A Test of the Relative Abundance, Diversity and Distribution of Ants at the Vireo Preserve in Relation to Habitat Manipulation for the Black-capped Vireo (*Vireo atricapilla*)

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Purpose

To Identify if there are changes in diversity (species and abundance) of ants species. One concern of manipulating the habitat for the Black-capped Vireo is how this will influence the associated arthropod community that is used as a food source.

Introduction

Biodiversity is a measure of the integrity of life within a particular ecosystem. The interconnectedness of biodiversity is what maintains a healthy ecosystem (Ehrlich and Wilson 1991). The health of the ecosystem is not only important as a moral obligation to protect life and the numerous benefits that humans receive but that same biodiversity maintains a homeostasis of ecological services on our planet (Ehrlich and Wilson 1991). Invertebrates make up an overwhelming majority of biodiversity in any ecosystem and therefore should be included in any monitoring program (Wilson 1988,Taylor & Doran 2011). As a result, a measure of biodiversity is particularly useful in determining the effectiveness of conservation practices and the changes that they have on the ecosystem.

Arthropods are commonly being used in rapid biodiversity surveys for conservation purposes (Romero and Jaffe 1989, King and Porter 2005, Groc et al. 2007). Among the arthropods, ants have commonly served as the focal group for structured inventories of arthropod diversity and abundance for a number of reasons. Ants are good bio-indicators as they are diverse and abundant, and colonies are generally in a fixed position. Consisting up to 15 percent of the entire animal biomass, ants are thought to be a keystone taxon in the functioning of terrestrial ecosystems due to their impact on soil ventilation, plant-arthropod interactions, seed dispersal, and predation (Hölldobler and Wilson 1990, King and Porter 2005). Ants also serve as a good bio-indicator due to their sensitivity to environmental changes within an ecosystem, allowing conservation practices and their results to be better understood (Groc et al. 2010). A number of studies have tested protocols and sampling methods for ants and have identified efficient practices and methodologies for strict inventory or community characterization (Romero and Jaffe 1989, King and Porter 2005, Groc et al. 2007).

The Black Capped Vireo is an endangered, neo-tropical species that breeds in parts of Mexico, Oklahoma, and Texas (BCP 2007a). In 1996, the Balcones Canyonlands Preserves in western Travis County were established to mitigate the losses of vireo habitat due to urban expansion that resulted in habitat destruction. The Black Capped Vireo has historically had a healthy population at the Black-capped Vireo Research Area (also known as the Vireo

Preserve), but the populations have steadily decreased since 1987 (BCP 2007a). The ideal habitat for the Black-capped Vireo consists of greater density of deciduous vegetation from 0-2 meters, deciduous cover from 30-45%, total woody cover including Ashe juniper covering from 35-55%, heterogeneity of vegetation structure allowing light penetration, and openness not exceeding 65% (BCP 2007b). The City of Austin has maintained a section of the Vireo Preserve to reproduce the habitat of Black-capped Vireo. In this experiment, we examine the differences of ant biodiversity between the managed plot and the unmanaged plot.

To most easily determine the biodiversity of an ecosystem, we will use terrestrial invertebrates with a focus on ant populations due to their vast population sizes compared to vertebrates, diversity, and the ease of which they can be collected (Anderson 2004). We will test the biodiversity of two differently managed areas of the Balcones Canyonland Preserve, the Black Capped Vireo Preserve (managed) and the juniper/oak woodland (unmanaged).

Materials and methods

Study sites

Ant sampling took place during May 2014 at the Vireo Preserve, a segment of the Balcones Canyonland Preserve consisting of 214 acres. The Vireo Preserve is part of a dedicated macrosite north of Wild Basin in the western hills of Austin, Texas. The Vireo Preserve was established to maintain and preserve future sites of habitation for the endangered Black Capped Vireo.

