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Effects of ecotourism on mammal diversity in the Monteverde cloud forest preserve

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ABSTRACT

Ecotourism is an increasingly popular way to promote and conserve biodiversity. Ecotourism provides a source of income, allowing reserves to promote education and afford protection. The downside to ecotourism is increased human activity, which can have negative impacts on local flora and fauna. I sampled mammal diversity at two sites in the Monteverde Cloud Forest Reserve; one site that is commonly visited by tourists, and one site that is never visited by tourists, using track plots and transects. Mammal abundance and densities were slightly higher on trails frequently used by tourists. However, using the Shannon-Weiner diversity index, I found a significant difference in diversity of mammals between the two trails. The lower impacted trail had a higher diversity (H'=1.689) than the moderately impacted trail (H"=0.254). I concluded that confining ecotourism to limited areas of activity is probably the ideal compromise and is necessary in order to protect the rest of the reserve. The benefits of ecotourism and education in the Monteverde Cloud Forest Reserve are probably worth the negative impacts, so long as the negative impacts are confined to small areas and are managed appropriately.

RESUMEN

El ecoturismo ha incrementado como una manera popular de conservar la biodiversidad. Este provee una fuente de ingreso económico permitiendo a las Instituciones encargadas de la conservación la posibilidad de promover la educación y subvencionar la protección de los recursos naturales. La desventaja del ecoturismo es el aumento en la presencia humana en zonas protegidas, lo que puede tener efectos negativos sobre la flora y fauna locales. Se midió la diversidad de mamíferos en dos sitios en la Reserva del Bosque Nuboso Monteverde. Se seleccionó un sitio comúnmente visitado por turista y uno que es de acceso limitado a ellos. Para este propósito se usaron transectos y trampas para huellas. La abundancia y diversidad de mamíferos fue levemente mayor en el sendero de menos impacto humano. Al utilizar los índices de diversidad Shannon-Weiner, se determinó una diferencia significativa en la diversidad de mamíferos entre los dos senderos. El sendero de menor impacto presentó un mayor diversidad (H´=1.689) que el sendero de mayor impacto (H´´= 0.254). Se concluyó que confinar la actividad humana a áreas limitadas es probablemente el compromiso ideal y es necesario para proteger el resto de la Reserva. Los beneficios del ecoturismo y la educación en la Reserva del Bosque Nuboso Monteverde probablemente se contrarresten con los impactos negativos siempre y cuando estos estén limitados a áreas pequeñas que estén bajo el manejo apropiado.

INTRODUCTION

In the last decade, the international tourism industry has become increasingly popular, generating in excess of $444 billion USD per year (Vanasselt 2001). Nature-based tourism may comprise 40-60% of these expenditures and is increasing 10-30% annually (Vanasselt 2001). Ideally, ecotourists learn about the habitats they visit, provide donations to conserve the areas, and create income for surrounding communities (Jaffe 2006). While ecotourism may increase money for conservation efforts, it also increases potentially harmful anthropogenic influences, like increasing air pollution, litter and

habitat fragmentation (Vanasselt 2001). Ecotourism may be much less destructive compared to other human activities, but considering the increasing number of people who visit formerly undisturbed and ecologically fragile environments, ecotourism could be a problem for the biodiversity it seeks to protect.

For example, Monteverde, Costa Rica has an estimated 200,000 tourists visiting annually, each of whom spends an average of two days in the area (Haley 2006). The Monteverde Cloud Forest Preserve has around 74,000 visitors annually (Haley 2006). With these large amounts of tourists, how has this human presence in the Monteverde Cloud Forest Reserve affected mammalian diversity in the area?

I believe mammals have the right to exist in their own right and tourism does not have the right to disrupt mammals. I want to discover how human presence in the Monteverde Cloud Forest Reserve is affecting mammal diversity, abundance and densities.

METHODS

Currently, tourists are only allowed on 2% of the total Cloud Forest Preserve and are limited in number, with 150 people permitted in the reserve at any one time (Haley 2006). To investigate the effect of tourism on mammal populations, I selected two sites in the Monteverde Cloud Forest Reserve. The Monteverde Cloud Forest Reserve is a premontane rain forest on the Continental Divide of the Tilaran Mountain Range of Costa Rica, at 1500-1800 m (Aylward 2996)(Figure 1). This reserve receives between 70,000 and 80,000 visitors per year (Haley 2006). Sendero Bosque Nuboso and Sendero Pantanoso trails are in the Triangle and are visited by over 20,000 tourists per year (Haley 2006). These trails go through old growth forest and have little infrastructure. Half of the Sendero Bosque Nuboso and the Sendero Pantanose trails have cinder block pathways. The trails do not have handrails and is about 1.5 meters wide. I refer to these trails as the "moderate impact trail". I also studied a research trail that was similar to eye, in terms of general forest structure and age, but is not used by tourists and rarely by employees of the reserve (Figure 1). Both trails were sampled for mammal presence between 25 October and 18 November 2010. I indentified all mammals using field guides and by talking with staff at the reserve.

