GEF-PNUD/ONAPLAN

Conservación y Manejo de la Biodiversidad en la Zona Costera de la República Dominicana

PROYECTO BIODIVERSIDAD

Oficina Nacional de Planificación
Secretariado Técnico de la Presidencia
Programa de las Naciones Unidas para el Desarrollo
Fondo para el Medio Ambiente Mundial

Informe Final
Subcontrato Los Haitises

Area de Proyecto:
Parque Nacional Los Haitises

Implementa:
Universidad de Cornell (CIIFAD)

Doc 2/4 – **Anexos**
Diciembre 1997

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CONSERVACIÓN Y MANEJO DE LA BIODIVERSIDAD EN LA ZONA COSTERA DE LA REPÚBLICA DOMINICANA

INFORME FINAL

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Doc 2/4 – **Anexo 1**
GEF Biological Surveys
Diciembre 1997

APPENDIX A.

GEF Biological Surveys

Activities 2.2.2/2.2.3/2.2.6

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December 1997

INTRODUCTION

Although mature forest is disappearing at an alarming rate in Latin America, secondary forest stands are increasing at a rate of 1% per year (Kabakoff and Chazdon, 1996). Nearly 30% of all productive tropical forest land is now classified as secondary vegetation (Brown and Lugo 1990). In the Caribbean, this secondary vegetation develops after the abandonment of pastures, plantations (coffee, cacao) and mixed cropping systems. Secondary forest associated with karst topography is distinguished by a high species diversity and endemism. This type of forest occurs in all of the Greater Antilles and parts of Central America (Kelly et al. 1988). In the Dominican Republic, most of the karst forest occurs in Los Haitises National Park (LHNP), which was established in 1976.

Agricultural activities carried out over the past several decades have extensively modified ecological communities within Los Haitises National Park, but most of these activities ceased in 1993. Although African oil palm plantations and cacao plantations are common in the areas surrounding the northeastern region of LHNP, the two dominant agricultural systems used inside the park were pastures and conucos (small-scale, semi-migratory, mixed cropping systems). The park is now a mosaic of habitats in different stages of recovery from agricultural activities, with only a few areas remaining relatively undisturbed by human activities. In this study we investigated patterns of floral and faunal biodiversity in these regenerating habitats. In general, we followed the approach to biodiversity assessments recommended by Debinski and Humphrey (1997).

There are 5600 vascular plant species in the Dominican Republic, of which 36% are endemic to the country (García and Roersch 1996). A large proportion of these plants are threatened by deforestation and other human-induced disturbances (García and Roersch 1996). In areas where the land has been released from intensive human disturbance (i.e. abandoned pastures), it is important to understand how the previous land use may have affected ecosystem processes necessary for forest regeneration. For example, disturbance may affect the processes that make N available for plant growth. Previous studies have shown that various land uses can affect soil organic matter availability, rates of N mineralization (the microbial conversion of organic matter to forms of N usable by plants) and denitrification (the microbial process that removes available N from the soil and releases it to the atmosphere) (Keller and Matson 1994, Veldkamp and Keller 1997, and Keller et al. 1993). In order to characterize nutrient availability across different land uses, we initiated a study of various processes of N cycling that make N (an essential nutrient) available to plants, including N mineralization, denitrification, and microbial respiration.

The conversion of primary forest to secondary vegetation can have significant adverse effects on fauna (e.g., Terborgh and Weske 1969, Terborgh 1989, Hagan and Johnson 1992). For example, Terborgh and Weske (1969) found greatly reduced diversity of birds in primary forest (141 species) compared to secondary forest (54 species). Active disturbance through agricultural activities often has significant impacts on faunal diversity and abundance. When land is abandoned from agriculture, faunal communities begin to recover. Blankespoor (1991) compared bird communities in shifting agriculture systems in Liberia and found greater diversity and abundance in farms that had been abandoned for seven years compared to farms that had been abandoned only two years. Both abandoned farms had higher diversity and abundance than farms in active use. However, it is common that bird species which are characteristic of primary forest never appear in regenerating habitats (e.g., Karr 1976).

Objectives

This project focused on developing baseline information on the flora and fauna of LHNP with the goal of understanding the impact of previous land use history on the regeneration of floral and faunal communities within the park. A second objective was to determine the extent to which agricultural systems in the periphery of the park may support faunal biodiversity. This information should be useful for designing conservation management strategies in the park and surrounding areas.

METHODS

Study Site Description

Los Haitises National Park is located in a karstic area, which is composed of limestone rocks of the Miocene and covers less than 10% of the Dominican Republic land area. The topographic features of the karst region are sink-holes, caves, cliffs, alluvial terraces (long and narrow valleys) and mogotes (low hills) (Kelly et al. 1988; Zanoni et al. 1990). The alluvial terraces were the principal feature used for pastures, shifting agriculture and plantations, whereas mogotes were burned periodically or cut for charcoal or wood production. The original vegetation of Los Haitises is classified as subtropical broadleaf forest with strong differences in vegetation composition between the narrow valleys and the mogotes (Zanoni et al. 1990). The average annual rainfall in the study sites was approximately 2,000 mm.

Biodiversity Monitoring Sites

In 1996, we established 42 study plots inside LHNP and on its periphery. A total of 33 permanent monitoring plots were located in three regions in the northeastern section of Los Haitises National Park, near the communities of Caño Hondo (CH), Los Naranjos (LN), and Trepada Alta (TA). Plots were each 400 m^2 and were selected to be representative of 6 types of habitats: mogote tops, remnant mature forest in the basins, abandoned cacao plantations (ca. 80 yrs old), abandoned conucos ("young": 2-3 yrs after abandonment; "old": 6-10 yrs after abandonment), and abandoned pastures (4-8 yrs after abandonment) (Table 1). For convenience we use the term "old" in reference to recovering cacao plantations and conucos, however, "old" cacao plots are considerably older communities than "old" conucos. Not all habitat types could be found at all sites, thus it was not possible to have a completely balanced design. Most striking was the virtual absence of old forest remaining in basins between mogotes in the park. We located only two stands of old forest in the three regions where we sampled, and park guards know of no others in these areas. We dated the abandonment of pastures and conucos at the three locations based on oral histories from park guards.

In addition, we used identical methods (see below) to monitor faunal biodiversity in three types of active agricultural systems that were dominant in the landscape surrounding northeastern LHNP: traditional shaded cacao plantations, African oil palm plantations, and pastures. A minimum of two replicate sites for each system was monitored each season.

Monitoring Strategy

Particular faunal groups, including birds, lizards, and arthropods, were selected for monitoring as indicators of biodiversity. Within arthropods, we focused primarily on ants and beetles. Certain organisms can be particularly useful for assessing the integrity of biological communities. Effective biological indicators should be relatively common, easily detected, restricted to one or a few habitats, and sensitive to habitat disturbance. Birds, for example, are often used as ecological indicators. Bird surveys can be used to assess quickly and accurately the ecological characteristics of many terrestrial communities (Stotz et al. 1996). The following characteristics make birds particularly good biological indicators: conspicuous behavior, rapid and reliable identification, ease of sampling, stable taxonomy, diversity and ecological specialization, and high sensitivity to disturbance (Stotz et al. 1996).

Ants have also been used as bio-indicators in a variety of contexts, including comparisons among habitats (Oliver and Beattie 1996), comparisons of agricultural management strategies (Perfecto and Snelling 1995, Perfecto et al. 1997), the role of disturbance (York 1994), and environmental monitoring in regenerating habitats (Majer 1983, 1992). Andersen (1990) has argued that ants are excellent bio-indicators because they are ubiquitously diverse and abundant, they are functionally important at all trophic levels, they are highly sensitive to environmental variables, and they respond rapidly to environmental change. Furthermore, the availability of taxonomic keys to the ants is among the best for neotropical insects.

Lizards were chosen as a third faunal indicator of biodiversity. We focused on lizards because they are taxonomically well known, common in LHNP, easily detected, and many are considered microhabitat specialists.

Birds and arthropods were monitored in two wet seasons (Summer 1996 and Summer 1997) and one dry season (Winter 1997), with a final monitoring planned for a second dry season (Winter 1998). Lizards were monitored during one dry season (Winter 1997) and one wet season (Summer 1997), and will be monitored during a second dry season in Winter 1998. These data will allow us to assess the relative abundance and diversity of different indicator groups in habitat types that vary in previous land use history within the park or in current land use on the periphery of LHNP.

Vegetation Survey

In Winter 1997, vegetation in all plots was characterized, all woody species ≥ 1 cm were identified, and voucher specimens were deposited at the Jardin Botanico de la Republica Dominicana. We identified and measured at breast height every woody plant ≥ 1 cm in diameter in 4 transects (1 x 50m; 200 m^2). In addition, we sampled every tree ≥ 10.0 cm of dbh in 500 m^2 to 1000 m^2. Biomass of non-woody vegetation (g/m^2) in the different types of land uses was estimated using 2 quadrats of 0.25 m^2 in each transect for a total sampled area of 2 m^2 per site. Non-woody biomass samples were separated into ferns, herbs, grasses, and vines.

Bird Survey

Bird communities were censused using fixed distance point counts, modifying methods of Blondel et al. 1970 (also see Bibby et al. 1992, Ralph et al. 1995). Counts were made by the same two observers throughout the study, in order to minimize observer variability (Faanes and Bystrak 1981). Counts were made by recording all birds heard or observed from a point in the center of a plot. Birds were separated into those that occurred within a 30 m radius of the observer, and those beyond this fixed distance. In this report, only data for birds within the fixed 30 m radius are included in the analyses. Although an unlimited distance often yields significantly more data (e.g., Lynch 1995, Ralph et al. 1995), the unique topography and small size of habitat patches within LHNP restricted our ability to accurately assign birds from beyond the fixed distance to particular habitat types. All sites in a given region of the park were censused once per day over a 5-6 day period. Counts were made between 6:30 to 10:00 during the rainy season (i.e., summer counts) and 7:00 to 10:30 during the dry season (i.e., winter counts), to compensate for differences in daylight schedules between seasons. Counts were restricted to the morning hours, as bird activity was generally stable during this period (Robbins 1981, Lynch 1995, Buskirk and McDonald 1995). Point counts were made over a 10-minute period (see Scott and Ramsey 1981). All plots in a region of the park were counted on a given day, with each of the two observers counting half of the plots. The use of playbacks for elusive species (Marion et al. 1981) was implemented only during the last part of the study, and results were used only to supplement biodiversity records.

Lizard Survey

Visual Surveys. During Summer 1997 (wet season) visual surveys of lizard abundance were made in each plot along 4 m x 50 m transects. At six points spaced 10 m apart along each transect, counts were made of lizards observed during a 3-minute period. Lizards observed between census points were also recorded. Transit time between points was approximately one minute, and the total time spent in the transects was ca. 25 minutes. Transect surveys were conducted in each plot on at least four days, between the hours of 9:00 and 14:00. The order in which transects were completed was randomized daily to avoid visiting the same plots at the same times each day.

For each reptile or amphibian observed in a transect, information was recorded that included species, location on transect, microhabitat, height (if on vegetation), orientation (horizontal/vertical), position (sun/shade), and time of day. Animals within the transects were never handled or collected. Animals observed outside the transect were noted, although they are not included in the formal data analysis.

Trapping Grids. A second sampling protocol involved the use of commercial mouse glue traps to capture lizards and other reptiles. Traps consisted of a 20.3 cm x 12.7 cm piece of cardboard coated with a thin layer of highly adhesive glue. The traps were effective at capturing all but the largest reptile species, but were ineffective in catching amphibians, perhaps due to their moist skin.

In each plot, a total of twenty traps was laid out in a 10 m x10 m grid. Traps were arranged to sample four microhabitats, *chosen a priori,* and five traps were used as replicates to sample each microhabitat (4 microhabitats x 5 replicate traps = 20 traps per grid). Microhabitats sampled were: 1) open ground, at least 1 m away from the nearest tree, 2) ground at tree base, 3) tree trunk, 1m above the ground, and 4) tree trunk, 2 m above the ground. Ground traps were placed on bare soil or rock, while tree traps were either tied or stapled into position. Traps were set in five rows of four with each row containing one of each of the four microhabitat traps set in a randomly determined order. No two traps targeting the same microhabitat were ever placed directly next to one another.

For each trapping grid, a map was drawn to depict where all of the traps were placed in relation to one another. In addition, the circumference of the tree associated with a given trap was measured and identified. No more than one trap was associated with each individual tree, and for this reason the trapping grids required a minimum of fifteen trees. In some habitats in which trees were scarce, this fifteen tree minimum necessitated the use of a trapping grid which had an uncharacteristically high number of trees relative to the rest of the plot. Active pastures which were completely devoid of trees were not trapped at all.

The trapping grids were checked every 24 hours for the duration of the 120-hour trapping cycle carried out at each plot. Lizards were released from the sticky traps by dissolving the glue around their limbs with vegetable oil applied by a paint brush. After removal, the following data were recorded prior to releasing the lizard: species, snout-to-vent length, dewlap size and color, and position in trap. After capture, the toenail of the third toe on the left hind limb was clipped so that the lizard could be recognized if recaptured.

Insect Sampling

Cursorial Insect Community. The primary focus of the insect sampling was the cursorial arthropod community, in particular the ant community, which we sampled with pitfall traps during three sampling periods: Summer 1996 (wet season), Winter 1997 (dry season), Summer 1997 (wet season). Pitfall traps are an extremely effective and reliable way to sample the ant community (Greenslade 1973, Andersen 1990). We used a grid of pitfall traps to sample the cursorial arthropod community within each of the 28 plots within Los Haitises and within the agricultural sites outside of the park. Ten pitfall traps were placed in each plot, aligned in two 20 m, parallel rows spaced 10 m apart. Within each row a pitfall trap was placed every five meters. The valleys in Los Haitises are often less than 100 m between mogote sides. To avoid edge affects from different habitats occurring on the slopes of the mogotes we placed the pitfall grids in the central areas of the valleys. On mogote tops, we placed the grids as close to the center of the highest point as possible. The mogote tops were typically very rocky and too narrow to accommodate a 10 m by 20 m grid for pitfall trapping. Therefore, on the mogote tops, two 20 m transects were measured out that were not less than 10 m apart. The topography often dictated that the transects were not precisely parallel ,and shallow soil and rocks on the mogotes prohibited the traps from being set exactly five meters apart along each transect. The pitfalls were set as close to each five meter mark along the transect as the terrain would allow.

Pitfall traps consisted of 16-ounce Solo plastic cups with a diameter of 9.5 cm and a circumference of 31 cm. We protected the cups from rain by suspending a plastic plate (30 cm circumference) 5-8 cm above each cup using nails. Pitfall traps were dug into the ground such that the lip of the cup was level with the surrounding soil surface and disturbance of the vegetation was kept to a minimum. After placing the trap, we replaced soil and leaf litter around the cup to restore a more natural ground cover. Each trap was then filled with approximately 3 ounces of a 50 percent ethylene glycol (antifreeze) solution to preserve the arthropods that fell into the cups.

After three days, pitfall traps were emptied into a Whirl-Pak and refilled with preservative, such that each sample represented a three-day catch. This yielded a total of two 10 trap samples from each plot for each of the wet season sampling periods (Summer 1996 and Summer 1997). Time constraints limited us to one 10 trap sample from each plot during Winter 1997. After hard rains the traps were often filled with water. Occasionally, the contents of the trap was entirely washed away, but if not the excess water was poured off and the remaining contents were collected.

Insects were later transferred to a 70% ethyl alcohol solution and sorted to order or family. Ants (Hymenoptera: Formicidae) were sorted to genus and morphospecies.

Flying Insect Community. We also sampled the flying insect community of the understory vegetation in each plot within Los Haitises. We used Sharkey type malaise traps (163 cm long by 108 cm high) to collect low level flying insects (Southwood 1978). The lower portion of the trap was constructed of black nylon mesh and the roof was constructed of white nylon mesh. A nalgene collection bottle was attached to one end of the roof and filled with approximately 200 ml of a 70% alcohol solution. We used ethyl alcohol when available, but if we could not obtain ethyl alcohol, isopropyl alcohol was used. We set the traps in the center of the plots, placed to take advantage of any natural insect flight paths in the vegetation (Southwood 1978). Where no natural paths were present, we created a small flight path extending approximately 5 m along the trapping axis of the trap. We collected the samples every two days during each collection period, yielding a total of three malaise samples from each plot for two sampling periods (Winter and Summer 1997). These samples have not been identified.

Soil Nitrogen Sampling

Five soil cores were collected from each plot at Trepada Alta, from the agricultural sites outside the park, and from one semi-active pasture at the park boundary. The samples were refrigerated until analyses were carried out, in order to slow microbial processes and maintain levels of activity found in the field. All soil samples were analyzed for various processes of nitrogen (N) and carbon (C) cycling. Microbial biomass (determined from C and N content in the soil) is a useful indicator of microbial activity and nutrient cycling within the soil. We analyzed microbial biomass using the chloroform fumigation incubation method (Jenkinson and Powlson 1976). Soils were fumigated with chloroform to kill and lyse microbial cells in the sample. A small amount of fresh soil, containing live microbes, was added to the fumigated soil sample where the introduced microbes were allowed to use that pool of killed cells as substrate for a period of 10 days. Both the change in inorganic N (ammonium and nitrate) and carbon dioxide were used as indicators of microbial activity, since they are assumed to be directly proportional to the amount of C and N in the microbial biomass of the original sample. At the same time, inorganic N and carbon dioxide production were measured from soil samples incubated, but not fumigated, for 10 days; these measurements were used to calculate rates of N mineralization and soil respiration.

Data Analysis

In analyzing the sampling data from LHNP and surrounding agricultural lands, we looked for similarities and differences in community structure of many groups of organisms across different landuse types, geographic regions and seasons. Taxonomic groups used in our analyses are: trees, birds, herps (primarily lizards), ants, and beetles. We used two methods to sample herps, so samples from sticky traps and those from transects are considered separately in all analyses. Furthermore, we performed two separate analyses on birds, one including migrants that are present only in the winter, and one that excludes migrants. Each taxonomic group and each sampling technique for that group was considered a different data set and each data set was analyzed separately. We used the same analytical methods on all data sets to facilitate making comparisons of community structure across groups.

We attempted to address how geography and landuse history affects both the diversity and the composition of biological communities. The six landuse types within the park that we used in the analysis are: recovering pastures, recovering young conucos, recovering old conucos, recovering old cacao, lowland forest and mogotes. Geographic regions in the analyses are Trepada Alta, Los Naranjos and Caño Hondo. We also included the three active agricultural landuse types (active pasture, active oil palm and active cacao) in some of our analyses, but they were omitted from those considering both landuse and park region since there is no overlap of landuse types between the park and agricultural plots. For birds, we were also able to consider the effect of our sampling season (Summer 1996, Winter 1997 and Summer 1997).

Community diversity and composition require different analytical techniques and so they are discussed separately in the following sections.

Ecological Diversity

We used several techniques to compare ecological diversity across landuse types, geographic regions and seasons. Both the abundance of individuals and richness of species are important factors in the diversity of a community and so both were considered in our analyses. Our primary analysis of diversity within the park was to perform separate ANOVAs on the abundance and richness of each taxonomic group per sample unit, using landuse and geographic region as predictors. For each taxonomic group, the average number of species and the average number of individuals for each count was calculated. A count was defined as a discrete sampling unit and the types of counts differed for each taxonomic group. For birds, each 10-minute point count was considered a count, whereas each 3-day sample of 10 pitfall traps of beetles and ants were considered a count. For trees, each set of four transects was considered a count and so there was only one count for each plot. Each herp transect was considered a count, and each set of 20 sticky traps was considered a count.

We ran two separate ANOVAs on each data set, one with abundance as the response variable and one with species number per count as the response (JMP statistical package for Macintosh). These tests compared the relative effect of landuse history and geographic region on diversity and abundance of different groups. In addition, we tested two independent hypotheses about differences in richness and abundance between groups of landuse types using *a priori* contrasts (JMP statistical package for Macintosh). Using *a priori* contrasts, we tested whether species richness and abundance differed in: 1) mogotes versus the five lowland landuse types within the park that have received heavier disturbance; and 2) young conucos versus old conucos.

We ran two further sets of ANOVAs on each data set that included the agricultural landuse types and excluded geographic region as a predictor. We also tested the hypothesis that species richness and abundance inside the park differed from the agricultural sites using an *a priori* contrast.

In addition to the statistical analyses, we calculated four diversity and abundance statistics to illustrate ecological diversity within different landuse types and across regions. These statistics were calculated for each landuse in two ways: broken down by season, but pooled across regions; and broken down by both region and season. The first of these statistics is species richness, or the total number of bird species seen in a landuse type for each season (or season and region). Species richness provides good discriminant ability, however, it is also very sensitive to differences in sample size (Magurran 1988). Since sample sizes were not equal across all landuse types, we also included diversity measures that are robust to sample size differences.

We calculated a Simpson Diversity Index as a dominance measure to show whether each landuse is dominated by one or a few species in each taxonomic group. A high value of the Simpson Index indicates that the community is dominated by a few species, and thus has lower diversity (Magurran 1988). We express the Simpson Index values in their inverse forms (1/D) so that they are comparable to the other diversity statistics.

The final two diversity statistics we calculated are the Log and Shannon Diversity Indices. The Log Index is robust to differences in sample size and abundance of species between landuses. It is also more weighted toward species richness than toward dominance, and so provides a more robust measurement of diversity within each landuse than do species richness measurements (Magurran 1988). The Shannon Diversity Index was included because it is a widely used and familiar index and it weights species richness and abundance fairly equally.

Change in Diversity over Time.

We could only consider the effect of seasons on diversity with the bird data because that was the only complete data set available for analysis of multiple seasons. For all bird ANOVAs, we included a season effect that represented whether the counts were performed during Summer 1996, Winter 1997 or Summer 1997. We also performed an *a priori* contrast to test whether diversity differed between the summer and winter seasons.

In presenting the diversity information in graphical format, we also broke the diversity index calculations down by seasons. One data set is pooled across regions but broken down by landuse and season, and the other is broken down across seasons, landuses and regions. Including season in the analyses allowed us to compare whether landuses differs in bird diversity between summer and winter considering only residents and considering both residents and migrants. It also provides a short window in which we can see whether diversity in the park appears to be increasing or decreasing.

Community Composition

We used two methods to compare community composition between landuse types, one of which could also be used to compare geographic regions. Community composition among landuse types was compared using cluster analyses for each data set based on the presence or absence of each individual species in each landuse. The distance metric used to generate these clusters is Normalized Percent Disagreement and they were joined using the Complete Linkage Method (SYSTAT for Macintosh). Normalized Percent Disagreement is the appropriate distance metric for presence/absence data and Complete Linkage is a conservative and straightforward linkage method.

To compare bird community composition across both regions and landuses, we used a De-trended Correspondence Analysis (DCA). Preliminary analyses using Correspondence Analysis (CA) revealed a "horseshoe effect" in our data that can lead to misleading interpretations of the patterns (PC-ORD Multivariate Analysis Package for Windows, Version 3). Therefore, we used DCA to achieve a more reliable and interpretable pattern than CA could provide.

To construct the ordination matrix, we calculated the average number of individuals of each species seen per count for each species and each plot. These values were put into a matrix and log-transformed using the equation:

$$V' = \ln(V+1)$$

where V' is the transformed value and V is the original. The ordination axes were created and the data graphed using PC-ORD Multivariate Analysis Package for Windows, Version 3.

RESULTS

Vegetation

Species Richness of Woody Vegetation

A total of 166 tree species were observed in the study plots (Table 2). Within the park, land use history significantly affected tree species richness ($F_{(1,20)}$=10.660, P<0.0001; Fig. 1). Tree species richness was lowest in regenerating pasture and highest on mogote tops. Planned contrasts showed that species richness was significantly higher on mogote tops than in any other habitat ($F_{(1,20)}$=29.317, P<0.0001; Fig. 1). Species richness also increased with age, such that old conucos (6-10 years after abandonment) had significantly higher species richness than young conucos (2-3 years after abandonment) ($F_{(1,20)}$=4.575, P=0.0450; Fig. 1). When tree diversity was calculated using Shannon's Diversity Index, Simpson's Diversity Index, and the Log Diversity Index, similar patterns were evident (Fig. 2). There were no significant differences between park regions (Caño Hondo, Los Naranjos, Trepada Alta) in tree species richness (Table 3).

Density and Basal Area of Woody Vegetation

Tree abundance per plot (number of stems per plot) varied significantly among land uses ($F_{(1,20)}$=5.817, P=0.0018; Fig. 1). Tree abundance was lowest in forest and abandoned cacao and highest on mogote tops. Planned contrasts showed that tree abundance was significantly higher on mogote tops than in any other habitat ($F_{(1,20)}$=19.329, P=0.0003; Fig. 1). Tree abundance also increased with age, such that old conucos had significantly higher tree abundance than young conucos ($F_{(1,20)}$=4.471, P=0.0472; Fig. 1). There were no significant differences between park regions in tree abundance.

There was a significant difference in basal area among the different types of land uses ($F_{(5,20)}$=6.400, P=0.0011; Fig. 3). Basal area was highest in forest and lowest in young and old conucos. Planned contrasts showed that basal area increased with age, such that old conucos had higher basal area than young conucos ($F_{(1,20)}$=4.078, P=0.0581; Fig. 3). There were no significant differences between regions of the park in basal area.

Biomass of Non-woody Vegetation

Estimates of total non-woody biomass were significantly higher in pasture sites in comparison to the rest of the land uses (P=0.0004, Fig. 3). This difference is due to high biomass estimates of ferns in abandoned pastures when compared to the rest of biomass components (graminoids, vines, herbs) and compared to other land uses (Fig. 4).

Community Composition

Mogote tops had an unique species composition in comparison with the other forest stands. Both DCA ordination (Fig. 5) and cluster analysis (Fig. 6) clearly separated mogote tops from the rest of the land uses. Separation of young and old conucos and separation of pastures and conucos were also evident in the ordination, although species composition in pastures overlapped most with young conucos in the cluster analysis (Fig. 6). Cacao plantations and forest grouped closely together in the cluster analysis and also overlapped somewhat with old conucos in the ordination.

Pastures were dominated by the shrubs *Piper aduncum* and *Psidium guahava.* Young conucos were also dominated by *Piper aduncum* as well as *Triumfetta* spp., *Citrus* spp. and *Cecropia schreberiana.* Old conucos were dominated *by Inga vera, Piper laeteviride, Spondias mombin,* and *C. shreberiana*. Abandoned cacao plantations were dominated by cacao *(Theobroma cacao)* as well as *Inga vera, Spondia mombin, Guarea guidonia,* and *C. schreberiana.* Forests were dominated by *Guarea guidonia* and included *Piper laeteviride, Artocarpus altilis* (breadfruit), and *Zanthoxylum martinicense.* Finally, mogote tops, the most diverse sites, contained *Ocotea coriacea, Bombocopsis ermarginata, Prunus myrtifolia, Clusia rosea,* and *Cinamodendron ekmanii*, among many others.

Birds

Species Richness, Abundance, and Diversity

Over the three sampling seasons (Summer 1996, Winter 1997, and Summer 1997), a total of 49 species of birds were observed in our study plots within the park (Table 4). Within the park, land use history significantly affected bird species richness per point count ($F_{(1,447)}$=16.983, P<0.0001; Fig. 7) and overall bird abundance per count ($F_{(1,447)}$=10.516, P<0.0001; Fig. 8). When only year-round resident birds were considered, species richness per count ($F_{(1,447)}$= 16.763, P<0.0001; Fig. 7) and abundance per count ($F_{(1,447)}$=10.441, P<0.0001; Fig. 8) differed significantly among land uses. Bird species richness per count ($F_{(1,529)}$=72.672, P<0.0001; Fig. 7) and bird abundance per count ($F_{(1,529)}$=3.316, P=0.0692; Fig. 8) were higher in plots within LHNP than in active agricultural systems on the periphery of the park. Resident birds also had higher species richness per count ($F_{(1,529)}$=71.644, P<0.0001; Fig. 7) and abundance per count ($F_{(1,529)}$=3.094, P=0.0792; Fig. 8) inside the park than outside. Similar patterns were evident from calculations of total bird species richness per land use (Fig. 9) and bird diversity using Shannon's Diversity Index (Fig. 10), Simpson's Diversity Index (Fig. 11), and the Log Diversity Index (Fig. 12).

Within the park, planned contrasts indicated that bird species richness per count ($F_{(1,447)}$=6.429, P=0.0116; Fig. 7) and abundance per count ($F_{(1,447)}$=7.690, P=0.0058; Fig. 8) was significantly lower on mogote tops than in any other habitat. Similarly, resident bird species richness per count ($F_{(1,447)}$=5.831, P=0.0161; Fig. 7) and abundance per count ($F_{(1,447)}$=7.434, P=0.0067; Fig. 8) were significantly lower on mogote tops than in other habitats. A comparison of bird species richness and abundance in young conucos (2-3 years after abandonment) and old conucos (6-10 years after abandonment) indicated that there was significantly higher species richness per count ($F_{(1,447)}$=35.091, P<0.0001; Fig. 7) and abundance per count ($F_{(1,447)}$=22.370, P<0.0001; Fig. 8) in old conucos. The pattern is similar when only resident birds are considered; species richness per count

($F_{(1,447)}$=35.623, P<0.0001; Fig. 7) and abundance per count ($F_{(1,447)}$=22.745, P<0.0001; Fig. 8) are higher in old conucos than in young conucos.

There were no significant differences between park regions (Caño Hondo, Los Naranjos, Trepada Alta) in bird species richness for either all birds or resident birds only (Figs. 13-18), but abundance was marginally higher in Caño Hondo than in the other regions (all birds: $F_{(1,447)}$=2.495, P=0.0837; resident birds: $F_{(1,447)}$=2.721, P=0.0669; Figs. 13-18). However, sampling periods differed significantly for total bird species richness ($F_{(1,529)}$=10.916, P<0.0001; Figs. 9-14), total bird abundance ($F_{(1,529)}$=6.701, P=0.0013; Figs. 13-18), resident species richness ($F_{(1,529)}$=8.401, P=0.0003; Figs. 13-18), and resident abundance ($F_{(1,529)}$=6.466, P=0.0017; Figs. 13-18). A comparison of wet season and dry season samples indicated that only total bird species richness differed between seasons ($F_{(1,529)}$=7.226, P=0.0074; Figs. 13-18), with greater richness in the dry season than in the wet season.

Community Composition

Composition of bird communities displayed considerable differences between active and regenerating habitats. This was reflected in the ordinations (Figs. 19-22) and cluster analyses (Figs. 23 & 24), in which active sites formed a discrete cluster. Thus species such as the White-necked Crow, Hispaniolan Parrot, Ridgeway Hawk, Red-legged Thrush, Cave Swallow, and various species of *Columba* pigeons were common only in the park and rarely seen in the peripheral active sites. Among the regenerating sites, newly regenerating habitats (pasture, young conuco) formed a discrete cluster when compared to the sites undergoing regeneration for a greater length of time. Furthermore, a number of species (e.g., Ruddy Quail Dove and Red-legged Thrush) were considered forest dwellers, and were found only in forested park habitats or the active cacao sites with a relatively dense tree canopy. This was also true for most neotropical migrants encountered in the census plots, which were most common in forested park and active cacao sites. Active agricultural sites generally contained fewer species of birds than the regenerating sites.

Particularly striking was the paucity of individuals and species in the oil palm plantations, where the only birds found were abundant and widespread species such as Bananaquit, Mourning Dove, Black-crowned Palm Tanager, Lizard Cuckoo, Hispaniolan Woodpecker, Antillean Piculet, Palm Chat, and Vervain Hummingbird.

Lizards

Species Richness, Abundance, and Diversity

A total of 21 species of reptiles and amphibians were observed within the study plots, including 14 species detected during transect surveys (Table 5) and 16 species caught in sticky traps (Table 6). As measured by transect surveys, land use history within the park significantly affected lizard species richness per count ($F_{(1,96)}$=9.084, P<0.0001; Fig. 25) and abundance per count ($F_{(1,96)}$=7.446, P<0.0001; Fig. 25). Lizard species richness per count was higher in young conucos than in older conucos ($F_{(1,96)}$=4.580, P=0.0349; Fig. 25), but abundance did not differ according to conuco age. Planned contrasts using transect data indicated that lizard species richness per count ($F_{(1,96)}$=18.178, P<0.0001; Fig. 25) and abundance per count ($F_{(1,96)}$=5.611, P=0.0198; Fig. 25) were significantly higher on mogote tops than in any other habitat. Overall species richness per land use (Fig. 25) and diversity indices (Fig. 26) showed highest diversity for mogote tops and young conucos within the park.

Sticky trap samples also indicated that lizard species richness per sample ($F_{(1,112)}$=2.560, P=0.0311; Fig. 27) and abundance per sample ($F_{(1,112)}$=2.167, P=0.0627; Fig. 27) varied significantly among land uses. Sticky trap catch indicated higher lizard species richness per sample in old conucos than young conucos ($F_{(1,112)}$=4.085, P=0.0457; Fig. 27), with no differences in abundance. As was the case with transect data, sticky trap data indicated that lizard species richness per sample ($F_{(1,112)}$=6.757, P=0.0106; Fig. 27) and abundance per sample ($F_{(1,112)}$=10.773, P=0.0014; Fig. 27) were significantly higher on mogote tops than in any other habitat. This was supported by overall species richness per land use (Fig. 27) and all the diversity indices (Fig. 28). Several species of lizards were detected only on mogote tops, and at least one of these, *Sphaerodactylus cochranae*, is endemic to mogote tops in LHNP and has been considered to be extremely rare. Before our studies, only three individuals had ever been collected (two in 1946 and one in 1971; Schwartz and Thomas 1982).

In agricultural systems outside the park, transect surveys indicated that lizard species richness and abundance were highest in active cacao systems and lowest in pastures (Fig. 25). Sticky trap data support the conclusion that species richness and abundance were highest in cacao plantations (Fig. 27). Because active cacao had extremely high species richness and abundance, agricultural sites on average had higher lizard species richness per count ($F_{(1,133)}$=4.850, P=0.0294; Fig. 25) and abundance per count ($F_{(1,133)}$=7.746, P=0.0062; Fig. 25) in transect surveys when contrasted with sites inside the park. Sticky traps similarly indicated that lizard species richness per sample ($F_{(1,132)}$=15.995, P=0.0001; Fig. 27) and abundance per sample ($F_{(1,132)}$=50.790 P<0.0001; Fig. 27) were higher in active agricultural systems on the periphery of the park than in plots within LHNP. However, transect surveys indicated that active pastures had the lowest species richness and abundance of any habitats, inside or outside the park (Fig. 25). When lizards were compared among different regions of LHNP (Caño Hondo, Los Naranjos, Trepada Alta), Trepada Alta had significantly higher lizard species richness per sample (transects: $F_{(1,96)}$=21.095, P<0.0001, Table 7; sticky traps: $F_{(1,112)}$=2.560, P=0.0311, Table 8) and higher lizard abundance per sample (transects: $F_{(1,96)}$=7.446, P<0.0001; sticky traps: $F_{(1,112)}$=2.167, P=0.0627).

Community Composition

There was considerable overlap in the composition of lizards assemblages among the different habitat types (Figs. 29-34). Most habitat types contained most species of *Anolis*. *A. distichus* was invariably the most abundant lizard in the sticky traps in all habitats, with the exception of oil palm plantations in which *A. cybotes* was the most abundant lizard species. Mogote tops displayed the most unique assemblages of lizards, as five species of *Sphaerodactylus* were found on mogotes including the rare *S. cochranae*. No single mogote contained all *Sphaerodactylus* species, and different species were found in different regions of the park. *Sphaerodactylus* was observed in only two other habitats; *S. difficilis* was collected in old conuco and a single *S. samanensis* was found in an old cacao site at Los Naranjos. Three species of the aguiid *Celestus* were collected in sticky traps. *C. sternurus* was the most abundant *Cestus* species and occurred in all habitats except young conuco. Interestingly, we only found *C. costatus* in the oil palm plantations.

Species of *Anolis* utilized ground and tree microhabitats differentially (Fig. 35). Species could be classified as clear ecomorphs, as has been reported elsewhere (e.g. Williams 19##). *A. baleatus* was found almost exclusively in trees, which is consistent with its classification elsewhere as a crown giant. *A. chlorocyanus* and *A. distichus* were also found mostly in trees and have been considered trunk-crown and trunk species, respectively. In contrast, *A. cybotes* and *A. semilineatus* utilized both tree trunks and ground, but the majority of captures occurred in ground traps. Likewise, *Celestus* was found almost exclusively on the ground and only a single individual was captured on a tree trunk. Most *Celestus* captures were evenly divided on the ground and tree base. Finally, *Sphaerodactylus* were found mostly at the base of trees, although a few individuals were found in traps on tree trunks at a height of 1 meter and several individuals were captured on ground traps away from the base of trees.

Insects

Fourteen orders of insects were represented in the pitfall samples from Summer 1996 (Table 9) and Winter 1997 (Table 10). In addition, at least 10 orders of other arthropods were also represented in the samples. Among these groups, ants have been separated into morphospecies and beetles separated into families for the Summer 1996 sample. Data on richness, diversity and community composition is thus available at the species level for ants and at the family level for beetles.

Species Richness, Abundance, and Diversity

Ants. A total of 63 morphospecies of ants were collected within our study plots (Table 11). Within the park, land use history significantly affected ant species richness per sample ($F_{(1,45)}$=9.983, P<0.0001; Fig. 36) and abundance per sample ($F_{(1,45)}$=5.794, P=0.0003; Fig. 36). Within the park, planned contrasts indicated that per sample ant species richness ($F_{(1,45)}$=6.417, P=0.0149; Fig. 36) and abundance ($F_{(1,45)}$=6.209, P=0.0165; Fig. 36) were significantly lower on mogote tops than in other habitats. In addition, ant species richness ($F_{(1,45)}$=35.248, P<0.0001; Fig. 36) and abundance ($F_{(1,45)}$=15.909, P=0.0002; Fig. 36) were lower in old conucos than in young conucos. In agricultural systems outside the park, ant species richness per sample and abundance per sample were highest in active pastures and lowest in oil palm plantations. Because of the extremely high species richness and abundance per sample in active pastures, agricultural sites on average had higher species richness per sample ($F_{(1,54)}$=11.633, P=0.0012; Fig. 36) and abundance per sample ($F_{(1,54)}$=229.497, P<0.0001; Fig. 36) when contrasted with sites inside the park. Total ant species richness per land use (Fig. 36) and overall ant diversity were calculated using Shannon's Diversity Index, Simpson's Diversity Index, and the Log Diversity Index, similar patterns are evident (Fig. 37). When ants were compared among different regions of LHNP (Caño Hondo, Los Naranjos, Trepada Alta), Trepada Alta had significantly higher ant species richness per sample ($F_{(1,45)}$=6.249, P=0.0040, Table 12) and abundance per sample ($F_{(1,45)}$=5.986, P=0.0050) than the other regions.

Beetles. A total of 20 families of beetles were collected within our study plots (Table 13). Within the park, land use history significantly affected beetle family richness per sample ($F_{(1,45)}$=2.611, P=0.0372; Fig. 38), but not beetle abundance. Per sample beetle family richness and abundance were highest in old forest and mogotes and lowest in young conuco. In agricultural systems outside the park, per sample beetle family richness and abundance were highest in active pastures and lowest in oil palm plantations. Agricultural sites outside the park had lower beetle family richness per sample ($F_{(1,54)}$=3.080, P=0.0850; Fig. 38) and abundance per sample ($F_{(1,54)}$=2.815, P=0.0993; Fig. 38) when contrasted with sites inside the park. When overall beetle family diversity were calculated using Shannon's Diversity Index, Simpson's Diversity Index, and the Log Diversity Index, similar patterns are evident (Fig. 39). When beetles were compared among different regions of LHNP (Caño Hondo, Los Naranjos, Trepada Alta), Trepada Alta had significantly higher per sample beetle family richness ($F_{(1,45)}$=3.091, P=0.0552, Table 14) and abundance ($F_{(1,45)}$=9.897, P=0.0003) than the other regions.

Community Composition

Ants. Ant community composition was difficult to interpret, as there were few generalizations that could be made about differences in species identities according to habitat type. Furthermore, there was a lack of congruence between the ordinations (Figs. 40 & 41) and cluster analyses (Fig. 42), and interpretations differed based on total number trapped versus number per unit effort. Young conuco contained considerably higher diversity and a higher number of unique species (i.e., species found in no other habitat type), and this was reflected in the ordination (Fig. 41), where young conuco formed a distinct cluster from all other habitat types. Active and regenerating pastures also contained a relatively large number of unique species. In contrast, regenerating cacao contained very few ants and these were dominated by a single species, *Odontomachus* sp. 1.

Beetles. Mogote tops had a unique composition of beetle families compared to other habitats, and this was evident in the DCA (Figs. 43 &44) and cluster analyses (Fig. 45). Other patterns for beetle families were difficult to discern. The most widespread families were Staphylinidae, Scarabidae, Nitidulidae, and Curculionidae. Carabids were generally common in all of the regenerating habitats except old cacao. Curiously, old cacao had few beetle families, although staphylinids and scarabids were abundant within old cacao plots.

Soil Nitrogen

Soil organic matter was extremely high and differed significantly among land uses ($F_{(8,80)}$=101.543, P<0.0001; Fig. 46). For habitats within the park, planned contrasts indicated that mogotes had significantly higher soil organic matter content than other habitats ($F_{(1,80)}$=399.894, P<0.0001; Fig. 46), and old conucos had higher organic matter content than young conucos ($F_{(1,80)}$=4.148, P=0.0450; Fig. 46). In agricultural systems outside the park, soil organic matter content was highest in semi-active pasture and active cacao plantations and lowest in oil palm plantations. In general, agricultural sites outside the park had significantly lower soil organic matter content than sites inside the park ($F_{(1,80)}$=188.373, P<0.0001; Fig. 46).

Nitrogen mineralization rates differed significantly among land uses ($F_{(8,40)}$=2.5074 P=0.0450; Fig. 47). For habitats within the park, planned contrasts indicated that mogotes had significantly higher nitrogen mineralization rates than other habitats ($F_{(1,40)}$=11.842, P=0.0014; Fig. 47), but there was no difference between old conucos and young conucos. In agricultural systems outside the park, nitrogen mineralization rates were highest in active cacao plantations and lowest in active pastures. In general, agricultural sites outside the park had lower nitrogen mineralization rates than sites inside the park ($F_{(1,40)}$=3.394, P=0.0729; Fig. 47).

Net nitrification rates differed significantly among land uses ($F_{(8,40)}$=4.313, P=0.0008; Fig. 48). For habitats within the park, planned contrasts indicated that mogotes had significantly higher net nitrification rates than other habitats ($F_{(1,40)}$=24.619, P<0.0001; Fig. 48), but there was no difference between old conucos and young conucos. In agricultural systems outside the park, nitrification rates were highest in active cacao plantations and lowest in active pastures. In general, agricultural sites outside the park had somewhat lower nitrification rates than sites inside the park ($F_{(1,40)}$=3.534, P=0.0674; Fig. 48).

Soil microbial respiration differed significantly among land uses ($F_{(8,40)}$=7.857, P<0.0001; Fig. 49). For habitats within the park, planned contrasts indicated that mogotes had significantly higher microbial respiration than other habitats ($F_{(1,40)}$=29.290, P<0.0001; Fig. 49), but there was no difference between old conucos and young conucos. In agricultural systems outside the park, microbial respiration was highest in semi-active pasture and lowest in oil palm plantations. In general, agricultural sites outside the park had somewhat lower microbial respiration than sites inside the park ($F_{(1,40)}$=3.317, P=0.0760; Fig. 49).

Soil moisture levels differed significantly among land uses ($F_{(8,80)}$=56.309, P<0.0001; Fig. 50). For habitats within the park, planned contrasts indicated that mogotes had significantly higher soil moisture levels than other habitats ($F_{(1,80)}$=49.0145, P<0.0001; Fig. 50), and old conucos had higher moisture levels than young conucos ($F_{(1,80)}$=18.138, P<0.0001; Fig. 50). In agricultural systems outside the park, soil moisture levels was highest in semi-active pastures and active cacao plantations and lowest in oil palm plantations. In general, agricultural sites outside the park had significantly lower soil moisture levels than sites inside the park ($F_{(1,80)}$=100.438, P<0.0001; Fig. 50).

DISCUSSION

Plant Communities

Previous land use had strong impacts on the diversity and species composition of forests in the karst region of Dominican Republic. Along with results from Wise (1997), the results reported here suggest that there are strong differences in successional trajectories in the plant communities of recovering pastures compared to recovering conucos. Wise's research on early stages of succession shows that the inhibition of plant regeneration in pastures is strongly influenced by a particular introduced pasture grass, *Brachiaria decumbens* (pelua). The plant data collected in this study are consistent with Wise's conclusions. The fern, *Nephrolepsis multiflora*, appears to be one of the few species able to invade pastures planted to *B. decumbens*, and the dominance of this species was reflected in the herbaceous biomass data in this study. Total herbaceous biomass (kg/ha) was significantly higher in recovering pastures than in recovering conucos, and this result was driven by the biomass of this fern species.

Tree species diversity appeared to increase faster in pastures than in cacao plantations, in part because cacao is shade tolerant and recruits naturally in these abandoned plantations. The overstory tree, *Guarea*, can respond to a wide range of light and nutrient condition (Fernández, 1997) and produce many medium size seeds. These characteristics have allowed this species to be one of the dominant species in cacao plantations and forest. The effect of previous land use and the dominance of a few species could influence forest dynamics and species composition for over 100 years.

Faunal Communities

It is unclear, however, how much these differences between previous land uses in the plant community will influence faunal recovery. Surprisingly, the composition of faunal assemblages displayed considerable overlap among many habitats, including recently abandoned pastures and conucos. One potential explanation is that much of the remaining species pool is composed of generalists that are able to utilize a broad variety of habitat types. Thus, if the remaining faunal diversity is composed largely of opportunistic "weedy" species, then few differences in community composition would be apparent. Such a patterns could result if the available pool of colonists has been drastically reduced due to habitat loss in the region. If such an explanation is correct, then faunal recovery in the park is likely to be slow or nonexistent. Further, it would underscore the importance of placing high priority on maintaining the few relatively intact fragments remaining in the park, since these would be the source pools for any future recovery.

Alternatively, static measures of abundance and diversity may not necessarily be good surrogates of the performance of species in different habitat types; thus, species abundance and diversity could be similar among habitat types, yet some habitats could serve as sources while others serve as sinks. For example, in the Northeastern U.S., ovenbird densities increased in forest fragments recently isolated due to logging (Hagan et al. 1996). Although densities of birds were high in these forest fragments, reproduction was low due to behavioral disfunction, demonstrating that some habitats can serve as population sinks despite high apparent densities.

When patterns of diversity and abundance are compared among habitats, not all faunal groups showed complete concordance in this study. Other authors have also found nonconcordance in species richness among different taxa (Prendergast et al. 1993, Dobson et al. 1997). However, these other studies were designed to examine the overlap of biodiversity "hotspots" and were carried out at large geographic scales. One conclusion, relevant across spatial scales, is that it is essential to use more than one taxa of indicator species when conducting a biodiversity assessment. For example, among lizards we see several extreme mogote specialists; that may turn out to be true for insects as well, but does not appear to apply to birds.

With respect to faunal communities in agricultural systems outside the park, we found relatively high numbers of individuals and high species diversity in cacao, whereas oil palm plantations were extremely depauperate. Active pastures appeared to be intermediate in their ability to support bird biodiversity, although lizard diversity was very low in these systems.

There is growing recognition that various agroforestry systems may be reasonably effective forest surrogates for some faunal groups in many tropical areas (e.g., Terborgh 1989, Robbins et al. 1992, Wunderle and Waide 1993, Wunderle and Latta 1994, Greenberg 1996). For example, other workers have shown that shaded coffee, with its vertical habitat structure, supports considerably more biodiversity than unshaded "sun" coffee, which lacks a well developed forest canopy. Wunderle and Waide (1993) found much higher species richness of migrant birds in shade coffee plantations compared to sun coffee plantations in Jamaica. Perfecto and colleagues (Perfecto and Snelling 1995, Perfecto et al. 1997) have found higher diversity of ants and other insects in shade coffee compared to sun coffee.

The large degree of habitat heterogeneity in cacao sites is probably one of the major reasons why they serve as good surrogates of natural forest compared to oil palms and pasture (Terborgh 1989). Traditionally, cacao is grown under cover of various species of large shade trees, and the understory often contains a diverse assemblage of herbaceous plants. Factors such as humidity, light, and ground cover in cacao groves may be much more representative of a natural forest than pastures and oil palm plantations. In fact, from aerial photographs of the Los Haitises region, it is hard to distinguish cacao groves from natural forest. One of the limitations on cacao groves serving as reservoirs of biodiversity is that they may not represent large enough forest tracts to support some vertebrate species. However, this is a problem associated with fragment size rather than the suitability of cacao *per se*.

