# The effects of deforestation and browsing by ungulates on habitat diversity in dry Chaco forest in Northern Argentina

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## Introduction

Site specifications

The area of study is in the Province of Salta in the department of San Martín (Grid. Ref. 22° 28.389'S 63° 38.692'W). It is in a flat area of diverse dry tropical forest in which human activity has been increasing rapidly with the increase in population in the nearby town of Tartagal and other settlements along the highway which skirts the plains. The main new activities are: mass clearances of the forest in order to grow extensively crops such as soya, selective logging of marketable timber, and the rearing of livestock, mainly cattle. In the past oil prospecting has had a significant impact on the forest.

Aims and objectives

The indigenous people of the area (the Wichi) are currently undertaking, with the government, a range of land claims, with a view to using the forest sustainably and traditionally. The purposes of this investigation are to examine the impacts of deforestation and browsing on the diversity and productivity of the forest and to suggest future areas of study and appropriate future land uses. This was achieved by comparing two sites of differing accessibility, and by making general observations regarding the environmental degradation observed in locations throughout the forest area.

## Methods

With the limited resources available during the study period (October–November 2003) it was necessary to rely on the considerable knowledge of the Wichi in the nearby community of Hoktek Toi (Lapacho Mocho) at Km 18 (Tartagal). Two guides, Cantor and Valencio, were used to navigate through the forest and to provide a blueprint for identification of the various species. A global positioning system was used to indicate key areas of interest in the study area.

Two sample quadrats of 900 square metres were chosen, one in a central area of forest not penetrated by logging tracks. The other was close to the main road connecting Tonono with Tartagal and beside a logging track. Both sites had an abandoned row of fence posts as one boundary of the quadrat. This was necessary as a means of ensuring that the two sites covered the same area of forest, limited as the team were with measurement apparatus. The fences did not mark a division in land use, the posts having no immediately apparent impact on the appearance of the forest cover, the posts were put in position to divide the unused properties of landowners.

The trees were counted by extending a measured length of string (30 metres) at 90 degrees from the line of posts, which were spaced at 5 metre intervals. All the trees and saplings above head height in the survey area were identified and an estimate of the diameter recorded.

While the survey work makes up the bulk of the data analysis, it would not have been possible to collect the data in a meaningful way without first covering a large area of the forest in order to become acquainted with the range of tree types, growth forms and habitat variety. This was achieved through the guidance of Cantor and Valencio who could identify all the tree species and could guide to the various distinctive zones in the area.

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## Data analysis

A simple species count of the two sites yielded the following figures:

**Fig. 1: Table of species numbers found at each of the two sites**

| SPECIES | SITE 1 (ROAD DISTANT) | SITE 2 (ROAD CLOSE) |
|---|---|---|
| Algarrobo blanco (*Prosopis alba)* | | 3 |
| Bola Verde (*Capparis speciosa*) | 4 | 2 |
| Caspi Zapallo (*Pisonia zapallo*) | 1 | |
| Cebil (*Anadenanthera macrocarpa*) | 21 | 63 |
| Coronillo (*Scatia buxifolia*) | | 1 |
| Duraznillo sp. 1 (*Ruprechtia triflora*) | 16 | 59 |
| Duraznillo sp. 2 | 18 | 43 |
| Garabato (*Acacia praecox*) | 10 | 5 |
| Guayacán (*Caesalpina paraguarensis*) | 1 | 3 |
| Lanza | 3 | 1 |
| Lapacho (*Tabebuia impetiginosa*) | | 2 |
| Meloncillo | | 1 |
| Mistol (*Zizyphus mistol*) | 1 | 3 |
| Molle (*Sideroxylon obtusifolium*) | | 1 |
| Naranjilla (*Fagara naranjillo*) | | 2 |
| Palo Amarillo (*Pyllostylon rhamnoides*) | 6 | |
| Palo Blanco (*Calycophyllum multiflorum*) | 6 | 2 |
| Palo Cruz (*Tabebuia nodosa*) | 1 | |
| Palo Cuchara | 2 | |
| Palo Mataco (*Prosopis kuntzei*) | 8 | 2 |
| Poroto del Monte (*Capparis retusa*) | | 3 |
| Puque | | 3 |
| Quebracho blanco (*Aspidosperma quebracho-blanco*) | 2 | |
| Quebracho colorado (*Schinopsis lorentzii*) | 1 | |
| Tala (*Celtis spinosa*) | | 2 |
| Ucle | 1 | |

Contrary to what might be expected, the site near to the forest road yielded a larger range of species (19 in total) than the site located deep in the forest (17 species). However it should be noted that the site near to the road was dominated by Cebil and, particularly, the understory species of the Duraznillos. The site more distant from the road had more individuals of other species.

It was observed from the raw data that, in the site closest to the road, the range of species with a low count also were very young species. It is usually the case that biodiversity is best expressed observing the variety of mature individuals present, as young individuals have a lower than average survival rate.

