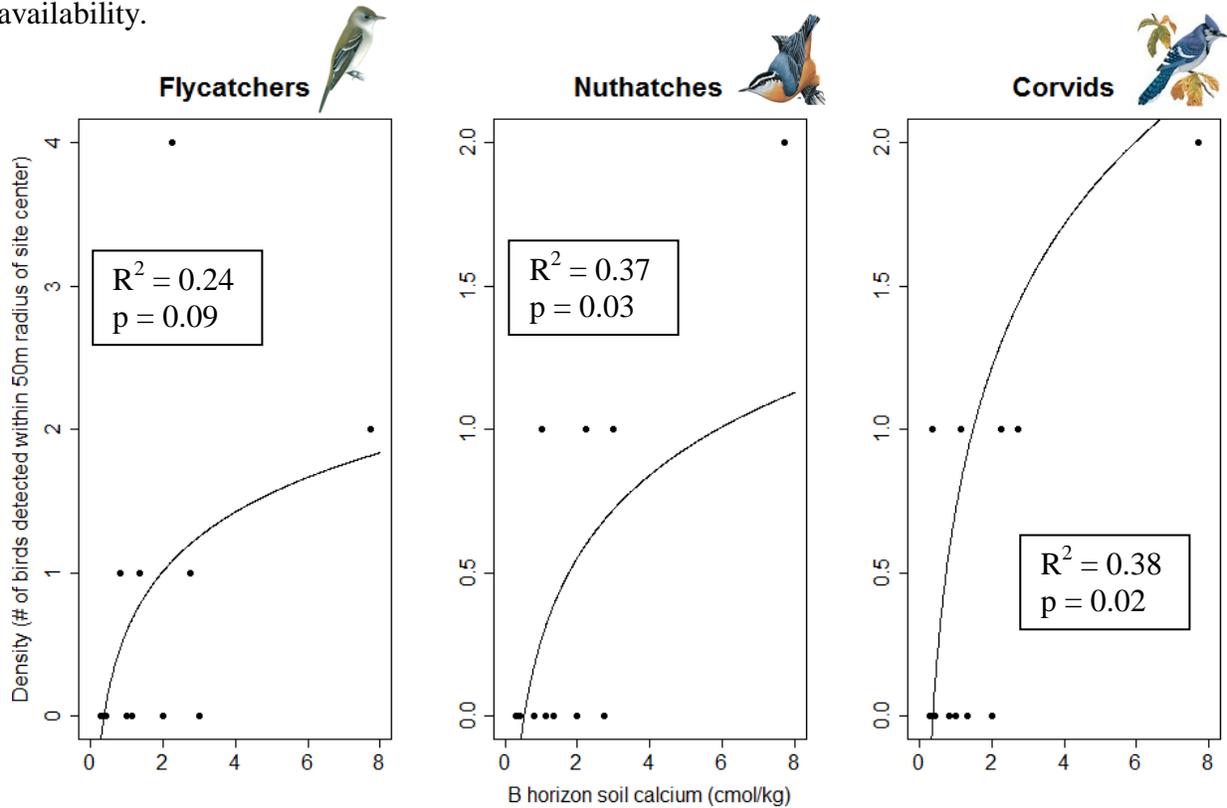
**Figure 1** Fifteen survey sites in the Adirondack Mountains of New York. All sites consist of similar upland hardwood vegetation located between 400 and 700 m in elevation.



**Figure 2** The ADRS unit and an example of a spectrogram visualizing the recorded songs of a Red-eyed Vireo (1), Black-throated Blue Warbler (2), and Scarlet Tanager (3).



**Figure 3** Density of flycatchers, corvids, and nuthatches increases with increasing calcium availability.



**Figure 4** Detection probabilities within each survey method for individual birds of each of the ten most common species. Estimates are derived from model  $M_{sm}$ . Standard error bars are provided. The figure also depicts the detection probability for the “average” bird within each survey method, “Overall.” An asterisk denotes species that did not satisfy certain model assumptions. For those asterisked species, the detection probabilities should be interpreted with caution.