Soil Nitrogen

Results from this study suggest that land use can have a significant impact on nitrogen (N) cycling in the region of Los Haitises National Park. Regenerating forest soils tend to have significantly higher amounts of moisture, organic matter, and microbial activity, as well as rates of N mineralization and nitrification. It is important to understand rates of N mineralization and nitrification within soils since it is one of the dominant processes controlling N availability for both crop plants and regenerating plant species. N mineralization is the process whereby organic matter gets converted to inorganic N, a form that is usable for uptake by plants. Since microbes carry out this process, studying their activity (i.e., microbial respiration) can help us to understand the rate at which N is turning over in the soil.

Previous studies have shown that various land uses can affect soil organic matter availability (the primary source of nitrogen and carbon for microbes), rates of N mineralization (the microbial conversion of organic matter to forms of N usable by plants) and denitrification (the microbial process that removes available N from the soil and releases it to the atmosphere). N cycling in soils changes drastically when the land is altered from a pristine forest (Keller and Matson 1994, Veldkamp and Keller 1997, and Keller et al. 1993). A study by Reiners et al. (1994) has shown that changing forest to pasture decreases soil acidity, lowers porosity (water availability), and lowers N-mineralization (N availability to plants). Additional studies have shown that converting forests to pasture can increase denitrification rates, although secondary

The high amount of microbial activity in regenerating sites may be due to the high amount of soil moisture and organic matter made available to them (see Soil Moisture Figure). Previous studies have shown that water availability to microbes can strongly affect the rate at which they mineralize fresh inputs of organic matter (Aber and Melillo 1982).

Within regenerating sites of Trepada Alta, mogote tops have a significantly higher amounts of N availability, as evidenced by the high amount of microbial activity, mineralization and nitrification rates. This may be due to the high amount of soil moisture and organic matter present in these soils; these areas may have been disturbed relatively less than the valley floors because of the very steep slopes leading up to them. Also within the park, there is a significant difference in both water and organic matter availability across old and young conuco stands. Old conucos tend to have a significantly higher amount of both soil moisture and organic matter availability. This may be due to the fact that the mixed gardens that were once present there were abandoned earlier, and thus a larger amount of natural vegetation has been able to recover in these areas. With forest recovery comes a larger amount of leaf litter input, and thus organic matter, to the forest floor. There is no significant difference across age of conucos for rates of microbial activity (including N mineralization and nitrification). The soils in the older conucos may not have had enough time to completely respond to the higher amounts of organic matter available there, and thus there has been no significant increase in microbial activity within those stands.

Outside of the park, the high rates of microbial activity found in cacao groves may be because they have dense canopy cover, high soil moisture and high organic matter, and are hence the most similar to natural forest conditions. On the other hand, the African oil palm plantations and active pasture sites have the lowest amount of microbial activity associated with them. This may be due to the large amount of soil disturbance present as a result of soil compaction caused by cows and the very low amount of plant and litter cover.

PRELIMINARY RECOMMENDATIONS

- Park managers should place high priority on maintaining the few relatively intact fragments of forest remaining in the park, since these will serve as the source pools for any future recovery of floral and faunal communities.
- Park managers may need to take an active role in restoration of some parts of the park. The pasture grass *Brachiaria decumbens* (pelua) has a significant, lasting influence on secondary succession in pastures, and the regeneration of forests is significantly retarded in pastures. Fostering restoration in pastures would require the aggressive removal of this grass. Few valleys have intact forest and replanting native species may be required, where natural seed sources are unavailable.
- If a buffer zone were established around the park where some agricultural activities are incorporated, cacao systems and conuco agriculture is preferable to African oil palm for supporting biodiversity in the area.
- LHNP should use an adaptive management approach to managing biodiversity. Adaptive management adjusts management strategies accordingly as new information is acquired (Grumbine 1994, Holling 1978, Walters 1986). This is especially important because few data are presently available pertinent to recovery and restoration of the region. It may be difficult to extrapolate from other tropical systems because of the unique geology of the Los Haitises region.

- In order to provide the information necessary to carry out adaptive management, it is critical that monitoring efforts be continued for both flora and fauna in LHNP. Monitoring will allow for evaluation of the results of management actions and modification of those actions. It is important that monitoring efforts are undertaken that sample a broader set of regions of LHNP. Our sampling was limited to one corner of LHNP, and the degree to which our findings are applicable to other park regions is still unknown.

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Table 1

Table 1. Number of permanent monitoring plots at each of three locations in LHNP.

Habitat Type	Caño Hondo	Los Naranjos	Trepada Alta
Mogote top	0	3	3
Forest	0	1	1
Old Cacao	2	0	0
Old Conuco	3	3	2
Young Conuco	2	1	2
Pasture	0	2	3

Table 2
Average Number of Individuals per Count of Tree Species in Each Landuse Type. Data are from Winter, 1997 Vegetation Surveys.

Genus	Species	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Alchornia	latifolia	--	--	2.00	--	--	4.67
Allophylus	cominia	--	--	--	--	--	13.33
Ardisia	obovata	--	--	--	--	--	4.17
Artocarpus	altilis	--	0.20	1.00	--	--	--
Artocarpus	altitis	--	--	--	--	4.00	--
Bixa	orellana	--	10.00	9.88	--	--	--
Bombacopsis	emarginata	--	--	--	--	--	70.00
Bursera	simaruba	--	--	--	--	--	5.50
Calliandra	calothyrsu	--	4.00	--	--	--	--
Calophyllum	brasiliens	1.00	--	--	--	--	23.33
Calycogonium	hispidum	--	--	0.63	--	--	--
Calyptranthes	pallens	--	--	--	--	--	2.50
Calyptranthes	zuzygium	--	--	--	--	--	3.67
Carica	papaya	--	0.40	--	--	--	--
Casearia	aculeata	--	3.00	7.50	--	--	--
Casearia	sylvestris	--	--	--	--	1.00	3.33
Cecropia	schreberia	2.20	3.80	5.63	2.50	2.50	3.67
Ceiba	pentandra	--	--	0.13	--	--	--
Chionanthus	domingensi	--	--	--	--	--	0.33
Chione	venosa	--	--	--	--	--	0.83
Chrysobalanus	icaco	--	--	--	--	--	0.83
Chrysophyllum	argenteum	--	--	--	--	--	2.50
Chrysophyllum	oliviforme	--	--	--	--	--	1.67
Cinnamodendron	ekmanii	--	--	--	--	--	9.33
Cinnamomum	elongatum	--	--	--	--	--	2.83
Cinnamonum	grisebachi	--	--	0.38	--	5.00	1.00
Citrus	sp.	--	8.80	14.13	0.50	0.50	--
Clerodendrum	spinosum	--	--	--	--	--	0.83
Clidemia	umbellata	1.00	--	--	--	--	--
Clusia	minor	--	--	--	--	--	16.83
Clusia	rosea	--	--	--	--	--	6.17
Coccoloba	diversifol	--	--	--	--	--	49.67
Coccoloba	pubescens	--	--	--	--	--	0.83
Cocos	nucifera	0.60	2.20	0.13	--	--	--
Coffea	arabica	--	9.00	11.25	--	2.50	--

Table 2

Tree Species by Landuse List - Page 2

Genus	Species	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Coffea	liberica	--	--	0.13	--	--	--
Coffea	sp.	--	2.00	--	--	--	--
Comocladia	glabra	--	--	--	--	--	8.33
Cordia	polycephal	2.00	--	--	--	--	--
Cupania	americana	6.00	--	1.50	--	--	--
Dendropanax	arboreus	1.00	--	4.38	20.00	8.50	35.50
Desc	LN630	--	--	--	--	--	0.17
Desc.	LN21	--	1.00	--	--	--	--
Desc.	LN616	--	--	--	--	--	0.50
Desc.	LN618	--	--	--	--	--	0.17
Desc.	LN619	--	--	--	--	--	0.17
Desc.	LN622	--	--	--	--	--	0.17
Desc.	LN623	--	--	--	--	--	0.17
Desc.	LN624	--	--	--	--	--	0.17
Desc.	LN625	--	--	--	--	--	0.17
Desc.	LN631	--	--	--	--	--	0.33
Desc.	LN632	--	--	--	--	--	0.33
Desc.	LN64	--	--	--	--	--	0.17
Desc.	LN65	--	--	--	--	--	0.17
Desc.	LN68	--	--	--	--	--	0.17
Desc.	LN711	--	--	--	--	--	6.67
Desc.	LN78	--	--	--	--	--	0.83
Desc.	LN814	--	--	--	--	--	0.33
Desc.	LN815	--	--	--	--	--	0.33
Desc.	TA102	--	--	--	--	--	0.33
Desc.	mog10	--	--	--	--	--	0.33
Desc.	mog8	--	--	--	--	--	0.83
Didymopanax	morototoni	--	--	0.38	--	--	1.83
Drypetes	alba	--	--	--	--	--	0.83
Drypetes	glauca	--	--	--	--	--	0.17
Drypetes	ilicifolia	--	--	--	--	--	3.83
Drypetes	lateriflor	--	--	--	--	--	1.67
Drypetes	sp.	--	--	--	--	--	3.33
Erythrina	poeppigian	--	--	1.13	--	--	--
Erythroxylum	rufum	--	--	--	--	--	0.83
Eugenia	confusa	--	--	--	--	--	1.67
Eugenia	domingensi	--	--	0.13	0.50	5.00	--
Eugenia	odorata	--	--	--	--	--	0.83

Table 2

Tree Species by Landuse List - Page 3

Genus	Species	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Eupatorium	odoratum	2.00	2.00	--	--	--	--
Euphor	LN91	--	--	--	--	12.50	--
Exothea	paniculata	--	--	--	--	--	4.50
Ficus	citrifolia	--	--	--	--	--	0.33
Ficus	maxima	--	--	0.75	--	--	8.83
Ficus	sintenisii	--	--	--	--	--	1.17
Ficus	sp.	--	--	--	--	--	0.67
Ficus	trigonata	--	--	--	--	--	1.50
Flemingia	strobilife	1.00	4.00	--	--	--	--
Genipa	americana	--	--	0.13	--	--	--
Gesneria	viridiflor	--	--	--	--	--	17.50
Gonzalagunia	hirsuta	2.00	--	1.25	--	--	--
Guapira	fragans	--	--	--	--	--	5.33
Guarea	guidonea	8.00	4.00	55.88	22.50	17.00	0.83
Guateria	blainii	--	--	--	--	--	0.17
Gymnanthes	lucida	--	--	--	--	--	2.50
Hamelia	patens	4.00	--	4.38	--	2.50	--
Hibiscus	rosa-sinen	--	--	3.75	--	--	--
Hura	crepitans	6.00	--	4.88	--	--	--
Hypelate	trifoliata	--	--	--	--	--	3.33
Hyptis	capitata	--	1.00	--	--	--	--
Ilex	krugiana	--	--	--	--	--	0.67
Inga	faguifolia	--	2.00	--	--	--	--
Inga	laurina	--	--	--	--	--	5.33
Inga	vera	2.60	2.20	17.00	14.50	11.00	5.00
Lantana	camara	18.00	36.00	8.75	--	--	--
Lauracea	sp2	--	--	1.38	2.50	--	--
Lauraceae	unknown	--	--	--	--	--	28.33
Lepianthes	sp.	22.00	26.00	5.00	--	--	--
Lonchocarpus	latifolius	--	--	1.25	--	--	26.50
Magnifera	indica	--	--	0.13	--	--	--
Manihot	esculenta	--	3.00	--	--	--	--
Manilkara	bidentata	--	--	--	--	--	2.00
Maytenus	laevigata	--	--	--	--	--	0.83
Miconia	LN41	2.00	--	--	--	--	--
Miconia	impetiolar	--	--	2.50	--	--	--
Miconia	laevigata	4.00	--	2.50	--	--	1.67

Table 2

Tree Species by Landuse List - Page 4

Genus	Species	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Musa	sp.	0.20	2.40	23.00	5.00	--	--
Myrtacea	sp.	--	--	--	--	--	0.33
Ochroma	pyramidale	--	--	0.63	--	--	--
Ocotea	coriacea	--	--	--	--	7.00	176.67
Ocotea	leucoxylon	--	--	1.38	5.00	--	4.83
Ocotea	membranace	--	--	2.63	--	15.50	4.50
Ocotea	sp.	--	--	--	--	0.50	--
Oxandra	laurifolia	--	--	--	2.50	2.50	--
Pavonia	fruticosa	1.00	7.00	5.00	--	5.00	--
Persea	americana	--	1.20	2.63	1.00	5.50	--
Pimenta	racemosa g	--	--	--	--	--	0.83
Pimenta	terebenthi	--	--	--	--	--	3.33
Piper	aduncum	181.00	140.00	45.25	--	--	--
Piper	amalago	--	--	9.38	--	--	--
Piper	jacquemont	--	--	101.25	35.00	60.00	0.83
Piper	laetevirid	16.00	13.00	175.00	2.50	92.50	--
Piper	marginatum	--	--	3.13	--	--	--
Plumeria	magna	--	--	--	--	--	3.00
Pouteria	multiflora	--	--	--	--	--	4.17
Prunus	myrtifolia	--	--	--	--	--	41.17
Pseudolmedia	spuria	--	--	0.63	2.50	8.50	23.33
Psidium	guajava	105.60	16.00	14.50	--	--	--
Psychotria	berteriana	--	--	--	--	--	0.83
Psychotria	domingensi	--	--	5.63	--	--	--
Psychotria	nervosa	--	--	--	--	--	3.33
Psychotria	pubescens	--	--	18.13	45.00	57.50	5.83
Psychotria	revoluta	--	--	--	--	--	0.83
Psychotria	sp.	--	--	--	--	2.50	--
Quararibea	turbinata	--	--	--	--	2.50	--
Roystonea	domingensi	--	--	1.63	0.50	0.50	--
Rubiacea	unknown	--	--	--	--	--	1.67
Salmea	scandens	--	--	0.63	--	--	--
Samanea	filipes	--	--	--	--	--	1.67
Sideroxylon	cubense	--	--	--	--	--	4.33
Sideroxylon	domingense	--	--	--	--	--	8.00
Simaruba	glauca	--	--	--	--	--	0.83
Sloanea	amigdalina	--	--	--	--	--	2.33

Table 2

Tree Species by Landuse List - Page 5

Genus	Species	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Solanum	torvum	--	4.00	--	--	--	--
Spathodea	campanulat	--	0.40	3.00	--	--	--
Spondias	mombin	--	1.60	14.75	1.50	--	1.00
Stachytarpheta	cayennensi	--	1.00	--	--	--	--
Swietenia	mahagoni	--	--	--	--	--	2.00
Tabernaemontana	citrifolia	--	--	1.25	--	--	--
Tetrazygia	sp.	--	--	--	--	--	11.33
Tetreagastris	balsamifer	--	--	--	--	--	4.67
Theobroma	cacao	--	14.80	13.00	178.00	--	--
Theophrasta	americana	--	--	--	--	--	1.67
Trichilia	pallida	--	--	0.63	--	2.50	8.33
Triumfetta	sp.	4.00	104.00	0.63	--	--	--
Trophis	racemosa	--	--	1.25	--	2.50	13.67
Turpinia	occidental	--	--	0.63	--	--	7.00
Urera	baccifera	--	4.00	10.63	15.00	10.00	--
Wallenia	laurifolia	--	--	--	--	--	1.67
Zanthoxylum	martinicen	1.60	--	5.88	1.00	4.00	--
Ziziphus	rodoxylon	--	--	--	--	--	3.83

Table 3

Tree Species Richness and Diversity in Each Landuse Type Within Different Park Regions. Data are from Transect Sampling During Winter, 1997

Landuse	Region	Richness	H'	1/D	alpha
Pasture	Trepada Alta	20	1.77	3.81	3.29
	Los Naranjos	12	1.38	2.52	2.18
Young Conuco	Trepada Alta	18	1.93	3.76	3.56
	Los Naranjos	20	2.11	5.87	3.71
	Caño Hondo	16	1.86	4.35	2.83
Old Conuco	Trepada Alta	44	2.46	5.83	8.08
	Los Naranjos	26	2.44	7.42	4.75
	Caño Hondo	29	2.29	6.27	4.77
Old Cacao	Caño Hondo	20	1.81	3.53	3.82
Forest	Trepada Alta	14	1.86	4.27	2.95
	Los Naranjos	25	2.45	6.72	6.08
Mogote	Trepada Alta	64	3.23	14.17	12.05
	Los Naranjos	66	2.70	7.64	12.86

H' = Shannon Diversity Index Value
1/D = Simpson Diversity Index Value
alpha = Log Diversity Index Value

Table 4

Average Number of Individuals per Count of Each Bird Species in Each Landuse Type. Data are from Bird Pointcounts during All Three Seasons.

Genus	Species	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Amazona	ventralis	--	--	--	0.02	0.03	0.02	--	0.11	0.23
Anthracothorax	dominicus	0.03	--	0.27	0.48	0.61	0.71	0.55	0.69	0.19
Aramus	guarauna	--	--	0.03	--	--	--	--	--	--
Bubulcus	ibis	0.77	--	--	--	0.01	--	--	--	--
Buteo	jamaicensis	--	--	--	--	0.01	--	--	--	--
Buteo	ridgwayi	--	--	--	--	--	--	--	--	0.01
Cathartes	aura	0.03	--	--	0.13	0.11	0.03	--	--	--
Chlorostilbon	swainsonii	--	--	--	0.04	0.14	0.28	0.10	0.29	0.07
Coccyzus	minor	--	--	--	0.02	0.04	--	--	0.03	--
Coereba	flaveola	--	0.04	1.47	0.45	0.50	1.58	1.84	1.71	0.47
Columba	inornata	--	--	--	0.09	0.10	0.07	--	--	0.14
Columba	leucocephalus	--	--	--	--	0.01	--	--	--	--
Columba	squamosa	--	--	--	--	--	--	--	--	0.01
Contopus	caribaeus	--	--	--	--	0.01	--	--	--	--
Corvus	leucognaphalus	--	--	--	0.11	0.13	0.02	--	0.03	0.23
Crotophaga	ani	--	--	0.17	0.38	0.28	--	--	--	--
Cypseloides	niger	--	--	--	--	--	--	--	0.03	--
Dendroica	caerulescens	--	--	--	--	0.08	0.02	0.03	0.03	0.01
Dulus	dominicus	5.83	0.13	1.80	0.68	0.65	0.24	--	0.11	0.09
Falco	sparverius	0.20	--	--	--	--	--	--	--	--
Geothlypis	trichas	--	--	--	0.01	--	--	--	--	--
Geotrygon	montana	--	--	0.03	--	--	0.02	0.03	0.06	0.05
Icterus	dominicensis	0.07	--	--	0.02	0.06	0.03	--	0.03	--
Loxigilla	violacea	--	--	0.03	0.12	0.14	0.66	0.94	0.74	0.32
Melanerpes	striatus	0.30	0.09	0.87	0.15	0.19	0.58	0.45	1.00	0.41
Mellisuga	minima	0.13	0.13	0.17	0.44	0.88	0.49	0.13	0.34	1.01
Microligea	palustris	--	--	--	--	--	--	--	0.03	0.01
Mimocichla	plumbea	--	--	--	--	--	0.03	0.13	0.03	--
Mimus	polyglottos	0.10	--	--	--	--	--	--	--	--
Mniotilta	varia	--	--	0.03	0.01	--	0.01	--	0.03	0.02
Myiarchus	stolidus	--	--	--	0.11	0.16	0.14	0.19	0.17	0.03
Nesoctites	micromegas	0.03	0.04	0.07	0.01	0.08	0.33	0.48	0.20	0.36
Numida	meleagris	--	--	--	0.01	--	--	--	--	--
Parula	americana	--	--	--	0.01	--	0.01	--	--	--
Petrochelidon	fulva	--	--	--	0.05	0.03	0.02	--	--	0.02
Phoenicophilus	palmarum	--	0.09	0.07	0.10	0.26	0.61	0.71	0.17	0.23
Ploceus	cucullatus	0.93	--	--	0.02	--	--	--	--	--

Table 4

Bird Species by Landuse List - Page 2

Genus	Species	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Quiscalus	niger	0.40	--	0.13	--	--	--	--	--	--
Saurothera	longirostris	0.07	--	0.33	0.23	0.13	0.21	0.26	0.20	0.11
Seiurus	aurocapillus	--	--	--	0.01	--	0.02	0.03	--	0.01
Seiurus	motacilla	--	--	0.07	--	--	--	--	--	0.02
Setophaga	ruticilla	--	--	--	--	--	--	--	0.03	--
Tachomis	phoenicobia	0.07	--	--	0.04	0.03	--	--	--	--
Tiaris	olivacea	--	--	--	0.01	0.03	--	--	--	--
Todus	subulatus	--	--	0.07	0.21	0.15	0.34	0.29	0.14	0.20
Tyrannus	dominicensis	0.03	--	--	0.07	0.08	0.02	0.10	--	--
Vireo	altiloquus	0.03	--	0.43	0.16	0.05	0.58	0.90	0.51	0.29
Vireo	nanus	--	--	--	--	--	--	--	0.11	0.07
Zenaida	macroura	--	0.09	0.03	--	0.03	--	--	--	--

Table 5

Average Number of Individuals per Count of Each Herp Species in Each Landuse Type. Data are from Transect Sampling during Summer, 1997.

Genus	Species	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Anolis	baleatus	--	--	0.15	--	--	--	0.13	--	0.12
Anolis	chlorocyanus	0.15	0.33	0.15	0.32	0.24	0.70	--	--	0.41
Anolis	cybotes	0.08	2.50	3.15	--	0.14	0.07	--	--	0.88
Anolis	distichus	0.39	2.00	9.39	1.79	4.91	4.60	3.63	3.33	4.77
Anolis	semilineatus	--	--	--	--	0.19	--	--	0.11	0.24
Bufo	marinus	--	--	--	--	0.05	--	--	--	--
Celestus	stenurus	--	--	0.31	0.05	0.10	--	--	--	0.35
Eleutherodactylus	abbotti	--	0.08	--	--	0.05	0.03	0.13	0.11	--
Eleutherodactylus	inoptatus	--	--	0.08	--	--	--	--	--	--
Osteopilus	dominicensis	--	--	0.08	--	--	--	--	--	--
Sphaerodactylus	difficilus	--	--	0.08	--	--	--	--	--	--
Sphaerodactylus	samanensis	--	--	--	--	--	--	--	0.11	--
Tropidophis	haitianus	--	--	0.08	--	--	--	--	--	--
Uromacer	catesbyi	--	--	--	--	0.05	--	--	--	--

Table 6

Average Number of Individuals per Count of Each Herp Species in Each Landuse Type. Data are from Sticky Trap Sampling during Summer, 1997.

Genus	Species	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Anolis	baleatus	--	0.20	0.10	--	0.11	--	--	0.20
Anolis	chlorcyanus	0.30	0.70	0.55	0.56	0.29	0.10	0.50	0.25
Anolis	cybotes	3.20	3.90	0.05	0.08	0.03	--	--	0.80
Anolis	distichus	1.00	10.10	2.40	2.72	2.74	1.90	2.20	3.40
Anolis	semilineatus	--	--	0.40	0.16	0.14	0.10	0.30	0.65
Antillophis	parvifrons	--	--	0.05	--	0.03	--	--	0.05
Celestus	costatus	0.60	--	--	--	--	--	--	--
Celestus	sepsoides	--	--	--	--	0.06	0.10	--	--
Celestus	stenurus	0.50	1.10	0.25	--	0.43	0.60	0.40	0.25
Epicrates	striatus	--	--	--	--	0.06	--	--	--
Sphaerodactylus	clenchi	--	--	--	--	--	--	--	0.05
Sphaerodactylus	cochranae	--	--	--	--	--	--	--	0.40
Sphaerodactylus	darlingtoni	--	--	--	--	0.03	--	--	0.10
Sphaerodactylus	difficilis	--	0.50	--	--	0.11	--	--	0.15
Sphaerodactylus	samanensis	--	--	--	--	--	0.10	--	0.05
Tropidophis	haitianis	--	0.10	--	--	--	--	--	--

Table 7

Herp Species Richness and Diversity in Each Landuse Type Within Different Park Regions. Data are from Transect Sampling During Summer, 1997.

Landuse	Region	Richness	H'	1/D	alpha
Pasture	Trepada Alta	2	0.16	1.08	0.88
	Los Naranjos	2	0.67	2.06	1.13
Young Conuco	Trepada Alta	3	0.62	1.57	0.85
	Los Naranjos	5	0.44	1.23	1.36
	Caño Hondo	5	0.61	1.38	1.51
Old Conuco	Trepada Alta	4	0.61	1.52	0.82
	Los Naranjos	2	0.25	1.15	0.49
	Caño Hondo	1	*	*	*
Old Cacao	Caño Hondo	3	0.28	1.15	0.82
Forest	Trepada Alta	1	*	*	*
	Los Naranjos	3	0.94	2.14	2.47
Mogote	Trepada Alta	6	1.14	2.18	1.46
	Los Naranjos	3	0.50	1.37	0.86

H' = Shannon Diversity Index Value
1/D = Simpson Diversity Index Value
alpha = Log Diversity Index Value

* Insufficient data

Table 8

Herp Species Richness and Diversity in Each Landuse Type Within Different Park Regions. Data are from Sticky Trap Sampling During Summer, 1997.

Landuse	Region	Richness	H'	1/D	alpha
Pasture	Trepada Alta	4	0.78	1.65	1.4
	Los Naranjos	7	1.58	4.3	3.74
Young Conuco	Trepada Alta	3	0.86	2.13	1.5
	Los Naranjos	2	0.54	1.59	0.83
	Caño Hondo	3	0.54	1.4	1.13
Old Conuco	Trepada Alta	9	1.31	2.37	3.23
	Los Naranjos	6	1.15	2.29	2.67
	Caño Hondo	3	0.58	1.52	1.12
Old Cacao	Caño Hondo	6	1.07	2.18	2.93
Forest	Trepada Alta	4	1.09	2.55	2.29
	Los Naranjos	4	0.92	2.07	2.5
Mogote	Trepada Alta	9	1.53	3.13	2.77
	Los Naranjos	9	1.57	3.19	5.75

H' = Shannon Diversity Index Value
1/D = Simpson Diversity Index Value
alpha = Log Diversity Index Value

Summer 1996 Insect Pitfall Samples. N is the number of three day samples.

			Coleoptera		Coleoptera	Orthoptera	Chilopoda	Diplopoda	Formicidae	Total
	n	Staphylinidae	Scarabaeidae	Carabidae	Total	Gryllidae				
Active Pasture										
PS1	2	1	1		7	22		10	1357	1396
Active Oil Palm										
PL1	2				1	5			75	81
PL2	2		2		6	4		2	26	38
Active Cacao										
CA2	2	27			33	76		1	202	312
CA3	2				2	6		6	48	62
Pasture										
LN4	2	1	3	3	7	9		4	51	71
LN5	2					3		5	40	48
TA1	2	111	4	8	126	118		1	103	348
TA5	2	29		1	33	26		4	363	426
TA12	2	7	1	2	12	18	3		110	143
Young Conuco										
CH2	2			1	4	14	12		168	198
CH4	2	1	1	2	4	30	5	3	135	177
LN2	2	3			4	7		15	129	155
LN3	1			1	2			2	83	87
LN10	2	2	1	1	5	12		3	46	66
TA2	2	36	1	11	54	59		6	127	246
TA7	1	25	1		28	6		1	155	190
Old Conuco										
CH3	2	5	9	5	19	6		1	26	52
CH5	2	16	3		21	3	1	1	67	93
CH7	2	18	3		21	38	1	6	17	83
LN11	2	4		1	6	14	1	1	55	77
TA4	2	35	11	33	84	54		3	108	249
TA13	2	6	1		7	33	2		76	118
Cacao										
CH6	2	17	10		27	49	3	2	69	150
CH8	2	14	2	2	19	6	2	5	50	82
Forest										
LN9	2	1	3	1	8	4	1	1	37	51
TA3	2	63	1	3	81	89		2	69	241
Mogote										
LN6	2	17	3		30	14	1	3	51	99
LN7	2	1	2		7	12		3	21	43
LN8	2	19	2		25	30		3	41	99
TA6	1	64	2		67	15	1		30	113
TA8	2	20	1	1	23	4			52	79
TA10	2	6	5		17	10	2	5	25	59
Total	63	549	73	76	790	796	35	99	4012	5732

Winter 1997 insect pitfall samples. N is the number of three day samples.

	n	Coleoptera Staphylinidae	Coleoptera Scarabaeidae	Coleoptera Total	Orthoptera Gryllidae	Chilopoda	Diplopoda	Formicidae	Other Arthropods	Total
Active Pasture										
PS1	2	1	2	6	18	1	8	736	323	1095
PS2	1			7	22	2		443	146	620
Active Oil Palm										
PL1	2	5		7	40	3		586	210	851
PL2	1				1	2		49	7	59
Active Cacao										
CA2	2	48		56	47	11		211	316	689
CA3	2	37	2	44	26	2		158	108	377
Pasture										
LN4	1	6		13	21	1	1	284	103	429
LN5	1	4	2	8	17			71	176	278
TA1	1	10	1	19	24			9	17	80
TA5	1	11		14	2					27
TA12	1	1		1	9	1	1	57	154	224
Young Conuco										
CH2	1			2	9			74	25	110
CH4	1		3	7	26	1	1	350	136	524
LN2	2	24		24	46	3	1	776	569	1443
LN3	2	18	10	44	25	4	2	397	321	821
LN10	1	11		14	18	1	1	7	10	62
TA2	1	48		55	46	7		95	368	619
TA7	2	27	3	40	11		2	274	169	526
Old Conuco										
CH3	1	18		18	13			13	11	73
CH7	1	72	1	80	48	1		126	212	540
LN11	2	121		134	119	2	1	216	340	933
TA4	1	35		36	93	1	2			167
TA13	1	17		20	22			48	308	415
Cacao										
CH6	1	93		108	59	2		72	233	567
CH8	1	56		68	28	2		82	239	475
Forest										
LN9	2	98	2	113	85		1	118	380	797
TA3	1	44		55	66	1		53	182	401
Mogote										
LN6	1	2	30	39	17	2		26	66	182
LN7	2	45	115	188	33	1		85	227	694
LN8	1	16	4	31	10			13	44	118
TA6	1	52	48	102	24			40	246	512
TA8	1	15	3	25	4		1	18	63	129
TA10	1	3	5	8	2			6	4	28
Total	43	938	231	1386	1031	51	22	5493	5713	14865

Table 11

Average Number of Individuals per Count of Each Ant Species in Each Landuse Type. Data are from Pitfall Trap Sampling during Summer, 1996.

Genus	Morpho-Species	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Anochetus	Sp1	--	0.25	0.25	0.40	0.38	0.31	--	0.25	0.18
Anochetus	Sp2	--	--	0.25	0.10	--	0.13	--	--	--
Aphaenogaster	Sp1	--	--	--	0.10	--	--	--	0.25	--
Brachymyrmex	Sp1	2.50	--	--	0.20	1.25	0.06	--	--	--
Brachymyrmex	Sp2	1.00	--	--	--	--	--	--	--	--
Brachymyrmex	Sp3	0.50	--	--	--	0.38	--	--	--	--
Brachymyrmex	Sp4	--	--	--	--	--	0.06	0.25	--	--
Brachymyrmex	Sp5	--	--	--	0.10	--	--	--	--	--
Camponotus	Sp1	--	--	0.25	--	0.13	0.13	--	--	0.09
Camponotus	Sp2	--	--	--	--	--	--	--	--	0.09
Camponotus	Sp3	--	--	--	--	--	--	--	0.25	--
Camponotus	Sp4	--	--	--	--	0.25	0.06	--	--	--
Cardiocondyla	Sp1	4.50	--	--	--	--	--	--	--	--
Crematogaster	Sp1	--	--	0.25	--	--	--	--	--	--
Eurhopalothrix	Sp1	--	--	--	0.10	--	0.06	--	--	--
Gnamptogenys	Sp1	--	6.25	20.00	0.40	10.88	0.44	--	0.25	0.09
Gnamptogenys	Sp2	--	3.50	--	--	1.38	--	--	--	--
Gnamptogenys	Sp3	--	--	--	0.10	--	--	--	--	--
Hypoponera	Sp1	--	--	0.50	0.30	--	0.19	--	--	--
Hypoponera	Sp2	--	--	--	--	0.13	0.06	--	--	--
Hypoponera	Sp3	--	--	--	0.10	--	--	--	--	--
Mycetarotes	Sp1	--	--	1.00	0.10	0.50	1.38	0.50	--	0.27
Mycetarotes	Sp5	--	--	--	--	0.25	--	--	--	--
Odontomachus	Sp1	8.00	0.75	7.75	22.40	10.25	13.44	17.50	11.50	5.00
Odontomachus	Sp2	0.50	--	0.50	0.90	0.25	1.06	1.75	0.25	0.18
Odontomachus	Sp3	--	--	--	--	--	0.06	--	--	--
Odontomachus	Sp4	--	--	--	0.20	--	--	--	--	--
Paratrechina	Sp1	2.00	--	--	0.20	0.63	0.19	--	--	--
Paratrechina	Sp2	--	--	0.25	0.90	--	0.50	--	1.75	1.36
Paratrechina	Sp3	--	--	--	--	0.50	--	--	--	--
Paratrechina	Sp4	--	--	--	--	1.25	--	--	--	--
Paratrechina	Sp6	--	--	--	0.10	--	--	--	--	--
Paratrechina	Sp7	--	--	2.00	--	0.25	--	--	--	--
Pheidole	Sp1	--	--	--	--	--	0.06	--	--	0.64
Pheidole	Sp2	1.50	0.75	5.00	1.00	0.25	2.75	0.25	1.25	2.00
Pheidole	Sp3	42.50	5.00	4.75	11.30	19.75	6.31	--	0.50	0.27
Pheidole	Sp4	67.00	--	1.25	--	3.75	--	--	--	0.09

Ant Species by Landuse List - Page 2

Genus	Morpho-Species	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Pheidole	Sp5	--	0.50	--	--	--	--	--	--	--
Pheidole	Sp6	--	--	--	0.30	--	0.81	0.50	--	--
Platythyrea	Sp1	--	--	0.75	0.50	0.25	0.19	--	--	--
Ponera	Sp1	--	--	--	--	--	0.06	--	--	--
Pseudomyrmex	Sp1	--	--	--	--	--	--	--	--	0.09
Rogeria	Sp1	--	--	--	--	--	0.06	--	0.50	0.09
Rogeria	Sp2	--	--	0.25	--	--	0.06	--	--	--
Rogeria	Sp3	--	--	--	--	--	0.06	--	--	--
Soldier	Sp1	0.50	--	--	--	0.13	--	--	--	--
Soldier	Sp2	0.50	0.25	0.25	0.90	0.25	0.19	--	--	--
Soldier	Sp3	6.50	--	--	--	--	--	--	--	--
Soldier	Sp4	4.00	--	--	--	0.13	--	--	--	--
Soldier	Sp5	--	--	--	--	0.13	0.06	--	0.25	0.09
Soldier	Sp6	0.50	--	--	--	0.13	--	--	--	--
Soldier	Sp7	--	--	--	--	0.13	--	--	--	--
Soldier	Sp8	--	--	--	--	0.25	--	--	--	--
Solenopsis	Sp1	2.00	0.50	0.50	0.90	0.13	--	--	--	0.09
Solenopsis	Sp2	168.00	1.25	8.00	0.60	4.50	0.06	--	2.25	0.36
Solenopsis	Sp3	--	--	--	--	--	--	--	--	0.27
Solenopsis	Sp4	4.00	0.75	3.00	0.90	1.50	1.44	0.50	1.50	1.27
Solenopsis	Sp5	--	--	--	--	0.25	--	--	0.25	--
Strumigenys	Sp1	2.50	0.25	1.00	0.30	1.50	0.06	0.25	0.25	0.18
Strumigenys	Sp2	--	--	0.50	0.20	--	0.13	--	--	--
Strumigenys	Sp3	--	--	--	--	0.13	--	--	0.25	--
Tetramorium	Sp1	--	--	--	0.10	1.13	0.06	--	--	--
Tetramorium	Sp2	--	--	--	--	0.13	--	--	--	--
Trachymyrmex	Sp1	--	--	--	--	0.13	--	--	--	1.64
Wasmannia	Sp1	358.00	5.00	3.00	22.60	18.88	4.19	--	4.25	5.27
Wasmannia	Sp3	--	--	--	--	0.13	--	--	--	--
Wasmannia	Sp4	--	--	--	--	0.13	--	--	--	--
Wasmannia	Sp5	0.50	0.25	1.25	0.30	1.50	--	--	0.75	0.36
Wasmannia	Sp6	0.50	--	--	--	--	--	--	--	--
Wasmannia	Sp7	1.00	--	--	--	--	--	--	--	--

Table 12

Ant Species Richness and Diversity in Each Landuse Type Within Different Park Regions. Data are from Pitfall Trap Sampling During Summer, 1996

Landuse	Region	Richness	H'	1/D	alpha
Pasture	Trepada Alta	28	1.68	3.56	6.44
	Los Naranjos	13	1.69	3.84	4.62
Young Conuco	Trepada Alta	13	1.47	3.22	3.38
	Los Naranjos	29	2.47	7.76	9.54
	Caño Hondo	25	2.29	6.93	6.81
Old Conuco	Trepada Alta	21	2.07	5.47	5.41
	Los Naranjos	19	2.02	4.97	7.48
	Caño Hondo	14	1.30	2.11	4.22
Old Cacao	Caño Hondo	8	0.79	1.50	2.53
Forest	Trepada Alta	14	1.88	4.26	5.30
	Los Naranjos	10	1.76	4.50	5.29
Mogote	Trepada Alta	16	2.10	6.18	5.69
	Los Naranjos	18	2.19	6.40	6.54

H' = Shannon Diversity Index Value
1/D = Simpson Diversity Index Value
alpha = Log Diversity Index Value

Table 13

Average Number of Individuals per Count of Each Beetle Family in Each Landuse Type. Data are from Pitfall Trap Sampling during Summer, 1996.

Genus	Active Pasture	Active Oil Palm	Active Cacao	Old Pasture	Young Conuco	Old Conuco	Old Cacao	Forest	Mogote
Apionidae	--	--	--	--	--	--	--	--	0.09
Bostrichididae	--	--	--	--	--	--	--	1.00	0.09
Byturidae	--	--	0.25	0.20	--	0.06	--	--	0.09
Carabidae	--	--	--	1.40	0.50	3.31	--	1.00	0.09
Chrysopidae	--	--	--	0.10	--	--	--	--	0.09
Coccinellidae	--	--	--	--	--	--	--	0.25	--
Curculionidae	0.50	--	0.25	--	0.50	0.25	--	0.75	1.18
Euglenidae	--	--	--	0.10	--	--	--	--	--
Hydrophilidae	0.50	--	--	0.20	0.13	0.19	--	0.50	--
Lampyridae	--	--	--	--	--	0.06	--	--	--
Leioedidae	--	--	0.75	0.10	0.13	0.19	--	0.25	0.09
Nitidulidae	0.50	1.25	0.75	0.10	0.13	0.13	--	0.50	0.18
Phalacridae	1.00	--	--	--	--	0.06	--	--	--
Pselaphidae	--	--	--	--	--	0.06	--	0.25	--
Rhizophagidae	--	--	--	--	--	--	--	--	0.09
Scarabaeidae	0.50	0.50	--	0.80	0.25	1.75	3.25	1.00	1.36
Scolytidae	--	--	--	--	--	--	--	--	0.27
Scydmaenidae	--	--	--	--	--	--	--	0.75	0.09
Staphylinidae	0.50	--	6.75	14.80	3.63	7.38	8.75	16.00	11.55
Tenebrionidae	--	--	--	--	--	--	--	--	0.09

Table 14

Beetle Family Richness and Diversity in Each Landuse Type Within Different Park Regions. Data are from Pitfall Trap Sampling During Summer, 1996

Landuse	Region	Richness	H'	1/D	alpha
Pasture	Trepada Alta	9	0.63	1.35	2.32
	Los Naranjos	3	1.00	3.50	3.88
Young Conuco	Trepada Alta	4	0.46	1.26	1.77
	Los Naranjos	4	1.24	5.00	14.12
	Caño Hondo	4	1.26	4.67	5.71
Old Conuco	Trepada Alta	10	1.25	2.64	2.76
	Los Naranjos	4	1.17	3.24	3.54
	Caño Hondo	5	1.09	2.42	1.67
Old Cacao	Caño Hondo	2	0.58	1.68	0.71
Forest	Trepada Alta	11	1.01	1.65	3.89
	Los Naranjos	5	1.49	7.00	10.91
Mogote	Trepada Alta	7	0.66	1.40	2.00
	Los Naranjos	11	1.43	2.63	4.43

H' = Shannon Diversity Index Value
1/D = Simpson Diversity Index Value
alpha = Log Diversity Index Value

Figure 1

Tree Species Richness, Richness per Count, and Abundance per Count from Surveys during Winter, 1997.

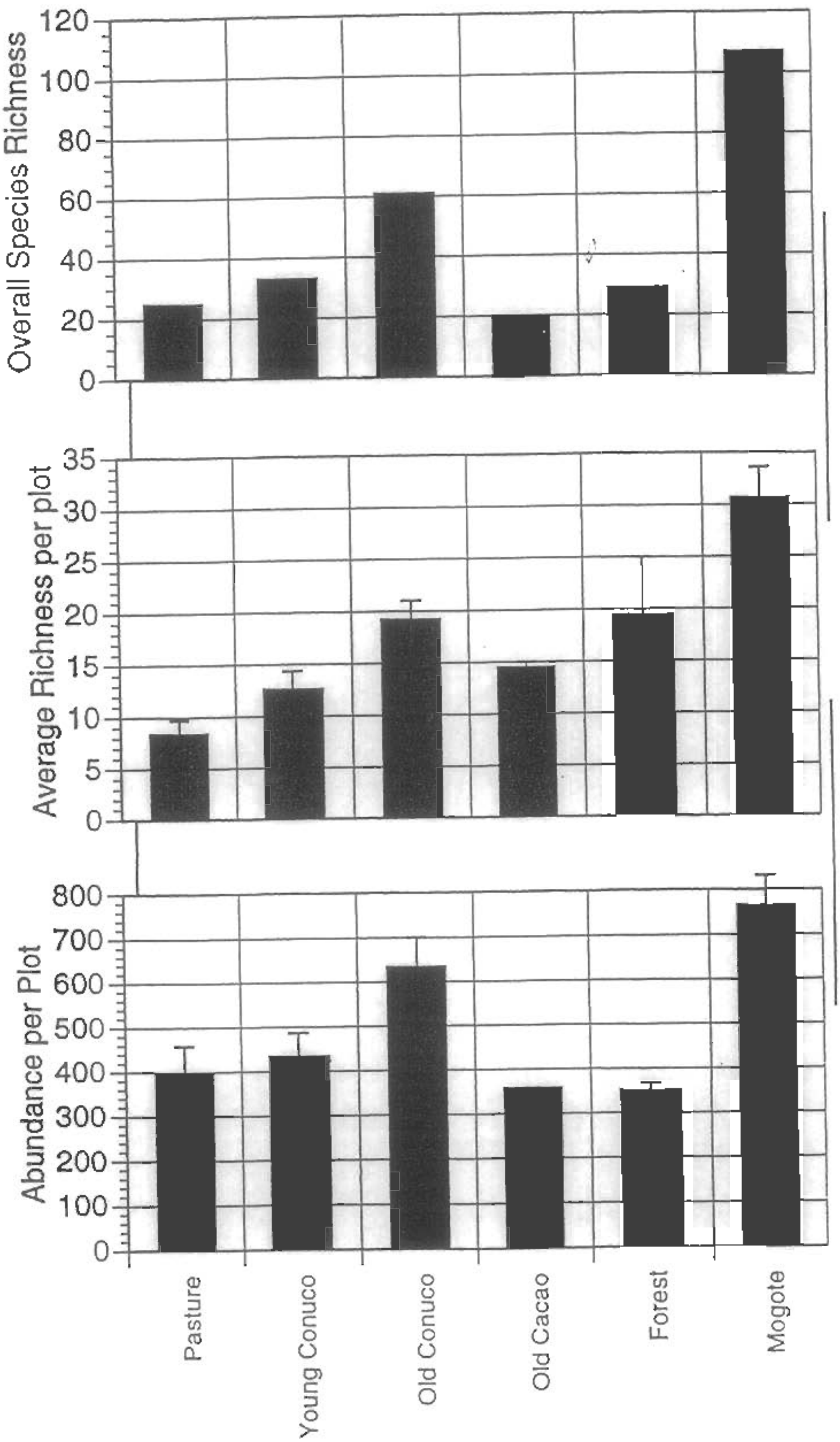


Figure 2

Tree Diversity as Measured by Shannon, Simpson and Log Diversity Indices from Surveys during Winter, 1997.

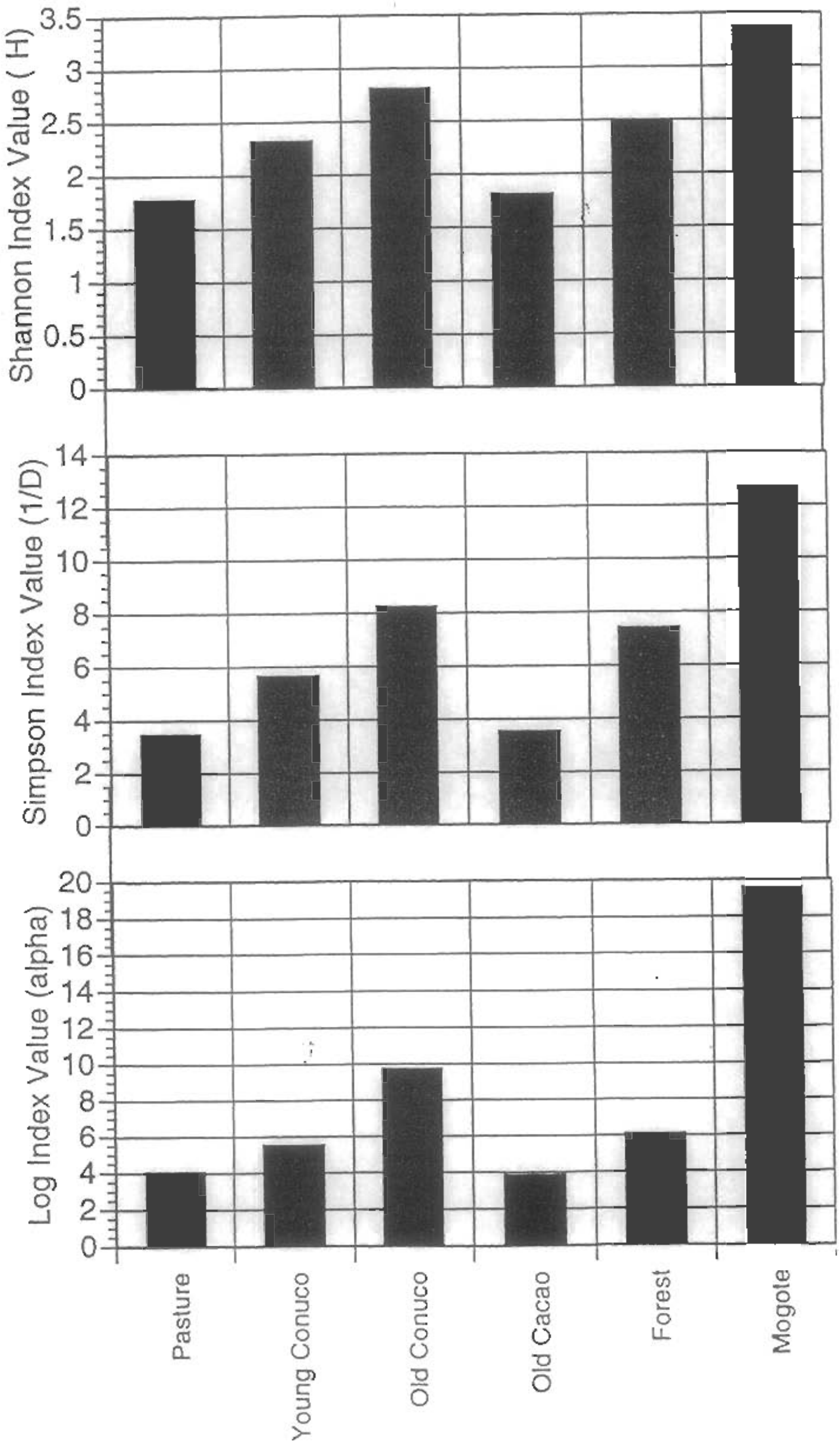


Figure 3

Total Tree Basal Area and Total Understory Biomass from Winter, 1997 Vegetation Surveys.