It should be noted from Figure 2 that, apart from there being a far greater proportion of the common species – the Duraznillos and Cebils – in Site 2 (the site adjacent to the forest road and probably selectively logged to a greater or more recent extent), the other species mostly are of the small size categories. The understory species and the Cebil dominate the larger trunk diameters to an even greater extent than they dominate the sapling population. For example:

- In site 1, 6 out of the 26 trees of a diameter greater than 20cm are of species other than Cebil and the Duraznillos.
- In site 2, only 6 out of 39 trees of a diameter greater than 20cm are from the other species.

The above is an example of the discrepancy in diversity between the two sites.

**Fig. 2: Table of species arranged against increasing categories of trunk diameter**

| SPECIES | SIZE CATEGORY (cm) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SITE 1 (ROAD DISTANT) | | | | | | | | SITE 2 (ROAD CLOSE) | | | | | | | |
| | 0–5 | 6–10 | 11–15 | 16–20 | 21–25 | 26–30 | > 30 | **Total** | 0–5 | 6–10 | 11–15 | 16–20 | 21–25 | 26–30 | > 30 | **Total** |
| Algarrobo Bl. | | | | | | | | | | | | | 1 | | 2 | 3 |
| Bola V. | 4 | | | | | | | 4 | 1 | | 1 | | | | | 2 |
| Caspi Z. | 1 | | | | | | | 1 | | | | | | | | |
| Cebil | | 1 | 6 | 4 | 2 | 7 | 1 | 21 | 10 | 7 | 6 | 15 | 7 | 13 | 5 | 63 |
| Coronillo | | | | | | | | | 1 | | | | | | | 1 |
| Duraznillo 1 | 2 | 1 | 2 | 1 | 3 | 5 | 2 | 16 | 25 | 5 | 15 | 7 | 6 | 1 | | 59 |
| Duraznillo 2 | 11 | 3 | 3 | 1 | | | | 18 | 32 | 1 | 7 | 2 | 1 | | | 43 |
| Garabato | 5 | 2 | 1 | 1 | | 1 | | 10 | 4 | | 1 | | | | | 5 |
| Guayacán | | | | 1 | | | | 1 | | | | 2 | 1 | | | 3 |
| Lanza | | | 1 | 1 | 1 | | | 3 | | | | 1 | | | | 1 |
| Lapacho | | | | | | | | | 1 | | | 1 | | | | 2 |
| Meloncillo | | | | | | | | | 1 | | | | | | | 1 |
| Mistol | | | 1 | | | | | 1 | | | 1 | | | | 2 | 3 |
| Molle | | | | | | | | | 1 | | | | | | | 1 |
| Naranjilla | | | | | | | | | | | 2 | | | | | 2 |
| P. Amarillo | 6 | | | | | | | 6 | | | | | | | | |
| P. Blanco | | 1 | 1 | 3 | | 1 | | 6 | 2 | | | | | | | 2 |
| P. Cruz | | | | | | | 1 | 1 | | | | | | | | |
| P. Cuchara | 2 | | | | | | | 2 | | | | | | | | |
| P. Mataco | 4 | 3 | 1 | | | | | 8 | | 1 | 1 | | | | | 2 |
| Poroto Mte. | | | | | | | | | 3 | | | | | | | 3 |
| Puque | | | | | | | | | 3 | | | | | | | 3 |
| Qbrcho. Bl. | | 1 | | | | | 1 | 2 | | | | | | | | |
| Qbrcho. C. | | | | | | | 1 | 1 | | | | | | | | |
| Tala | | | | | | | | | 2 | | | | | | | 2 |
| Ucle | | | 1 | | | | | 1 | | | | | | | | |
| **TOTAL** | 35 | 12 | 17 | 12 | 6 | 14 | 6 | **102** | 86 | 14 | 34 | 28 | 16 | 14 | 9 | **201** |

From the above table perhaps the most telling difference appears to be the fact that in Site 1 the diameters are much more widely spread than in Site 2. This would be expected given the assumption that years of selective logging had standardised the type and age of the species present in Site 2. Therefore a reasonable hypothesis might be that the variation in Site 1 is significantly greater than in Site 2.

In Site 2, the deviation in diameters about the mean diameter of 13.1cm is 10.8cm. In Site 1, the deviation about the mean diameter of 15.9cm is 13.1cm.

An analysis of variance performed using the F-value showed that the probability of these variations being so different entirely by chance (in samples of 102 and 201) was only 0.4%. For the difference in variances to be statistically significant a probability of less than 5% is required. In this instance it is clear that there is a large statistical difference between the two sites.

The following graphs show another marked difference between the two sites. In Site 1, there is no clear progression from large numbers of small trees to small numbers of large trees, it can be seen that points do not follow on from one another in a linear fashion as they do in Site 2.

In Site 2, the logarithmic progression shows that growth is vigorous at ground level with many saplings competing with each other for space. This is consistent with a canopy made up principally of Cebil, which does not monopolise the light in the canopy, as might be expected in a forest where the very shady Quebrachos, Lapachos, Palo Blancos are found in the canopy, as in Site 1.