I used footprint traps and transects to survey mammals in the area. Both methods represent an inexpensive and noninvasive method to survey mammals, which makes them an ideal tool for assessing activity. Footprint traps consisted of an approximately 1 m^2 cleared and smoothed square of mud. Bait was not used to avoid bias. On 25 October 10 footprint traps were set up at 60 pace intervals and set back approximately 25 paces from the both tails studied. I visited traps daily and identified, photographed, and casted (with plaster) any mammal track within the plot. Plots with tracks were subsequently repaired smoothed after each visit. Furthermore, during my study it rained consistently. Thus many animal tracks were washed away and could not be observed. I would expect to see more tracks if study was repeated in the dry season, and this repetition is encouraged for future studies. Transects may also be biased towards large mammals. Larger mammals are easier to detect than smaller ones. Small mammals are often hidden by vegetation. Regardless of such inconsistencies, transect census is still considered the best method to estimate overall mammal densities in rainforest (Louise Emmons1984).

In addition to track plots, I walked timed transects every morning. Walking transects consisted of slowly walking for two hours while scanning the forest for mammals and signs of mammals. Around every fifty steps I would stop and look around to aid in finding mammals. Upon visual observation of a mammal I recorded the date, time, transect number, species name, number of individuals present, and the perpendicular distance of the animal from the center of the transect.

To examine species abundance I checked track plots, and visually searched for mammals. I recorded both the species presence and the number of species present, assuming each track and sighting was independent. Species seen more than 8 times were considered common, species seen 5 times or less were considered uncommon and if only seen 2 times or less were considered rare. I categorized mammals as common, uncommon or rare for my tables. I used the Shannon-Weiner diversity index to examine differences in mammal diversity across study sites. In addition, I examined mammal densities, I using the statistical equation D=n/2Lw, where:

"D" denotes the density of mammals in the area.
"n" is the number of individuals counted within transect.
"L" length of the transect, and
"w" is the mean perpendicular distances of the organism from transect line (Wakeley, J.S. 1987).

RESULTS

Species- I recorded the presence of 7 different mammalian species in the low impact trail. These species included the paca *(Cuniculus paca)*, agouti *(Dasyprocta punctata)*, red brocket deer *(Mazama americane)*, collared peccary *(Tayassu tajacu)*, puma *(Puma concolor)*, white-nosed coati *(Nasua narica)*, and variegated squirrel *(Sciurus variegatoides)*. I recorded the collared peccary, red brocket deer and puma using track plots. I observed the paca, agouti, white-nosed coati and variegated squirrel walking transects. On the moderate impact trail, I recorded three species of mammals, including puma, white-nosed coati, and nine-banded long-nosed armadillo. The puma and nine-banded long-nosed armadillo were recorded using track plots, and white-nosed coatis were observed walking transects.

Abundance- I found that in the low impact trail the paca was uncommon observed on 3 times out of my 16 visits. The agouti was found to be uncommon appearing 5 times. The red-brocket deer and collared peccary were found to be rare and were only observed 2 times. The puma was also rare observed only once. The white-nosed coati was common and was observed 10 times. The variegated squirrel was common and was observed 9 times.

On the moderate impact trail, I found the white-nosed coati to be common, appearing 16 of my 16 visits. The nine-banded long-nosed armadillo were rare and were only observed 1 time. The puma appeared to be rare and was only observed 1 time (Table 2).

Diversity- using abundance of mammals I found that Trails differed significantly in species diversity ($t=7.33$, $df= 167.40$, $p< .001$). A significant difference was found using the Shannon-Weiner diversity index. The lower impact trail had a higher diversity or mammals ($H' =1.689$) than the moderately impacted trail ($H'=0.254$).

Mammalian Densities- Using the Wakeley density equation the density of *Cuniculus paca* for low impact trail was calculated to be 150 individuals. *Dasyprocta punctata* had an estimated density of 278. *Nasua narica* had an estimated density of 1,600. *Sciurus variegatoides* had a calculated density of 646. For the moderate impacted trail the estimated density was 2,833 of *Nasua rarica*. All calculated densities are the estimated densities of an area about 1 km^2. But for each species each area is a little different, since the Wakeley equation uses transect length multiplied by average distance of mammal species from the transect. Furthermore, for animals only tracked or observed once or twice the mammalian density equation was not accurate and densities are not included.

Discussion

My data shows that mammal diversity is altered due to ecotourism in the Monteverde Cloud Forest Reserve. Areas with high amounts of tourists had a greater abundance of mammals but very low diversity. However, I do not believe the reserve should stop tourists from entering the reserve.