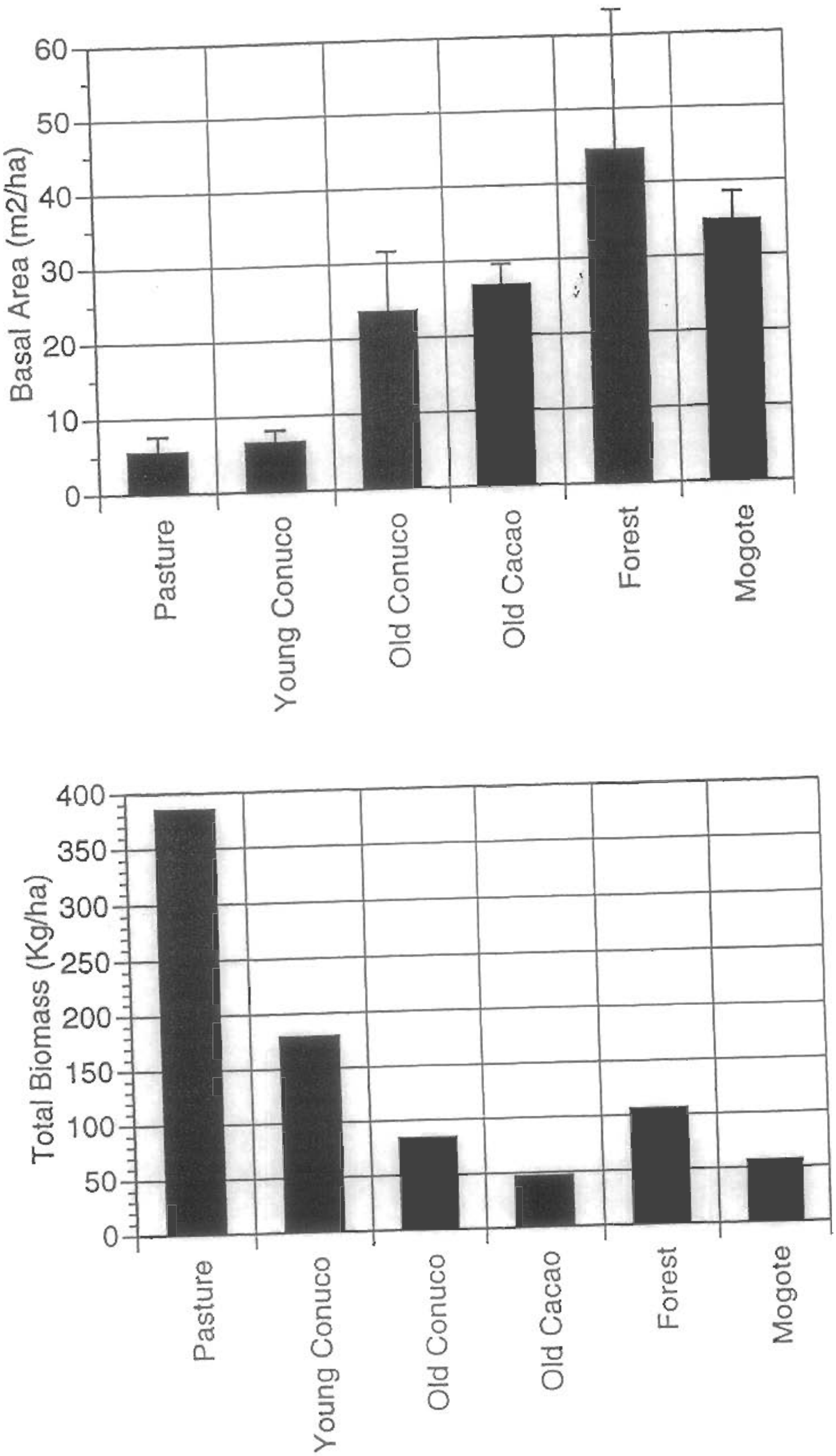


Figure 4

Understory Biomass of Different Vegetation Types from Winter, 1997 Vegetation Surveys.

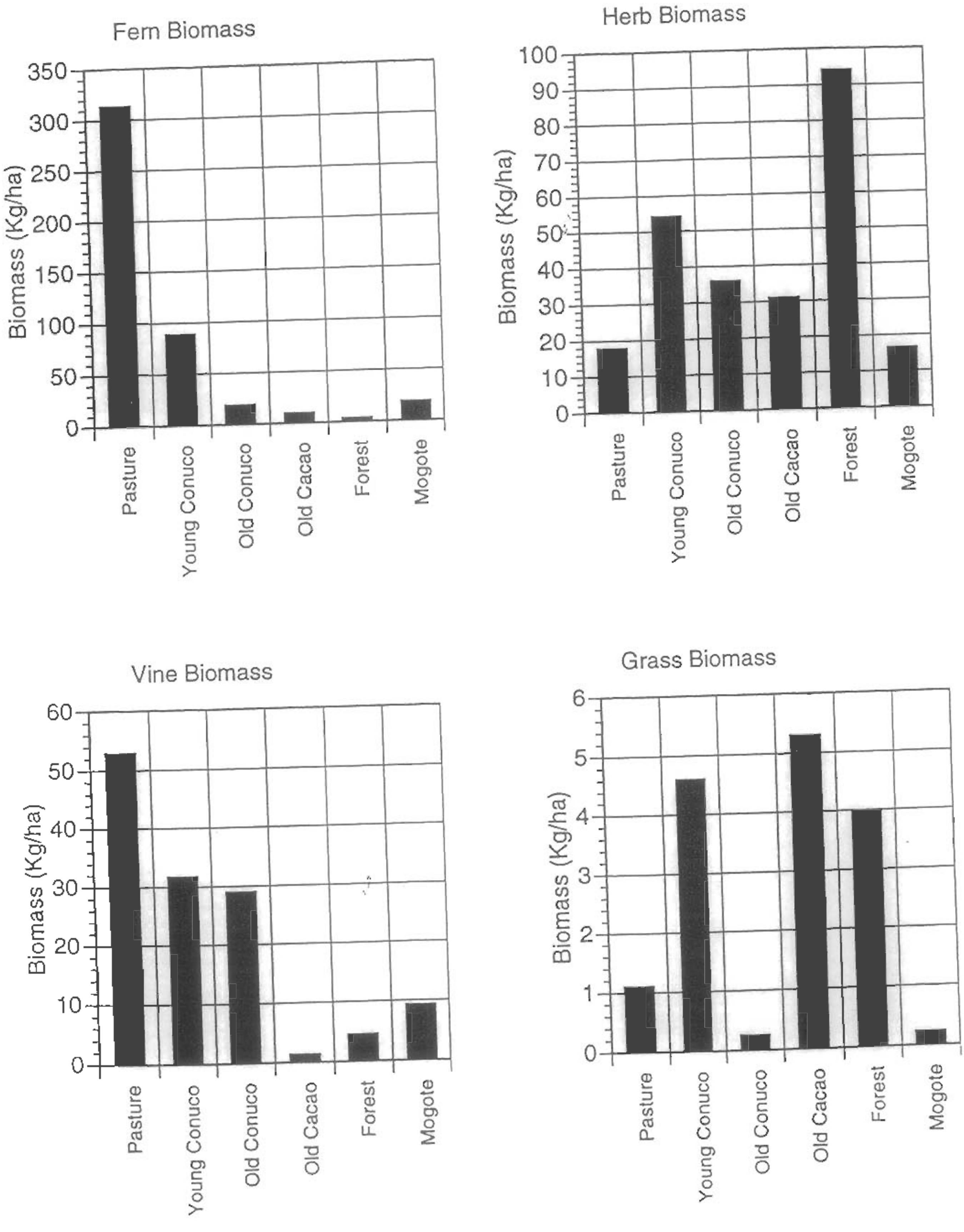
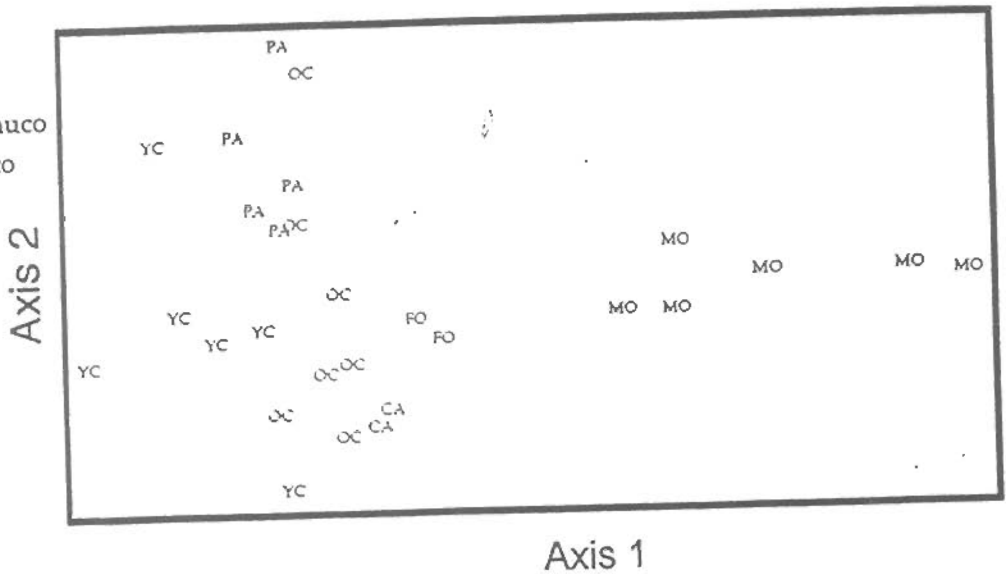


Figure 5

Ordination of Plots within Los Haitises Based on Trees Identified During Winter, 1997. Ordination Method is De-trended Correspondence Analysis (DCA).

PA Recovering Pasture
YC Recovering Young Conuco
OC Recovering Old Conuco
CA Recovering Cacao
FO Forest
MO Mogote



Trepada Alta
Los Naranjos
Caño Hondo

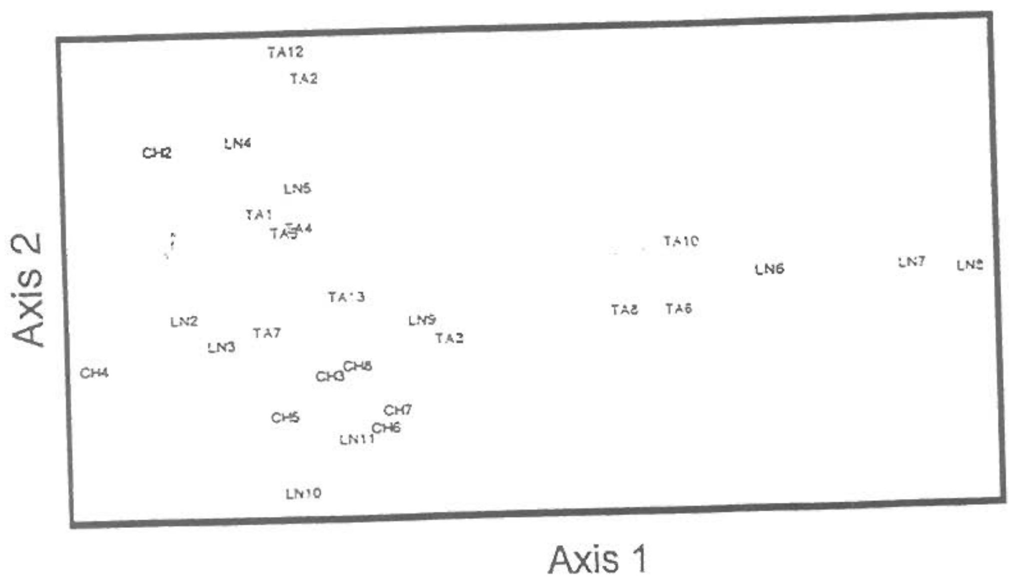


Figure 6

Cluster Analyses of Landuse Types Based on Presence or Absence of Tree Species in Surveys During Winter, 1997. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

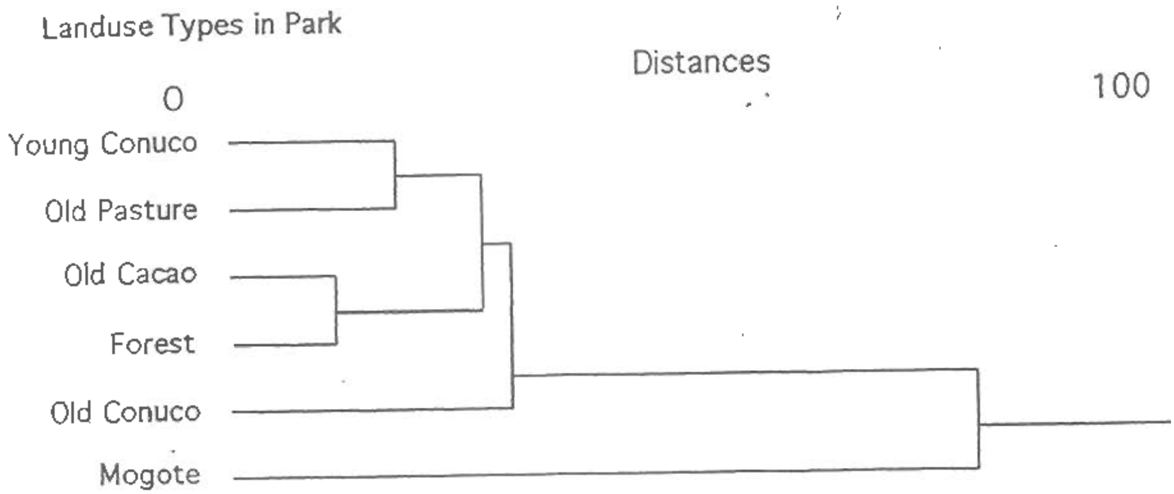


Figure 7

Average Bird Richness per Pointcount in Los Haitises and Agricultural Sites. Error Bars are Standard Errors.

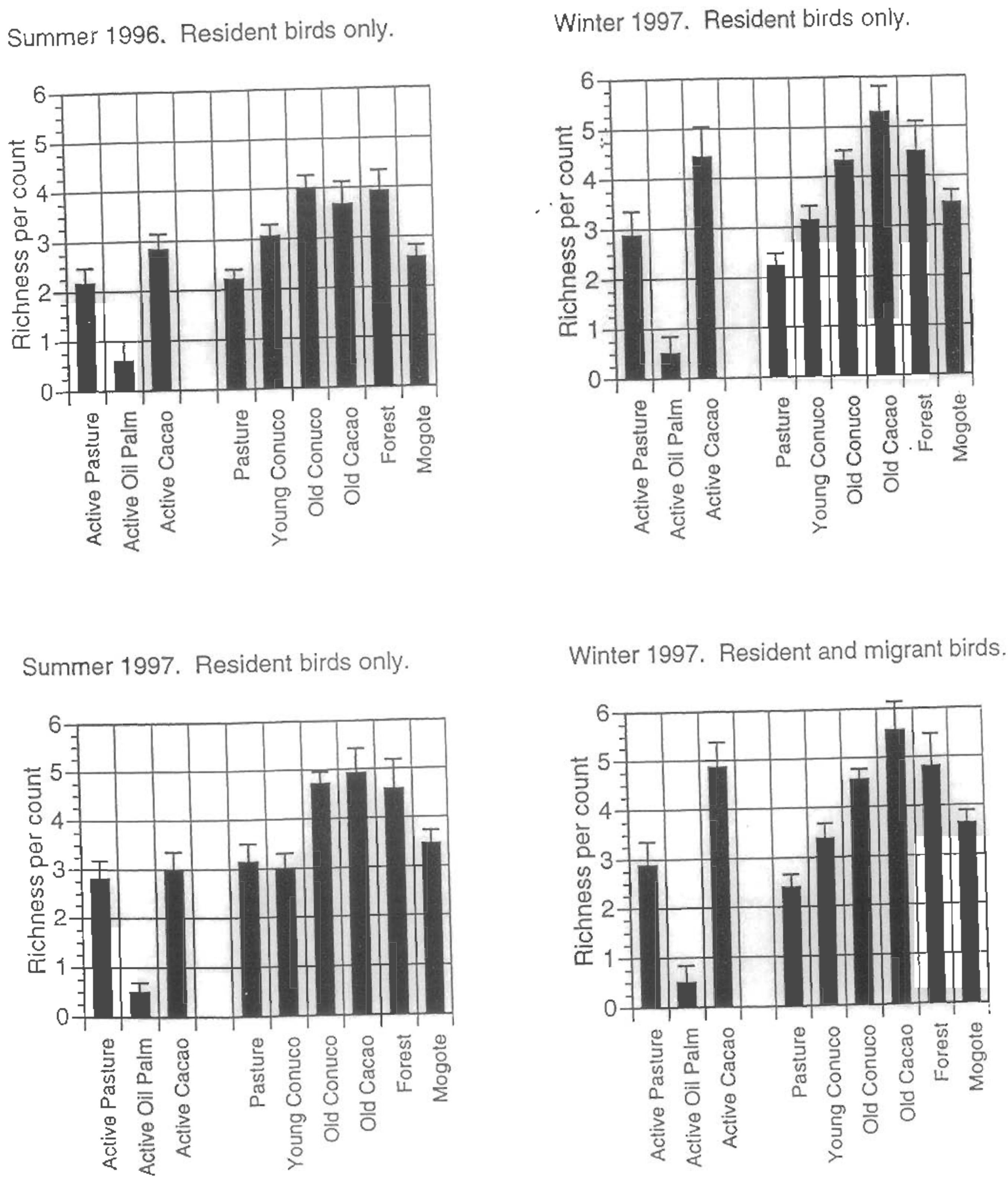


Figure 8

Average Bird Abundance per Pointcount in Los Haitises and Agricultural Sites. Error Bars are Standard Errors.

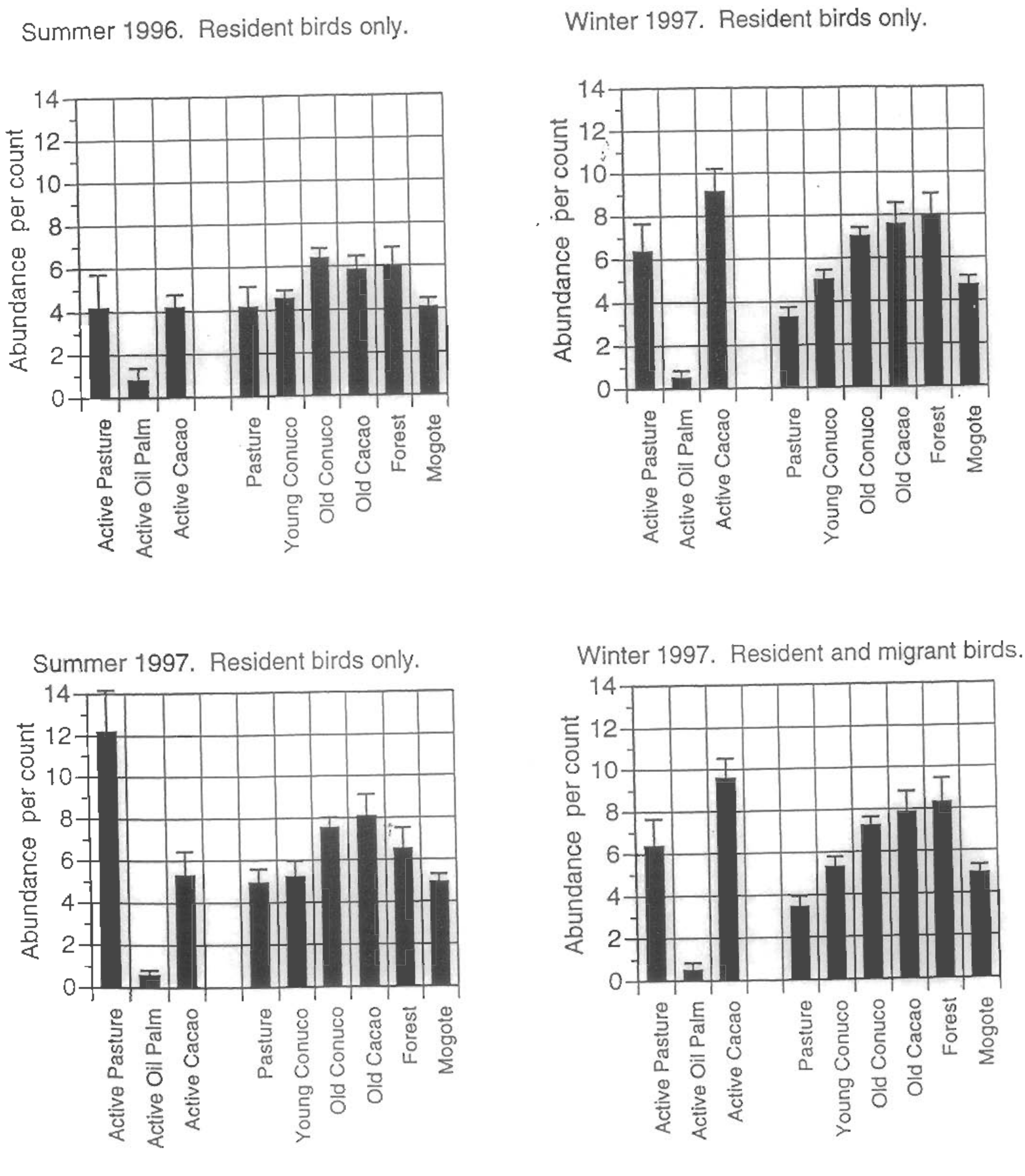


Figure 9

Bird Species Richness in Los Haitises and Agricultural Sites.

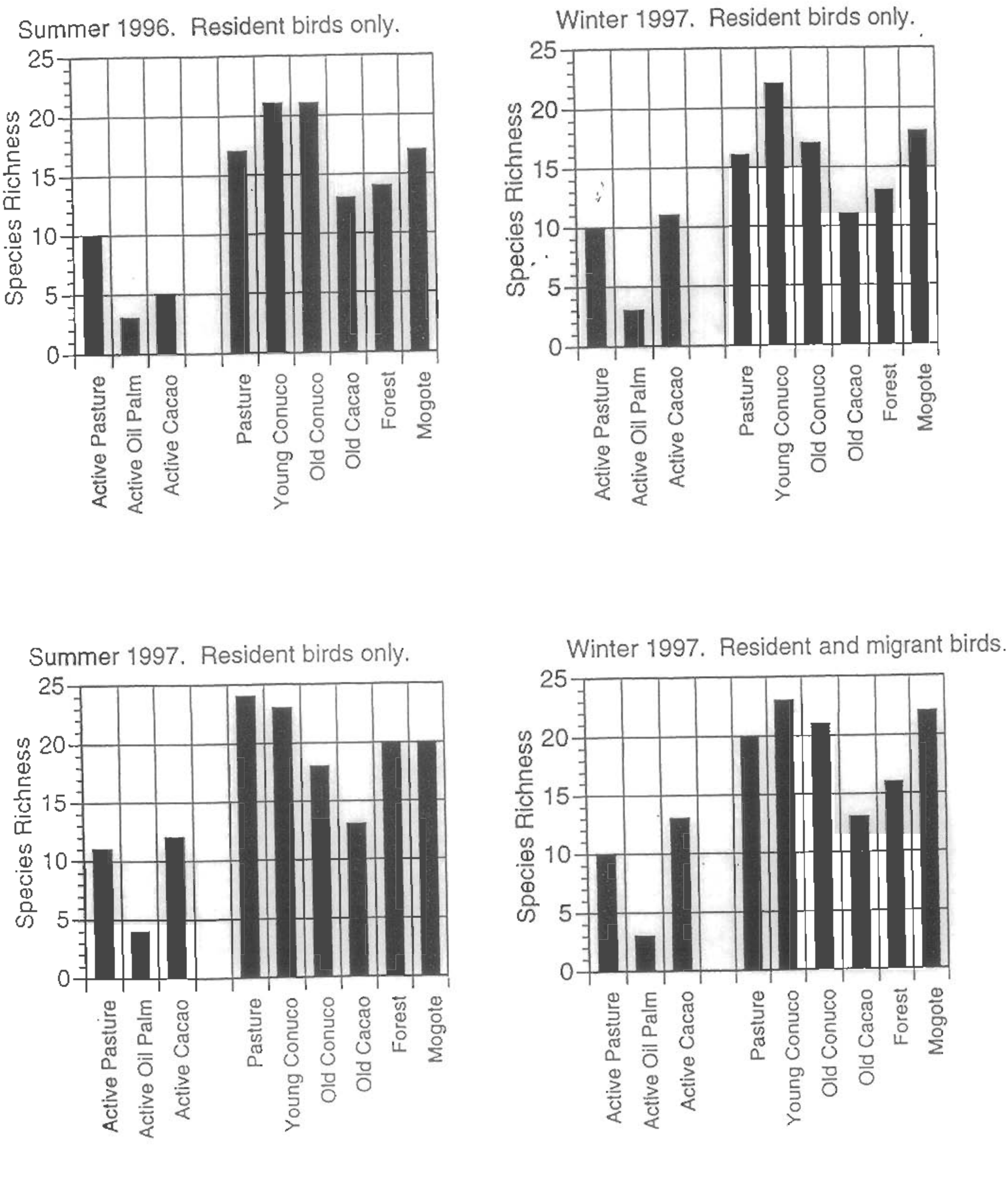


Figure 10

Bird Species Diversity in Los Haitises and Agricultural Sites Using a Shannon Diversity Index.

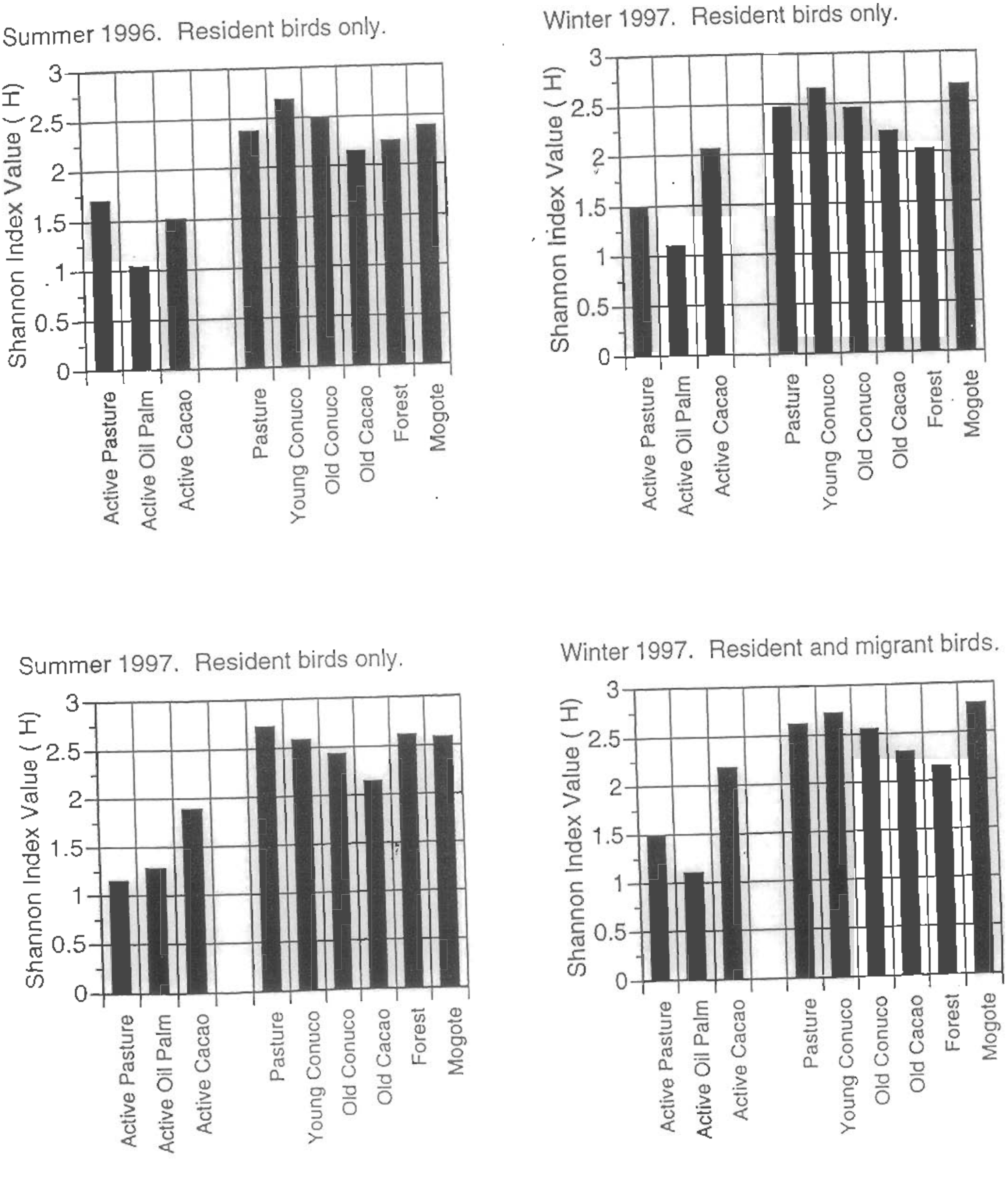
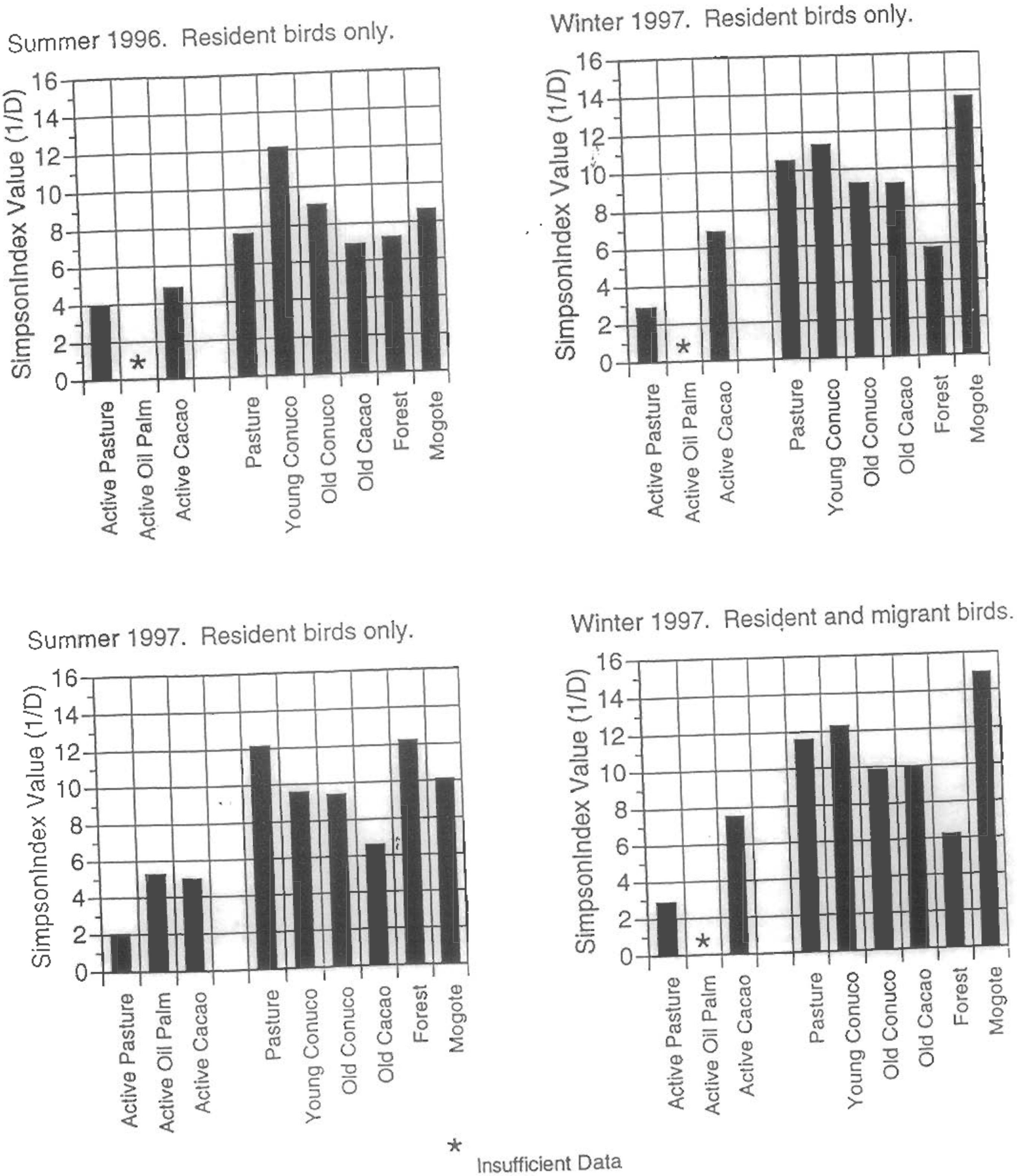


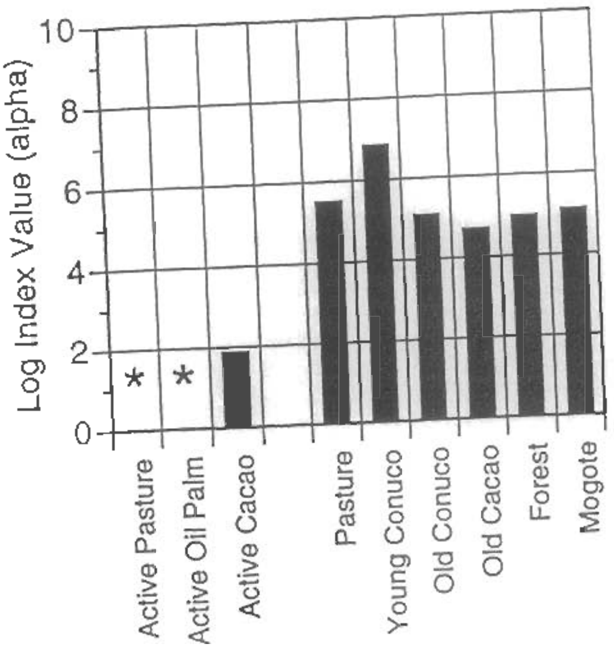
Figure 11

Bird Species Diversity in Los Haitises and Agricultural Sites Using a Simpson Diversity Index.

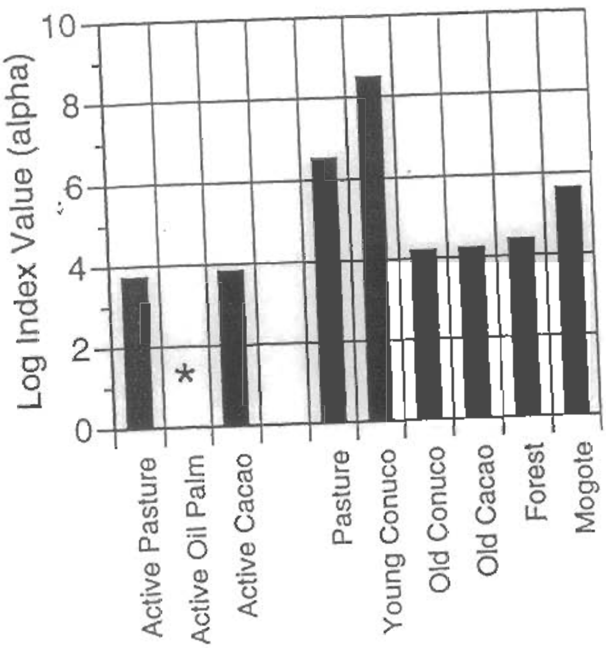


Bird Species Diversity in Los Haitises and Agricultural Sites Using a Log Diversity Index.

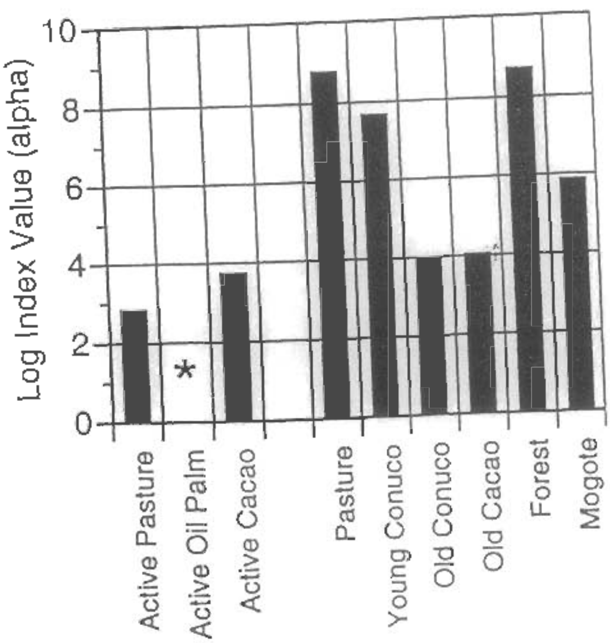
Summer 1996. Resident birds only.



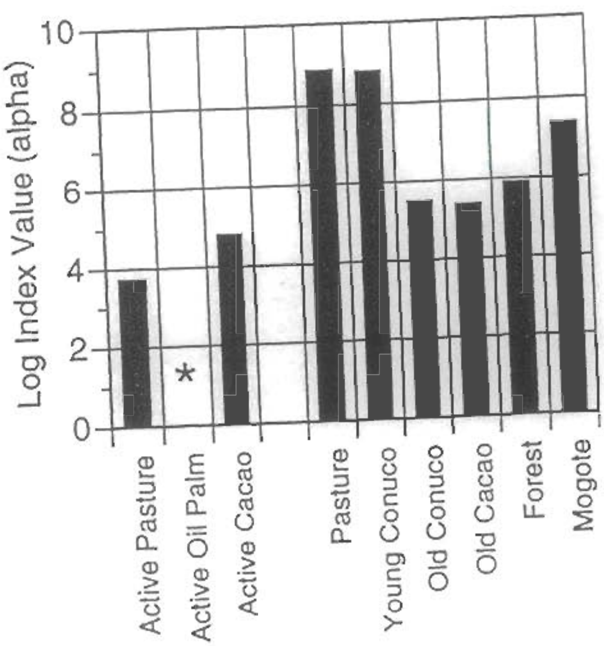
Winter 1997. Resident birds only.



Summer 1997. Resident birds only.



Winter 1997. Resident and migrant birds.



* Insufficient Data

Figure 13

Richness, Abundance and Diversity of Resident Birds in Recovering Pasture Plots, Graphed by Park Region and Season.

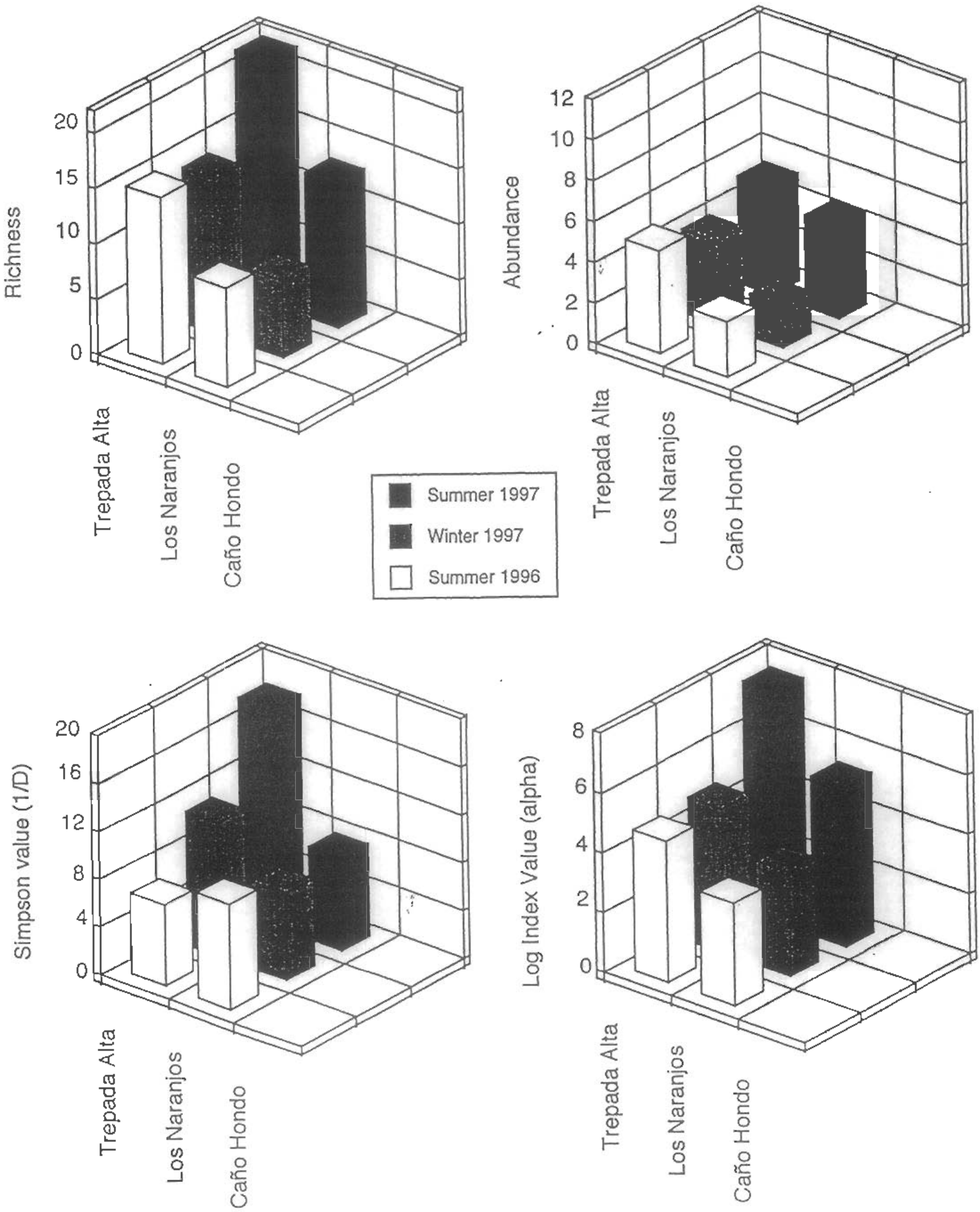


Figure 14

Richness, Abundance and Diversity of Resident Birds in Recovering Young Conuco Plots, Graphed by Park Region and Season.

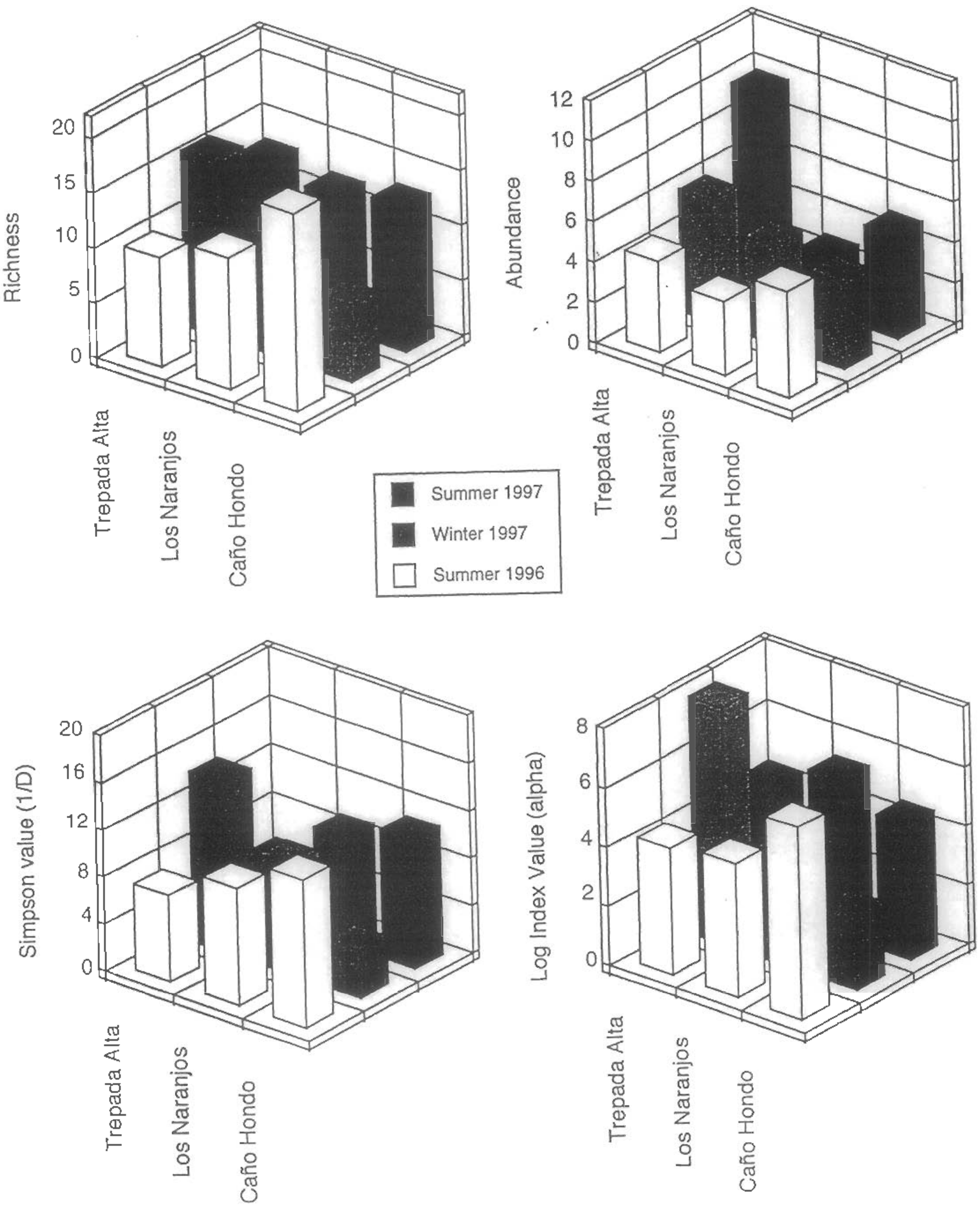


Figure 15

Richness, Abundance and Diversity of Resident Birds in Recovering Old Conuco Plots, Graphed by Park Region and Season.

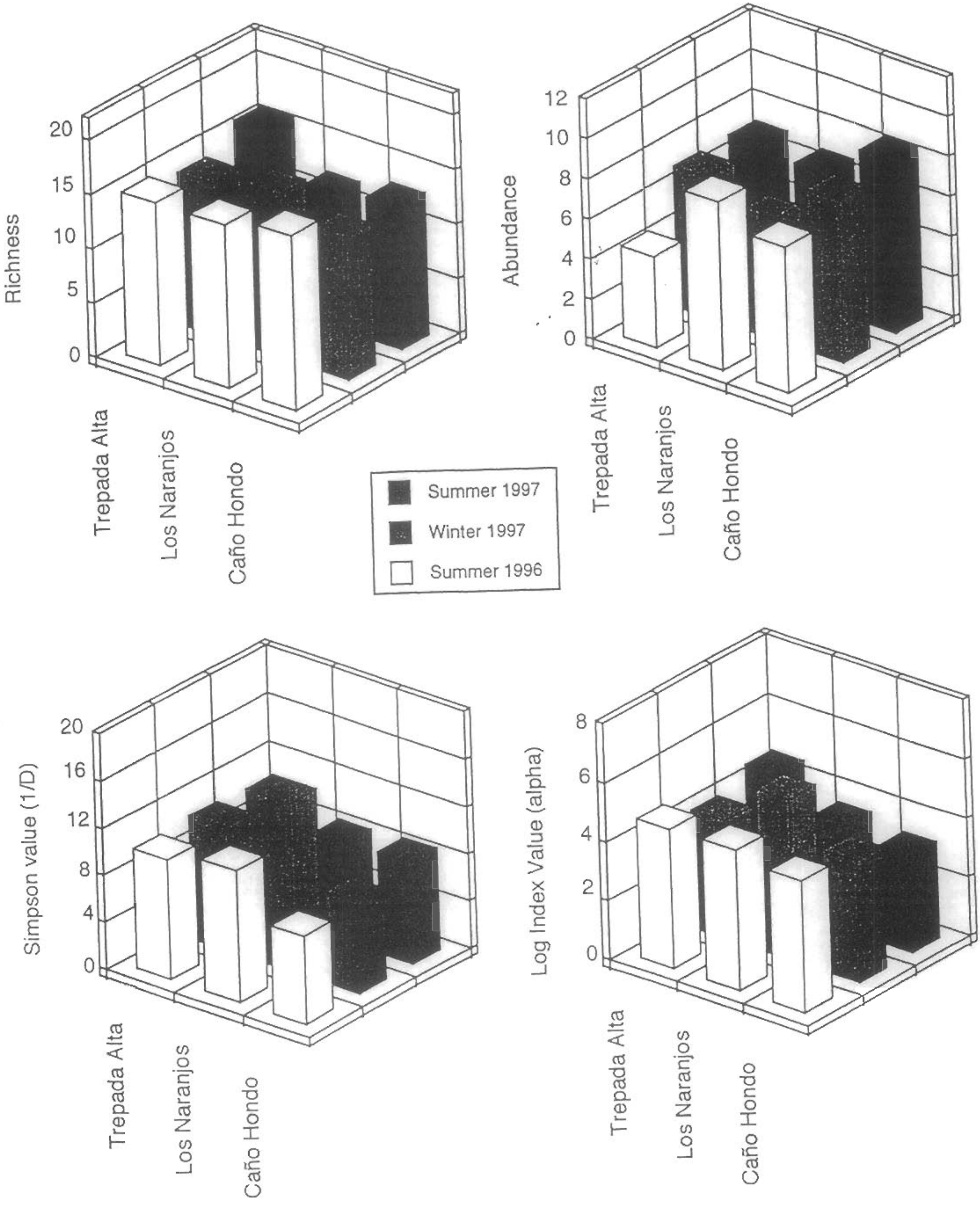


Figure 16

Richness, Abundance and Diversity of Resident Birds in Recovering Cacao Plots, Graphed by Park Region and by Season.