**Fig. 3: Diameter against frequency on Site 1 and corresponding logarithmic progression**

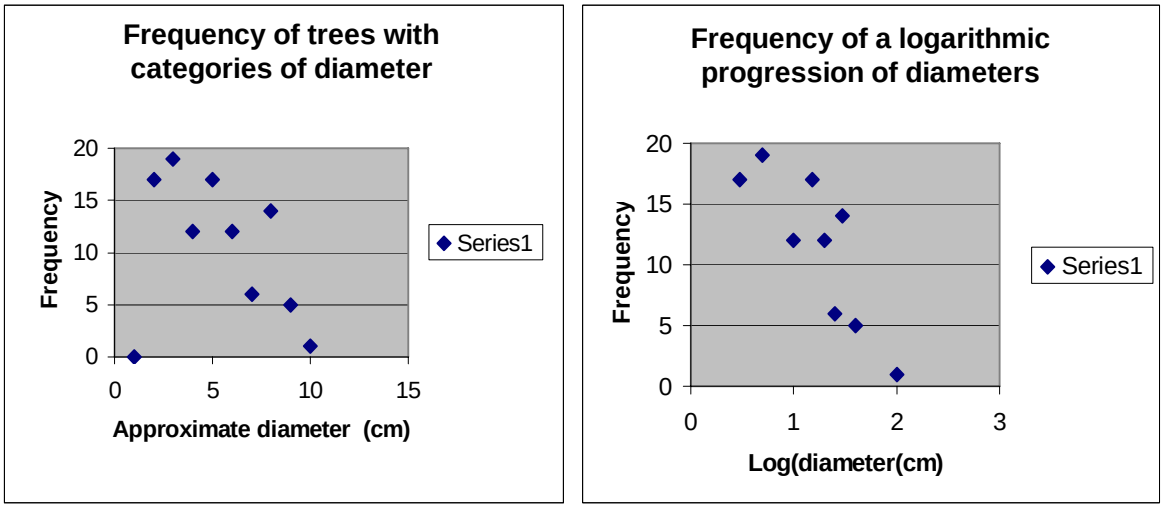
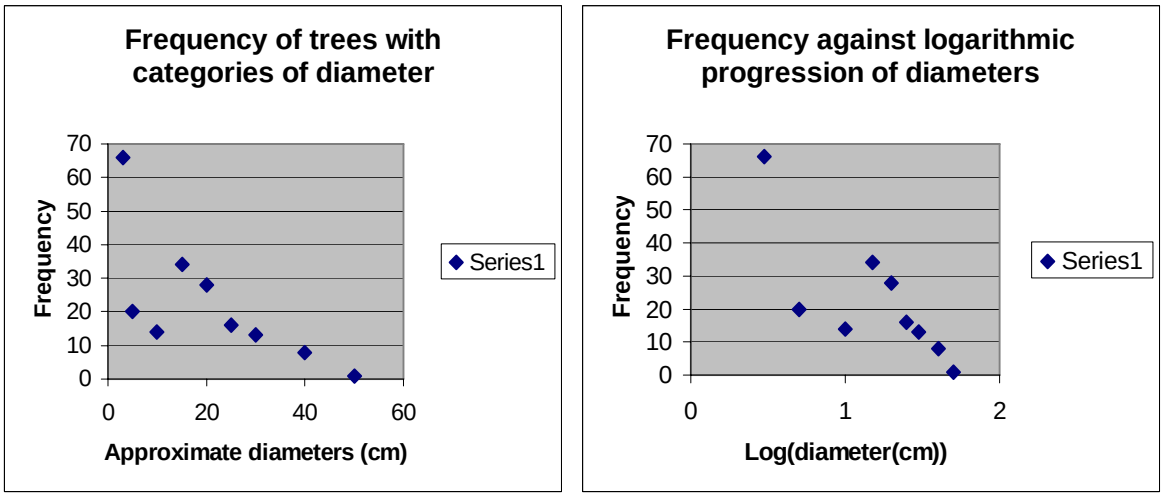



**Fig. 4: Diameter against frequency on Site 2 and corresponding logarithmic progression**




## Conclusions

The fact that the two sites have some key distinctions between them indicates that the proximity to the logging road has increased human impact. While differences in species composition may be attributable to soil and moisture variables, the differences in average size and variability of size are more likely to be caused by human impact, principally past clearance of larger trees for logging.

The graphs of frequencies back up this supposition by showing that Site 2, the one next to the road, appears to have a larger rate of production of new, young individuals. This indicates that it is in a state of flux as a result of past disturbances.

Advice for future management of the forests might be that the removal of the larger trees results in a sustained period of flux. During this period, there may be unknown consequences, high densities of trees of one species may result in disease spreading through the tree population. Also the relatively unshady Cebil trees may result in a tinder dry understory increasing the likelihood of forest fires. The results for the indigenous people of the Chaco forests may also be devastating. The larger trees form the bulk of the habitat of animal species, on which they depend. In particular, bees are more likely to find hollows suitable to build combs for honey storage in older, larger trees. There may be many other examples which are yet to be investigated. The

overriding point is that the indigenous people have adapted their survival techniques to an environment which is threatened by outside influences.