Treatments

At the Vireo Preserve, we looked at two specific plots of land: managed and unmanaged. The managed plot of land was hand and mechanically cleared in 2011. Trees that were less than 15 feet in height and less than 8 inches diameter at breast height were cut if they fell under the list of target species. The list of target species included but was not limited to sumacs, silk tassel, yaupon holly, mountain laurel, live oaks, Ashe juniper, and persimmon. If there was a slope of greater than 15% than trees were hand cleared and less than 15% they were mechanically cleared. Mechanical and hand removal was done to encourage stump-sprouting of the existing woody vegetation (BCP Land Management Plan 2007). The unmaintained plot is a juniper-oak woodland/grassland dominated by *J. ashei* and *Q. buckleyi*. The tree canopy is closed containing dense understory of a variety of tree seedlings. There are a few open grasslands that become more abundant on slopes.

Sampling methods

To compare the two sites, we chose to use pitfall traps to perform a taxonomic evaluation of ant biodiversity between two sites. Evaluation of present ant species, particularly fire ant species, genus *Solenopsis*, found present within the Vireo Preserve are of particular interest. Red Imported Fire Ants (*Solenopsis invictus)*, classified as an invasive species, are known to disrupt the diversity of an ecosystem by taking advantage of recently disturbed sites.

The pitfall traps consisted of 50 ml test tubes placed within plastic pipes that have been dug into the ground; the traps were then filled ⅔ of the way with a diluted solution of non-toxic antifreeze. Pitfall traps were then set up in a four by five grid, set apart by a distance of ten meters. Each trap consists of a short (7cm) length of PCV pipe that contains an 80cc centrifuge tube with the top portion (grooved section) removed so as to fit in the PVC pipe (Fig. 1).



Figure 1: Pitfall Trap number 5 showing PVC insert in soil, cut centrifuge tube with cap, metal tag with blue stake wisker.

When not in use, the cut tube is switched out with a tube containing a screw cap so that the trap is closed (Fig. 2). Holes for the PVC pipe were created by hammering a 1 inch by 7 inch conduit nipple into the ground and then removing the nipple with soil inside (Fig. 3).



Figure 2: Pitfall trap showing centrifuge tube with cap;trap closed. Also shown is nail holding numbered metal tag and stake wisker to the left of the capped-tube.



Figure 3: Conduit nipple used to create hole for PVC pipe.

Each trap received a numbered metal tag, attached to a 15.24 cm nail (driven into the ground) by 24 gauge steel galvanized wire. Attached upright to each nail was a "blue stake whisker" to facilitate relocating of the trap. Each trap had a GPS location recorded to facilitate relocation (Appendix A). Traps removed due to natural forces, weather or animals, were replaced. After replacing broken or missing traps, all traps were left unbaited for a period of four days to avoid the digging-in effect. The traps were then baited with nontoxic propylene glycol and run for a period of six days. When not in use empty traps remained closed so as not to capture any organisms. Samples were collected in Whirl-Pak sample bags on May 19th, 2014. After the pitfall traps were collected, ants and any other arthropods were counted and sorted to species level. This research will document changes in the ant fauna in the treated compared to untreated area and how this may impact the terrestrial community in the treated areas.

Results/Discussion

All ants were curated and identified to species level and housed at Wild Basin Creative Research Center. Species were counted and photographed to confirm identification.

*Analyse*s

Pitfall traps yielded 17 species of ants at the Vireo Preserve, totaling 579 individual ants. Of the ants collected, a majority of the individuals consisted of either *Forelius pruinosus* (265 individuals) or *Pheidole dentata* (149 individuals). Both the number of distinct species and the total abundance of ants has decreased from the previous year of study. In comparison, in 2013, 23 distinct species of ants were collected with a total of 1,096 individual ants. The number of *Solenopsis invicta* individuals has decreased from previous years of study.

The unmanaged area of the Vireo Preserve has a much more even diversity index than the recently (2011) managed areas for the Vireo. Disturbed areas generally take several years (depending on the species) for species composition and recruitment to become more stable.

Table 1: Different species observed at both managed and unmanaged areas of the vireo preserve.