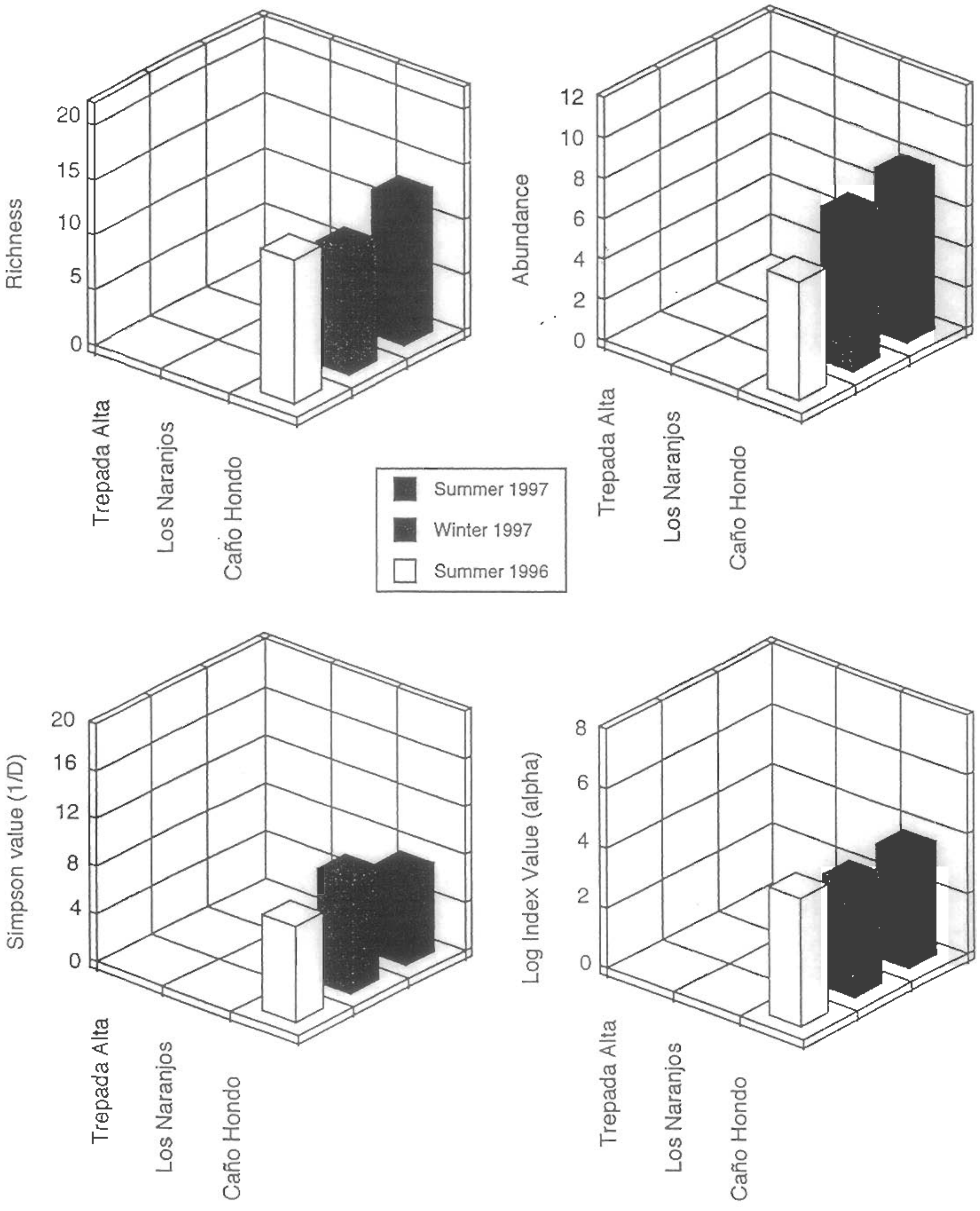


Figure 17

Richness, Abundance and Diversity of Resident Birds in Forest Plots, Graphed by Park Region and Season

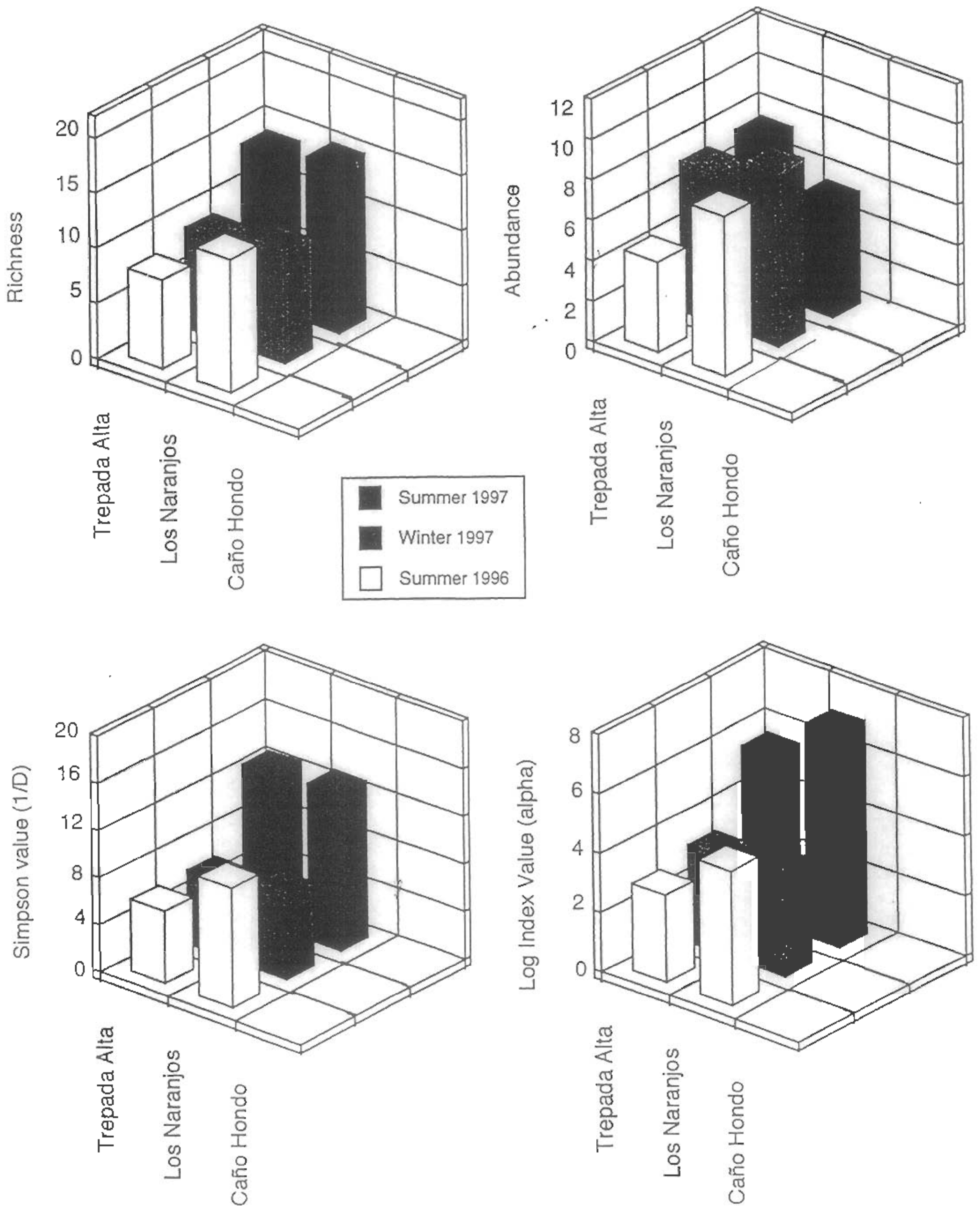


Figure 18

Richness, Abundance and Diversity of Resident Birds in Mogote Plots, Graphed by Park Region and Season.

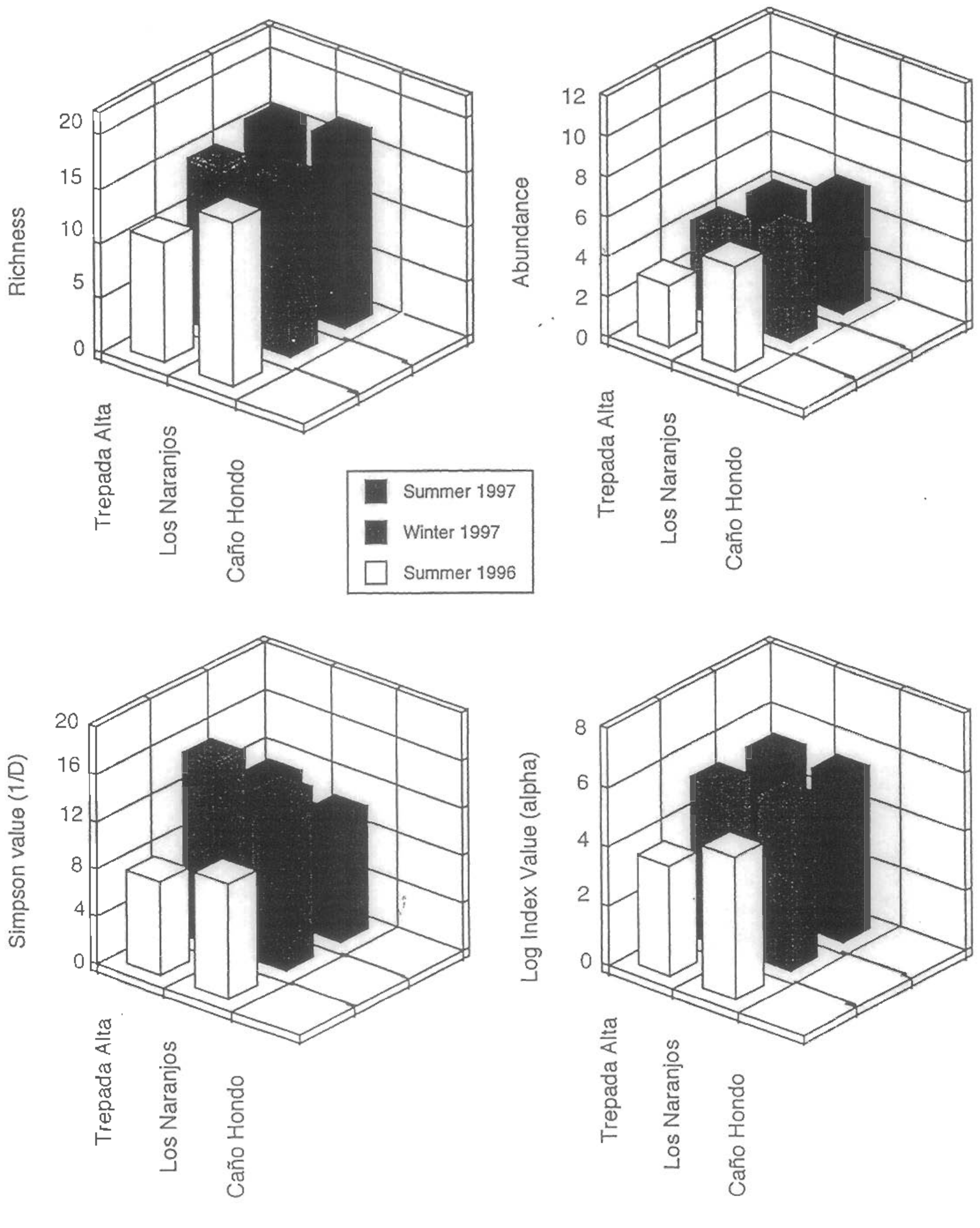
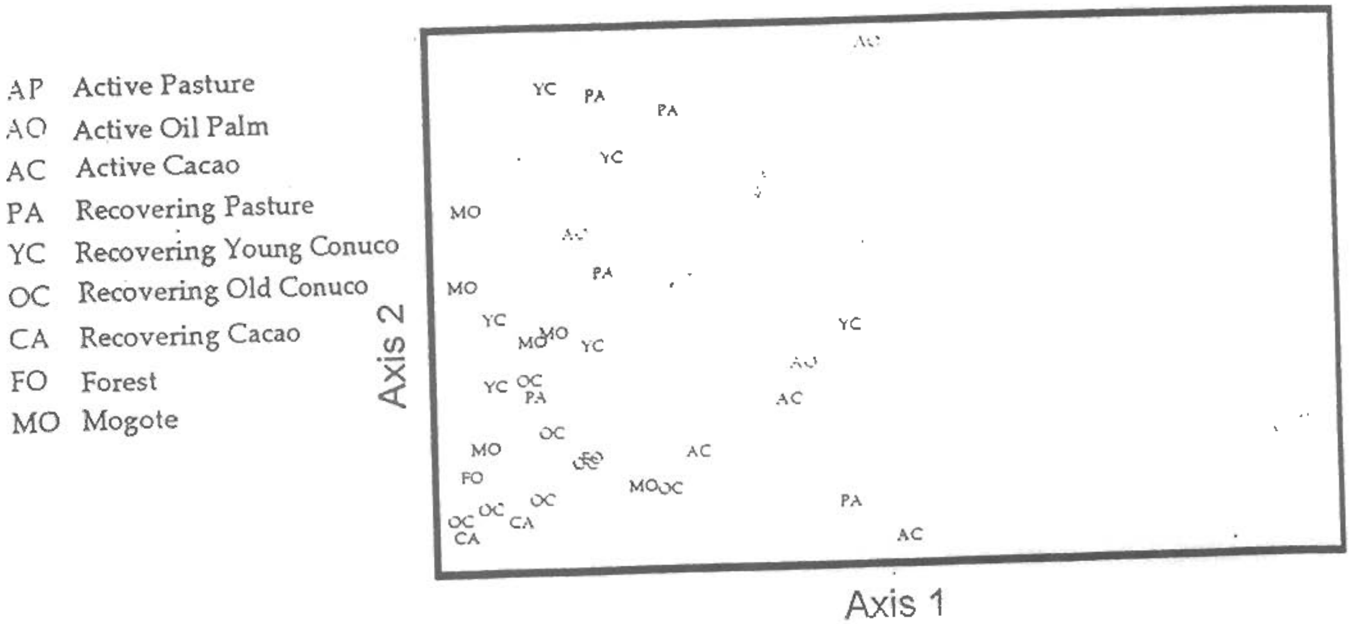


Figure 19

Ordination of Plots in Los Haitises and Agricultural Sites Based on Resident and Migrant Birds in Pointcounts during All Three Seasons. Ordination Method is De-trended Correspondence Analysis (DCA).



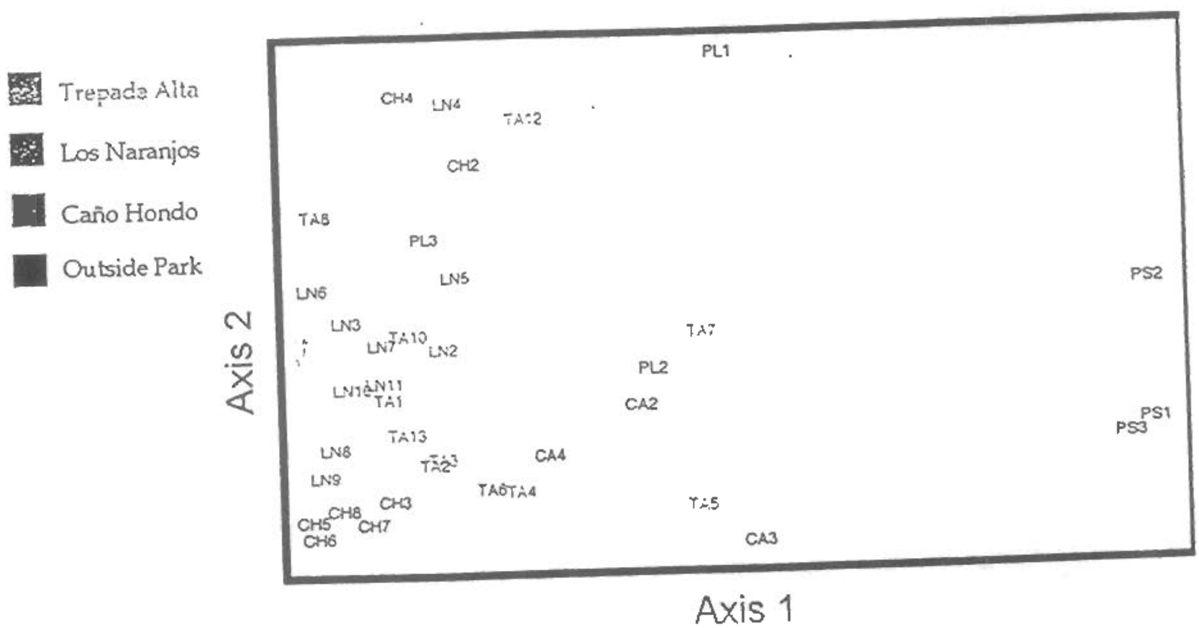
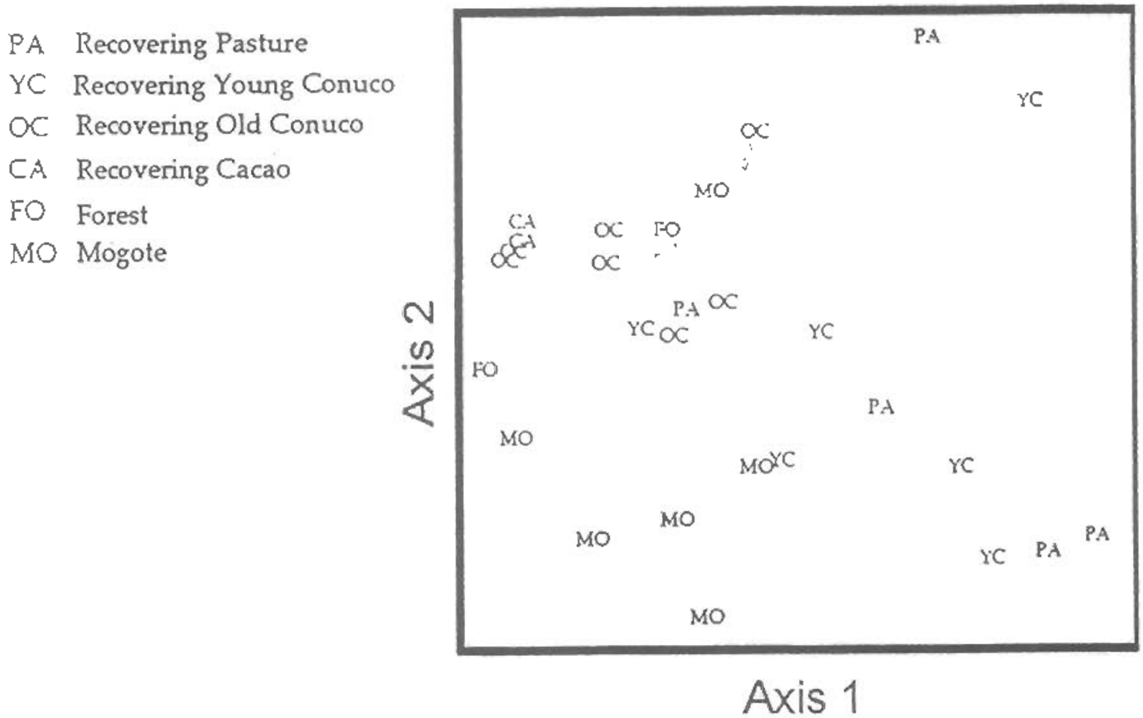


Figure 20

Ordination of Plots within Los Haitises Based on Resident and Migrant Birds in Pointcounts from all three Seasons. Ordination Method is De-trended Correspondence Analysis (DCA).



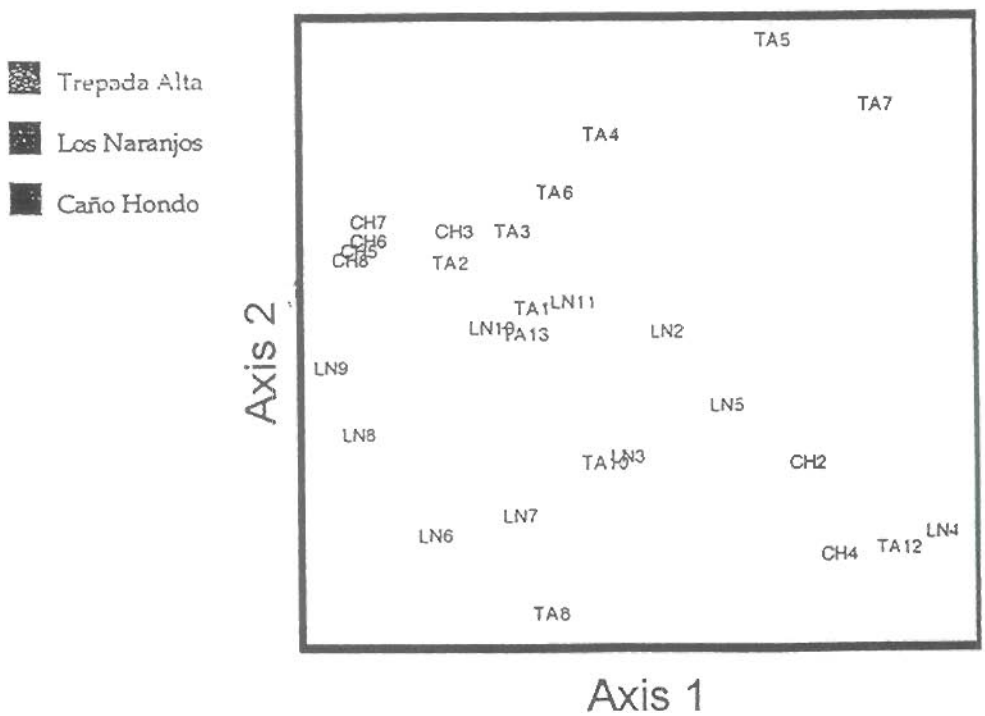
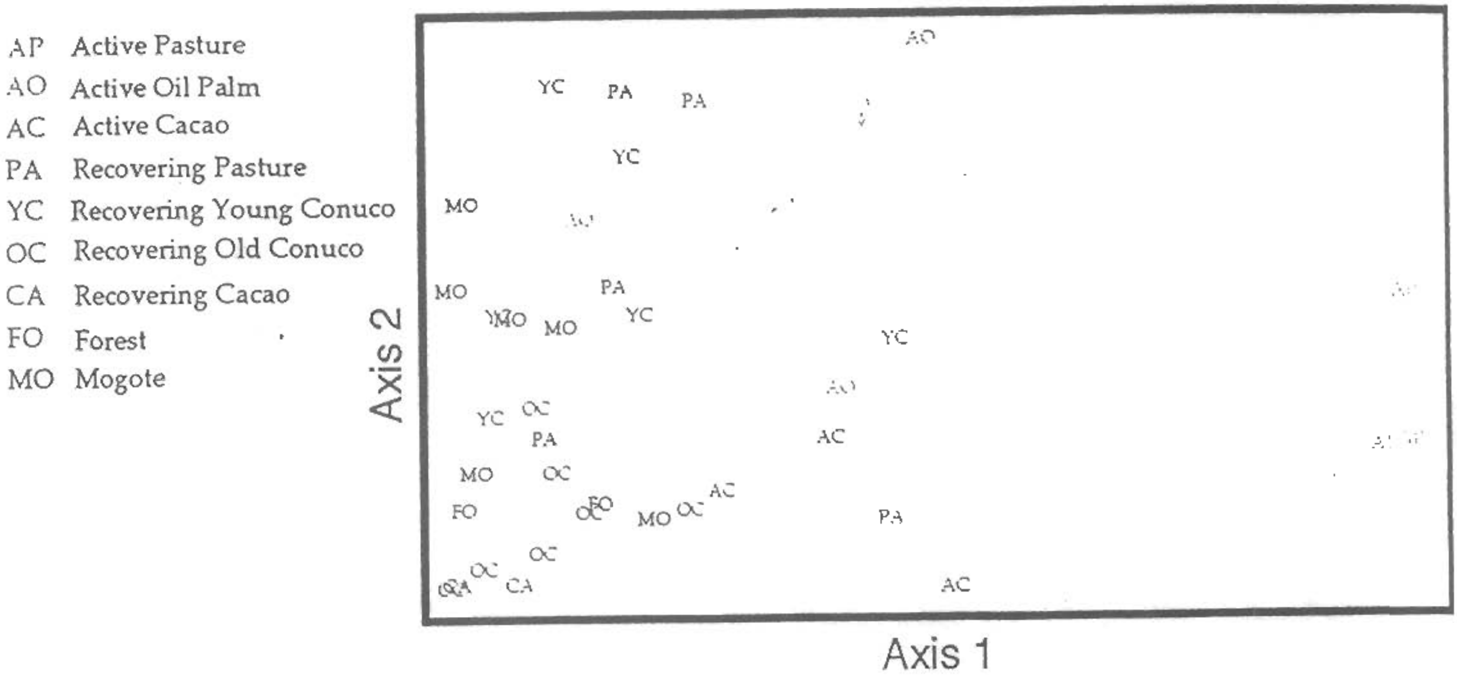


Figure 21

Ordination of Plots in Los Haitises and Ag Sites based on Resident Birds in Pointcounts from all three seasons. Ordination method is De-trended Correspondence Analysis (DCA).



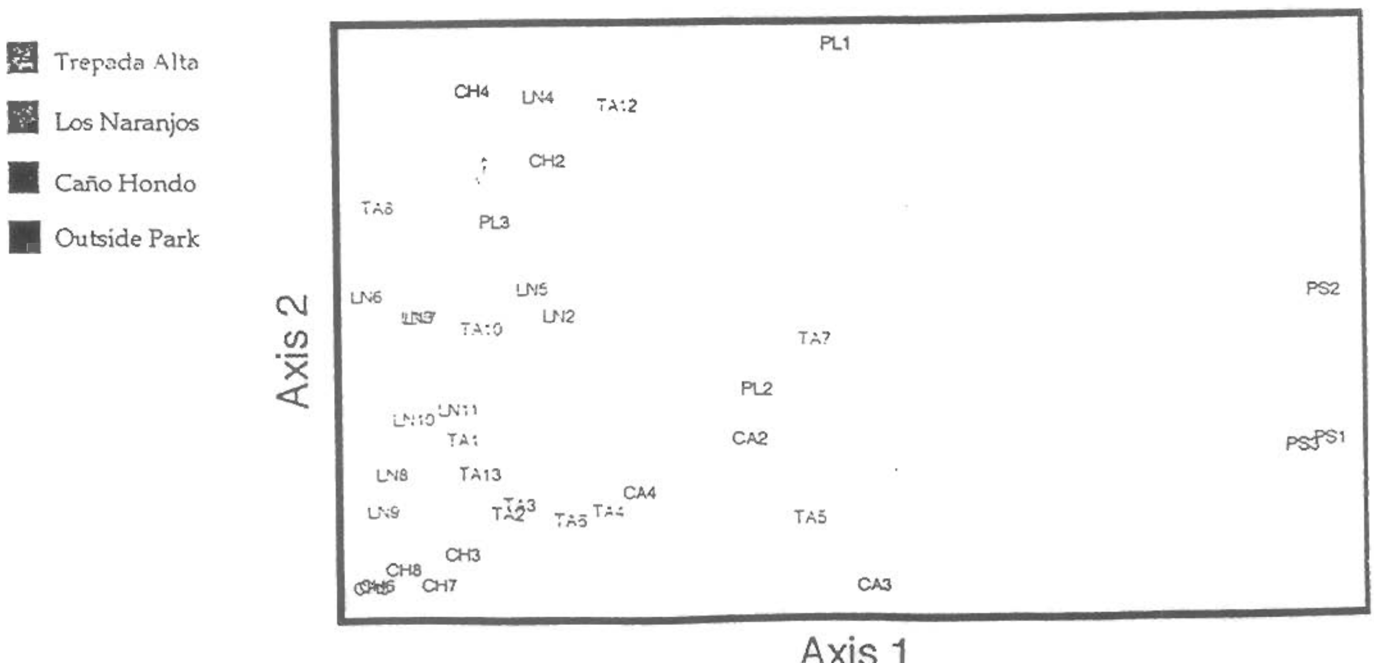
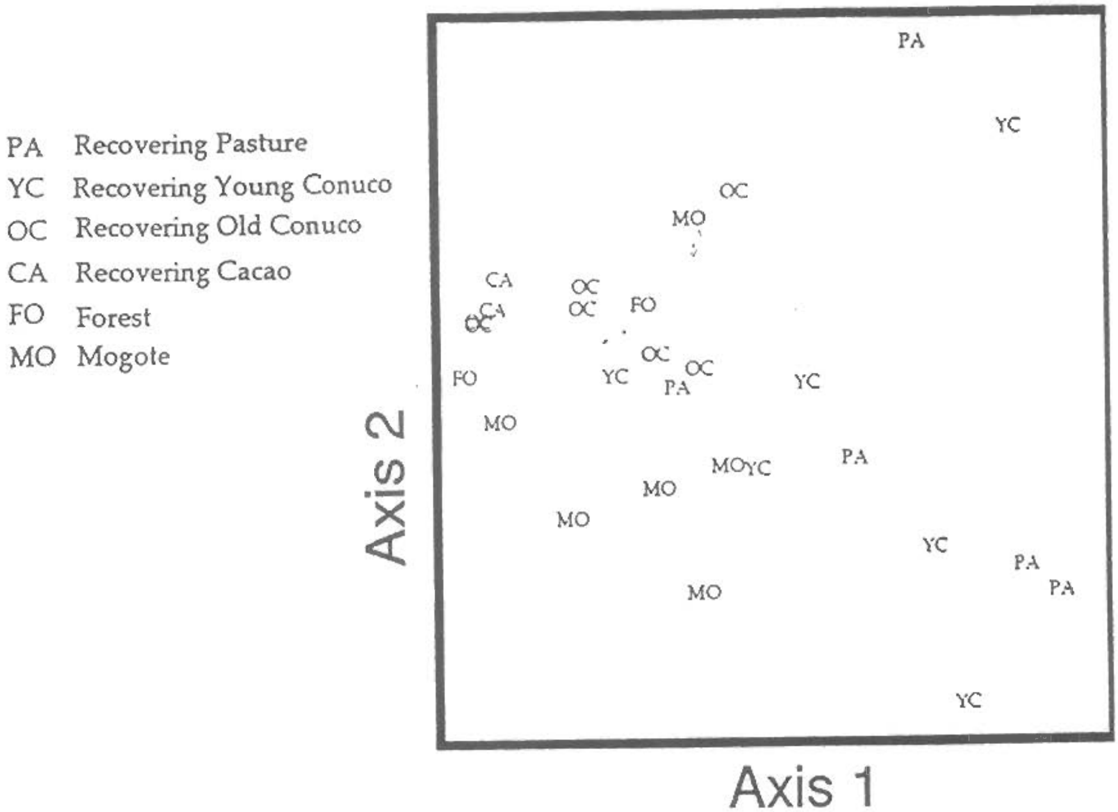


Figure 22

Ordination of Plots within Los Haitises Based on Resident Birds in Pointcounts from all three Seasons. Ordination Method is De-trended Correspondence Analysis (DCA).



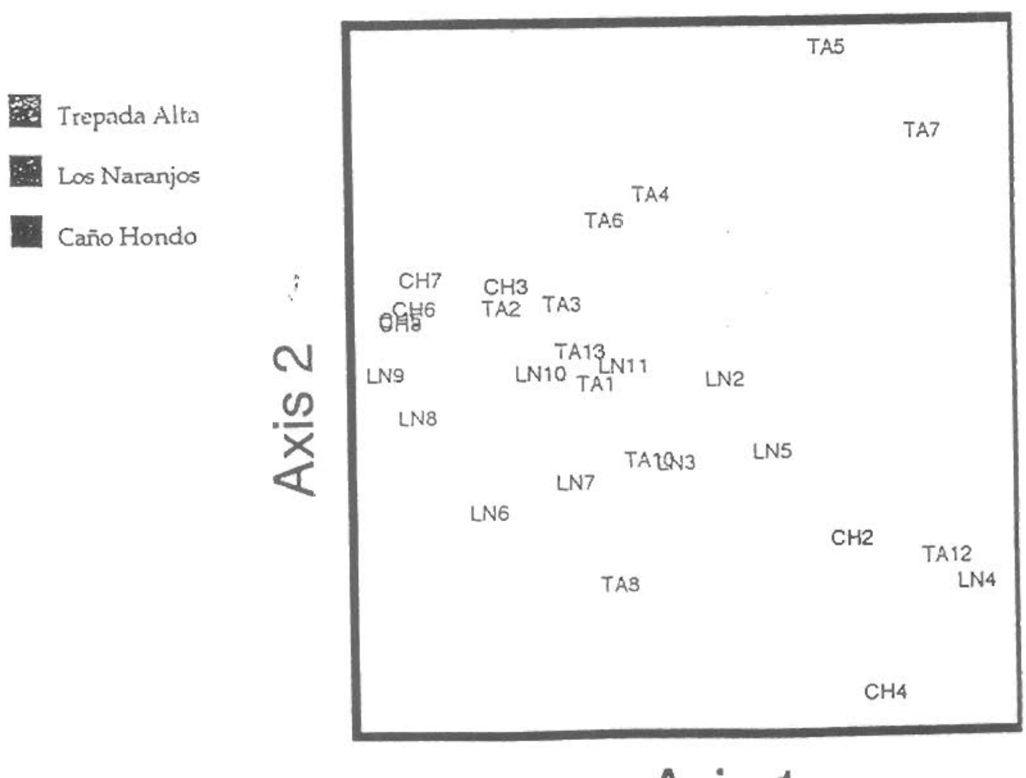
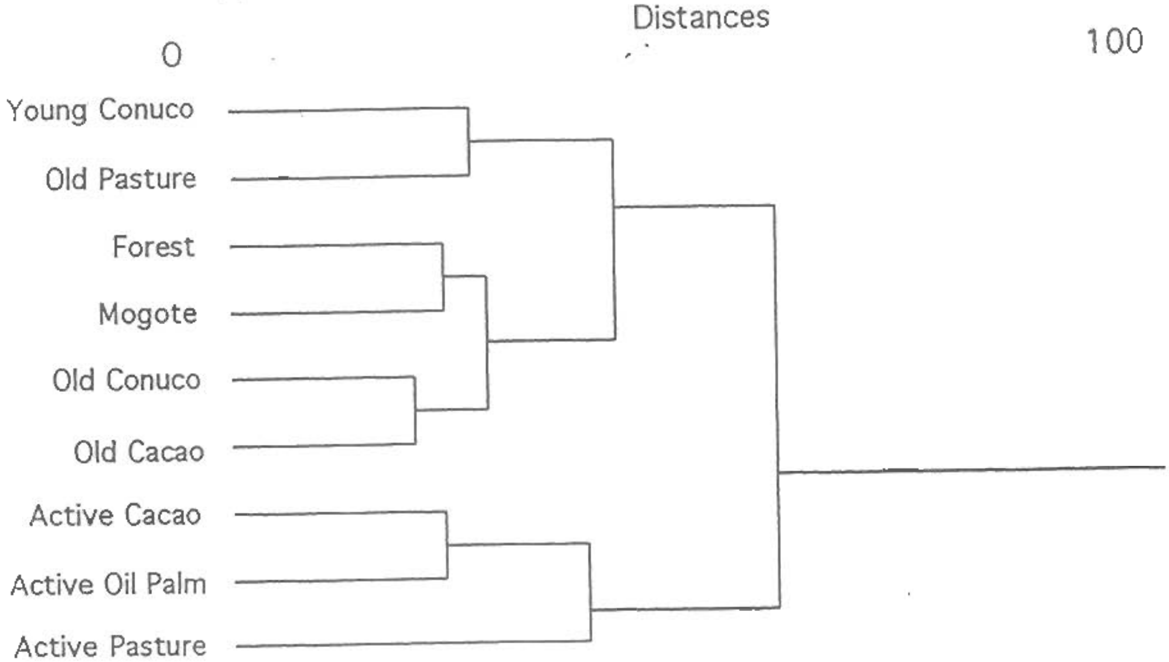


Figure 23

Cluster Analyses of Landuse Types Based on Presence or Absence of Resident and Migrant Bird Species in Pointcounts During All Three Seasons. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

All Landuse Types



Landuse Types in Park

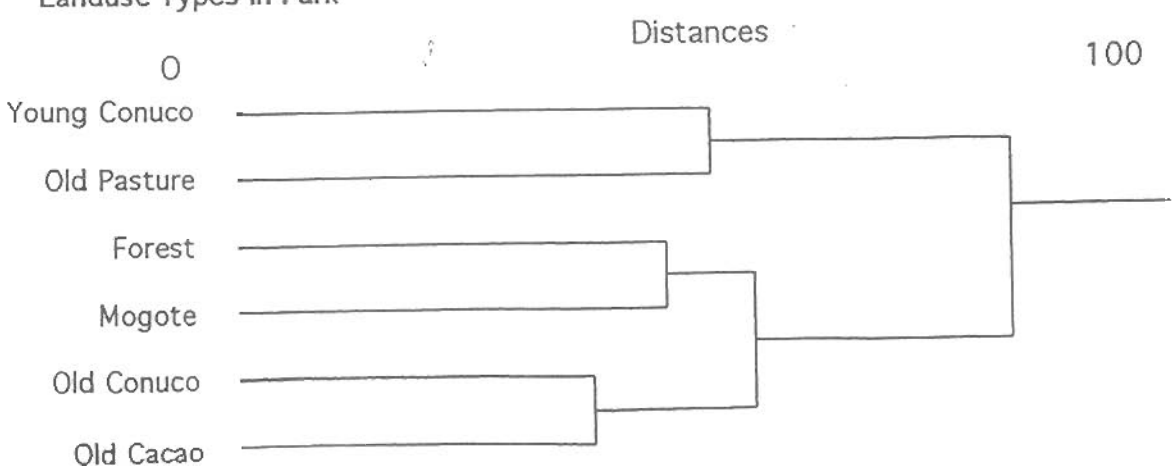
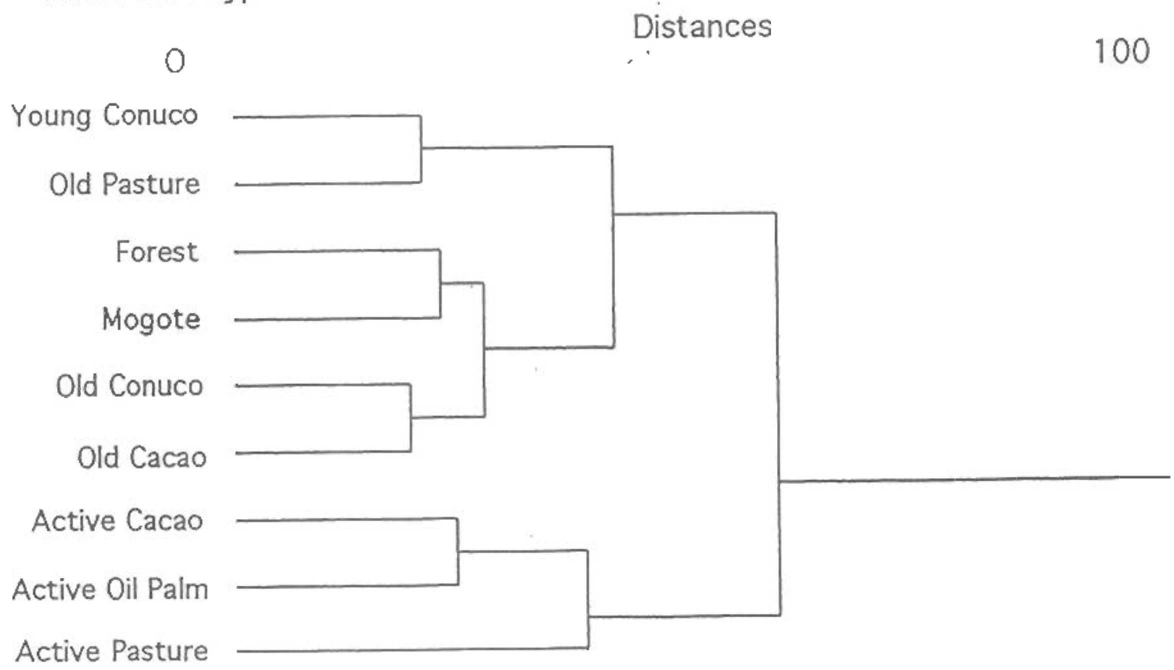


Figure 24

Cluster Analyses of Landuse Types Based on Presence or Absence of Resident Bird Species in Pointcounts During All Three Seasons. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

All Landuse Types



Landuse Types in Park

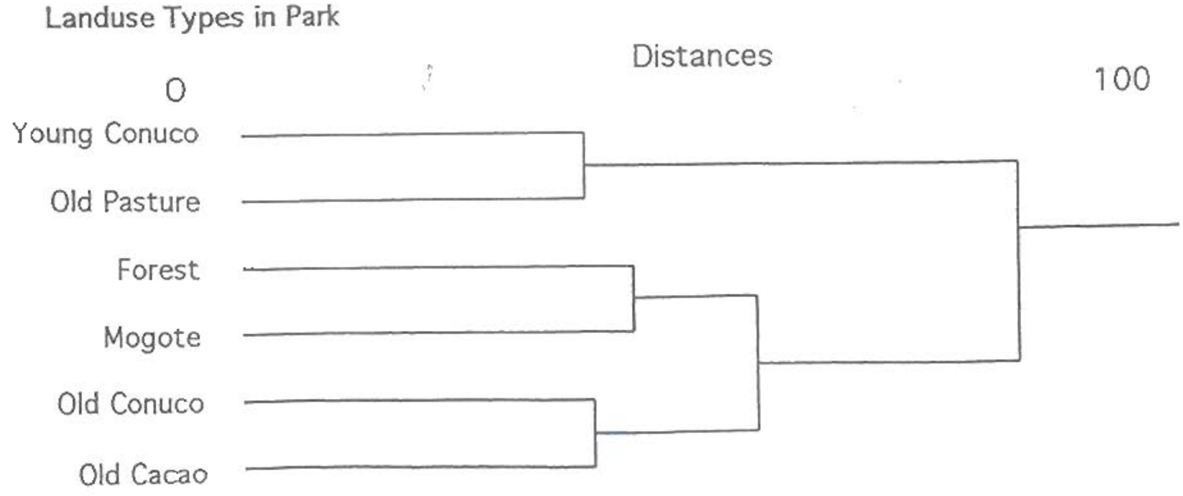


Figure 25

Herp Species Richness, Richness per Count, and Abundance per Count from Transects during Summer, 1997

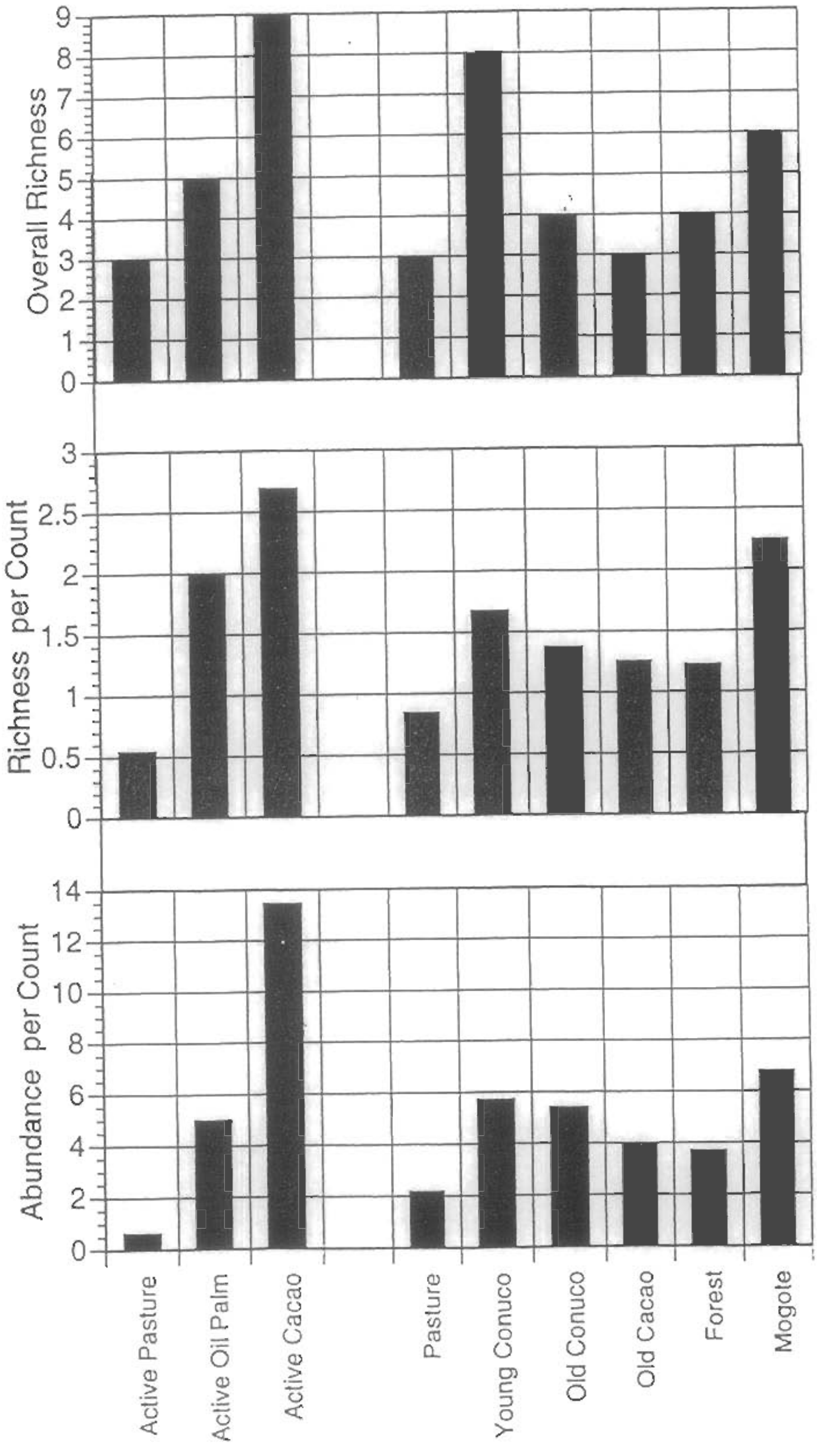
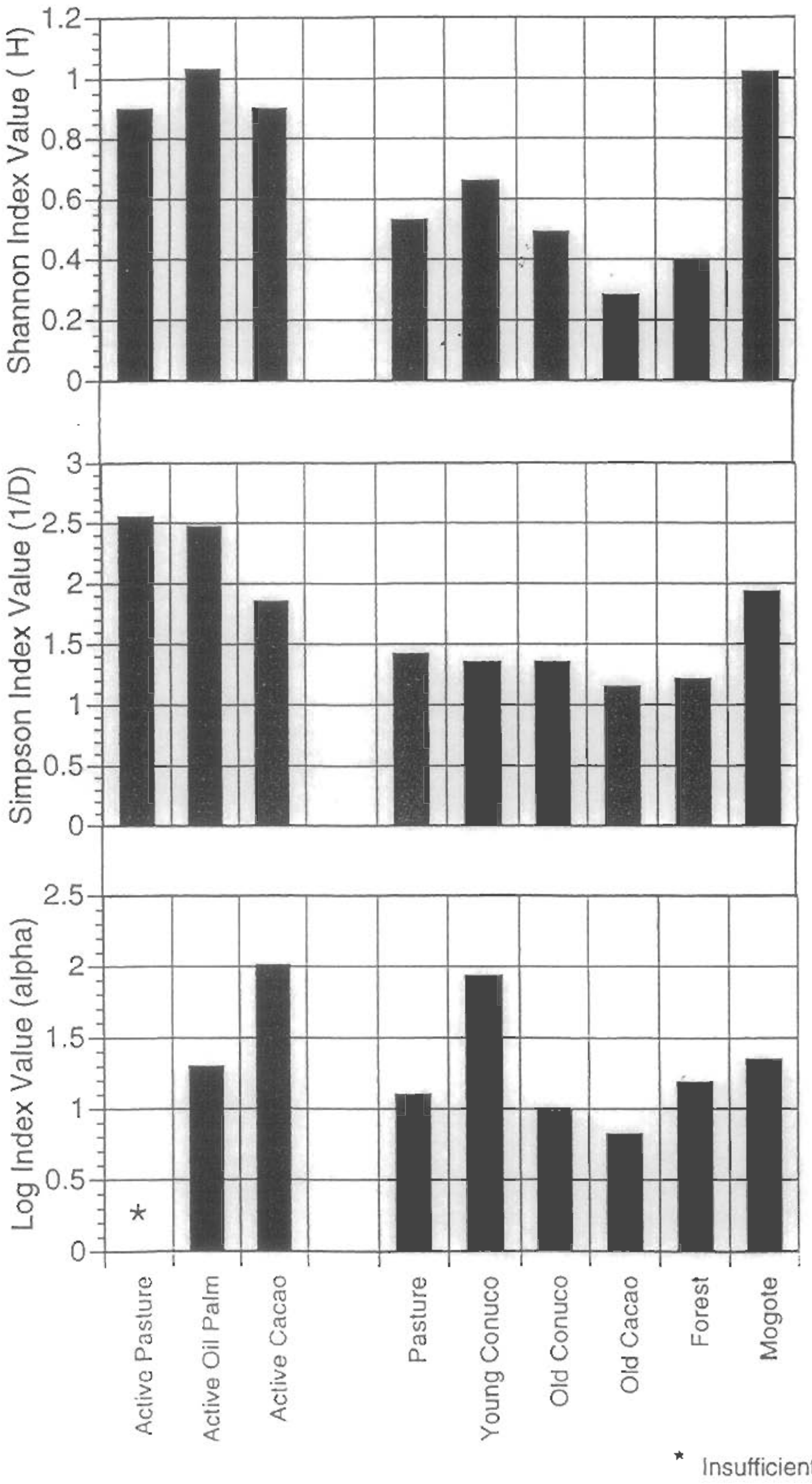


Figure 26

Herp Diversity as measured by the Shannon, Simpson and Log Diversity Indices from Transects during Summer, 1997.