Each species present may respond differently to human presence. Overall, the trail frequently visited by tourists had large numbers of white-nosed coatis. I believe that they were common on trails with tourism for a couple of reasons. For one, white-nosed coatis are not afraid of most tourists. I saw on many occasions white-nosed coatis walking close to tourists and seem unaffected. Furthermore, white-nosed coatis are attracted to trash. White-nosed coatis could probably smell refuse deposited by tourists and were trying to find food. The puma was recorded on both trails. Showing that pumas are still around the reserve and are not greatly affected by tourists. Agoutis, pacas, collared peccaries, red brocket deer, and variegated squirrels seemed to avoid areas with tourism. I believe these mammals feel threatened around people and prefer to avoid areas with high numbers of tourists.

Although the trends reported in this study are clear-cut, project methodology may have influenced the differing composition of species between the restricted site and the Sendero Bosquw Nuboso and Sendero Pantanoso trails. Track plots, unless made of soft sand, (which is not possible in areas with high amounts of rain) could not record animals with a low body weight. Future studies could use small mammal trapping to catch mammals that were low in body weight.

Some people contend that Monteverde Cloud Forest Preserve should be completely closed to tourism and kept free of human impact (Shrimp 2003). However, since ecotourism is a primary source of income, such restrictions are unlikely to occur. Currently, tourists are only allowed on 2% of the total Cloud Forest Preserve and are limited in number, with 150 people permitted in the reserve at any one time. Confining ecotourism to limited areas of activity is probably the ideal compromise and is necessary in order to protect the rest of the Preserve. The benefits of tourism and education in the

Monteverde Cloud Forest Preserve are probably worth the negative impacts, so long as the negative impacts are confined to small areas and are managed appropriately.

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Table 1. Species presence and method of detection. An "x" indicates the species was present on site.

Species	Common name	Low Impact Trail	Moderate Impact Trail	Evidence of Presence
Cuniculus paca	Paca	X		Observed
Dasyprocta punctata	Agouti	X		Observed
Mazama americana	Red Brocket Deer	X		Tracks
Tayassu tajacu	Collared Peccary	X		Tracks
Puma concolor	Puma	X	X	Tracks/scratching post
Nasua narica	White- Nosed Coati	X	X	Observed
Sciurus variegatoides	Variegated Squirrel	X		Observed
Dasypus novemcinctus	Nine-Banded Long-Nosed Armadillo		X	Tracks

Table 2: Total number of observations of mammals.

Species	Low Impact total times recorded	Low impact species abundance	Moderate impact total times recorded	Moderate impact species abundance
Cuniculus paca	3	Uncommon	0	Not observed
Dasyprocta punctata	5	Uncommon	0	Not observed
Mazama americana	2	Rare	0	Not observed
Tayassu tajacu	2	Rare	0	Not observed
Puma concolor	1	Rare	1	Rare
Nasua narica	10	Common	34	Common
Sciurus variegatoides	9	Common	0	Not present
Dasypus novemcinctus	0	Not present	1	Rare

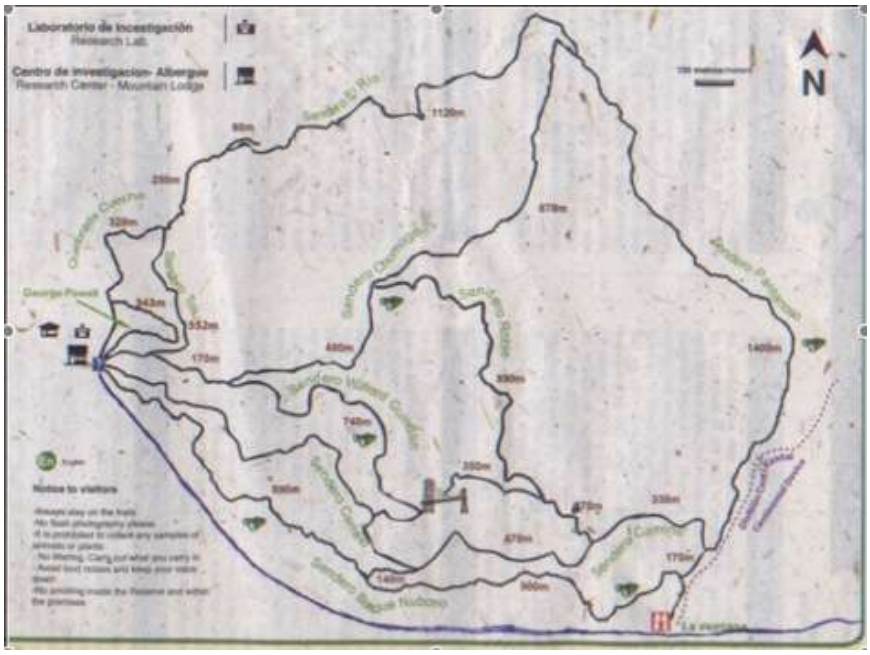

Figure 1: Map of the preserve. The blue line is low impact trail and The Sendero Bosque Nuboso and Sendero Pantanoso are the outer trails labeled on map.

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