Ant Species	Site A (managed)	Site B (unmanaged)
Campanotus festinatus	3	1
Campanotus sayi	0	1
Crematogaster punctulata	0	11
Cyphomyrmex americana	1	0
Forelius mccooki	1	0
Forelius pruinosus	61	204
Labidus coecus latreille	0	5
Monomorium minimum	16	10
Neivamyrmex fallax	0	2
Pheidole dentata	80	69
Pheidole hyatti	12	16
Pheidole tetra	5	19
Solenopsis aurea	0	4
Solenopsis geminata	1	0
Solenopsis invicta	23	5
Solenopsis xyloni	14	25
Tachymyrmex turrifex	1	0
Total Ants Per Site	218	372
Number of Species Per Site	13	13

To evaluate the differences between the two plots of land at the Vireo Preserve, a multi-response permutation procedure (MRPP) and Dufrêne and Legendre's indicator species analysis for the managed and unmanaged plot were established. A MRPP is a nonparametric procedure useful for testing the hypothesis of no difference between two groups; in this case, the groups are defined as the unmanaged and managed plots of land at the Vireo Preserve . An indicator species analysis was run to assess at what level certain species of ants correspond to either the unmanaged or managed plots of land. The statistical package, PC-ORD, was to run both procedures.

The MRRP was run to assess the differences of species composition between the managed and unmanaged plots of land at the Vireo Preserve. The Sørensen (Bray-Curtis) distance measure was used to compare the similarity between the two groups, which consisted of twenty pitfalls each. When all items are identical within groups, observed delta (δ) = 0 and A = 1. Chance-corrected within-group agreement (A) was measured at A = 0.00172128 and δ = 0.65265039. There is little within group similarity (A) due to the variety of species at each site and the clustering of each within group difference (δ) is relatively high. The probability of a smaller or equal delta, p = 0.35737143. As a result, we accept the null hypothesis that there is no difference between the groups. This outcome may be the result of a largely reduced sample size from the previous year; however, it still proves useful in assessing the preserve.

Dufrêne and Legendre's indicator species analysis is used to determine indicator values for species within groups, either managed or unmanaged sites. The indicator species analysis combines information on species abundance and the degree to what the species represents a particular group. A perfect indicator species for a group will only ever show up in that particular group (McCune, Grace and Urban, 2002). To randomize the data, a Monte Carlo test was run using 4,999 permutations. The indicator species analysis revealed there to be only one significant indicator species (p=0.0092), *Solenopsis invicta*, having an indicator value (*IV*) of 47.3. As a result, the presence of *Solenopsis invicta* strongly designates the presence of managed habitat compared to unmanaged habitat at the Black Capped Vireo Preserve

To further assess the data in comparison to the previous year's, a Simpson's diversity index, the method used previously, was run to assess index differences in the span of a year. Simpson diversity index ranges from 0-1. Zero being no diversity and 1 being the most diverse. Most diverse is defined by Simpson diversity index as have the same number of individuals within each species. In 2013, the Simpson diversity index (*D*) for the managed area at the Vireo Preserve was D = 0.1208. This year, 2014, the diversity had a significant increase to D = 0.7667. The majority of this increase can be attributed to the significant decline in the dominant species, *Pheidole dentata*, from the previous year (435 individuals to 80 individuals), allowing for more even species distribution at the managed site. In 2013, the diversity index of the unmanaged area of the Vireo Preserve was D = 0.6426. In 2014, the diversity index for the unmanaged area of the Vireo Preserve increased to D = 0.6556. While the diversity index differences in 2014 between the two sites are not significant ($p=0.8066$), it is interesting to see the diversity index value of the managed site increase significantly from the previous year. Reasons for this significant increase are diverse and can include, but are not limited to, changes in weather patterns and plant-arthropod community stabilization.

With a visual scan of the managed area of the Vireo Preserve, the number and type of different plants and insects seem to be much more diverse compared to the unmanaged area. As the system stabilizes, we would predict the managed area would have more diverse set of species because the food source is more diverse. A thorough plant community analyses should be conducted at each site and compared to previous data if available.

Assessment

This project has helped me to further my research from the previous summer. This opportunity has let me expand the robustness of research that will, hopefully, ultimately conclude with a possible submission for research publication. Additionally, the research has allowed for a more thorough assessment of management to the Black Capped Vireo Preserve. I would strongly recommend this research to my peers, especially to those who want the opportunity to work outside and with great individuals. If I am permitted, I would like to continue this research in my final summer at St. Edward's University.

Citations

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Appendix A: Map of pitfall trap arrays in the two different treatment areas. Plot 1A has 20 pitfalls in the vireo managed area and Plot 1B has 20 pitfalls in the unmanaged area.