* Insufficient Data

Figure 27

Herp Species Richness, Richness per Count, and Abundance per Count from Sticky Trap Sampling during Summer, 1997

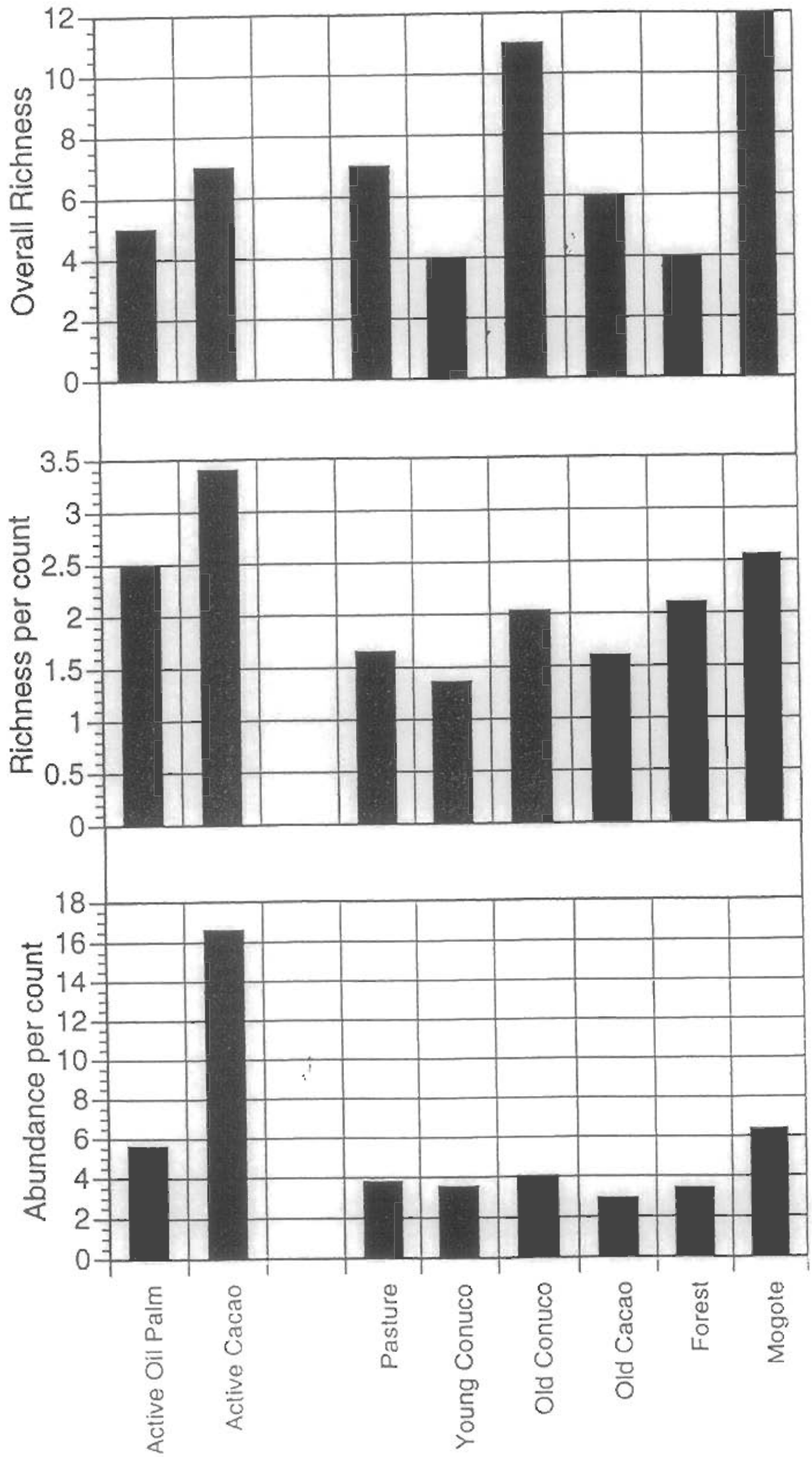


Figure 28

Herp Diversity as measured by the Shannon, Simpson and Log **Diversity Indices** from Sticky Trap Sampling during Summer, 1997.

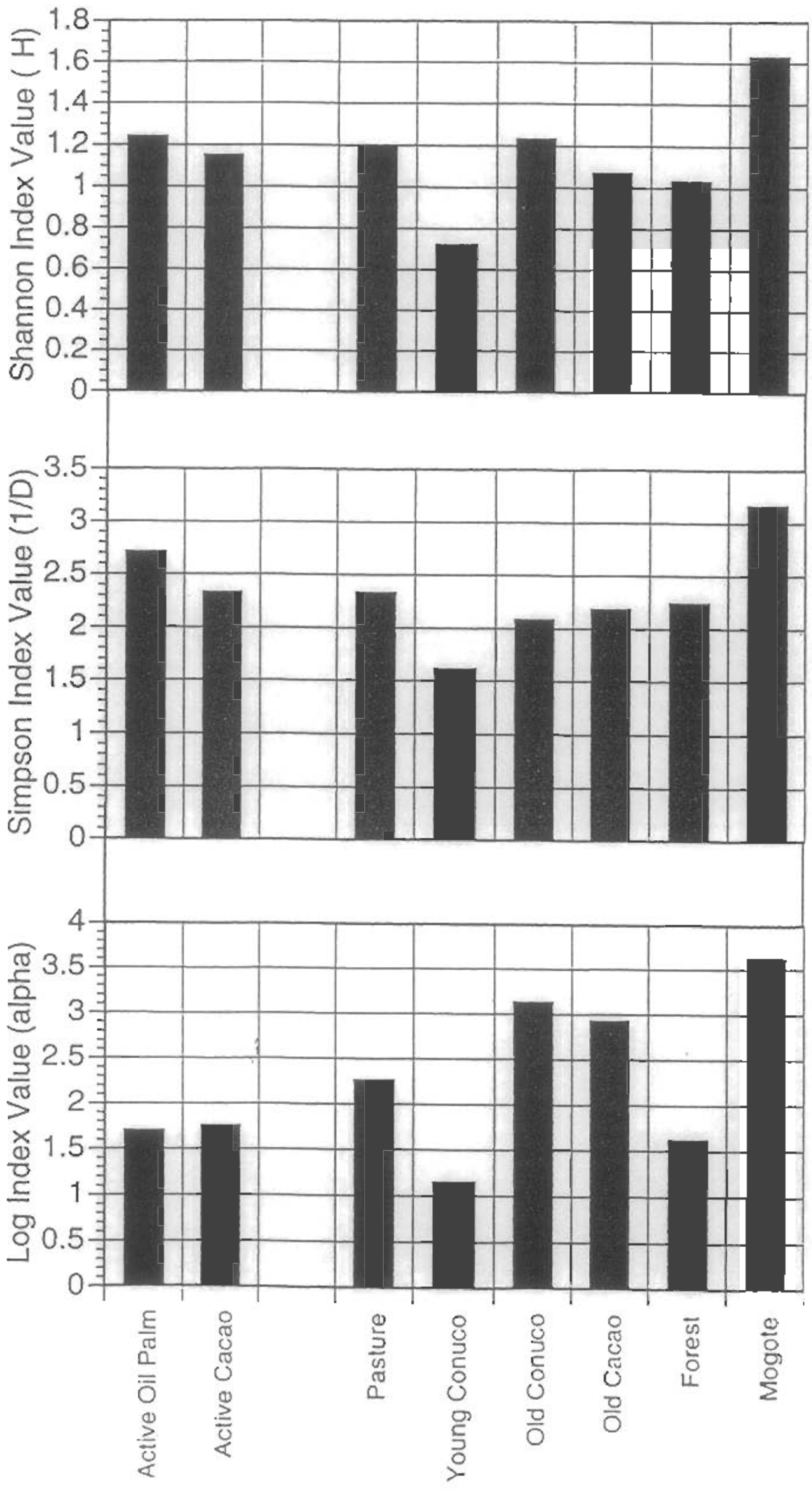


Figure 29

Ordination of Plots in Los Haitises and Ag Sites Based on Herps in Transects during Summer 1997. Ordination Method is De-trended Correspondence Analysis (DCA).

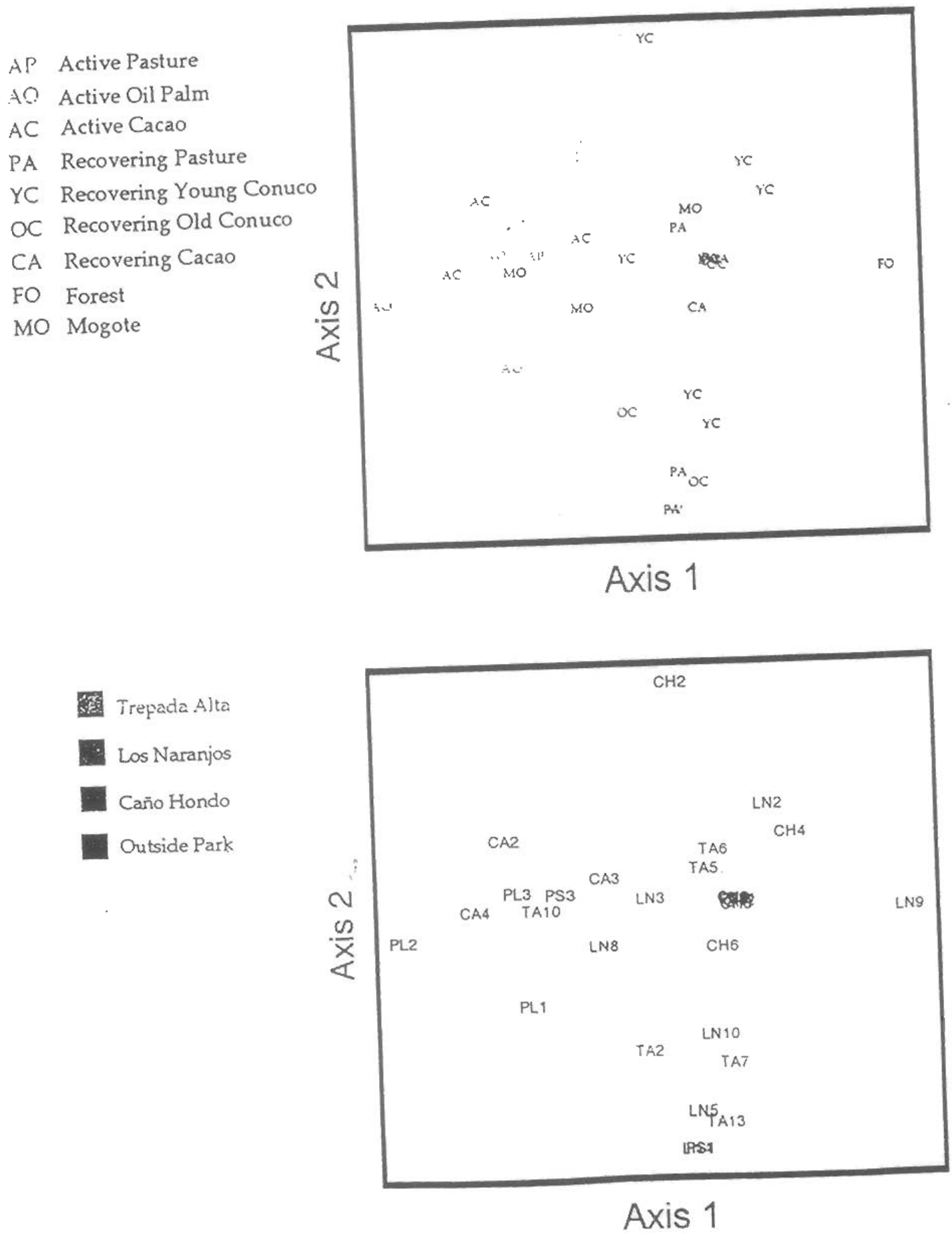
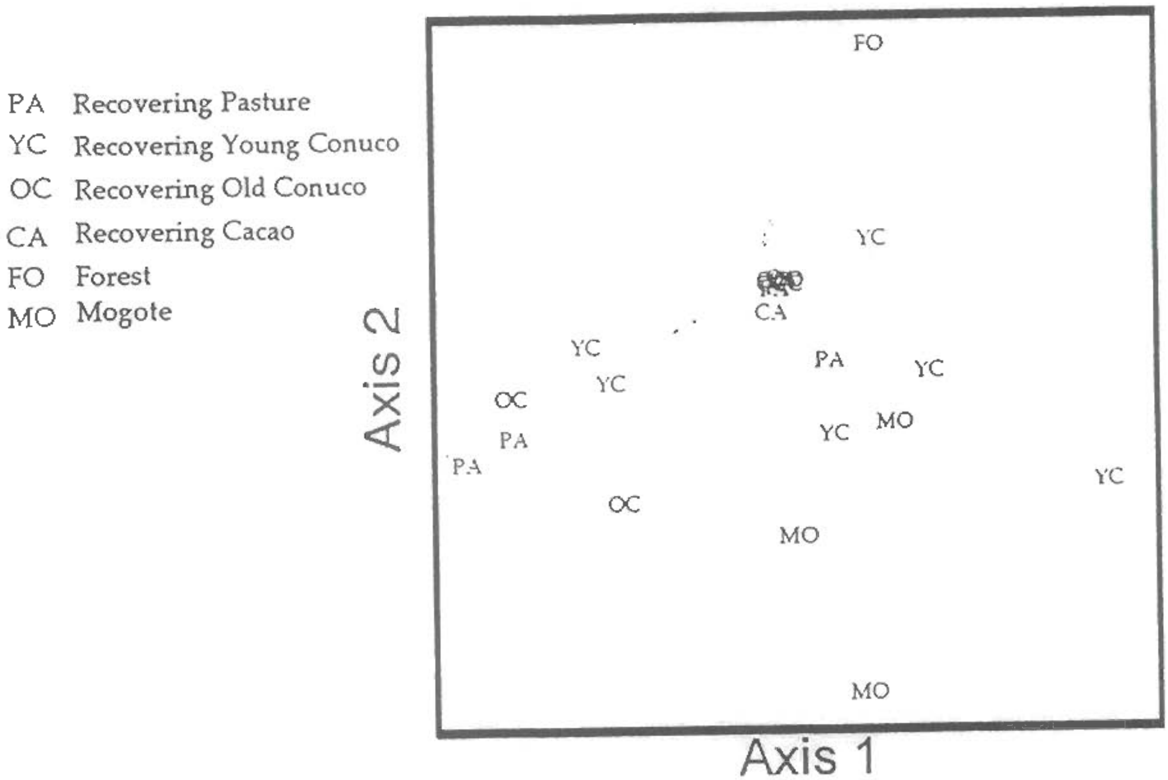


Figure 30

Ordination of Plots within Los Haitises based on Herps Caught in Transects during Summer 1997. Ordination Method is De-trended Correspondence Analysis (DCA).



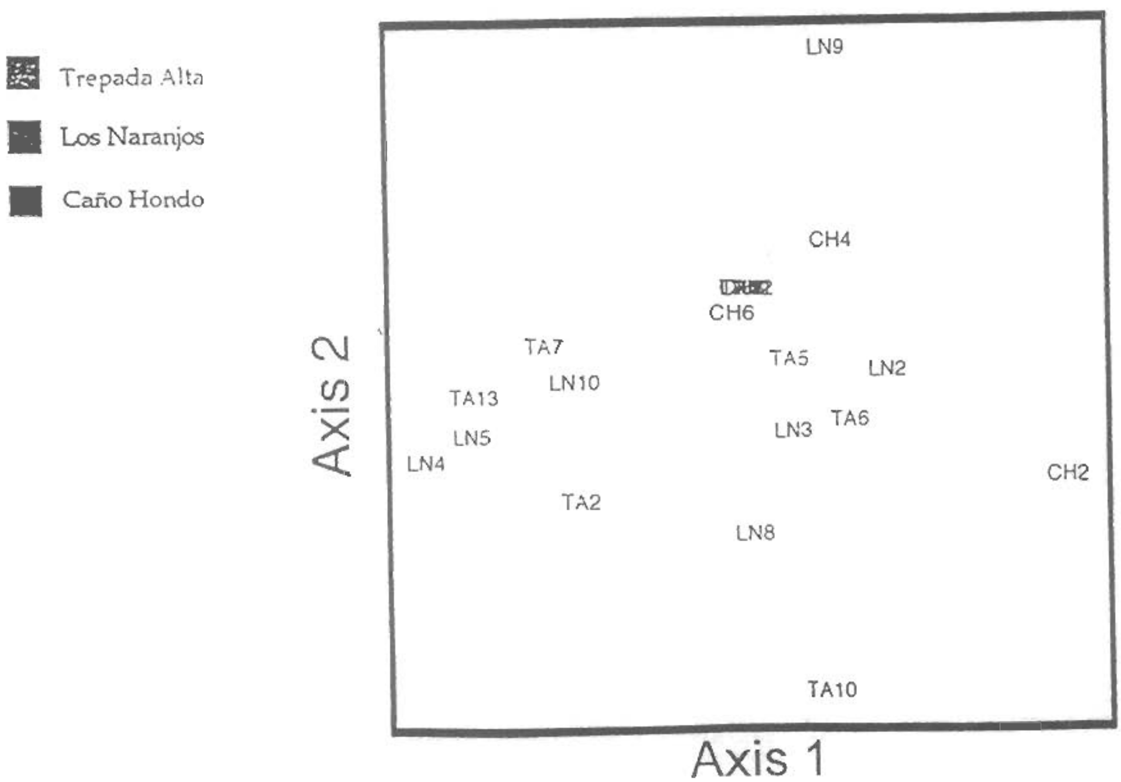
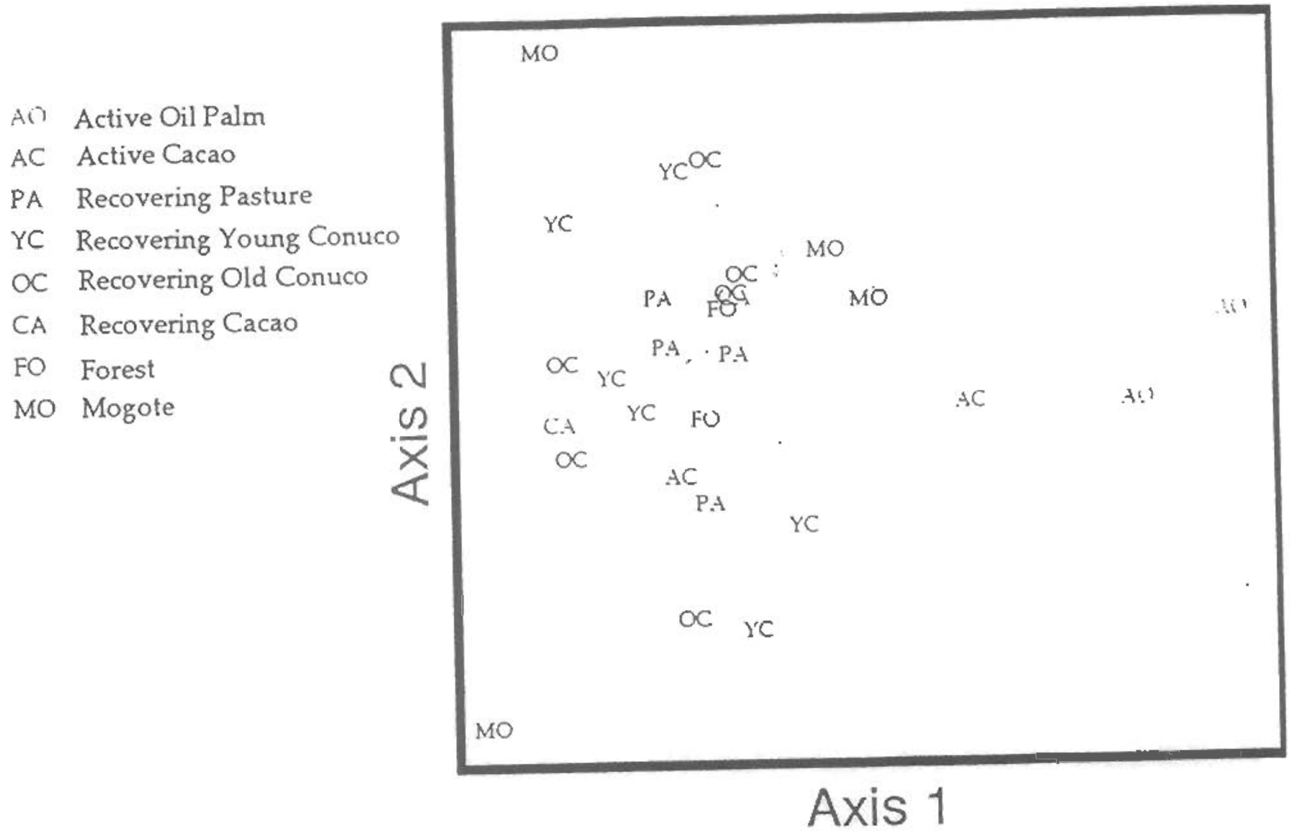


Figure 31

Ordination of Plots in Los Haitises and Ag Sites Based on Herps Caught in Sticky Traps during Summer 1997. Ordination Method is De-trended Correspondence Analysis (DCA).



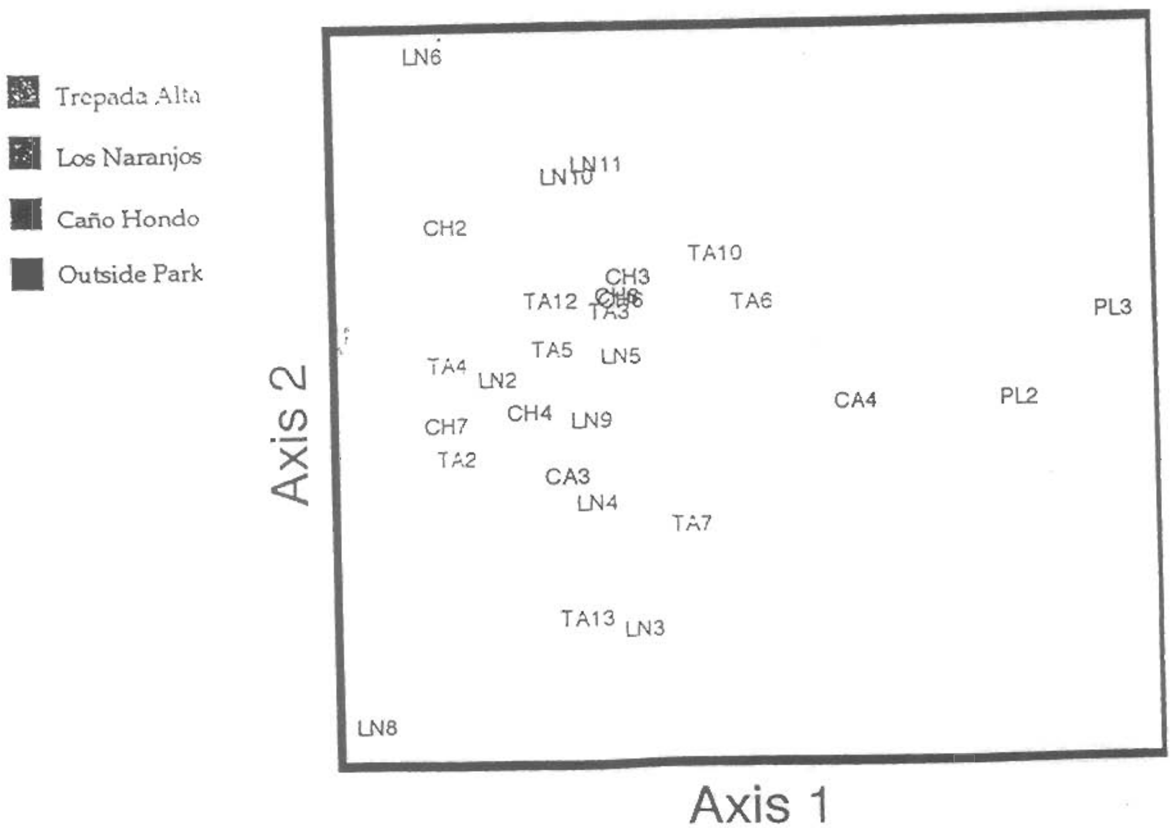
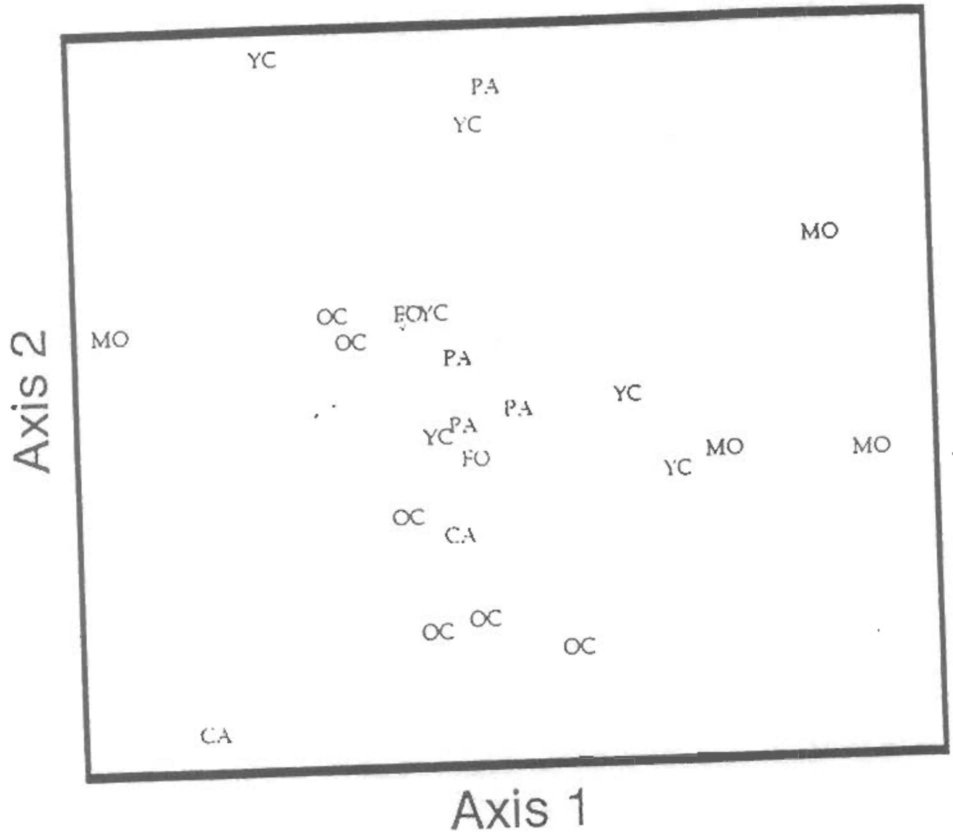


Figure 32

Ordination of Plots within Los Haitises based on Herps Caught in Sticky Traps during Summer 1997. Ordination Method is De-trended Correspondence Analysis (DCA).

PA Recovering Pasture
YC Recovering Young Conuco
OC Recovering Old Conuco
CA Recovering Cacao
FO Forest
MO Mogote



Trepada Alta
Los Naranjos
Caño Hondo

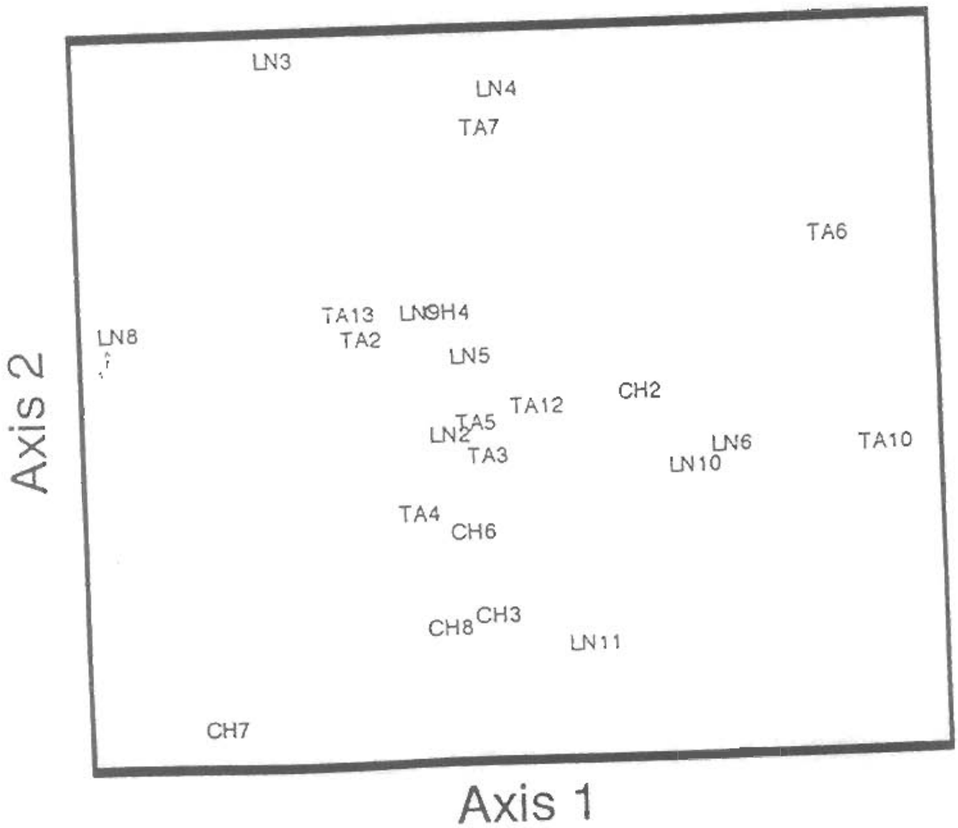
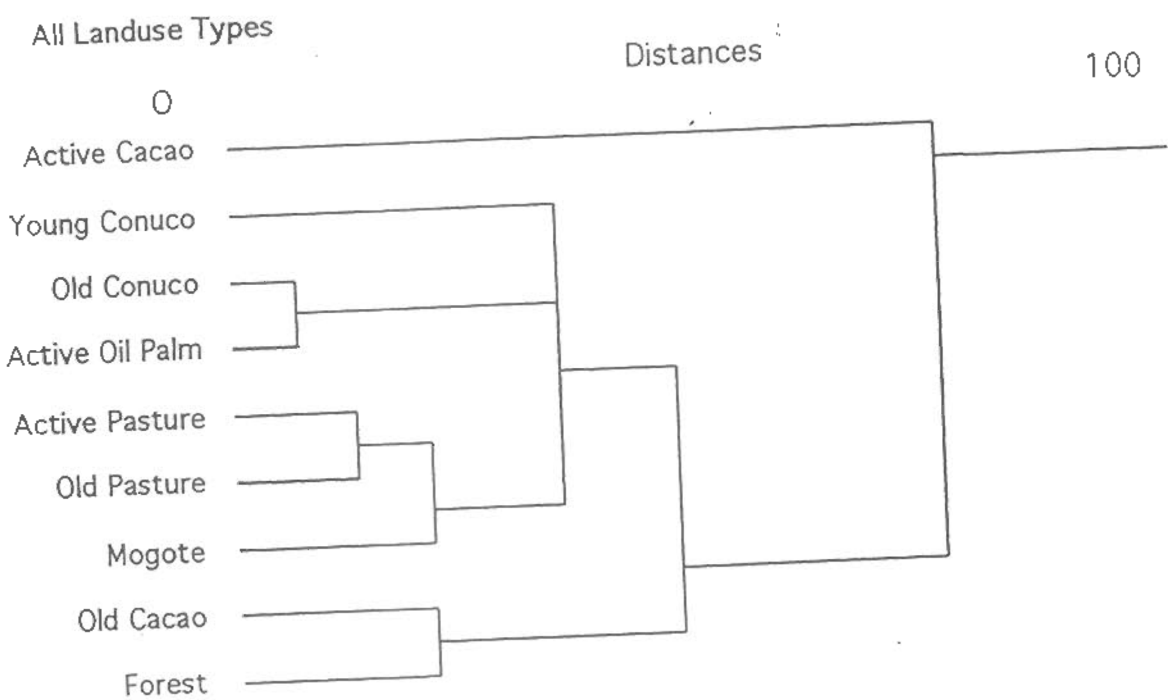


Figure 33

Cluster Analyses of Landuse Types Based on Presence or Absence of Herp Species in Transects During Summer, 1997. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).



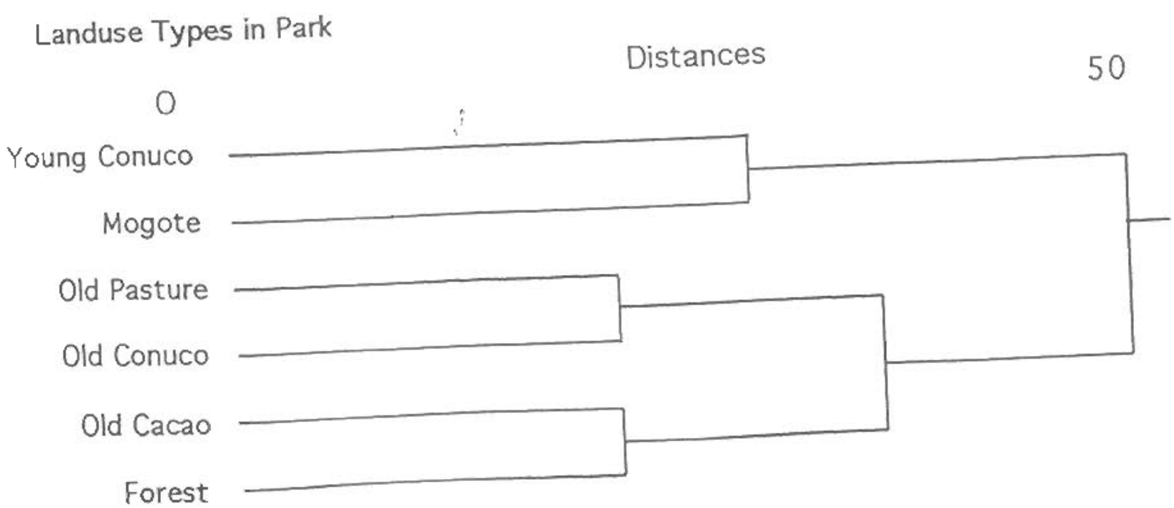


Figure 34

Cluster Analyses of Landuse Types Based on Presence or Absence of Herp Species Caught in Sticky Traps During Summer, 1997. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

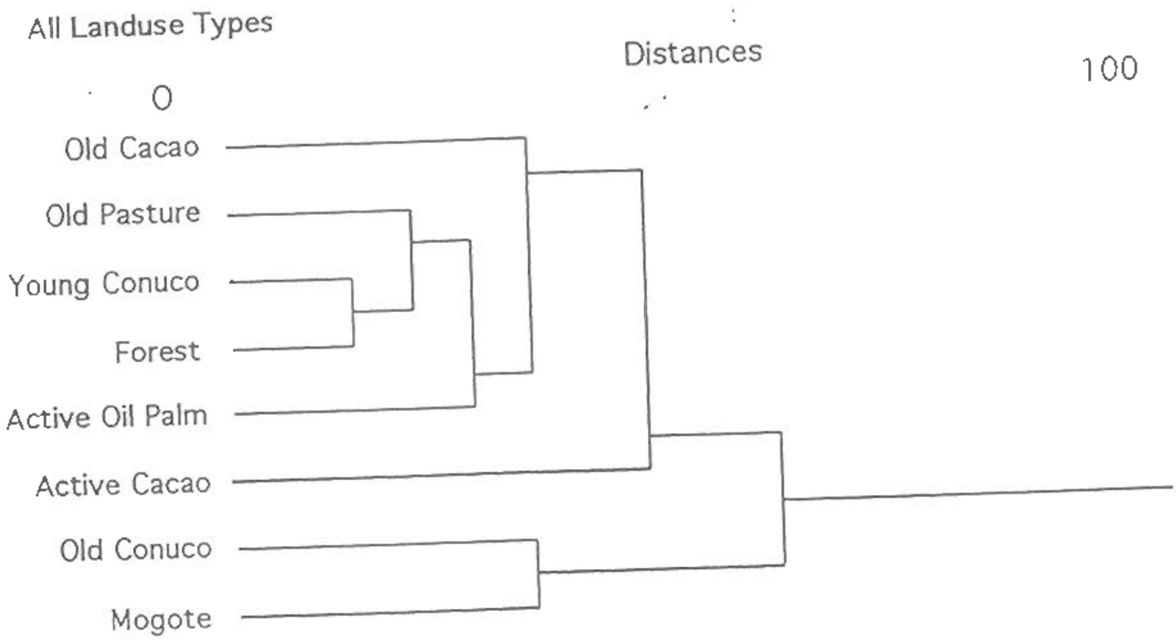
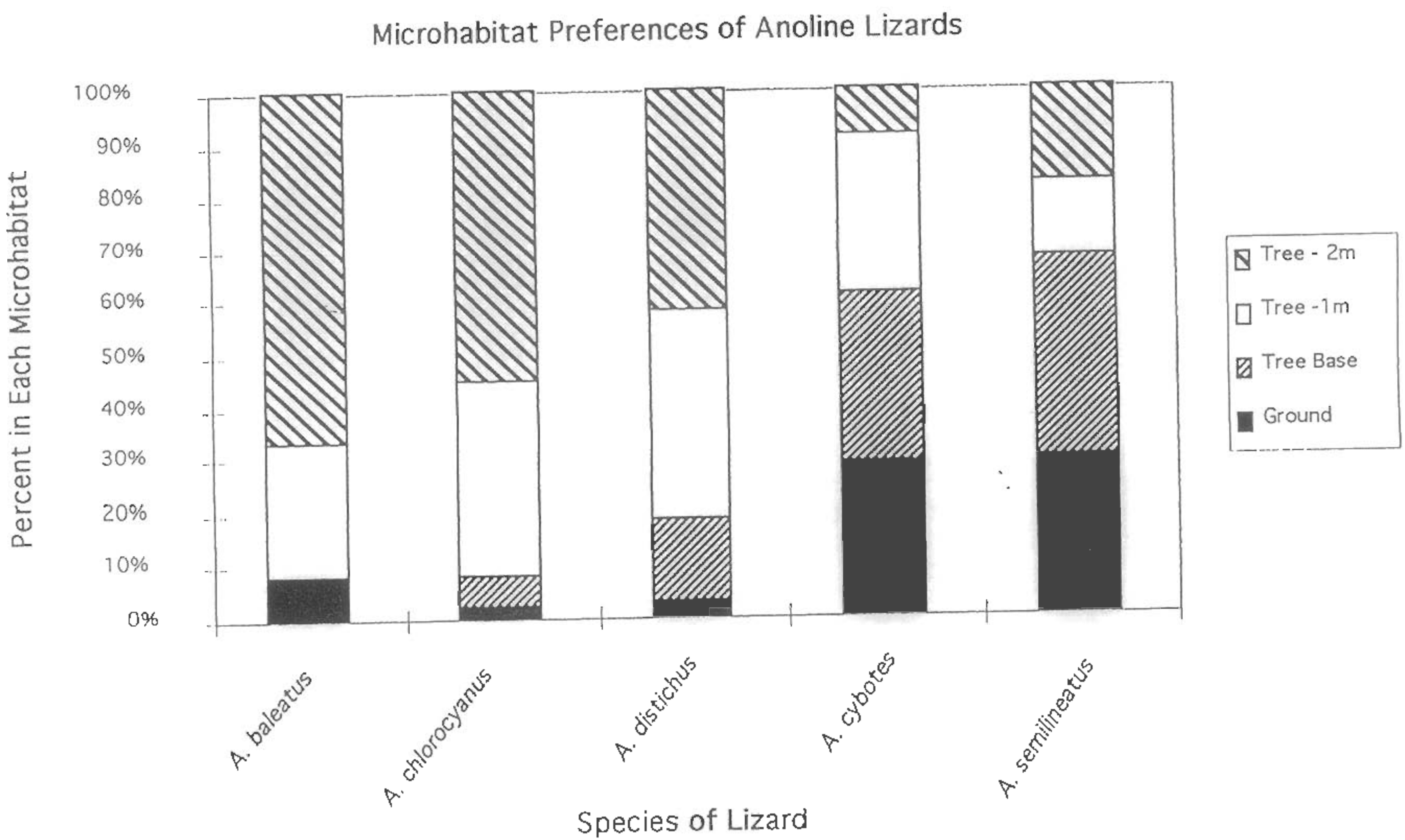


Figure 35



Microhabitat Preferences of Anoline Lizards
Percent in Each Microhabitat
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
A. baleatus
A. chlorocyanus
A. distichus
A. cybotes
A. semilineatus
Species of Lizard
Tree - 2m
Tree -1m
Tree Base
Ground

Figure 36

Ant Species Richness, Richness per Count, and Abundance per Count from Pitfall Trap Sampling during Summer, 1996

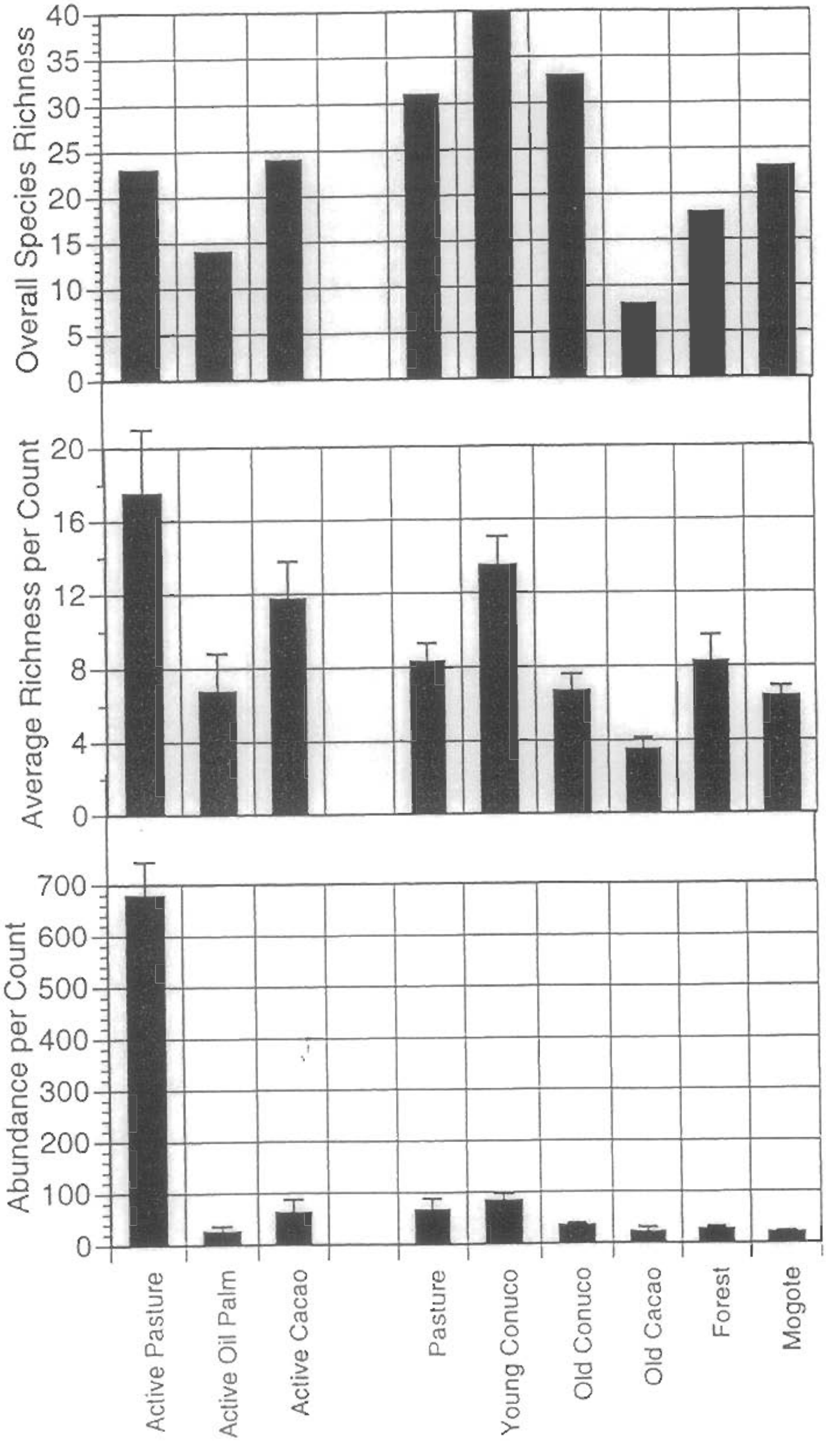


Figure 37

Ant Diversity as measured by the Shannon, Simpson and Log Diversity Indices from Pitfall Trap Sampling during Summer, 1996

