SMALL MAMMAL DIVERSITY AND VARYING HABITAT

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Small Mammal Diversity and Varying Habitat. (May 2015)

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Few studies have been conducted related to mammalian diversity in the transitional montane cloud forest region of Costa Rica. It is critical that the void in available data be filled in order to support future research efforts. In the summer of 2014 I completed data collection for a population abundance analysis of small and medium mammals in four different habitat zones of the montane cloud forest. The purpose of this research is to determine what differences exist in species richness and population density between residential, tree plantation, secondary forest, and primary forest habitats in the area. The four habitats represent different stages of human development on forested land, with primary forest being historically un-degraded habitat, secondary forest being formerly degraded habitat, plantation representing an agroforested crop land, and residential being a completely human-controlled degraded habitat.

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CHAPTER I

INTRODUCTION

Agroforestry is an important tool in combating deforestation's effect on biodiversity in tropical hotspots [1]. Agroforestry is a form of sustainable agriculture where crops are planted under existing canopy. Agroforestry has been a main subject of conservation research in Costa Rica since the government installment of the Forestry Bond Certificate in Advance in 1988, and the Forestry Development Fund in 1989. These programs reward farmers for varying the levels of intensity of land conservation practices that they implement on their property.

Agroforestry's success in Central America is pertinent to conservation efforts. It is thought that agroforested crop areas create small, biodiversity friendly habitats by creating a viable biological corridor among protected areas and eventually between North and South America while still allowing for human agricultural production. While these programs have been an effective incentive for farmers to reforest their land, it is still an ongoing research topic as to whether the corridors allow for an effective dispersal of biodiversity. Mammalian studies represent only 5% of articles published concerning the effect of agroforestry on biodiversity [2].

1.1 Background on Small Mammal Ecology

This research studies the impact that varying stages of human development have on small and medium body-size mammal populations on the Caribbean side of the montane cloud forest of Costa Rica. Endemic small and medium mammals are considered a universal indicator of forest success [3] Burrowing species aerate soil, insectivores control insect populations, frugivores disperse seeds and scansorial species are appreciated for their ability to disperse spores and, via epizoochory, seeds throughout the forest floor and underbrush. Small mammals also provide a key prey source for forest predators. Species richness and diversity are strong positive indicators of forest floor health. Multiple studies have been conducted in many regions assessing the health of small mammal and rodent populations in order to analyze conservation success. [3,4,5,6] These studies indicate that assessing the health of small mammal populations is a successful tool in establishing the ecological health of a habitat. The species and size of the small mammals found in a habitat are also indicators of that's habitat's ecological success. Larger rodent species are less resistant to habitat change and degradation; therefore, specimen size can be an indicator for the biological health of the habitat. [7]

1.2 Relevance of Research to Costa Rica Ecology and Conservation

Costa Rica is a key area for conservation research since it hosts an abundance of biodiversity and is a major part of the Mesoamerican Biological Corridor. Costa Rica makes a large proportion of its national income from ecotourism [8], providing the country with a significant incentive to protect its natural wildlife and restore its biodiversity. This is fortunate for conservationists as Costa Rica makes up a large proportion of the land funnel that serves as the only means of movement for terrestrial species between South and Central America. Systems of smaller corridors must remain intact in order to provide adequate movement of species through the Mesoamerican Biological Corridor.

In recognizing the value of ecotourism to Costa Rica's economy, the government implemented the Payments for Environmental Services program (PES) in 1997. PES rewards landowners monetarily for their various land usages that counter-deforestation or increase reforestation. These different usages could include not cutting already existing primary forest, restoring cut primary forest areas to secondary forest, or implementing shade grown crops (agroforestry) as opposed to traditional agricultural fields. Studies have shown that landowners participating in the PES program have higher forest cover on their land than those not participating, and it has been estimated that in 2005, primary forest cover in Costa Rica was 10% higher than it would have been without the PES program. [9]

CHAPTER II

METHODS

Four habitats were sampled for small mammalian population abundances during the month of August, 2014. Each habitat expressed different stages of deforestation and post-deforestation regrowth. A representative residential area was sampled around the Soltis Research center; it has been completely deforested for human residential development. A tree plantation, close to the Soltis center, was sampled to provide an agroforested environment. Agroforested areas are areas that have been completely deforested, and replanted with no undergrowth. Instead the undergrowth areas are utilized for crops. The third habitat was a secondary forest, which is more densely vegetated than the tree plantation. This area was completely deforested approximately 30 years ago, and since has been allowed to grow back with thin, sparsely situated trees and moderate underbrush. Lastly, the primary forest is the most densely vegetated sampled area and has never been deforested. The primary forest provides a control for historic population and diversity.

Each of the four habitats were sampled sequentially for 5 days each. One hundred Sherman® and 4 Tomahawk® traps were baited each evening at approximately 16:00 o'clock and checked each morning at approximately 05:30 o'clock. Sherman traps were baited with a mixture of oats and peanut butter. Tomahawk traps were baited with canned tuna. Each captured specimen was measured for weight in a capture bag (g) with a Pesola scale. Ear length (cm), tail length (cm), body length (cm), and hind foot length (cm) were measured with a caliper ruler. The weight of each specimen was ascertained by subtracting the weight of the bag from the weight of each specimen measured while in the bag. Pictures were taken of the dorsal, ventral, posterior, and anterior of each specimen. Each specimen was then released in the area where it was captured and data collected during processing was used for species identification.