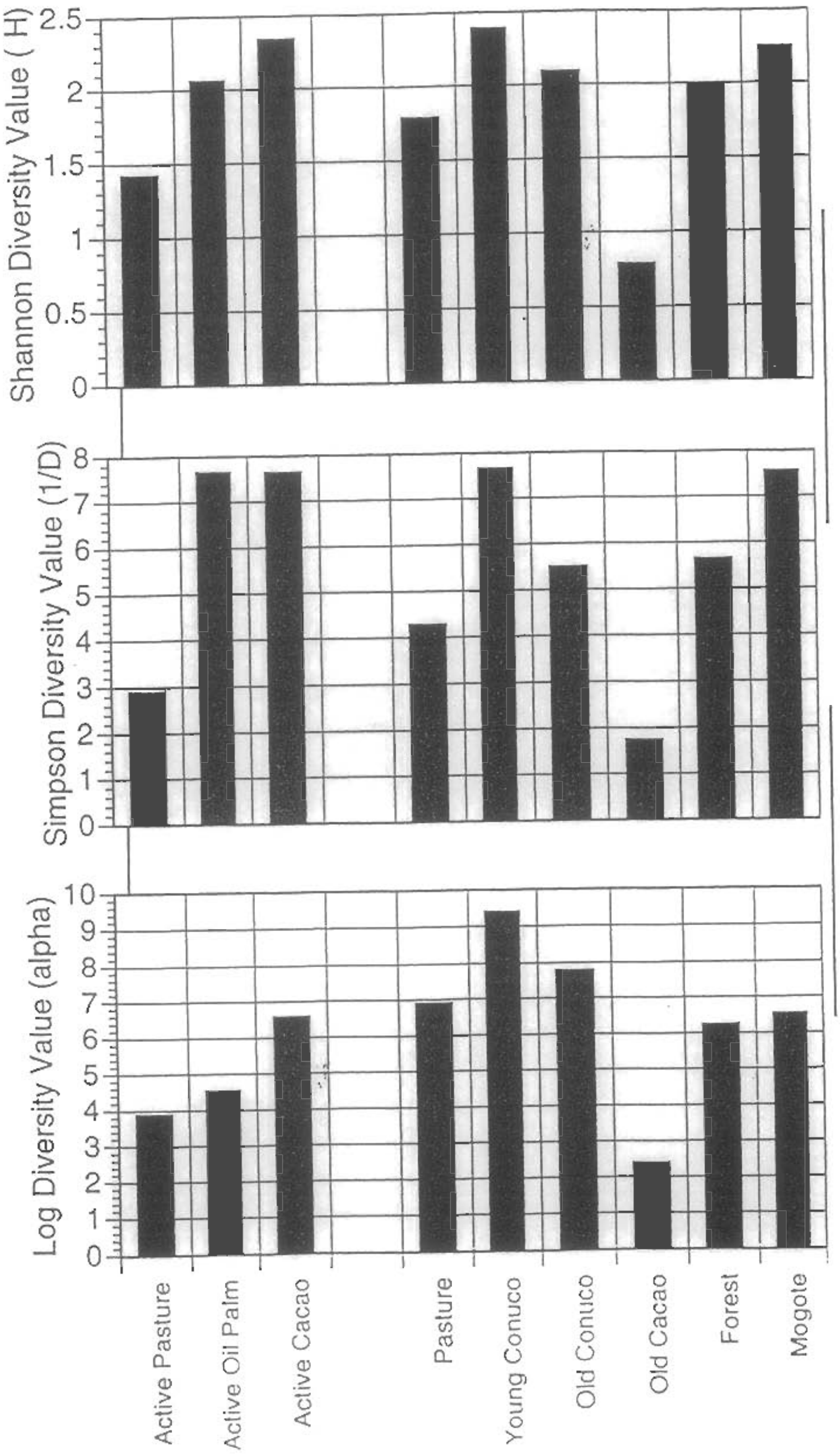


Figure 38

Beetle Family Richness, Richness per Count, and Abundance per Count from Pitfall Trap Sampling during Summer, 1996

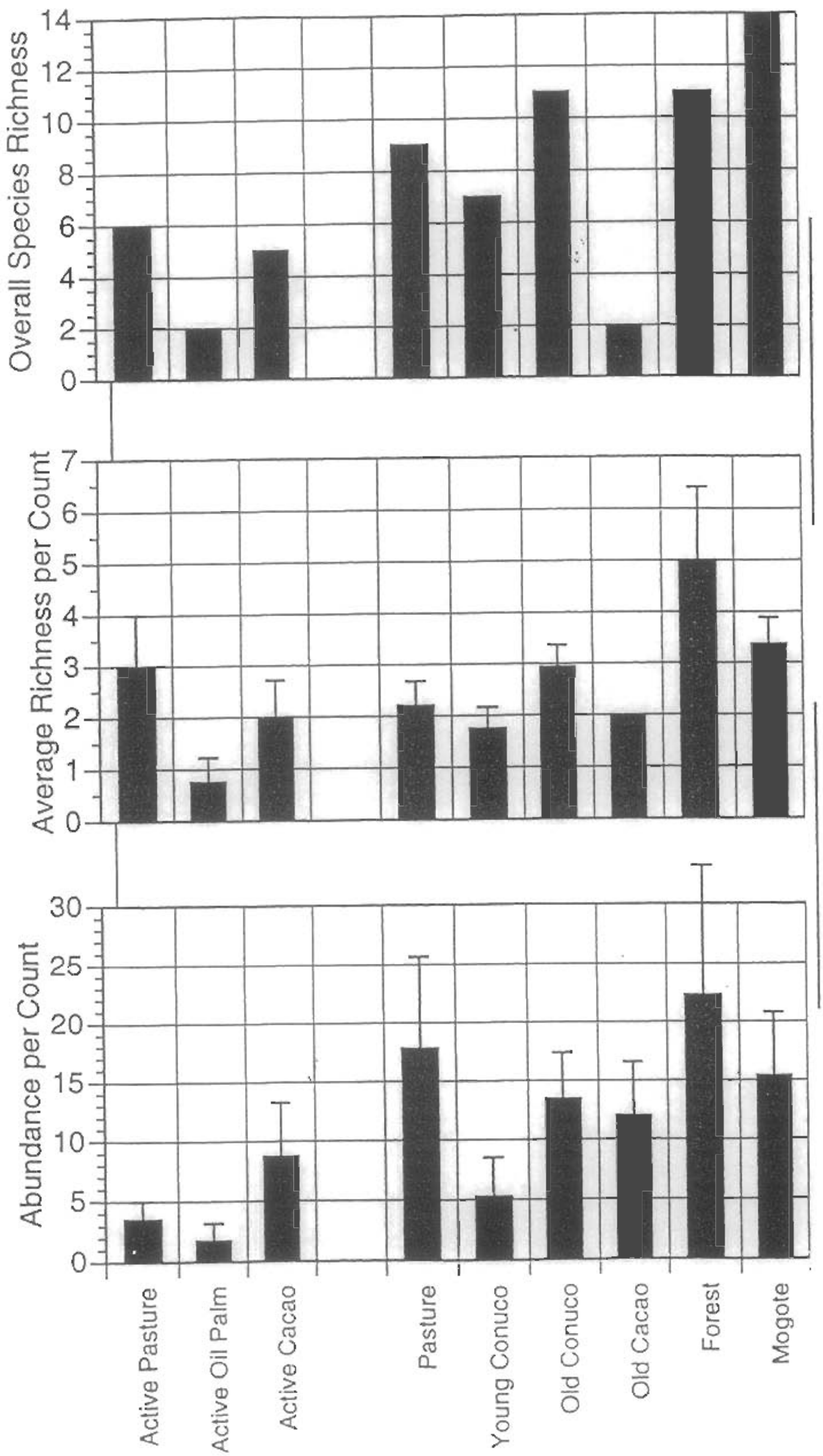


Figure 39

Beetle Family Diversity as measured by the Shannon, Simpson and Log Diversity Indices from Pitfall Trap Sampling, Summer, 1996

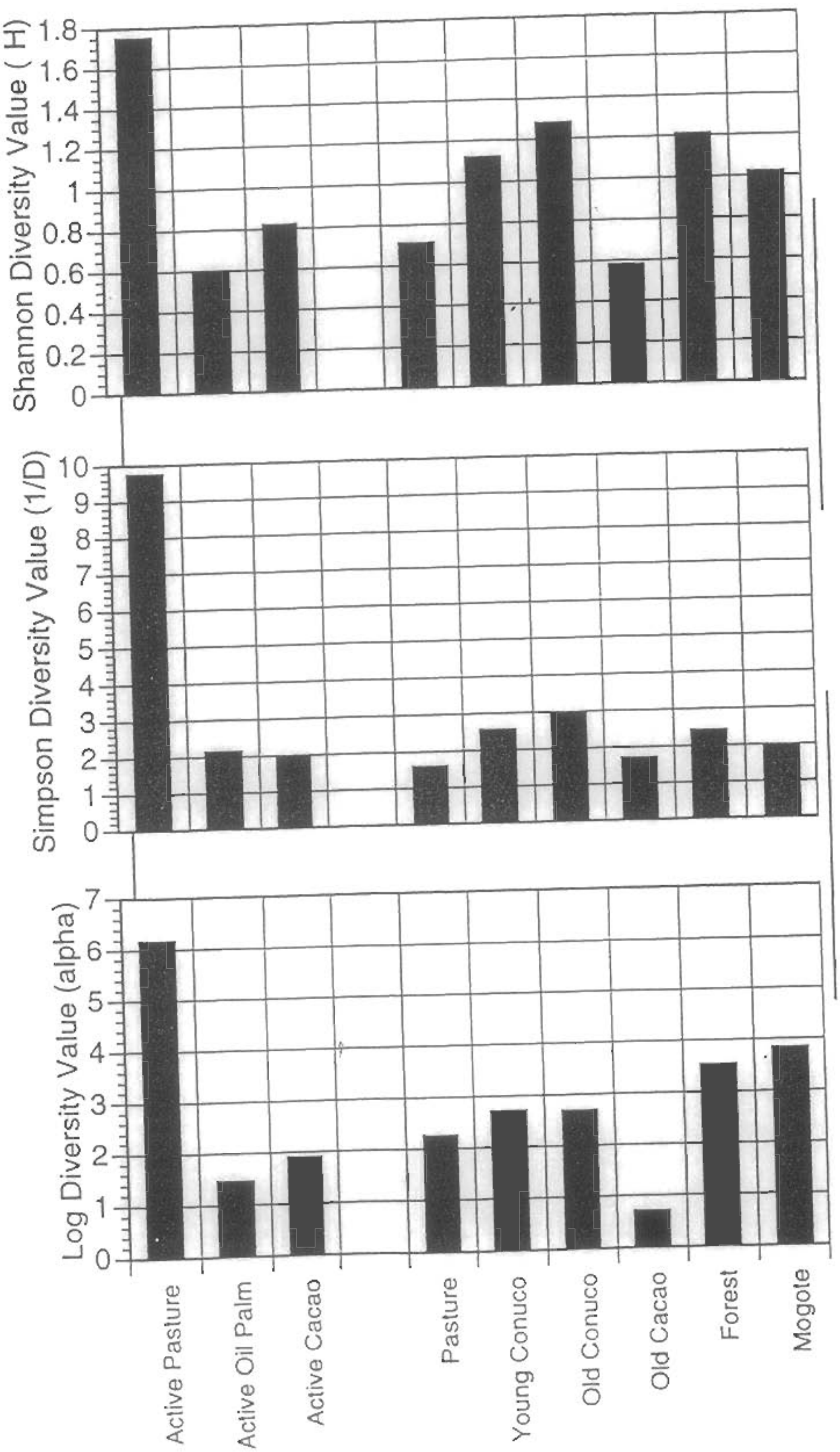
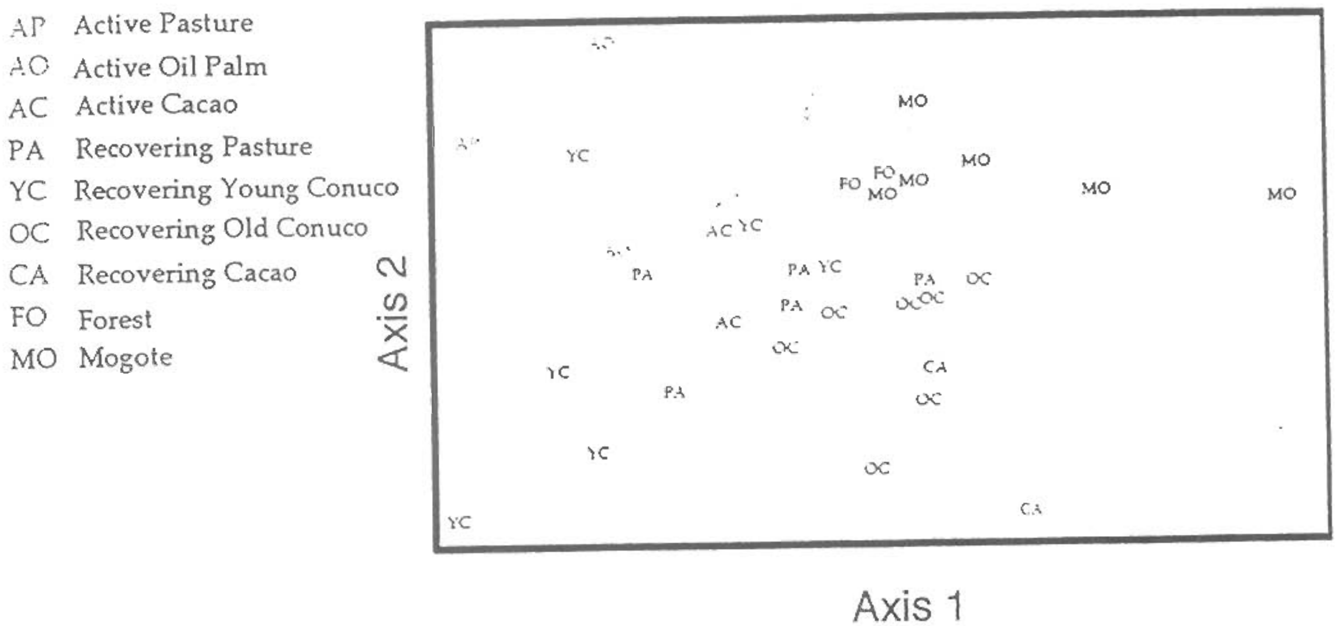


Figure 40

Ordination of Plots in Los Haitises and Agricultural Sites Based on Ants Caught in Pitfall Traps during Summer 1996. Ordination Method is De-trended Correspondence Analysis (DCA).



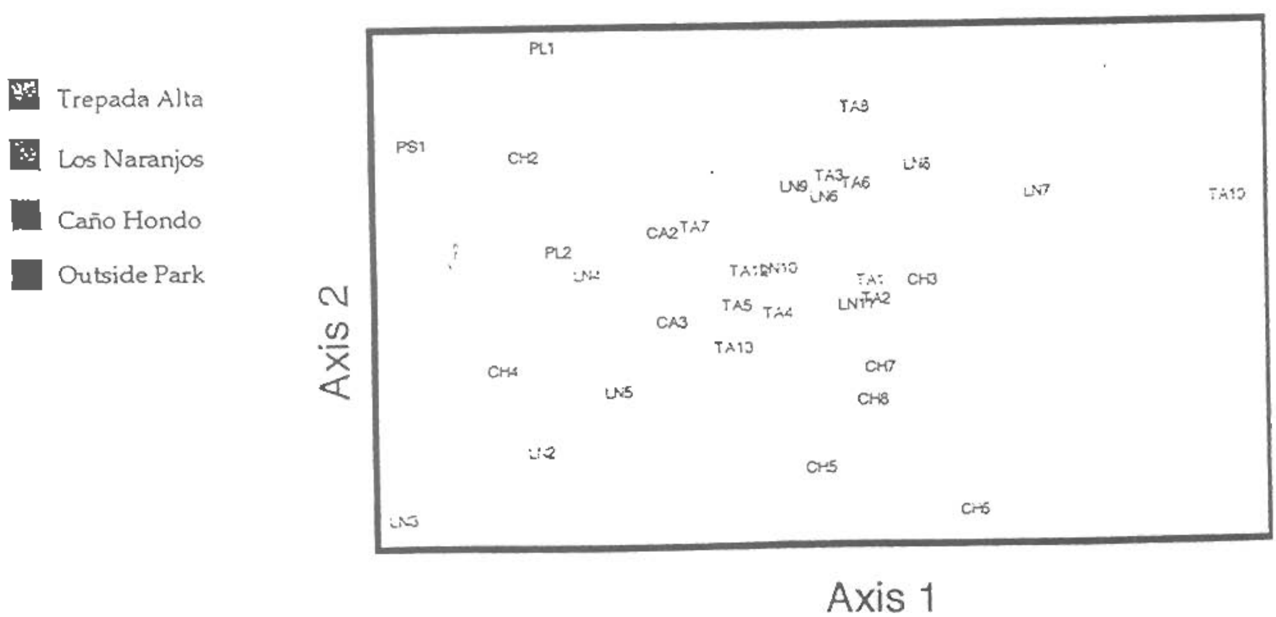


Figure 41

Ordination of Plots within Los Haitises Based on Ants Caught in Pitfall Traps during Summer 1996. Ordination Method is De-trended Correspondence Analysis (DCA).

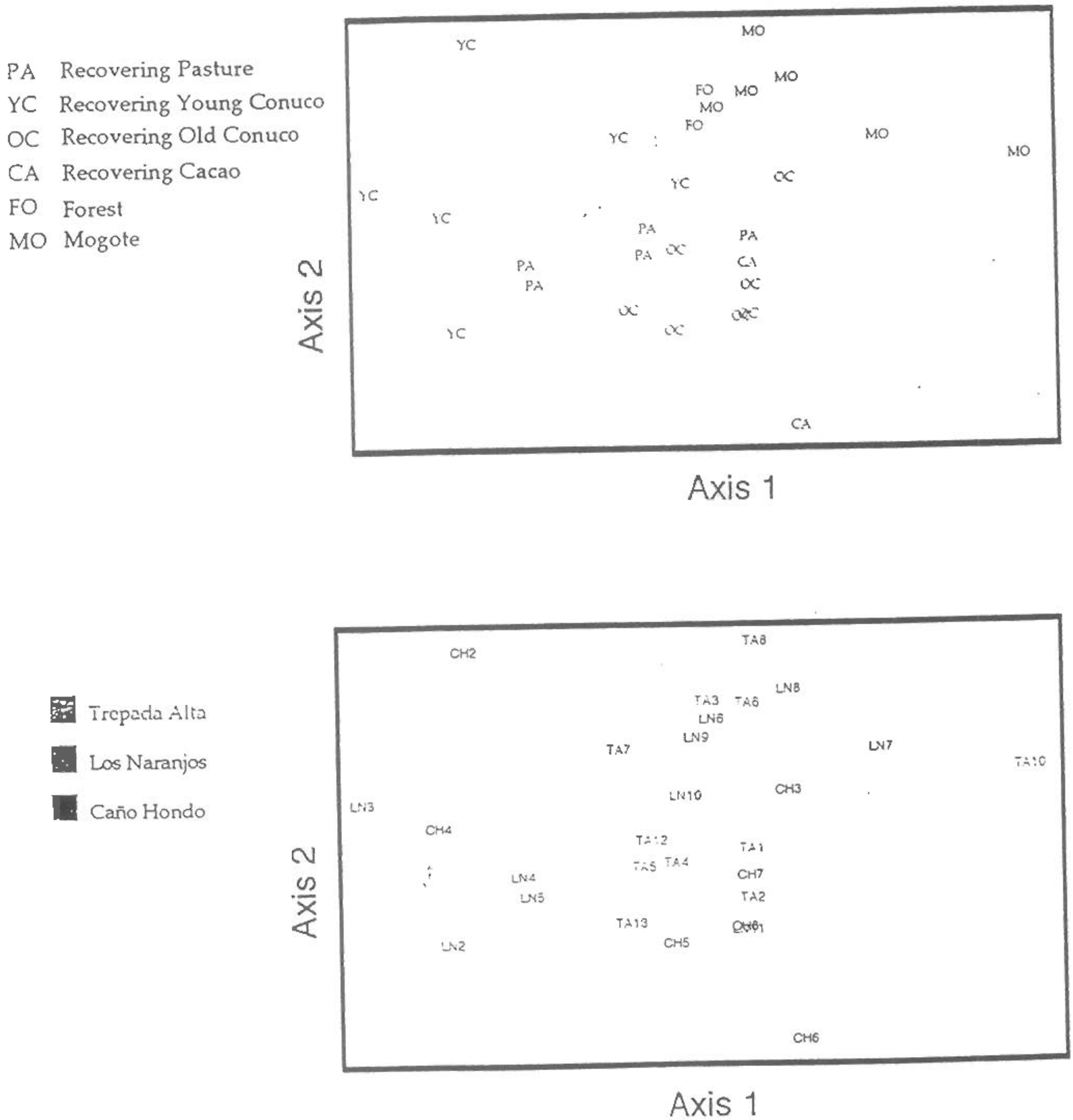
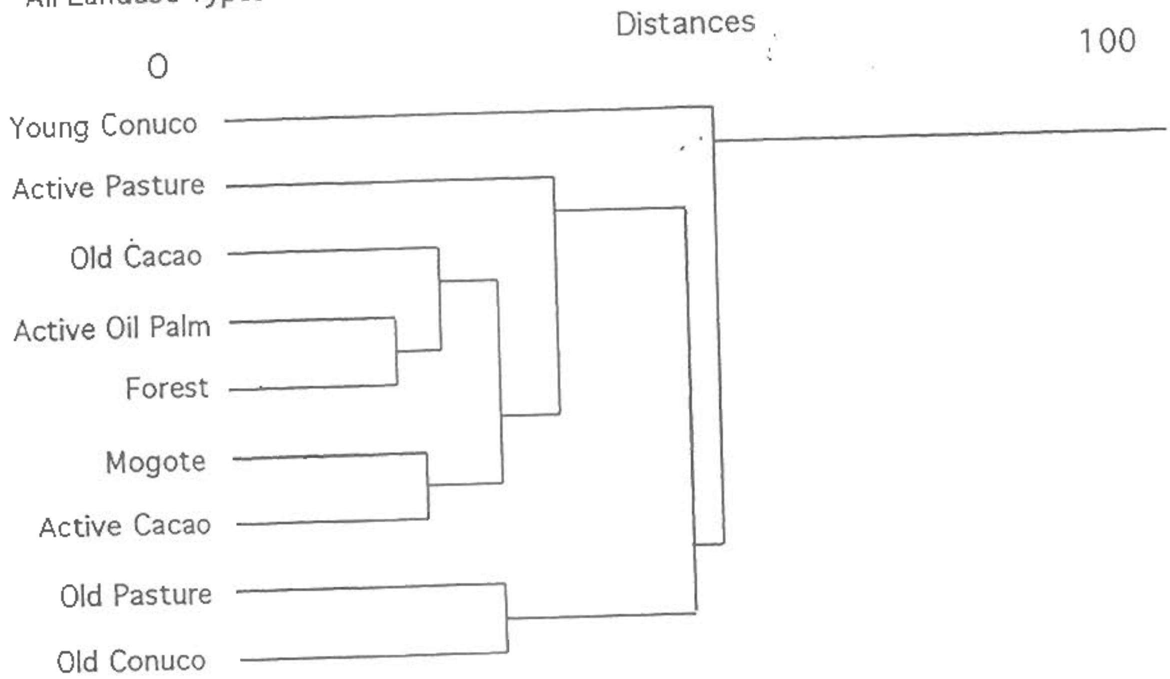


Figure 42

Cluster Analyses of Landuse Types Based on Presence or Absence of Ant Species Caught in Pitfall Traps During Summer, 1996. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

All Landuse Types



Landuse Types in Park

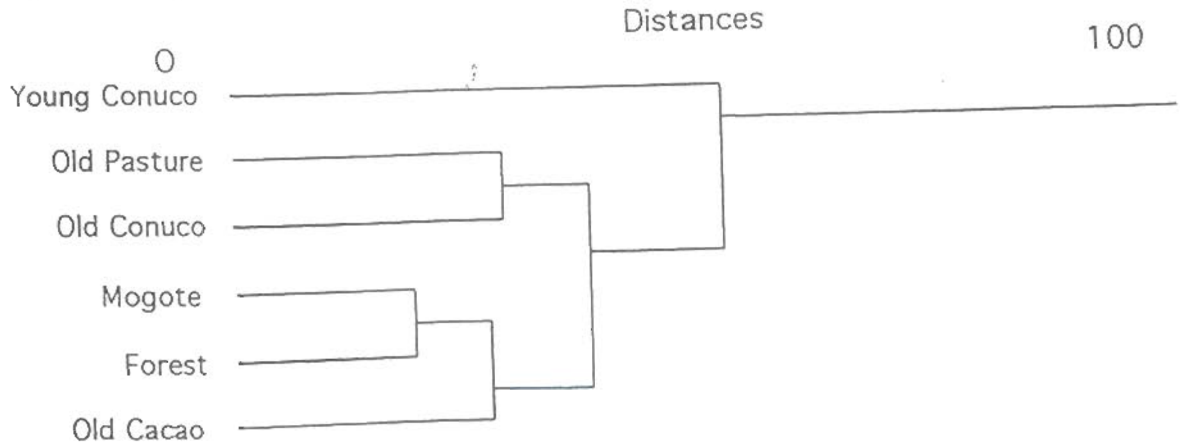
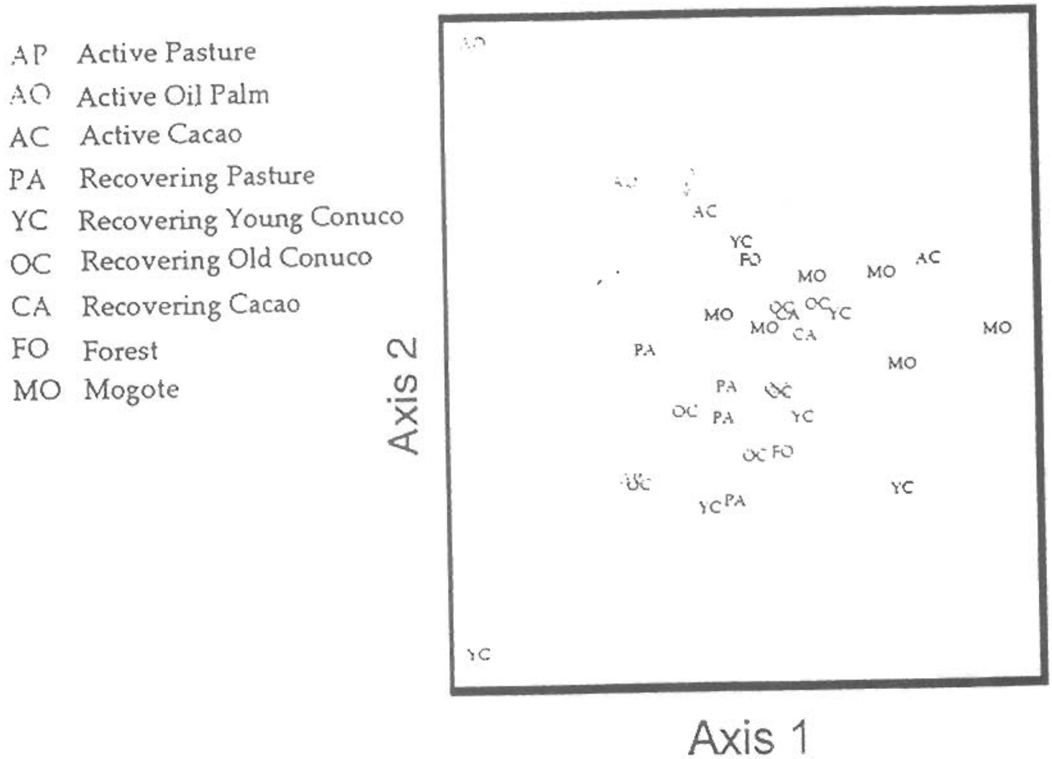


Figure 43

Ordination of Plots in Los Haitises and Agricultural Sites Based on Beetles Caught in Pitfall Traps during Summer 1996. Ordination Method is De-trended Correspondence Analysis (DCA).



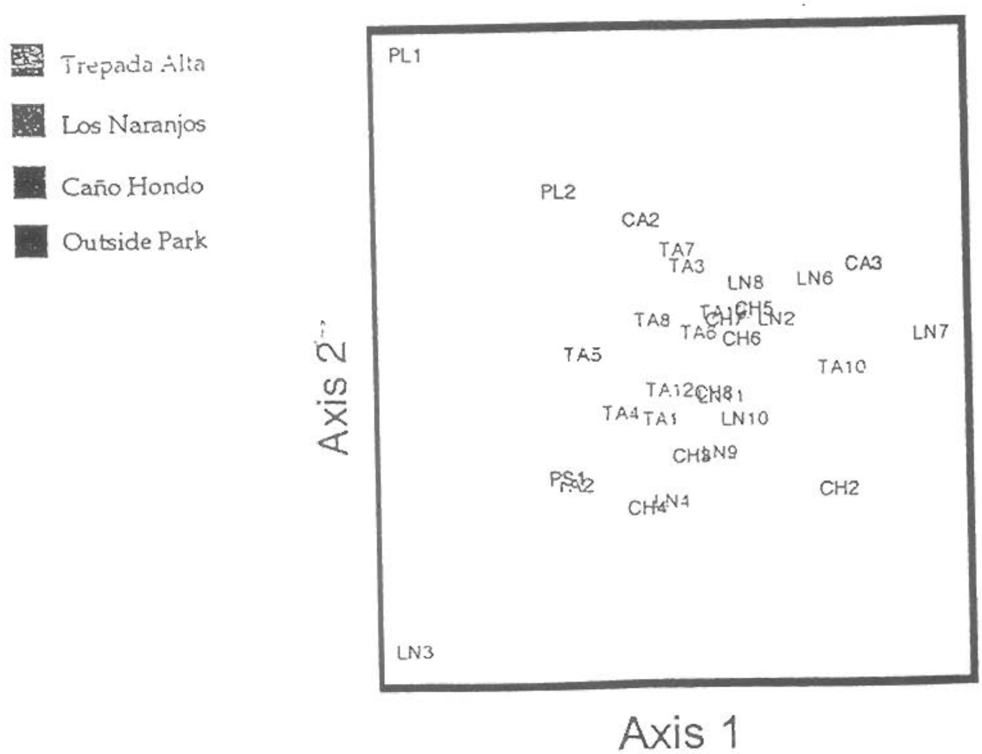
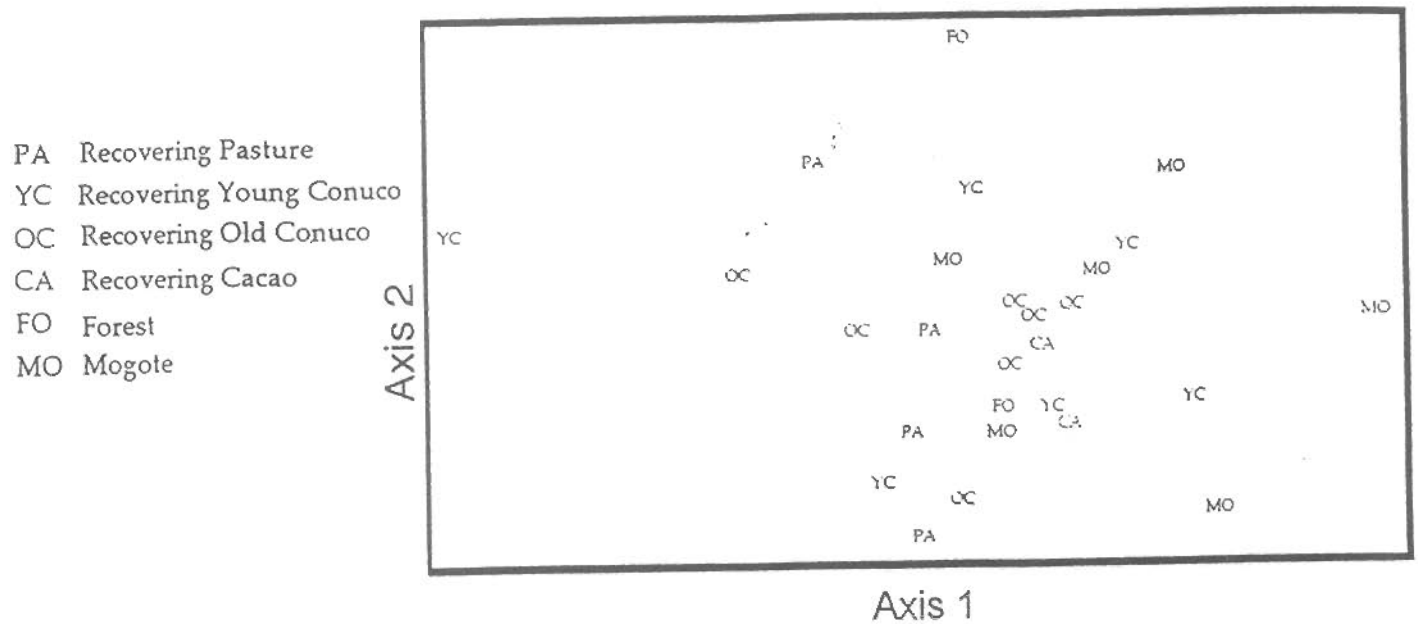


Figure 44

Ordination of Plots within Los Haitises Based on Beetles Caught in Pitfall Traps during Summer 1996. Ordination Method is De-trended Correspondence Analysis (DCA).



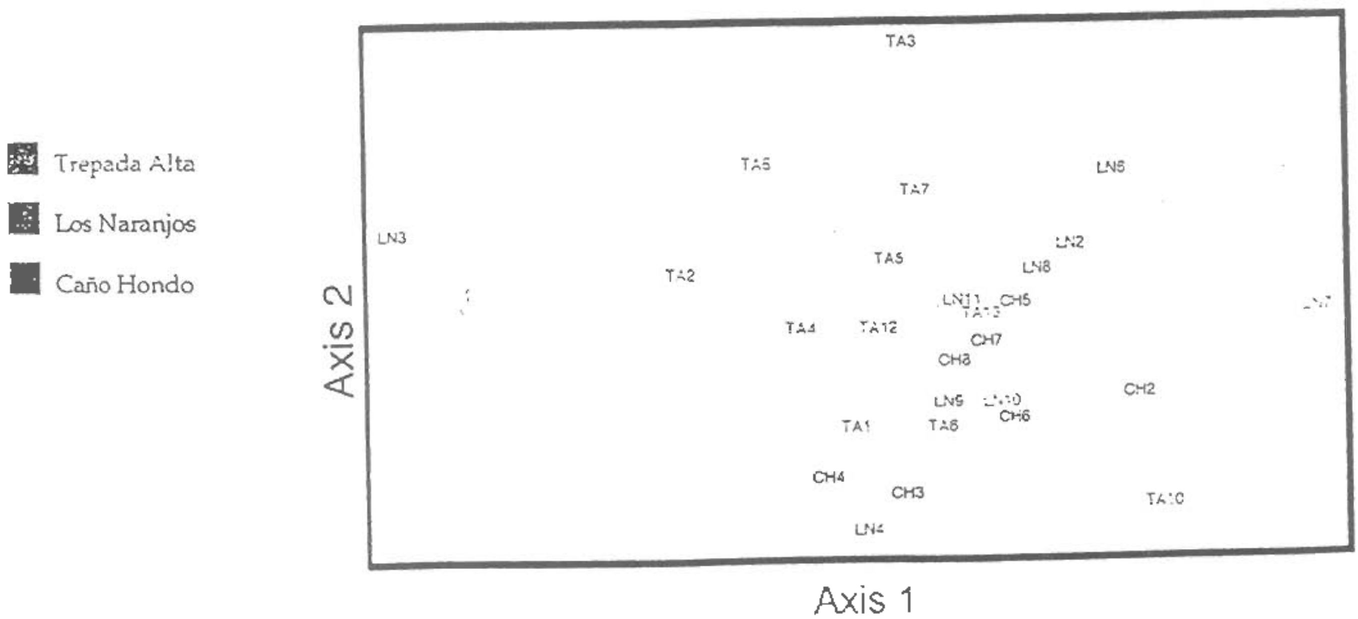


Figure 45

Cluster Analyses of Landuse Types Based on Presence or Absence of Beetle Families Caught in Pitfall Traps During Summer, 1996. Distance Metric is Normalized Percent Disagreement and Clusters are Joined Using the Complete Linkage Method (Farthest Neighbor).

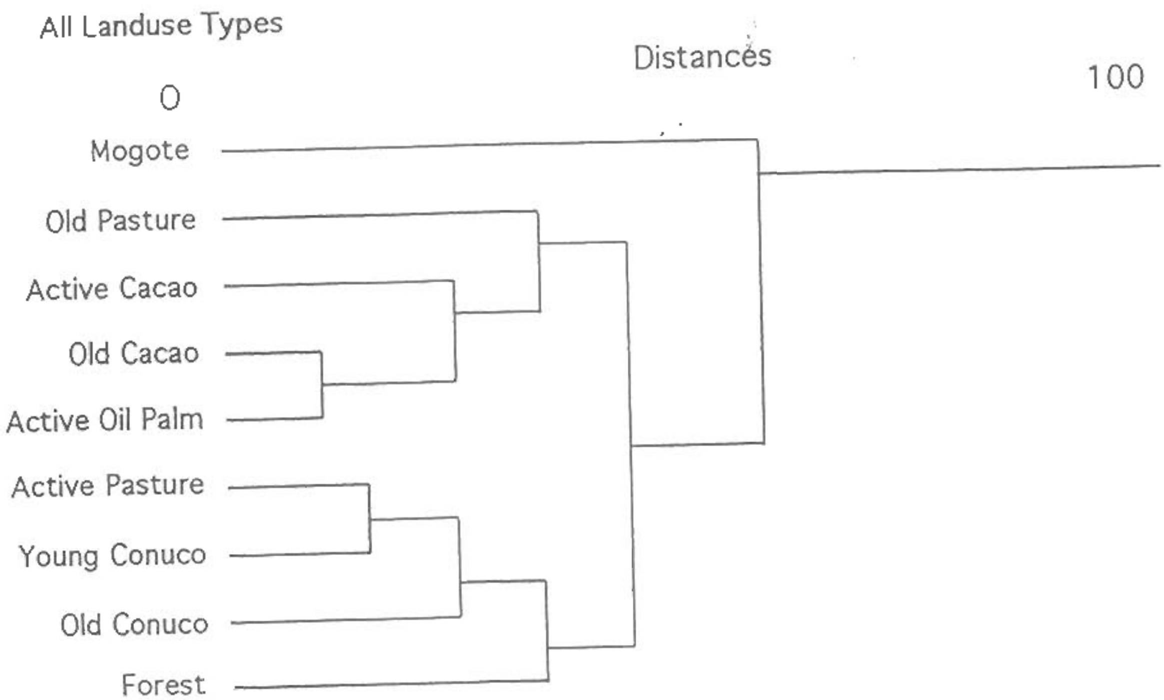
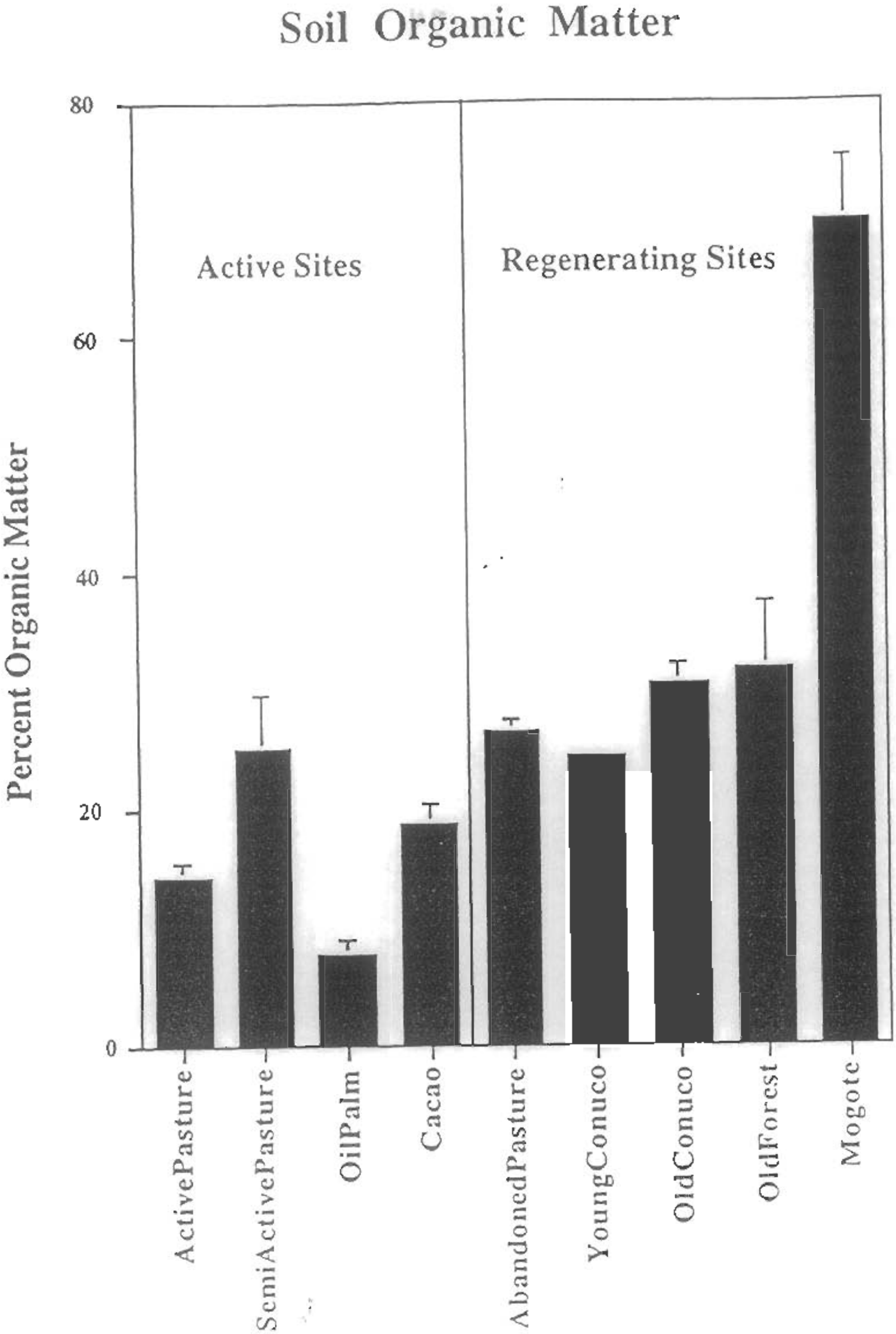
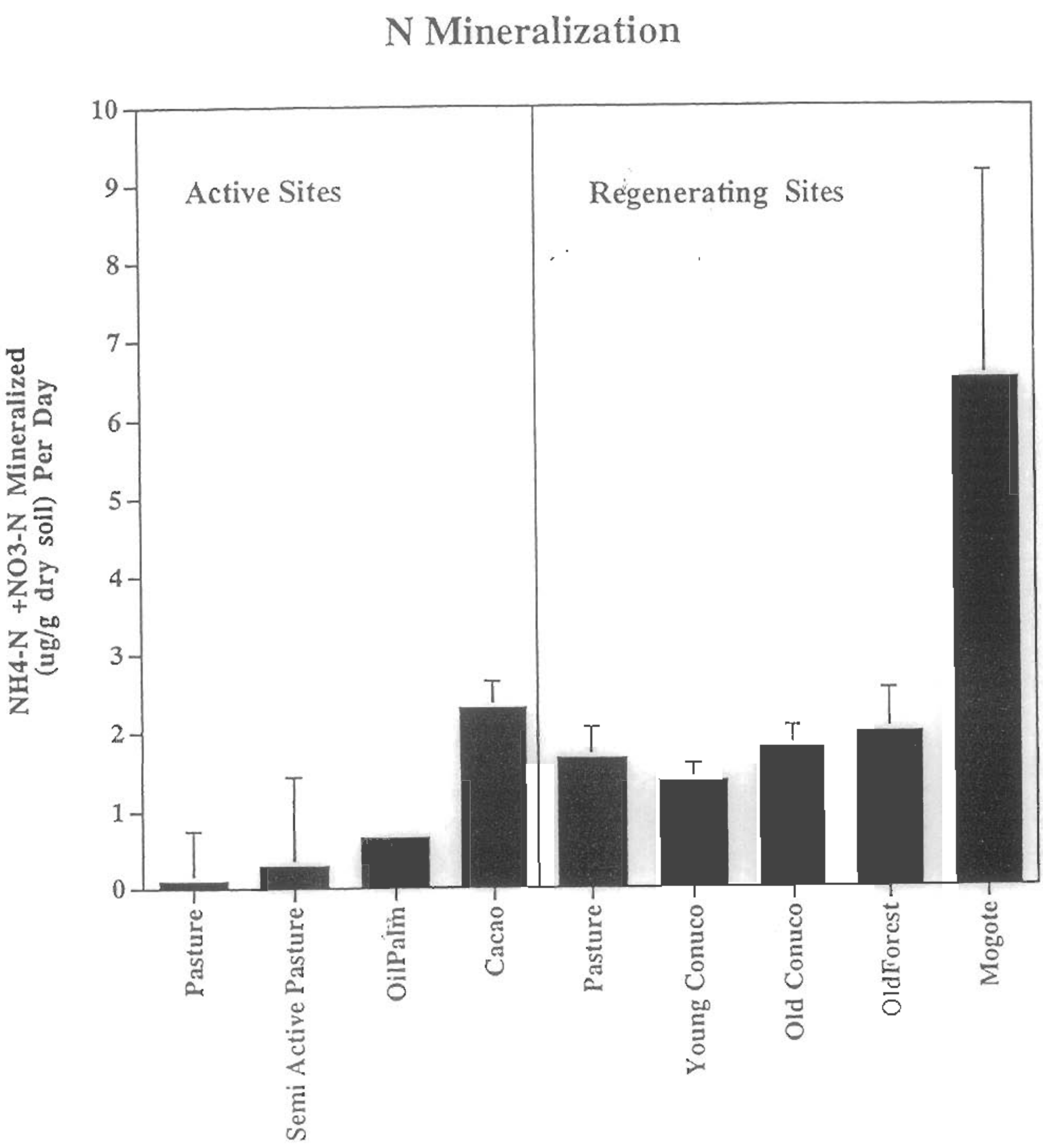


Figure 46



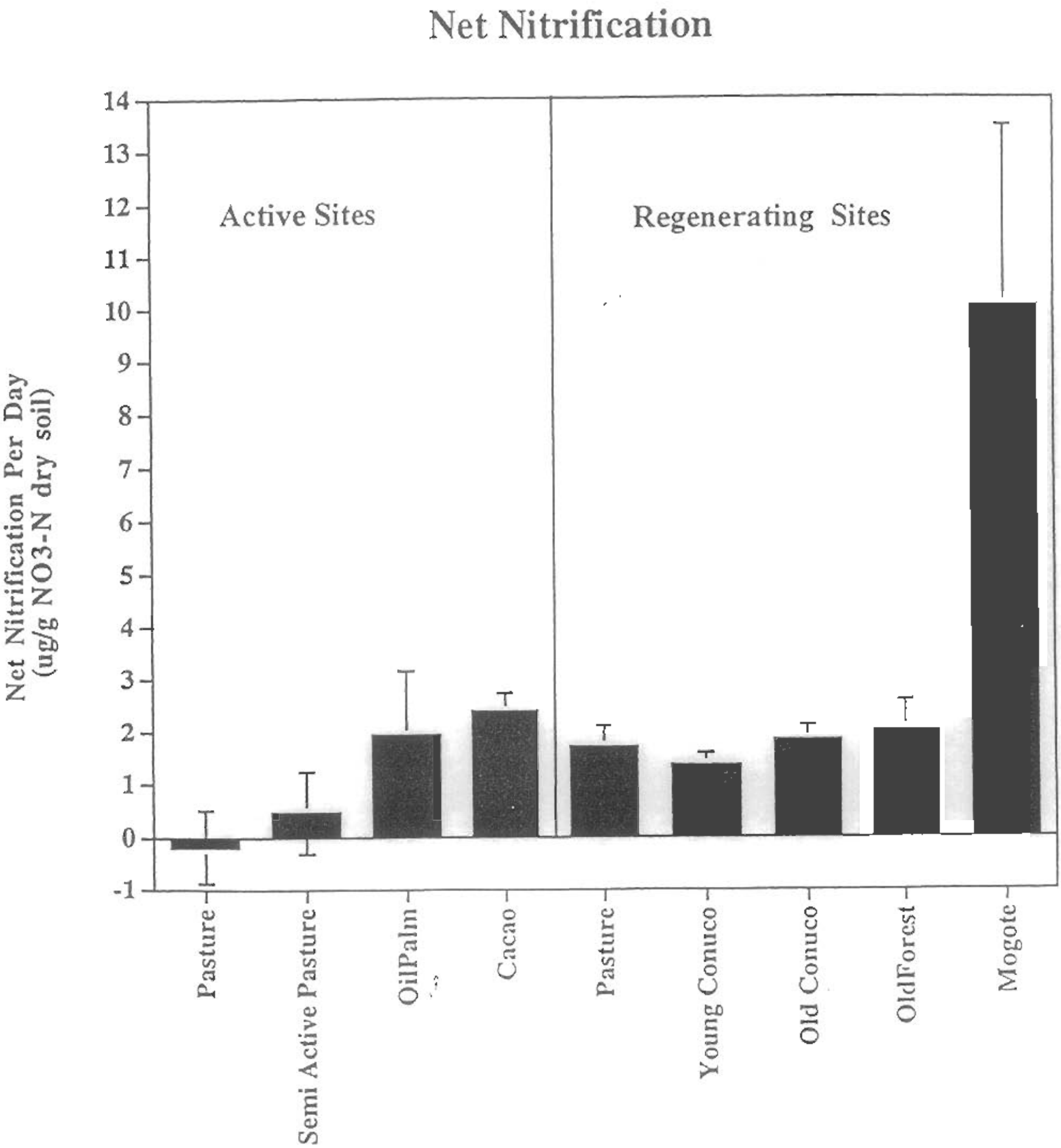
Percent Soil Organic Matter across gradient of land use (n=15,5,15,15,15,10,10,5, and 15 for each land use respectively; error bars represent standard error).

Figure 47



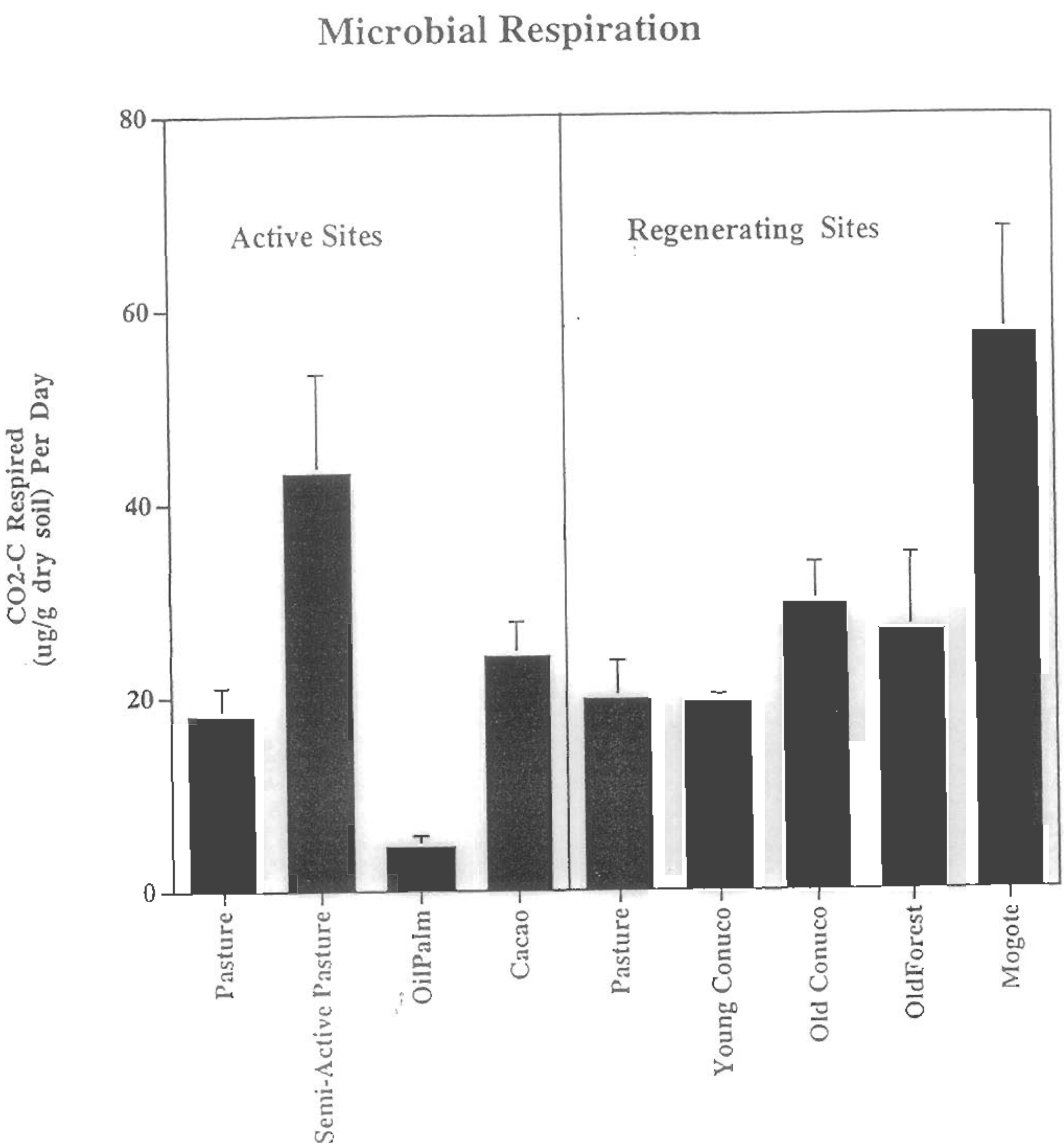
Net nitrogen mineralization rates across gradient of land use (n=9,3,9,9,9,6,6,3,and 9 for each land respectively; error bars represent standard error).

Figure 48



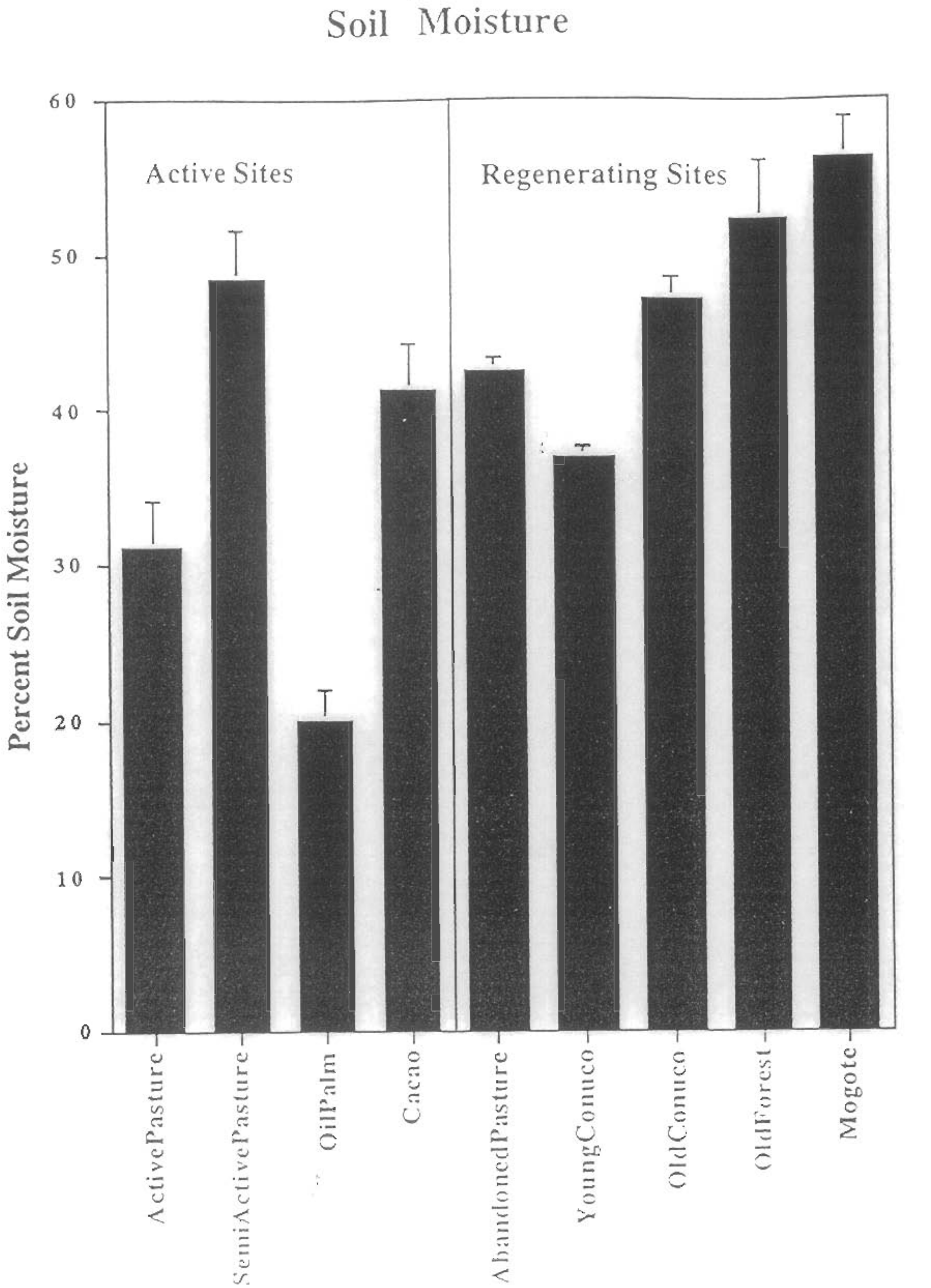
Net nitrification rates across gradient of land use (n=9,3,9,9,9,6,6,3,and 9 for each land respectively; error bars represent standard error).

Figure 49



Microbial respiration across gradient of land use (n=9,3,9,9,9,6,6,3,and 9 for each land respectively; error bars represent standard error).

Figure 50



Percent Soil Moisture across gradient of land use (n=15,5,15,15,15,10,10,5, and 15 for each land use respectively; error bars represent standard error).

GEF-PNUD/ONAPLAN

Conservación y Manejo de la Biodiversidad en la Zona Costera de la República Dominicana

PROYECTO BIODIVERSIDAD

Oficina Nacional de Planificación
Secretariado Técnico de la Presidencia
Programa de las Naciones Unidas para el Desarrollo
Fondo para el Medio Ambiente Mundial

INFORME FINAL

Subcontrato Los Haitises

Area de Proyecto:

Parque Nacional Los Haitises

Implementa:

Universidad de Cornell (CIIFAD)

Doc 2/4 – **Anexo 2**
Summary GIS Database
Diciembre 1997

Appendix B

SUMMARY GIS DATABASE

Table 1. Summary of GIS database created for the Los Haitises region as ArcInfo coverages. Some coverages also exist as ArcView themes. Some coverages are not described due to insufficient information on data sources.

(I) Workspace: \UTM

Available Coverages:

BASEMAP	COMMUN	COMM_SEL	DRHIKEGP
ELDEAN_B	ELDEAN_S	FL93BUFF	FLIGHTS
GRIDLINE	GRIDTICS	HY62721	HY62722
HY62733	HY63724	LHNP93	LHNP9395
LHNP95	LHNPAECI	LHNPL2	LHNP_ALL
LHNP_Z	MGTZONES	MUNICIP	NEWFL_B
NEWFL_U	PARAJES	PNLH9604	PROPOSED
QUADU	RD62721	RD62722	RD62733
RD63724	ROADS66	ROADS84	RRA
SECCION	TICCOV	USOS1	USOS2
YUNA			

Theme: **commun**

DESCRIPTION: # RECORDS 1138

Point coverage of communities within and in proximity to LHNP.

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	COMMUN#	4	5	B	-
13	COMMUN-ID	4	5	B	-
17	OLDNUM	4	4	I	-
21	NAME	35	35	C	-
56	QUAD	5	5	I	-
61	YEAR	4	4	I	-
65	SCHOOL	2	2	I	-
67	CHURCH	2	2	I	-
69	HOSP	2	2	I	-
71	CEM	2	2	I	-
73	STAD	2	2	I	-
75	AGBANK	2	2	I	-
77	GOFF	2	2	I	-

Table 1. (con't)

79	POL	2	2	I	-
81	MIL	2	2	I	-
83	TRANS	2	2	I	-
85	MAIL	2	2	I	-
87	MINES	2	2	I	-
89	METSTAT	2	2	I	-

Theme: **basemap**

DESCRIPTION: # RECORDS

Polygon coverage delineating study area and coast line in vicinity of Los Haitises NP. 49

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	BASEMAP#	4	5	B	-
13	BASEMAP-ID	4	5	B	-

Theme: **eldean_b**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	ELDEAN_B#	4	5	B	-
25	ELDEAN_B-ID	4	5	B	-
29	TYPE	5	5	C	-

Table 1. (con't)

Theme: **drhikegp**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	DRHIKEGP#	4	5	B	-
25	DRHIKEGP-ID	4	5	B	-

Theme: **eldean_s**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	ELDEAN_S#	4	5	B	-
25	ELDEAN_S-ID	4	5	B	-
29	TYPE	5	5	C	-

Theme: **fl93buff**

DESCRIPTION: # RECORDS

Buffer polygon of original 15 flight lines for 1993 aerial photography of Los Haitises and vicinity. 1

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	FL93BUFF#	4	5	B	-
13	FL93BUFF-ID	4	5	B	-
17	INSIDE	4	5	B	-

Table 1. (con't)

Theme: **flights**

DESCRIPTION:

Line coverage of 15 aerial photography flight lines established in 1993 for LHNP and vicinity.

RECORDS
15

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	FLIGHTS#	4	5	B	-
25	FLIGHTS-ID	4	5	B	-
29	STATUS	1	1	I	-

Theme: **gridline**

DESCRIPTION:

Line coverage of 1:50,000 scale topographic maps encompassing the study area.

RECORDS
24

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	GRIDLINE#	4	5	B	-
25	GRIDLINE-ID	4	5	B	-
29	LABEL	5	5	C	-

Theme: **gridtics**

DESCRIPTION:

RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	GRIDTICS#	4	5	B	-
13	GRIDTICS-ID	4	5	B	-

Table 1. (con't)

Theme: **hy62721**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	HY62721#	4	5	B	-
25	HY62721-ID	4	5	B	-

Theme: **hy62722**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	HY62722#	4	5	B	-
25	HY62722-ID	4	5	B	-
29	TYPE	1	1	I	-
30	NAME	40	40	C	-

Theme: **hy62733**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	HY62733#	4	5	B	-
25	HY62733-ID	4	5	B	-

Table 1. (con't)

Theme: **hy63724**

DESCRIPTION:	# RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	HY63724#	4	5	B	-
25	HY63724-ID	4	5	B	-
29	TYPE	4	5	B	-

Theme: **lhnp93**

DESCRIPTION:	# RECORDS
Polygon coverage of park zone boundaries established in 1993.	8

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNP93#	4	5	B	-
13	LHNP93-ID	4	5	B	-
17	ZONE93	2	2	I	-
19	KM2	16	16	I	-

Theme: **lhnp9395**

DESCRIPTION:	# RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNP9395#	4	5	B	-
13	LHNP9395-ID	4	5	B	-
17	LHNPB#	4	5	B	-
21	LHNPB-ID	4	5	B	-
25	ZONE93	2	2	I	-
27	LHNP95#	4	5	B	-
31	LHNP95-ID	4	5	B	-
35	ZONE95	2	2	I	-
37	ZONE9395	2	2	I	-
39	KM2	16	16	I	-

Table 1. (con't)

Theme: **lhnp95**

DESCRIPTION: # RECORDS

Polygon coverage of park zone boundaries established in 1995. 2

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNP95#	4	5	B	-
13	LHNP95-ID	4	5	B	-
17	ZONE95	2	2	I	-
19	KM2	16	16	I	-

Table 1. (con't)

Theme: **lhnpaeci**

DESCRIPTION: # RECORDS

Polygon coverage of Spanish Master Plan use and management zones for LHNP. 12

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNPAECI#	4	5	B	-
13	LHNPAECI-ID	4	5	B	-
17	ZONE_AECI	2	2	I	-
19	USE_ZONE	2	2	I	-
21	MGT_ZONE	2	2	I	-

Theme: **lhnpl2**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNPL2#	4	5	B	-
13	LHNPL2-ID	4	5	B	-
17	KM2	16	16	I	-

Table 1. (con't)

Theme: **lhnp_all**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNP_ALL#	4	5	B	-
13	LHNP_ALL-ID	4	5	B	-
17	ZONE_ALL	4	4	I	-

Theme: **lhnp_z**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNP_Z#	4	5	B	-
13	LHNP_Z-ID	4	5	B	-
17	LHNP9395#	4	5	B	-
21	LHNP9395-ID	4	5	B	-
25	LHNPB#	4	5	B	-
29	LHNPB-ID	4	5	B	-
33	ZONE93	2	2	I	-
35	LHNP95#	4	5	B	-
39	LHNP95-ID	4	5	B	-
43	ZONE95	2	2	I	-
45	ZONE9395	2	2	I	-
47	LHNPAECI#	4	5	B	-
51	LHNPAECI-ID	4	5	B	-
55	ZONE_AECI	2	2	I	-
57	USE_ZONE	2	2	I	-
59	MGT_ZONE	2	2	I	-
61	ZONE_ALL	4	4	I	-

Table 1. (con't)

Theme: **mgtzones**

DESCRIPTION: # RECORDS

Polygon coverage of Spanish Master Plan management zones for LHNP. 5

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	MGTZONES#	4	5	B	-
13	MGTZONES-ID	4	5	B	-
17	NAME	35	35	C	-
52	POLYCOL	4	5	B	-

Theme: **municip**

DESCRIPTION: # RECORDS

Polygon coverage of municipios in and in proximity to LHNP. 7

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	MUNICIP#	4	5	B	-
13	MUNICIP-ID	4	5	B	-
17	NAME	35	35	C	-

Theme: **newfl_b**

DESCRIPTION: # RECORDS

Buffer polygon of new flight lines for CEBSE for southern coastline of Samana Bay. 1

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	NEWFL_B#	4	5	B	-
13	NEWFL_B-ID	4	5	B	-
17	INSIDE	4	5	B	-

Table 1. (con't)

Theme: **newfl_u**

DESCRIPTION: # RECORDS

New flight lines for CEBSE for southern coastline of Samana Bay. 3

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	NEWFL_U#	4	5	B	-
25	NEWFL_U-ID	4	5	B	-
29	STATUS	1	1	I	-

Theme: **pnlh9604**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PNLH9604#	4	5	B	-
13	PNLH9604-ID	4	5	B	-
17	KM2	16	16	I	-

Theme: **pnlh9604**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PNLH9604#	4	5	B	-
13	PNLH9604-ID	4	5	B	-
17	KM2	16	16	I	-

Table 1. (con't)

Theme: **pnlh9604**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PNLH9604#	4	5	B	-
13	PNLH9604-ID	4	5	B	-
17	KM2	16	16	I	-

Theme: **parajes**

DESCRIPTION: # RECORDS

Polygon coverage of parajes within and in proximity to LHNP. 321

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PARAJES#	4	5	B	-
13	PARAJES-ID	4	5	B	-
17	CENSUSID	8	8	I	-
25	RAZON	8	18	F	5
33	OCU	4	5	B	-
37	VIVI	4	5	B	-
41	MEN	4	5	B	-
45	WOMEN	4	5	B	-
49	TOTAL	4	5	B	-
53	MAYORES	4	5	B	-
57	SEOM	4	5	B	-
61	NAME	35	35	C	-
96	OCUDENS	4	12	F	3
100	AREAKM2	8	18	F	5
108	OCUDENSGRP	8	18	F	5
116	FLAG	4	5	B	-
120	MINOR1	6	6	I	-
126	MAJOR1	6	6	I	-

Table 1. (con't)

Theme: **proposed**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PROPOSED#	4	5	B	-
13	PROPOSED-ID	4	5	B	-
17	NAME	35	35	C	-
52	KM2	16	16	I	-

Theme: **quadu**

DESCRIPTION: # RECORDS

Polygon coverage of 1:50,000 scale topographic maps encompassing the study area. 57

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	QUADU#	4	5	B	-
13	QUADU-ID	4	5	B	-
17	BLOCK	4	4	I	-
21	QUADRANT	3	3	C	-
24	NAME_3	32	32	C	-
56	NAME_3NA	32	32	C	-
88	NAME_1	32	32	C	-

Theme: **rd62721**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	RD62721#	4	5	B	-
25	RD62721-ID	4	5	B	-

Table 1. (con't)

Theme: **rd62733**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	RD62733#	4	5	B	-
25	RD62733-ID	4	5	B	-

Theme: **rd63724**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	RD63724#	4	5	B	-
25	RD63724-ID	4	5	B	-

Theme: **roads66**

DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	ROADS66#	4	5	B	-
25	ROADS66-ID	4	5	B	-

Table 1. (con't)

Theme: **roads84**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	ROADS84#	4	5	B	-
25	ROADS84-ID	4	5	B	-

Theme: **rd62722**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	RD62722#	4	5	B	-
25	RD62722-ID	4	5	B	-
29	TYPE	4	5	B	-

Theme: **rra**
DESCRIPTION: # RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	RRA#	4	5	B	-
25	RRA-ID	4	5	B	-

Table 1. (con't)

Theme: **seccion**

DESCRIPTION: # RECORDS

Polygon coverage of secciones within and in proximity to LHNP. 17

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	SECCION#	4	5	B	-
13	SECCION-ID	4	5	B	-
17	NAME	35	35	C	-

Theme: **usos1**

DESCRIPTION: # RECORDS

Polygon coverage of land use interpreted from 1993 color aerial photographs by Tomas Montilla, ICM. Includes southern and mangrove portions of Los Haitises NP and lower Rio Yuna watershed 753

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHUSOS#	4	5	B	-
13	LHUSOS-ID	4	5	B	-
17	USOS	45	45	C	-

Theme: **usos2**

DESCRIPTION: # RECORDS

Polygon coverage of land use interpreted from 1997 color aerial photographs by Tomas Montilla, ICM. Includes west-central and southeastern portions of Los Haitises NP. 312

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	8	18	F	5
9	PERIMETER	8	18	F	5
17	USOS97#	8	18	F	5
25	USOS-ID	8	18	F	5
33	USOS	30	30	C	-

Table 1. (con't)

Theme: **yuna**

DESCRIPTION: # RECORDS

Line coverage of the lower Rio Yuna, northwest of LHNP. 192

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	YUNA#	4	5	B	-
25	YUNA-ID	4	5	B	-

(II) Workspace: \LOSHAITISES

Available Coverages

CARSTICO	LHGEO	LHRIOS	LHVIAS
PHLH97	PNLH68	PNLH96	
PNLH96BU	RDLAGOS	REPDOM27	

Theme: **carstico**

DESCRIPTION: # RECORDS

Polygon coverage of karst geomorphology in Los Haitises NP and vicinity, extracted from regional geology map. 31

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	8	18	F	5
9	PERIMETER	8	18	F	5
17	CARSTIC#	8	18	F	5
25	CARSTIC-ID	8	18	F	5
33	MORFOLOGIA	8	20	F	5

Table 1. (con't)

Theme: **lhgeo**

DESCRIPTION: # RECORDS

Polygon coverage of regional geology for Los Haitises region. 96

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	GEOLOGIC#	4	5	B	-
13	GEOLOGIC-ID	4	5	B	-
17	CLASE	12	12	C	-

Theme: **lhrios**

DESCRIPTION: # RECORDS

Line coverage of rivers for four 1:50,000 scale topographic maps in the Los Haitises region. 645

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	PNLHRIO#	4	5	B	-
25	PNLHRIO-ID	4	5	B	-
29	NOMBRE	30	30	C	-

Theme: **lhvias**

DESCRIPTION: # RECORDS

Line coverage of roads for four 1:50,000 scale topographic maps in the Los Haitises region. 154

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	FNODE#	4	5	B	-
5	TNODE#	4	5	B	-
9	LPOLY#	4	5	B	-
13	RPOLY#	4	5	B	-
17	LENGTH	4	12	F	3
21	ANTONVI#	4	5	B	-
25	ANTONVI-ID	4	5	B	-
29	VIASCODE	6	6	C	-

Table 1. (con't)

Theme: **pnlh97**
DESCRIPTION: # RECORDS
Polygon coverage of park zone boundaries established in 1997. 4

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	8	18	F	5
9	PERIMETER	8	18	F	5
17	TEMP#	8	18	F	5
25	TEMP-ID	8	18	F	5
33	ZONA	50	50	C	-

Theme: **pnlh68**
DESCRIPTION:
RECORDS
Polygon coverage of park boundary established in 1968. 1

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LHNPL2#	4	5	B	-
13	LHNPL2-ID	4	5	B	-

Theme: **pnlh96**
DESCRIPTION:
RECORDS
Polygon coverage of park zone boundary established in 1996. 1

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PNLH9604#	4	5	B	-
13	PNLH9604-ID	4	5	B	-

Table 1. (con't)

Theme: **pnlh96bu**
DESCRIPTION:

RECORDS
1

Polygon coverage of park zone buffer from Pnlh96 coverage.

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	PNLHBUF1#	4	5	B	-
13	PNLHBUF1-ID	4	5	B	-
17	INSIDE	4	5	B	-

Theme: **rdlagos**
DESCRIPTION:

RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	LAGOSCN2#	4	5	B	-
13	LAGOSCN2-ID	4	5	B	-
17	NOMBRE	25	25	C	-

Theme: **repdom27**
DESCRIPTION:

RECORDS

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
9	REPDOM27#	4	5	B	-
5	PERIMETER	4	12	F	3
13	REPDOM27-ID	4	5	B	-

Theme : **suelos**
DESCRIPTION:

RECORDS
76

Polygon coverage of soil association map for Los Haitises NP and vicinity.

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	AREA	4	12	F	3
5	PERIMETER	4	12	F	3
9	SUELOS#	4	5	B	-
13	SUELOS-ID	4	5	B	-

GEF-PNUD/ONAPLAN

CONSERVACIÓN Y MANEJO DE LA BIODIVERSIDAD EN LA ZONA COSTERA DE LA REPÚBLICA DOMINICANA

PROYECTO BIODIVERSIDAD

OFICINA NACIONAL DE PLANIFICACIÓN
SECRETARIADO TÉCNICO DE LA PRESIDENCIA
PROGRAMA DE LAS NACIONES UNIDAS PARA EL DESARROLLO
FONDO PARA EL MEDIO AMBIENTE MUNDIAL

INFORME FINAL

Subcontrato Los Haitises

Area de Proyecto:

Parque Nacional Los Haitises

Implementa:

Universidad de Cornell (CIIFAD)

Doc 2/4 – **Anexo 3**
Description of Field and Office Methods Used to CompileThe Reconnaissance Soil Survey of the Los Haitises National Park
Diciembre 1997

Appendix C

Description of Field and Office Methods Used to Compile The Reconnaissance Soil Survey of the Los Haitises National Park

The Los Haitises karst area is a region of rugged terrain, with much of the interior nearly inaccessible. Until recently, there was very little known about the soils of this region. The only pre-existing soil map (scale of 1:250,000) lumps the entire area into one map unit (Petrell and Soto, 1966). A reconnaissance level survey with the mapping units defined in terms of soil associations is the first logical step in remedying the lack of soil information in unique areas (Kellogg, 1949). In agreement with Kellogg's procedure, the reconnaissance survey was initiated by assembling pre-existing information that related to the soil forming factors (geologic, climatic, biologic, etc.). Field work consisted of day trips and longer expeditions (penetrating the core zone as much as possible), gathering soils data in conjunction with landscape patterns that were recognizable on 1:50, 000 topographic maps. Soils were described and sampled for analyses. The map units were defined in terms of composition keyed to elements of landscapes that could be interpreted from topographic maps. Each of the 1000 meter cells in the karst region on the several topographic maps were classified as one of the 7 landscape patterns (map units) that emerged. The cells were aggregated into polygons .

To avoid square cornered delineations, soil boundaries were interpolated through the cells. While the original intent was to map only the park area, the lines were extended to include the <u>entire karst region</u> so that interpretations would extend to almost any buffer area that would arise. The map was then compiled on stable base film and digitized using Arc/Info. The final map was composed in Arc/View 3.0. Block diagrams were developed and incorporated into the master map as a way to define the landscapes more visually in terms of spatial composition. Pedon descriptions (descriptions of soil profiles) were chosen to represent the dominant soil taxon for each landscape element in the various mapping units. These taxons, given alphabetical designations on the block diagrams, are defined by a profile description, chemical analyses of the various horizons, and by taxonomic placement, this information was assembled in the taxonomic descriptions for each of the seven mapping units. Mapping Unit descriptions were then composed to define the mapping units in terms of landscape, composition and interpretations. A team of experts identified and derived interpretations that would be most helpful to the users.

Map Unit Descriptions Reconnaissance Soil Survey
Los Haitises National Park

Map Unit One

General Description (also see Figure 1, block diagram): This map unit consists of Taxons A, B, D, and E. The landscape is comprised of mogotes or karst hills separated by expansive, nearly level topographic surfaces or slightly concave basin areas. Surface drainage is provided by meandering streams (arroyos) and in places, small rivers (rios). Taxon A developed from hard limestone and occurs on the crests, backslopes and noseslopes of the mogotes. Taxon B developed from colluvium and occurs on the footslopes and occasionally on the headslopes of the mogotes. Taxon D developed from soft limestone and occurs on slight benches at mid-backslope and on the crests of some secondary ridges. Taxon E developed from marine or alluvial parent materials, and occurs on the nearly level or slightly concave intervening areas separating the mogotes.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon A: This Taxon comprises about 15 percent of the mapping unit. It ranges from 60 to 80 percent in slope (except on the narrow crests). Capability subclass VIIIe. The permeability of this soil is either moderately rapid or rapid, Lime is usually not required due to the closely underlying high carbonate parent materials. Fertilizer applications should be based on a soil test. This is a high risk soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover. Prescribed burning should be avoided at all costs on these soils due to the hazards of erosion and wildfire.

Taxon B: This Taxon comprises about 15 percent of the mapping unit. It ranges from 10 to 25 percent in slope. The capability subclass is IVe. Permeability is either moderate or moderately rapid. Lime is often not required for good crop response. Fertilizer applications should be based on a soil test. The erosion hazard should be evaluated on a site specific basis, however in most places, a vegetative cover should be maintained to conserve the soil. Prescribed burning is very hazardous due to the position in the landscape of these soils immediately below the very steep Taxon A soils.

Taxon D: This Taxon comprises about 5 percent of the mapping unit. Slopes range from 40 to 60 percent (except on the narrow crests of subordinate ridges). The capability subclass is VIIe. The permeability ranges from moderately slow to moderately rapid. Lime is rarely required due to the high carbonate content in the closely underlying bedrock. Fertilizer applications should be based on a soil test. This is a sensitive soil due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Taxon E: This Taxon comprises about 65 percent of this mapping unit. Slopes range from 0 to 10 percent. The capability subclass is IVw. Permeability is slow or moderately slow. Lime and fertilizer are usually required for best crop response, however applications of both should be based on a soil test, This soil can be managed for cultivated crops. There is a hazard of wildfire and subsequent erosion, particularly if burning is employed near mogotes.

Water Quality Hazard. The water quality hazard in this mapping unit can be minimized if fertilizer and pesticide applications are managed with restraint. Springs and other places where water is gathered for human consumption should be protected from plant litter and animal waste by barriers and periodic clean-up. Shallow diversion ditches dug up slope from the water supply can protect against contaminating surface runoff. Maximum distances should be maintained between human waste facilities and the water supply.

Water Supply. Within this mapping unit, the supply of water is mainly from streams, and widely separated springs. There are a few drilled wells. Sometimes shallow excavations that trap runoff can be dug in Taxon D, particularly in included areas where the soil depth is greater. Water for human consumption is supplied within this mapping unit.

Wildfire Hazard. The wildfire hazard, often from imperfectly managed burning, is great throughout much of this unit. It is particularly hazardous around and on the mogotes where certain topographic surfaces have a funnel affect on the fire.

Erosion Hazard. The erosion hazard is confined mostly to steeper areas on and around the mogotes.

Trail and Road Construction. Wetness can be a problem for the layout, construction and maintenance of roads on the flatter areas of Taxon E. Slope and relief creates problems for layout and construction of trails and roads within the steeper areas of this mapping unit dominated by the mogotes. Overall though, this mapping unit does not present problems that cannot be overcome with slight routing changes.

Map Unit Two

General Description (see Figure 2, block diagram): This map unit consists of Taxons A, B, and C. The landscape is comprised of mogotes or karst hills and ridges separated by dolines or sinkholes. The dolines range from less than 100 meters in length or width to several hundreds of meters in length, and 100 meters in width. Relief in places exceeds 100 meters. Precipitation is lost chiefly to infiltration in the highly permeable soils and bedrock. Runoff is captured by sinkholes that drain the bottoms of the primary dolines. These sinkholes range from 10 to 30 feet in diameter. Water that does not eventually find it's way to the aquifer is lost through evapotranspiration. Taxon A developed from hard limestone and occurs on the crests, backslopes and noseslopes of the mogotes, Taxon B developed from colluvium and occurs on the footslopes and occasionally on the headslopes of the mogotes. Taxon C developed from colluvium and occurs on toeslopes, at the bottoms of the dolines.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon A: This Taxon comprises about 40 percent of the mapping unit. It ranges from 60 to 80 percent in slope (except on the narrow crests). The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid, Lime is usually not required due to the closely underlying high carbonate parent materials. Fertilizer applications should be based on a soil test, This is a risky soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Taxon B: This Taxon comprises about 30 percent of the mapping unit. Its slope ranges from 10 to 25 percent. The capability subclass is IVe. Permeability is either moderate or moderately rapid. Lime is often not required for good crop response. Fertilizer applications should be based on a soil test. The erosion hazard should be evaluated on a site specific basis, however in most places, a vegetative cover should be maintained to conserve the soil. Burning is very hazardous due to the position in the landscape of these soils immediately below the very steep Taxon A soils.

Taxon C: This Taxon comprises about 30 percent of the mapping unit. Slopes range from 0 to 10 percent (except on the narrow crests of subordinate ridges). The capability subclass is IIe. The permeability ranges from moderately slow to moderately rapid. Lime requirements are variable and along with fertilizer applications should be based on a soil test. This soil has few limitations for most crops grown in the area. There is an erosion hazard where slopes are near the upper part of the range. Also, most of these areas, although variable, tend to be small, many of them consisting of only one or two tierras. Some dolines are entirely lacking in Taxon C, the steep sideslopes merging to form a "V" shaped bottom to the doline.

Water Quality Hazard. The hazard to groundwater in this mapping unit is severe because of the permeability of the soils and the bedrock. The dolines are usually drained by secondary sinkholes that funnel directly into the aquifer. Maximum distances should be maintained between human waste facilities and these secondary sinkholes.

Water Supply. There is little water available from springs or shallow wells in this mapping unit because of the high porosity of the soils and bedrock.

Wildfire Hazard. The wildfire hazard in this mapping unit is great because of the steepness of the topography and the small size of the dolines.

Erosion Hazard. Erosion is a severe hazard in this mapping unit because such a large proportion of these landscapes are steep.

Trail and Road Construction. The steep terrain and the close spacing of the mogotes without topographic orientation make this mapping unit particularly difficult for trail layout and construction.

Map Unit Three

General Description (see Figure 3, block diagram): This map unit consists of Taxons A, B, D, G, and J. The landscape is comprised of mogotes or karst hills separated by expansive, nearly level topographic surfaces or slightly concave basin areas. Since this map unit is mostly on the edge of the karst area, there are small areas of soil that developed over igneous rocks. Surface drainage is provided by meandering streams (arroyos) and in places, small rivers (rios). Taxon A developed from hard limestone and occurs on the crests, backslopes and noseslopes of the mogotes. Taxon B developed from colluvium and occurs on the footslope and occasionally on the headslopes of the mogotes. Taxon D developed from soft limestone and occurs on slight benches at mid-backslope and on the crests of some secondary ridges. Taxon G developed from marine or alluvial parent materials, and occurs on the nearly level or slightly concave intervening areas separating the mogotes. Taxon J developed from igneous rocks, and occurs on sloping to very steep surfaces on hills near the outer fringe of the karst area.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon A: This Taxon comprises about 10 percent of the mapping unit. It ranges from 60 to 80 percent in slope (except on the narrow crests). The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid. Lime is usually not required due to the closely underlying high carbonate parent materials. Fertilizer applications should be based on a soil test. This is a high risk soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Taxon B: This Taxon comprises about 10 percent of the mapping unit. It ranges from 10 to 25 percent in slope. The capability subclass is IVe. Permeability is either moderate or moderately rapid. Lime is often not required for good crop response. Fertilizer applications should be based on a soil test, Erosion hazards vary widely across this landscape and should be evaluated on a site specific basis, however in most places, a vegetative cover should be maintained to conserve the soil. Burning is very hazardous due to the position in the landscape of these soils immediately below the very steep Taxon A soils.

Taxon D: This Taxon comprises about 5 percent of the mapping unit. Slopes range from 40 to 60 percent (except on the narrow crests of subordinate ridges). The capability subclass is VIIe. Permeability ranges from slow to moderately rapid. Lime is rarely required due to the high carbonate content in the closely underlying bedrock. Fertilizer applications should be based on a soil test. This is a high risk soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Taxon G: This Taxon comprises about 70 percent of this mapping unit. Slopes range from 0 to 5 percent. The capability subclass is IIIw. Permeability is slow or moderately slow. Lime and fertilizer are usually required for best crop response, however applications of both should be based on a soil test. This soil can be managed for cultivated crops. There is a hazard of wildfire and subsequent erosion, particularly if burning is employed near the steep sided mogotes.

Taxon J: This Taxon comprises about 5 percent of the mapping unit. It ranges from 40 to 80 percent in slope. The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid, Applications of lime are often needed for best crop production. Fertilizer and lime applications should be based on a soil test, There is a very severe erosion hazard with this soil because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided at all costs on these soils due to the hazards of erosion and wildfire.

Water Quality Hazard. The water quality hazard in this mapping unit can be minimized if fertilizer and pesticide applications are managed with restraint. Springs and other places where water is gathered for human consumption need to be protected from plant and animal litter by barriers and periodic clean-up. Shallow diversion ditches dug upslope from the water supply can protect against contaminating runoff. Minimum distances should be maintained between human septic facilities and the water supply.

Water Supply. Within this mapping unit, the supply of water is mainly from streams, and widely separated springs. There are a few drilled wells. Sometimes shallow excavations that trap runoff can be dug in Taxon D, particularly in included areas where the soil depth is greater.

Wildfire Hazard. The wildfire hazard, often from imperfectly managed prescribed burning, is great throughout much of this unit. It is particularly hazardous around and on the mogotes where certain topographic surfaces have a funnel affect on the fire.

Erosion Hazard. The erosion hazard is confined mostly to steeper areas on and around the mogotes and the other hills cored with igneous rocks.

Trail and Road Construction, and Layout. Wetness can be a problem for the layout, construction and maintenance of roads on the flatter areas of Taxon E. Slope and relief creates problems for layout and construction of trails and roads within the steeper areas of this mapping unit. Overall though, this mapping unit does not present problems that cannot be overcome with slight routing changes.

Map Unit Four

General Description (see Figure 4, block diagram): This map unit consists of Taxons A, B, C and D. The landscape is comprised of more or less elliptical or ridge-like mogotes or karst hills separated by successions of dolines that are often separated by secondary ridges. The topography is oriented generally NW-SE. The dolines range from 50 to 100 meters in width and tend to be elliptical. The ridges are often several thousands of meters in length. Relief in places exceeds 100 meters. Precipitation is lost chiefly to infiltration in the highly permeable soils and bedrock. Runoff is captured by sinkholes that drain the bottoms of the primary dolines. These sinkholes range from 10 to 30 feet in diameter. Water that does not eventually find it's way to the aquifer is lost through evapotranspiration. Taxon A developed from hard limestone and occurs on the crests, backslopes and noseslopes of the mogotes. Taxon B developed from colluvium and occurs on the footslope and occasionally on the headslopes of the mogotes. Taxon C developed from colluvium and occurs on the toeslopes of the mogotes, at the bottom of the dolines. Taxon D developed from soft limestone and occurs on slight benches at mid-backslope and on the crests of some secondary ridges.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon A: This Taxon comprises about 35 percent of the mapping unit. It ranges from 60 to 80 percent in slope (except on the narrow crests). The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid. Lime is usually not required due to the closely underlying high carbonate parent materials. Fertilizer applications should be based on a soil test. This is a high risk soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided at all costs on these soils due to the hazards of erosion and wildfire.

Taxon B: This Taxon comprises about 25 percent of the mapping unit. It ranges from 10 to 25 percent in slope. The capability subclass is IVe. Permeability is either moderate or moderately rapid. Lime is often not required for good crop response. Fertilizer applications should be based on a soil test. The erosion hazard should be evaluated on a site specific basis, however in most places, a vegetative cover or mulch should be maintained to conserve the soil. Burning is very hazardous due to the position in the landscape of these soils immediately below the very steep Taxon A soils.

Taxon C: This Taxon comprises about 30 percent of the mapping unit. Slopes range from 0 to 10 percent (except on the narrow crests of subordinate ridges). The capability subclass is IIe. The permeability ranges from moderately slow to moderately rapid. Lime requirements are variable and along with fertilizer applications should be based on a soil test. This soil has few limitations for most crops grown in the area. There is an erosion hazard where slopes are 8-10 percent. Also, most of these areas, although variable, tend to be small, many of them only one or two tierras. Some dolines are entirely lacking in Taxon C, the steep side slopes merging to form a "V" shaped bottom of the doline.

Taxon D: This Taxon comprises about 10 percent of the mapping unit. Slopes range from 40 to 60 percent (except on the narrow crests of subordinate ridges). The capability subclass is VIIe. The permeability ranges from slow to moderately rapid. Lime is rarely required due to the high carbonate content in the closely underlying parent materials. Fertilizer applications should be based on a soil test. This is a risky soil for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion due to slope. The soil should be protected by tree cover or permanent herbaceous cover crop or mulch. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Water Quality Hazard. The hazard to groundwater contamination in this mapping unit is severe because of the permeability of the soils and the bedrock. The dolines are usually drained by secondary sinkholes that funnel directly into the aquifer. Springs and other places where water is gathered for human consumption need to be protected from plant and animal litter by barriers and periodic clean-up. Shallow diversion ditches dug upslope from the water supply can protect against contaminating runoff. Minimum distances should be maintained between human waste facilities and the water supply.

Water Supply. There is little water available from springs or shallow wells in most parts of this mapping unit because of the porosity of the soils and bedrock. Sometimes shallow excavations that trap runoff can be dug in Taxon D, particularly in included areas where the soil depth is greater.

Wildfire Hazard. The wildfire hazard in this mapping unit is great because of the steepness of the topography and the small size of many of the dolines.

Erosion Hazard. Erosion is a severe hazard in this mapping unit because such a large proportion of these landscapes are steep.

Trail and Road Construction. The orientation of the topography facilitates layout of trail and road systems that are going N-S. The gritty or mealy surface of the soft limestone seems to provide good footing for trail systems. The steep terrain and the narrow spacing of many of the mogotes make much of this mapping unit particularly difficult for road construction.

Map Unit Five

General Description (see Figure 5, block diagram): This map unit consists of Taxons A, B, D, and F. The landscape is comprised of linear mogotes or karst ridges separated by valleys. The topography is usually oriented NW-SE. Surface drainage is provided in a few places by meandering streams (arroyos). Taxon A developed from hard limestone and occurs on the crests, backslopes and noseslopes of the mogotes. Taxon B developed from colluvium and occurs on the footslope and occasionally on the headslopes of the mogotes. Taxon D developed from soft limestone and occurs on slight benches at mid-backslope and on the crests of some secondary ridges. Taxon F developed from marine or alluvial parent materials, and occurs on the nearly level valley bottoms.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon A: This Taxon comprises about 30 percent of the mapping unit. It ranges from 60 to 80 percent in slope (except on the narrow crests). The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid. Lime is usually not required due to the closely underlying high carbonate parent materials. Fertilizer applications should be based on a soil test. This is a risky soil due to its shallow depth, and the vulnerability of this thin layer to erosion due to slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided at all costs on these soils due to the hazards of erosion and wildfire.

Taxon B: This Taxon comprises about 10 percent of the mapping unit. It ranges from 10 to 25 percent in slope. The capability subclass is IVe. Permeability is either moderate or moderately rapid. Lime is often not required for good crop response. Fertilizer applications should be based on a soil test. The erosion hazard should be evaluated on a site specific basis, however in most places, a vegetative cover should be maintained to conserve the soil. Burning is very hazardous due to the position in the landscape of these soils immediately below the very steep Taxon A soils.

Taxon D: This Taxon comprises about 10 percent of the mapping unit. Slopes range from 40 to 60 percent (except on the narrow crests of subordinate ridges). The capability subclass is VIIe. The permeability ranges from slow to moderately rapid. Lime is rarely required due to the high carbonate content in the closely underlying parent materials. Fertilizer applications should be based on a soil test. This soil presents a risk for agriculture due to its shallow depth, and the vulnerability of this thin layer to erosion because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils due to the hazards of erosion and wildfire.

Taxon F: This Taxon comprises about 75 percent of this mapping unit. Slopes range from 0 to 5 percent. The capability subclass is IVw. Permeability is slow or moderately slow. Lime and fertilizer are usually required for best crop response, however applications of both should be based on a soil test, This soil can be managed for cultivated crops. There is a hazard of wildfire and subsequent erosion, particularly if prescribed burning is employed near the valley sides.

Water Quality Hazard. The water quality hazard in this mapping unit can be minimized if fertilizer and pesticide applications are managed with restraint. Springs and other places where water is gathered for human consumption need to be protected from plant and animal litter by barriers and periodic clean-up. Shallow diversion ditches dug upslope from the water supply can protect against contaminating runoff. Maximum distances should be maintained between human septic facilities and the water supply.

Water Supply. Within this mapping unit, the supply of water is mainly from streams, widely separated springs, and shallow dug wells. Sometimes shallow excavations that trap runoff can be dug in Taxon D, particularly in included areas where the soil depth is greater.

Wildfire Hazard. The wildfire hazard is great throughout much of this unit. It is particularly hazardous in smaller valleys or near steeper topography.

Erosion Hazard. The erosion hazard is confined mostly to the steep valley walls.

Trail and Road Construction, and Layout. Wetness can be a problem for the layout, construction and maintenance of roads on the flatter areas of Taxon F. Slope and relief creates problems for layout and construction of trails and roads within the steeper areas of this mapping unit. Layout of N-S roads and trails is made easier by the orientation of the terrain.

Map Unit Six

General Description (see Figure 6, block diagram): This map unit consists of Taxons G, H and I. The landscape consists of the Rio Payabo Valley. Comprising the landscape are several distinctive landforms. Central to the valley is the Rio Payabo, bracketed by natural levees. Paralleling the berm-like natural levees are the planar surfaces of alluvial terraces. Finally, linear depressions separate the terraces from the surrounding karst landscape of mogote and doline. Surface drainage is provided by the river and a few meandering flood channels. Taxon H developed in organic matter that accumulated in slackwater depressional areas. It occurs in the linear depressions at the toeslopes of the valley sides. Taxon G developed in fine alluvial sediments deposited by the Rio Payabo, and occurs on the nearly level plane between the natural levees of the river and the linear depressions. Taxon I developed in coarse alluvial sediments that were deposited first as the Rio Payabo's flood waters, no longer contained by its banks, spread out and immediately began to lose energy due to decrease in velocity (energy necessary to float and move coarse sediments). It occurs on the embankments or natural levees along the banks of the river.

Percentage composition, slope, capability class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon G: This Taxon comprises about 65 percent of this mapping unit. Slopes range from 0 to 5 percent. The capability subclass is IIIw. Permeability is slow or moderately slow. Lime and fertilizer are usually required for best crop response, however applications of both should be based on a soil test. This soil can be managed for cultivated crops

Taxon H: This Taxon comprises about 25 percent of the mapping unit. Slopes range from 0 to 2 percent. The capability subclass is Vw. Wetness makes this soil impractical for cultivated crops for much of the year.

Taxon I: This Taxon comprises about 10 percent of this mapping unit. Slopes range from 5 to 10 percent. The capability subclass is IIs. Permeability is moderate to moderately rapid. Lime and fertilizer are usually required for best crop response, however applications of both should be based on a soil test. This soil has wide suitability for a variety of crops adapted to the area. The main constraint is the width of the landform, and flood channels that bisect it. Lack of water holding capacity may be a problem during periods times

Water Quality Hazard. The water quality hazard in this mapping unit can be minimized if fertilizer and pesticide applications are managed with restraint and septic facilities are located a satisfactory distance away from wells, springs, and other places where water is collected for human consumption.

Water Supply. Within this mapping unit, the supply of water mainly is from the Rio Payabo, streams, and widely separated springs.

Wildfire Hazard. Wildfire is a hazard from imperfectly managed prescribed burning.

Erosion Hazard. Stream bank erosion is a hazard along the course of the Rio Payabo and the banks of flood channels. If the banks and suitable margin areas are maintained in vegetation the erosion hazard is reduced.

Trail and Road Construction, and Layout. Wetness can be a problem for the layout, construction and maintenance of roads on the flatter areas of Taxons G and H. Overall though, this mapping unit does not present problems that cannot be overcome with slight routing changes.

Map Unit Seven

General Description: This map unit consists of Taxon J and Taxon K. The landscape is comprised of hilly terrain that overlooks the surrounding areas of karst mogote and doline landforms. Surface drainage is provided largely by intermittent and ephemeral streams that dissect the area. Taxon J formed in residual parent materials overlying igneous bedrock and occurs on the crests, backslopes and noseslopes of the hills and ridges. Taxon K developed from colluvium and occurs on the footslope of the hills and ridges.

Percentage composition, Slope, Capability Class, permeability and lime and fertilizer requirements of the map unit components, and conservation management.

Taxon J: This Taxon comprises about 50 percent of the mapping unit. It ranges from 40 to 80 percent in slope. The capability subclass is VIIIe. The permeability of this soil is either moderately rapid or rapid, Applications of lime are often needed for best crop production. Fertilizer and lime applications should be based on a soil test. There is a very severe erosion hazard with this soil because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Burning should be avoided on these soils because of the hazards of erosion and wildfire.