Picture 1:Specimen being measured for body length with caliper ruler

Picture 2: specimen inside Sherman trap

The unique trap number in which each specimen was caught was recorded. This unique number corresponds to the location of each trap which was recorded with a Garmin GPSmap 78® GPS. The recorded data included the location of each trap and whether the trap was sprung or not sprung. Sprung traps were investigated for contents. In some cases, traps sprung without capturing a small mammal, in which case the incident was recorded as a null event. A map was generated on ArcMap to display the trapping area and recorded. The data analysis was performed with Python, and the Python-based Pandas library was used specifically for data import and manipulation. [10]

CHAPTER III

RESULTS

3.1 **Species captured**

Eight different species were captured among all habitats (Table 1). This included seven rodent species and one marsupial (*D. virginiana*). An "X" indicates the presence of a species in each of the four habitats. No species were captured in the primary forest. Small numbers of captures/species precludes any comparison of capture success on a specie-specific basis; for subsequent analyses we evaluate community level captures of small mammals by pooling all species.

Species Captured	**Primary Forest**	**Secondary Forest**	**Tree Plantation**	**Residential**
Didelphis virginiana				X
Heteromys desmarestianus				X
Heteromys oresterus				X
Sigmodon hirsutus				X
Oligorzomys fulvescens		X	X	X
Melanomys calignosus		X	X	
Reithrodontomys sumichrasti			X	
Oryzomys aphrastus		X		

Table 1: Species captured in each habitat

3.2 Spatial analyses

Population relative abundance is evaluated by assessing the frequency of captured small mammals in each region, shown in Figure 1. White dots represent the primary forest transect, green dots the secondary forest, blue residential and yellow the tree plantation.

Figure 1: Map of trap placement generated by ArcGIS

3.3 Trapping results (population abundance all species pooled)

Table 2 shows the total results of the data collection. The total samples indicate the total number of traps set in each specific region. For example, the residential region had a total of 700 traps set resulting from 7 individual days of 100 traps set each day. The table also shows sprung traps indicating the total number of traps which were sprung, the number of specimens caught in the traps, and the resulting sprung traps which were found to be empty.

	Primary Forest	Secondary Forest	Tree Plantation	Residential
Total Samples	515	515	618	700
Sprung Traps	5	34	31	75
Specimens Caught	0	10	17	12
Sprung without Catch	5	24	14	63

Table 2: Bulk data collected over 28 day period.

The first analysis, seen in Table 3, was performed on the known captured samples pooled across all species. This provides a very rough index of the small mammal community abundance in each of the four habitats. The sampling ratio specifies the fraction of traps set in each region compared to all of the traps set over the 28 day period. A weighting factor can be generated to provide normalization based on the bias in sampling since, for example, the residential region is sampled more than any other region. The success rate is determined by computing the ratio of total number of successful captures to the total number of samples for each region. The total hit ratio shows the fraction of samples caught in the region over the total number of samples for all regions. The sample hit ratio is the ratio of samples caught in each region over all of the samples caught for all regions. Finally, the weighted sample hit ratio weights the sample catch ratio to account for the bias in the number of samples for each region.

	Primary Forest	**Secondary Forest**	**Tree Plantation**	**Residential**
Sampling Ratio	0.2193	0.2193	0.2632	0.2981
Success Rate	0.0000	0.0194	0.0275	0.0171
Total Hit Ratio	0.0000	0.0043	0.0072	0.0051
Sample Hit Ratio	0.0000	0.2564	0.4359	0.3077
Weighted Sample Hit Ratio	0.0000	0.3485	0.4937	0.3077
Weighting Factors	1.3592	1.3592	1.1327	1.0000

Table 3: Data analysis results for known capture events.

Since many sprung traps did not result in a successful captured small mammal, it may be important to assess these results to indicate the activity in each region. The sprung trap may have been sprung for a variety of reasons:

- Improperly set

- Environmental factors such as heavy insects or rain drops triggering the trap
- Triggered by a specimen but failed to capture the specimen

The results of the total sprung trap analysis is shown in Table 3. The weighting factor used for this analysis is the same for the known capture events shown in Table 2.

	Primary Forest	Secondary Forest	Tree Plantation	Residential
Sampling Ratio	0.2193	0.2193	0.2632	0.2981
Success Rate	0.0097	0.0660	0.0502	0.1071
Total Hit Ratio	0.0021	0.0145	0.0132	0.0319
Sample Hit Ratio	0.0345	0.2345	0.2138	0.5172
Weighted Sample Hit Ratio	0.0469	0.3187	0.2422	0.5172
Weighting Factors	1.3592	1.3592	1.1327	1.0000

Table 4: Data analysis results for all sprung traps.

CHAPTER IV

DISCUSSION

Small mammals were captured in all habitats except for primary forest. Low capture success is typical of moist tropical forest habitat, frequently less than 3 % (12). In addition, many small mammal species in forested habitat are scansorial and arboreal, so it is not surprising that those species would miss capture. Habitats with some varying level of disturbance were most successful in capturing small mammals. While trapping in the residential habitat area and the plantation habitat area, the traps that generally had the best success were set up along edge habitats such as strips of foliage along pathways and roads. It is possible that small mammals are more abundant in the forested areas, but they had not been confined to small amounts of suitable area by human degradation, as was the case where only patches of cover remain. It would therefore be more likely that a trap placed adjacent to these patches would sample a higher concentration of small mammals.

This differential capture success could also be related to a particular species that is common in altered habitats having high abundances there. Therefore this could be driven by one common species. Frequently generalist species can reach high abundance in altered habitats. [11] As the Table of captured species indicates, a large number of captured specimens in disturbed or altered habitats were identified as being *Oligorzomys fulvescens*, known to favor forest edge and second growth habitats (13).

If this study were to be repeated, it is suggested that traps be placed similar to a grid-like pattern in each habitat in order to minimize preferential placement along edge habitat areas.

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