Taxon K: This Taxon comprises about 50 percent of the mapping unit. It ranges from 10 to 40 percent in slope. The capability subclass is VIe. Permeability is either moderately rapid or rapid. Applications of lime are often needed for best crop production. Fertilizer and lime applications should be based on a soil test. There is a severe erosion hazard with this soil because of slope. The soil should be protected by tree cover or permanent herbaceous cover crops. Agroforestry is another management practice that can conserve soil. Burning should be avoided at all costs on these soils due to the hazards of erosion and wildfire.

Water Quality Hazard. The water quality hazard in this mapping unit can be minimized if fertilizer and pesticide applications are managed with restraint. Springs and other places where water is gathered for human consumption need to be protected from plant and animal litter by barriers and periodic clean-up. Shallow diversion ditches dug up-slope from the water supply can protect against contaminating runoff. Maximum distances should be maintained between human waste facilities and the water supply.

Water Supply. Within this mapping unit, the supply of water is mainly from streams, springs, and shallow wells.

Wildfire Hazard. The wildfire hazard, often from imperfectly managed burning, is great throughout much of this unit because of the steep slopes.

Erosion Hazard. The erosion hazard is great throughout this mapping unit. Management systems that incorporate conservation practices are necessary for sustained production. In many areas of this map unit agroforestry systems such as coffee cultivation are important for both conservation and income.

Trail and Road Construction, and Layout. Trail and road construction is difficult in most places because of the steepness of the terrain and the hard, unrippable bedrock.

Following are descriptions of soil capability within each map unit. The classes are ranked according to limiting criteria, such as depth, texture, drainage, mechanical limitations, erosion hazard, flooding, slope, and rainfall. The Roman numbers show the class and what limits the soil have and the lower case letter next to it show what causes the limitation. The larger the number, the more limiting the land use. For example, in map 3 (Antón Sánchez quadrant) we find that in Map Unit 2 component C is capability class IIe (soils with some limitations due to erosion), component B is capability class IVe (requires very careful human management due to erosion) and component A is capability class VIIIe (severe limitations due to erosion) .

SOIL CAPABILITY

Soil capability is one of a number of interpretative groupings made primarily for agricultural purposes. It shows in a general way how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soil. This affords eight classes of land and four subclasses; these classes and subclasses have been sorted according to the degree of limitation or potential damage. The risks become greater as the number increases from Class I to VIII. These classes are summarized as follows:

Class I - Soils in this class have few limitations that restrict their use.

Class II - Soils in this class have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III - Soils in this class have severe limitations that reduce the choice of plants or require especial conservation practices or both.

Class IV - Soils in this class have severe limitations that restrict the choice of plants or require very careful human management or both.

Class V - Soils in this class are not likely to erode but have other limitations which are impractical to eliminate and restrict their use largely to pasture, range, woodland, or wildlife cover. Examples would be soils too wet for cultivation or subject to flooding.

Class VI - Soils in this class have severe limitations that make them unsuitable to cultivation and limit their use to pasture, range, woodland, or wildlife cover.

Class VII - Soils in this class have severe limitations that make them unsuitable to cultivation and limit their use to pasture woodland, or wildlife.

Class VIII - Soils in this class have severe limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply or for esthetic purposes.

The capability subclasses are groups of classes that have the same types limitations for agricultural use as a result of soil and climate. The following four related subclasses:

e = erosion caused by either water or wind hazard.
w= wetness, drainage, or flooding hazard
s = soil limitation affecting plant growth mainly due to shallow, droughty or stony
c= climatic limitations

SUMMARY OF THE SEVEN SOIL MAP UNITS

Map Unit 1

Taxon	Component %	Slope %	Soil Capability
A	15	60-80	VIIIe
B	15	10-25	IVe
D	5	40-60	VIIe
E	65	0-10	IVw

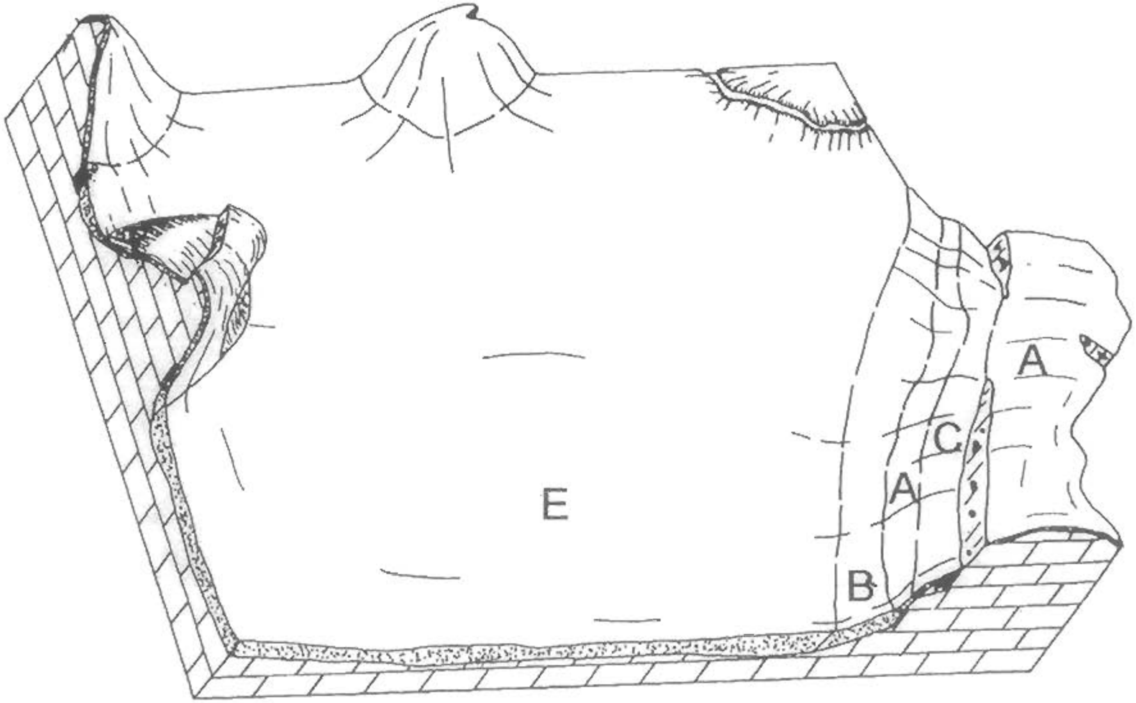
Map Unit 2

Taxon	Component %	Slope %	Soil Capability
A	40	60-80	VIIIe
B	30	10-25	IVe
C	30	0-10	IIe

Map Unit 3

Taxon	Component %	Slope %	Soil Capability
A	10	60-80	VIIIe
B	10	10-25	IVe
D	5	40-60	VIIe
G	70	0-5	IIIw
J	5	40-80	VIIIe

Figure 1



Soils, Soft Sediments

Igneous

Hard Limestone

Soft Limestone

Taxon A* well drained, shallow, fine loamy, kaolinitic , isohyperthermic Lithic Troporthents

Taxon B* well drained, deep or moderately deep, fine loamy, kaolinitic, isohyperthermic Typic Paleudults

Taxon C* well drained, deep and very deep, fine loamy, kaolinitic, isohyperthermic Typic Paleudults

Taxon D* well drained, shallow, fine loamy, kaolinitic, isohyperthermic , Lithic Dystropepts

Taxon E* poorly drained, very deep, fine, kaolinitic, isohyperthermic, Typic Plinthudults

Taxon F* poorly drained,very deep, fine, kaolinitic, isohyperthermic, Plinthic Paleudults

Taxon G* somewhat and poorly drained, very deep, fine, kaolinitic, isohyperthermic, Plinthic Paleudults

Taxon H* very poorly drained, very deep, isohyperthermic, Typic Tropohemists

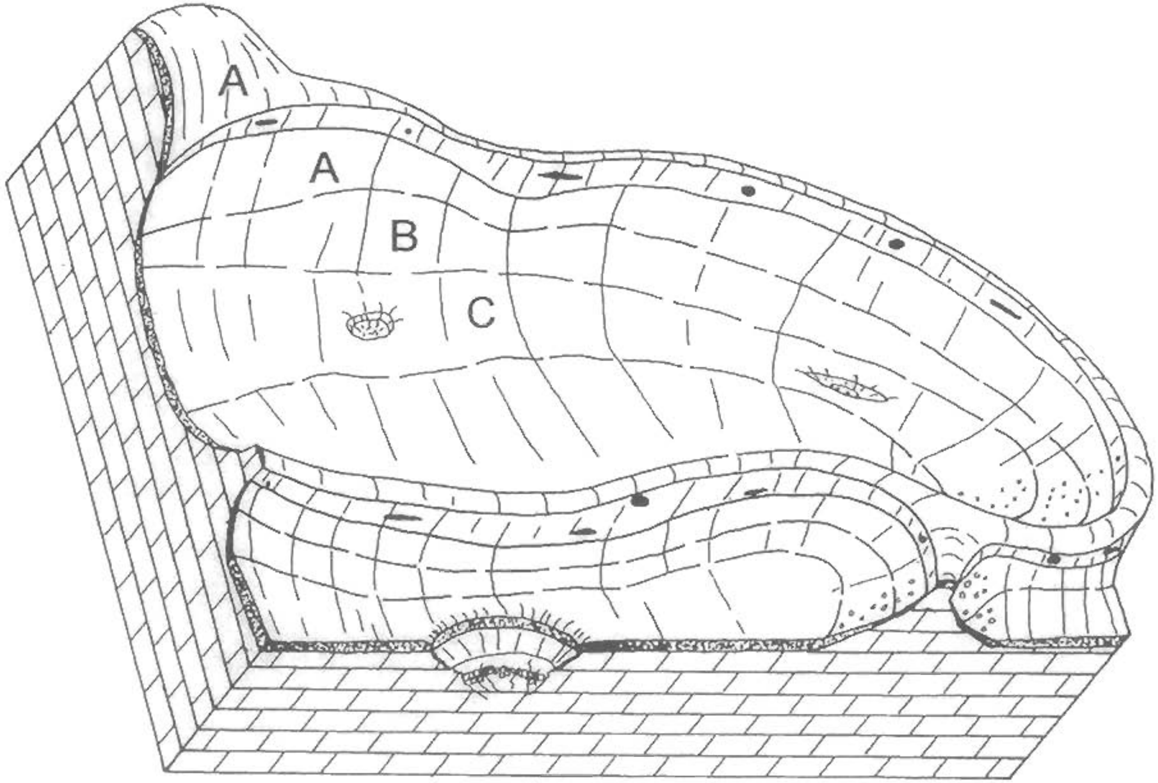
Taxon I* well drained, very deep, sandy skeletal, mixed, isohyperthermic, Typic Tropofluvents

* provisional classifications pending laboratory data

Soil Unit 1

Reconnaissance Soil Survey of the Los Haitises Karst Region Dominican Republic, 1997

Figure 2



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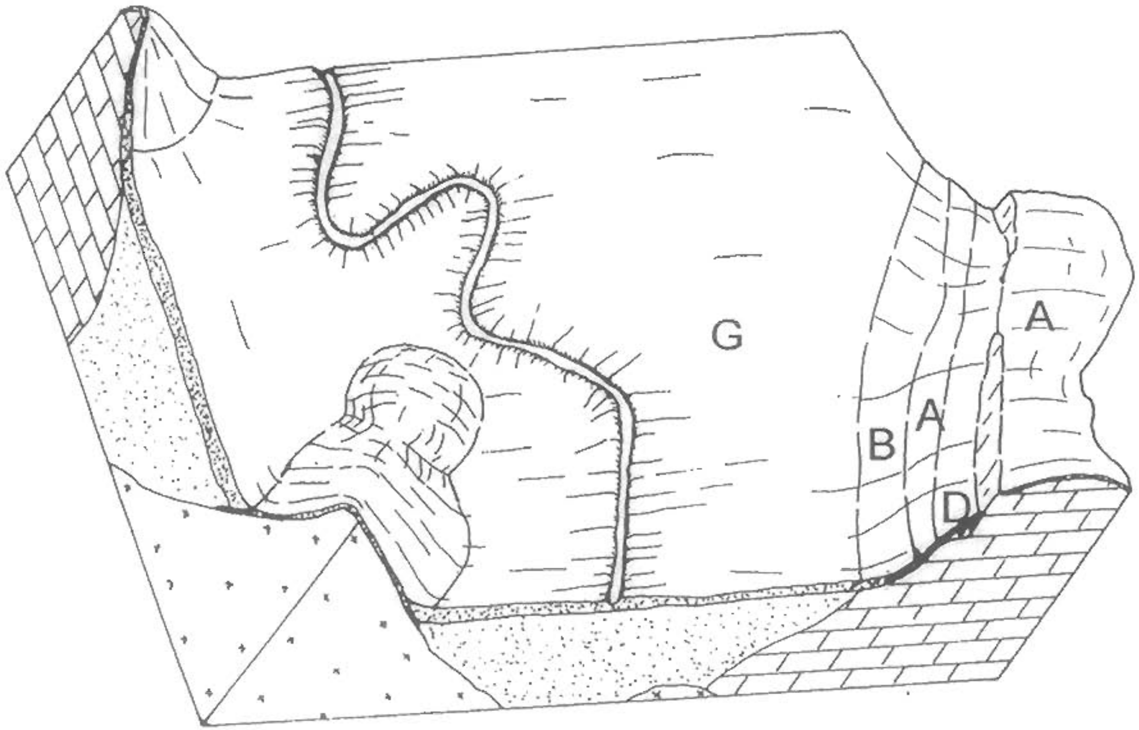
Soil Unit 2

Reconnaissance Soil Survey of the Los Haitises Karst Region Dominican Republic, 1997

Figure 3



Soils, Soft Sediments

Igneous

Hard Limestone

Soft Limestone

Taxon A* well drained, shallow, fine loamy, kaolinitic , isohyperthermic Lithic Troporthents

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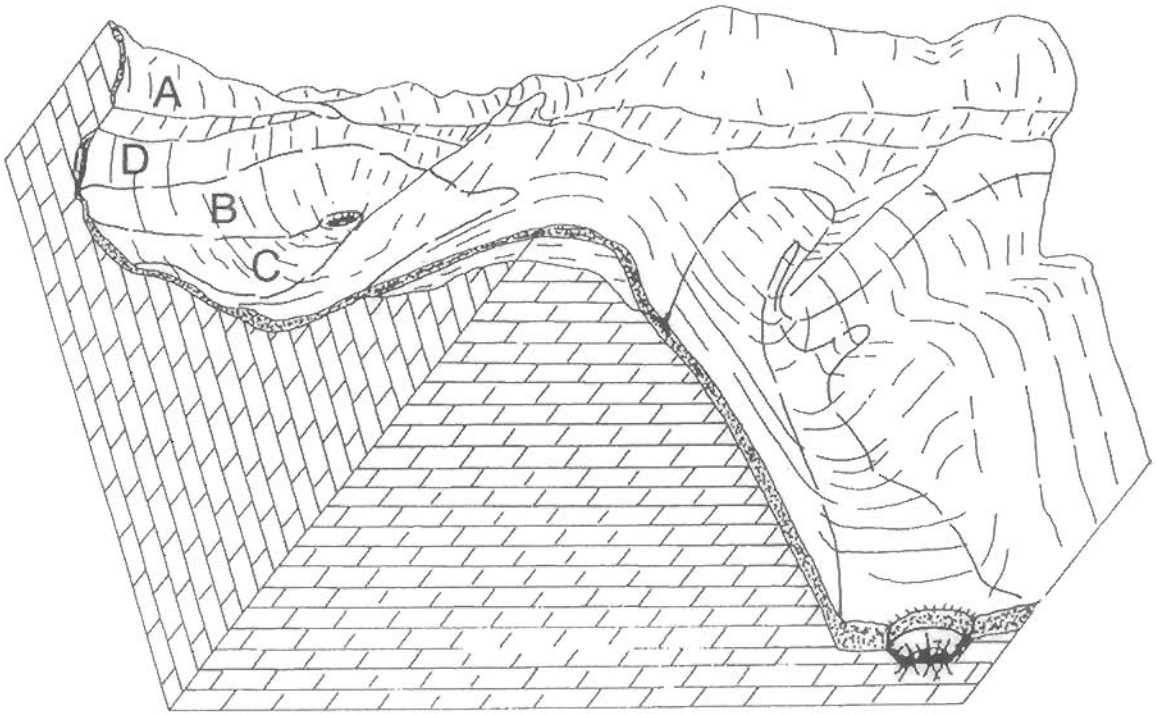
* provisional classifications pending laboratory data

Soil Unit 3

Reconnaissance Soil Survey of the Los Haitises Karst Region Dominican Republic, 1997

Figure 4



Soils, Soft Sediments

Igneous

Hard Limestone

Soft Limestone

Taxon A* well drained, shallow, fine loamy, kaolinitic , isohyperthermic !

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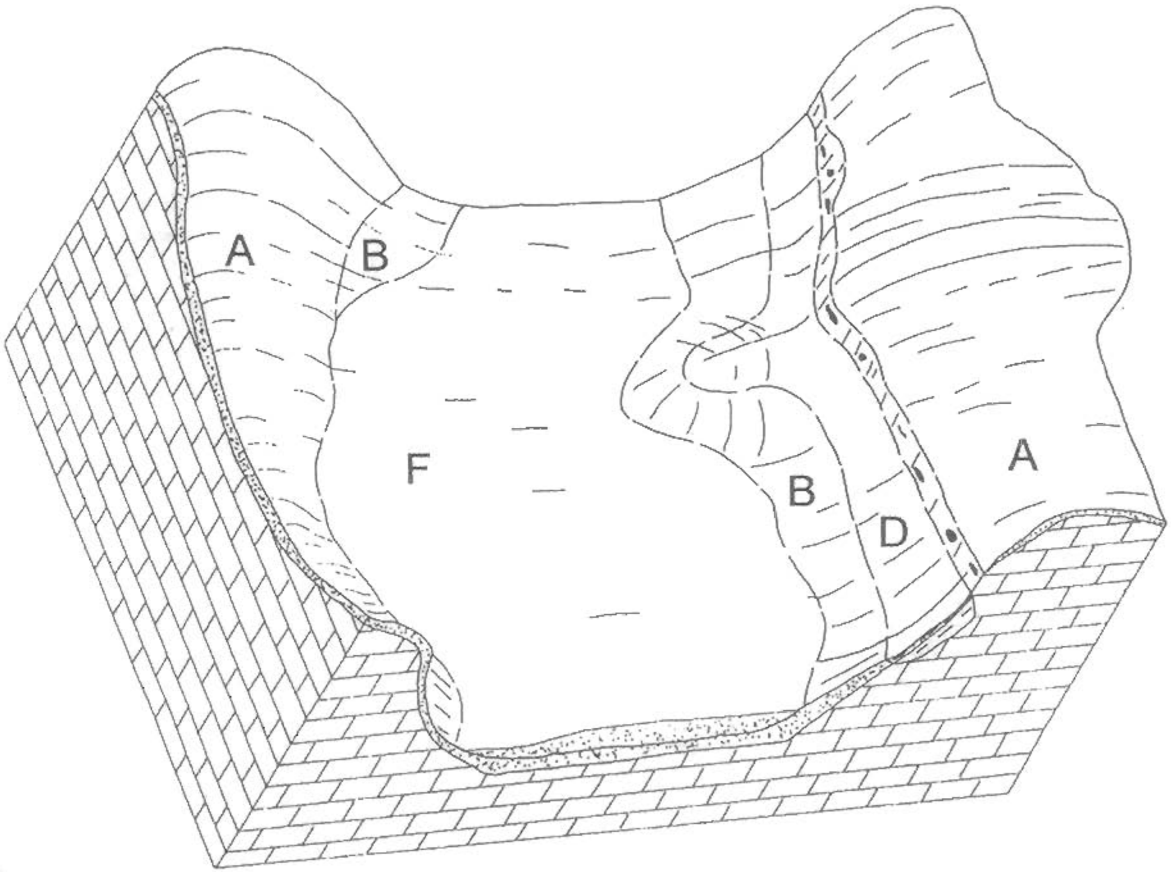
* provisional classifications pending laboratory data

Soil Unit 4

Reconnaissance Soil Survey of the Los Haitises Karst Region
Dominican Republic, 1997

Figure 5



Soils, Soft Sediments

Igneous

Hard Limestone

Soft Limestone

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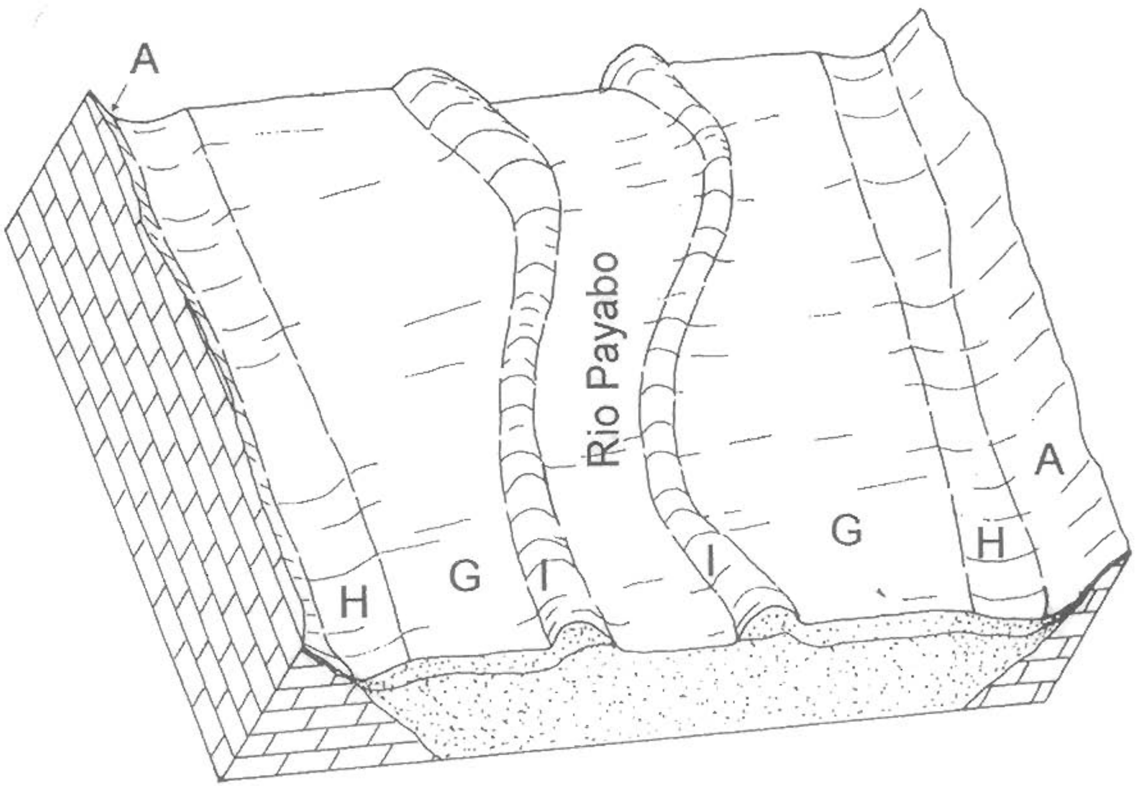
* provisional classifications pending laboratory data

Soil Unit 5

Reconnaissance Soil Survey of the Los Haitises Karst Region
Dominican Republic, 1997



- Soils, Soft Sediments
- Igneous
- Hard Limestone
- Soft Limestone

Taxon A* well drained, shallow, fine loamy, kaolinitic , isohyperthermic Lithic Troporthents

Taxon B* well drained, deep or moderately deep, fine loamy, kaolinitic, isohyperthermic Typic Paleudults

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* provisional classifications pending laboratory data

Soil Unit 6

Reconnaissance Soil Survey of the Los Haitises Karst Region Dominican Republic, 1997

GEF-PNUD/ONAPLAN

Conservación y Manejo de la Biodiversidad en la Zona Costera de la República Dominicana

PROYECTO BIODIVERSIDAD

Oficina Nacional de Planificación
Secretariado Técnico de la Presidencia
Programa de las Naciones Unidas para el Desarrollo
Fondo para el Medio Ambiente Mundial

INFORME FINAL

Subcontrato Los Haitises

Area de Proyecto:

Parque Nacional Los Haitises

Implementa:

Universidad de Cornell (CIIFAD)

Doc 2/4 – **Anexo 4**
Research Implications for Management Planning in The Los Haitises National Park
Diciembre 1997

Appendix D

RESEARCH IMPLICATIONS FOR MANAGEMENT PLANNING IN THE LOS HAITISES NATIONAL PARK

Charles Geisler, Lourdes Brache and Louise Silberling
Cornell University

Outline

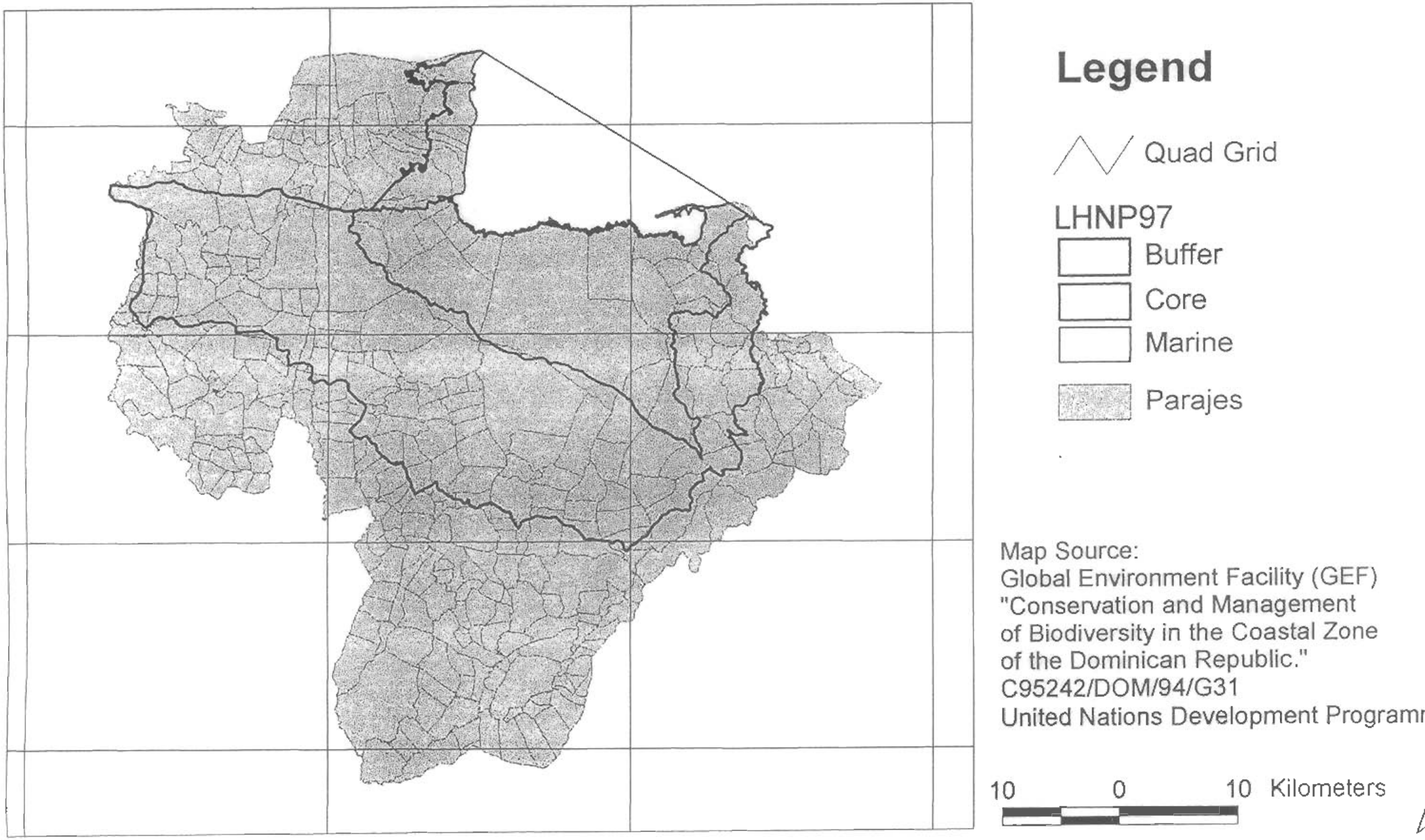
I. Introduction:

I-a: The Task Ahead: Managing PNLH

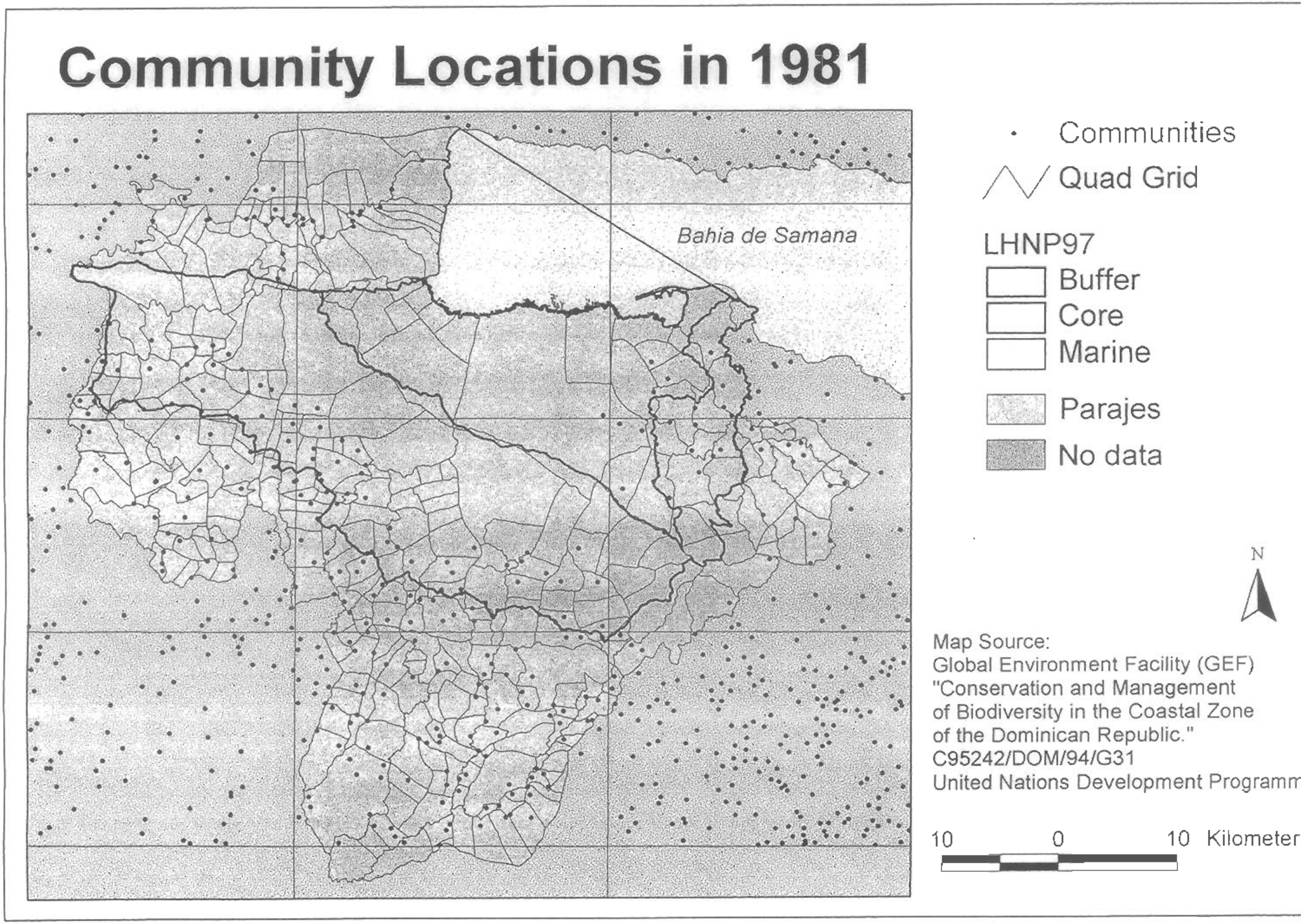
In the early 1970s, the Food and Agricultural Organization (FAO) of the UN made a concerted effort to assist in the development of regional planning documents for national parks in Latin America. By 1976, over 55 plans and planning documents had been prepared for parks in this part of the world and several highly useful documents had resulted (in Spanish and English) from the so-called FAO Regional Project (Miller, 1982). One of these was a guide for the preparation of management plans (Moseley, Thelen and Miller, 1974) and another was a guide to applying multiple use concepts within national parks (Deshler, 1973).

In this same period, Los Haitises National Park (PNLH) was created on the north central coast of the Dominican Republic through Law 67 (1976). It is today one of the country's largest protected areas,[1] having grown considerably and shifted its boundaries repeatedly over the past 22 years ago (Map 1). Much has been learned about the biophysical and social characteristics of the karstic plateau where it is located, yet it lacks a clear-cut management plan and multiple use strategy. With the park's expansion and inclusion of several dozen rural communities (Map 2) has come a compelling need for wise

Los Haitises National Park, 1997



Map 2


Community Locations in 1981
Bahia de Samana
Communities
Quad Grid
LHNP97
Buffer
Core
Marine
Parajes
No data
N
Map Source:
Global Environment Facility (GEF)
"Conservation and Management
of Biodiversity in the Coastal Zone
of the Dominican Republic."
C95242/DOM/94/G31
United Nations Development Programm
10 0 10 Kilometer

management, without which PNLH will remain a paper park and an uncertain experiment in integrated conservation.

In recent years, LHNP has been in the headlines more because of conflict than because of cooperation. This is somewhat hard to explain in light of the excellent Plan de Uso y Gestión completed by the Spanish Agency for International Cooperation (AECI) in 1991. In retrospect, the Spaniards called for a management approach to the Los Haitises region which was enlightened and based on their exhaustive research using information available roughly a decade ago. We view our contribution as a sequel to the work of AECI and a complement to it. In general terms, we endorse their integrated approach to humans and their environment, their use of zones, and their emphasis on research as a basis for decision making. At the same time, given the opportunity we have had to do additional research and to use geographic information system (GIS) mapping resources, we suggest modifications they themselves might have made with an additional decade of data and field observations.

The following document is not a "management plan," but a series of suggestions and research implications from investigations made by Cornell and its companion institutions in the Dominican Republic, particularly the Universidad Nacional Pedro Henriquez Ureña (UNPHU). We hope that our findings, combined with those of the Spaniards who preceded us, will assist the appropriate agencies within the Dominican Government in planning and managing PHLH. To be successful, we believe, these efforts must balance numerous legitimate interests, subscribe to a strategy which is both adaptive and participatory, and learn from the successes and failures of other park management experiences in Latin America.

I-b. Management Suggestions Summarized

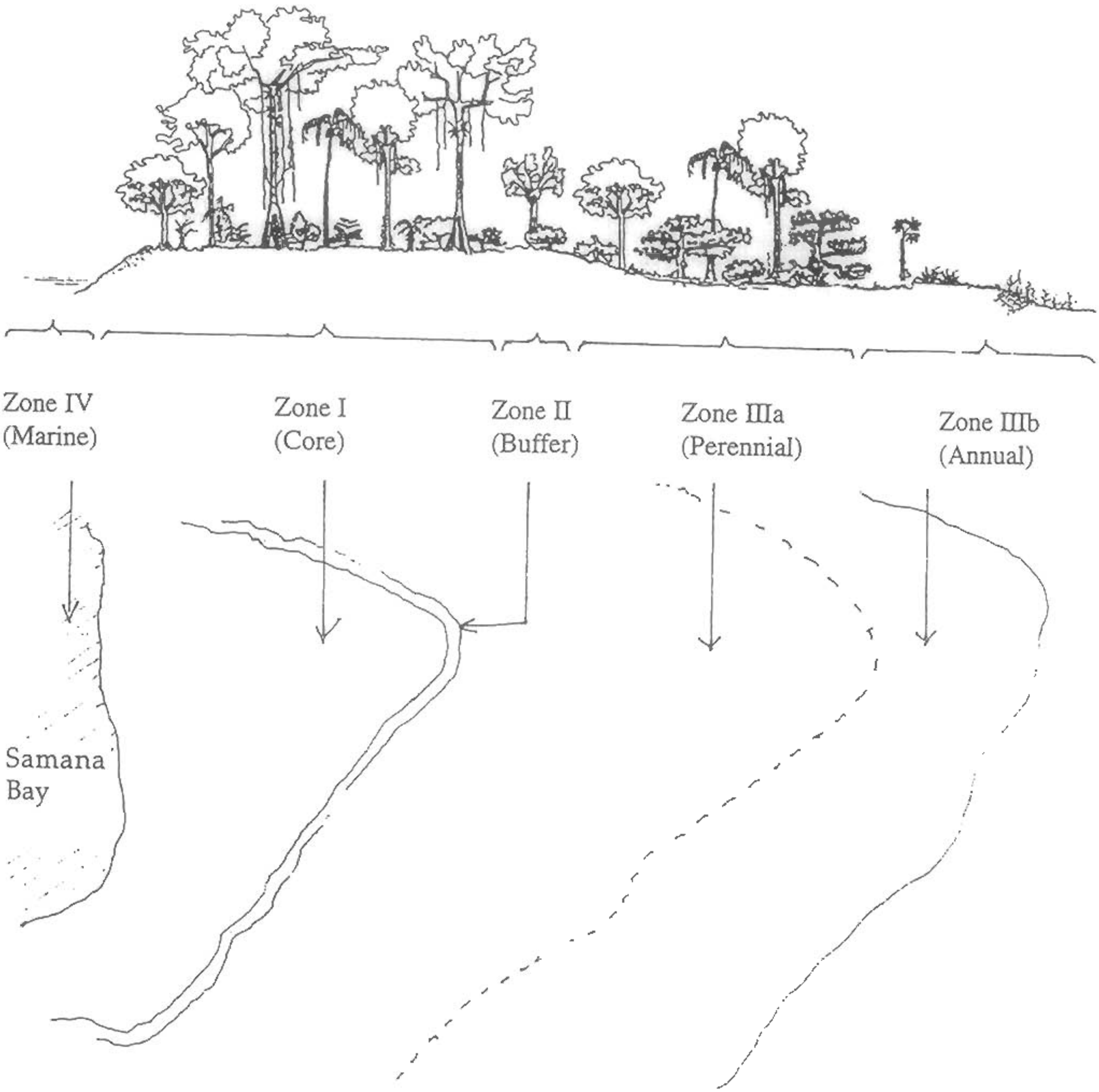
Below, we treat each of these topics in turn, noting where our collaborative research is relevant, for use by national planning bodies, by government agencies with explicit administrative responsibilities in the Los Haitises region, by local communities and citizens groups, and by nongovernmental and church-based organizations. Preceding this are suggestions, both general and specific, intended to complement and in some instances alter management recommendations offered by the Spaniards. Our working assumption throughout these suggestions is that Decree 319 will become law with minor modifications.

General Suggestions

1. Combine Samana Bay, the mangroves, and PNLH into one ecological management unit. All three are important components of the national patrimony and interdependent with the coastal eco-region of the Caribbean.
2. Through this broader environmental framework, amplify the Park's administrative framework to include both government and non-governmental stakeholders, local and regional, as well as rich and poor from the region, and put in place a democratic structure to give voice to all interests.
3. Pursue just compensation for those families being removed from PNLH and even-handed resettlement policy for those allowed to establish permanent homes in the co-management areas of Zone III (see below).

4. Adopt the following four management zones in the LHNP (see Figure 1):

Figure 1: Illustrative Cross Section of Park Zone



Zone I: The core zone, which measures 303 km2 according to Decree 319 (which should include another 56 km2 to fully protect mangroves on the west end of Samana Bay).

Zone II: The buffer zone, which divides Zone I and III and includes a living fence (e.g. *Gliricidia sepium or Senna reticulata*) marked with signs indicating closeness to borders and rules which apply in each zone.

Zone III: The zone of cooperation and extraction, measuring 857 km2, with restricted farming where there is high biodiversity or steep slopes, fragile soils or contamination risks to aquifers and surface waters from farming or grazing.

III-a: The co-management zone closest to Zone II where fruit trees, perennials and agroforestry are permitted.

III-b: The co-management zone most distant from Zone I which permits all uses in III-a as well as annuals and nonintensive, small-operator agrosilvo-pastoriLism. The border exterior to III-b requires either a live fence or posts/signs showing the park's outer limit.

Zone IV: The marine zone, measuring 215 km2. (Research is needed to assess the current boundary between Sanchez and Sabana de la Mar. A more modest boundary which follows the coast between these communities at a distance of approximately 1 or 2 kilometers adequately may buffer the park from the north.)

5. Define and rigorously monitor multiple use within PNLH and adjust its meaning as new investigations, in which farmers themselves should be involved, provide evidence that economic activities are environmentally sustainable.

6. Practice adaptive co-management in PNLH, that is, management which is periodically reviewed and revised based on monitoring of progress towards park goals and policies.

7. Treat the aquifer under the karstic plateau of PNLH as a major societal resource and attribute of the park. As such, seek INDHRI's immediate assistance in mapping and interpreting it; use extraordinary means to protect it if Zone III is opened to settlement and use; and conscienticize area residents about the permeability of its limestone cover and its immediate susceptibility to human pollution.

8. For those on the census performed by the Dirección Nacional de Parques (DNP), continue to use land resettlement outside PNLH to relieve human pressure on the protected area and assure that those who are resettled benefit from services, technical assistance and title security in order to avoid their return to former park holdings (see our GEF Report of December, 1996).

9. Foster on-going cross-visits by park managers, Zone III leaders and residents to other parks and protected areas in the D.R. and elsewhere, where integrated conservation and sustainable development are practiced and where local participation and co-management are successful.

10. Establish an accountability system for Zone III which encourages and rewards compliance with landuse guidelines and rules. This system should entail certification courses for sustainable farming and forestry, permits or *cedulas* enabling residency and use, and courses covering skill areas farmers request to increase their command of sustainable farming.

Specific Suggestions

1. Boundaries

The area included in PNLH has varied greatly, from 208 Km2 in 1976 to 1617 Km2 in 1995. In Decree 319, it is 1375 km2. (Map 1). This variation has contributed to confusion and credibility problems that surround PNLH. Yet the present decree has several merits:

a. It roughly conforms to the karstic plateau east of the River Payabo, making demarcation clear in a gross sense of what is "protected," and therein maximizing the likelihood that the aquifer under the plateau will be conserved.
b. It increases Zone I from 208 km2 to 303 km2 (a net gain of roughly 100 km2) and shifts the location of the core to the coast and to karst lands south of the coast where the forest cover is least altered. The core zone should be protected from all commercial extraction.
c. It contains 215 km2 of Samana Bay (see suggestion for further study in description of Zone IV, above) and mangrove forests on the south side of the Bay, an important source of some species of crabs, shrimp and fish.

We suggest the following modifications:

a. The mangroves at west end of Samana Bay, between Sanchez to the north and the karstic plateau to the south, be included in the core area of PNLH to which it is contiguous.
b. That the karstic region west of the Rio Payabo be used as a control area in which agricultural activities in Zone III can be compared with respect to such things as soil conservation, ground and surface water quality, and biodiversity.
c. The entire core area should be clearly marked with a (native) vegetative fence, informative signs as to location and regulations in effect, and patrolled by Park guards to enforce limited entry to Zone I.
d. Boundaries of the core and multiple-use zones should be entered in a automated digital (GIS) map that is shared with public agencies with administrative mandates in the region. Copies of the map should be widely distributed and displayed in regional schools, public buildings, tourist offices and, where requested, farmer households.
e. Global positioning systems (GPS) should be used to accurately establish the map position of the above Zones and of individual parcels allocated in Zone III.
f. A grievance procedure should be established through which disputes regarding the location of any park boundary or allotment therein can be settled openly and fairly.
g. Parcels within Zone III allocated for private use should not exceed 100 tareas, a limit which over 70 percent interviewed said was sufficient for their needs (see Cornell's December, 1996, GEF Report). Every effort

should be made to avoid allocation of Zone III lands which have problematic slopes, soils, proximity to groundwater or where biodiversity warrants protection rather than use (see later sections of this report as well as Dirección Nacional de Parques, 1996).

2. Economic Activities:

The desperate economic conditions to which the majority of families awaiting settlement in IAD resettlements or in Zone III cannot be overstated. As noted in a recent report compiled for CEZOPAS (GUIA, 1997), in the frequent public releases made by the Movimiento de Campesinos Trabajadores "Las Comunidades Unidas" (MCCU, 1996), and by GEF consultant Allen Putney (1997). Putney (1997:4) states: "*A series of worsening socio-economic factors are creating increasing pressures on the protected areas. These pressures include rural unemployment, destruction of the natural resource bases outside of protecdted areas, poor distribution of the benefits from resource use, poorly planned tourism development, limited alternatives for income generation by local communities, and poor understanding of resource use limitations and potentials.*"

We concur with the conclusions reached by the Spaniards in 1991 (see Section III.5) and by various governmental and nongovernmental organizations now operating in the region that economic activity in the zone of cooperation is basic to social development and to biological protection in the core zone. This activity is a joint public-private- and nonprofit venture. All three sectors must collaborate if it is to succeed.

Economic activities appropriate to the zone include eco- and agro-tourism, environmentally conscious agriculture, artesanal fishing, and micro-industries which add value, employment, and livelihood to Zone III. Just as local inhabitants supplement their incomes as farmer-trainers through Instituto de Información Técnica (INFOTEP), there are numerous public sector employment opportunities which can expand household income, including farmer extensionists, farmer surveyors, and farmer conservationists. Surveyors, for example, should be paid to position parcel boundaries using global positioning services (GPS), after taking a course to acquire this skill through INFOTEP or similar training institutions.

The mainstay of economic activity in the zone of cooperation will be agroforestry and eco-conuco (environmentally conscious) agriculture. These production strategies have been elaborated and subjected to cost-benefit analysis in our prior GEF reports. We urge that the government and nongovernmental sectors actively support sustainable agriculture initiatives (which include but are not limited to organic farming techniques) with training, education, extension, technical assistance and low-interest and long-term credit programs. As with commercial agriculture outside PNLH which benefits from extensive assistance and subsidy of this kind, no one should expect sustainable farming to succeed within Zone III without concerted effort and attention from outside.

The region has several other comparative advantages which can be commercialized for the advantage of local residents:

<u>Ecotourism:</u> We have previously given our support to ecotourism (GEF Report, June, 1996), as have the Spaniards. A great deal of ecotourism already exists in the Dominican Public, most of it managed by the private sector. The growth of national parks and reserves in the country is apt to increase hotel and hospitality industry revenues and to offer service sector employment. As has often been noted, however, this employment is seasonal and does not pay well for entry-level jobs. Tourist guide jobs, sometimes held

out as something local farmers and fishermen can hope for based on their intimate knowledge of local natural resources, often go to nonlocal people who speak foreign languages and have the political connections leading to such employment.

Allen Putney's 1997 report, referred to earlier, notes (p. 5) the importance of stabilizing and enhancing the flow of financial resources for the management of protected areas nationally, including the sustainable development of associated human communities. A variant of ecotourism which might produce local jobs and revenues in the future is agro-tourism. Here, farmers operate their farms in environmentally conscious ways and receive some portion of the revenues collected from tourists who, as part of their regional tours, visit successful agroecology and agroforestry sites in action. It is often commented that bring tourists to the country and the region is one thing; getting them to pay to see local "sustainable agriculture" programs or low impact approaches to forest extraction and use is quite another.

We agree with Putney and urge that some source of dependable revenues be earmarked for national park needs, be this an increased airport tax on foreigners, an exclusive commitment of Sello Pro Parque funds to this objective, or an international "Million Meters Squared" campaign in which foreigners are solicited, as in Costa Rica and Japan, to contribute to the "purchase" of added park lands. It is highly likely that the many visitors to the Dominican Republic are attracted because of "Caribbean Island amenities" such as beaches, reefs, waterfalls, mountains, tropical forests, and exotic biota and would be sympathetic to contributing to their protection. A portion of these funds should go into local rotating loan funds or to environmental challenge grants for local conservation and sustainable development.

Yautía., about which we have written in early GEF reports, is a lucrative crop with a dependable market demand. Much of the best yautia grown in the Dominican Republic comes from the LHNP region, a cash crop which could supplement subsistence farming and make it less precarious. There is, however, a widely held impression (among the Spaniards and others) that migratory agriculture in pursuit of yautía is the chief enemy of conservation in PNLH. When the Spaniards performed their research, the park boundaries were ambiguous, migratory farmers were convinced that "good" yautía only grew in what is now considered Zone I of the park, and few observers understood the three-way connection between deforestation, yautía and cattle. Cattlemen often employed landless farmers to clear pasture in the park in exchange for rights to cultivate these parcels for a brief period after burning them. This relationship and the high concentrations of cattle which followed were the principal sources of forest deterioration and groundwater threats; migratory agriculture was often done in the service of another lucrative enterprise--cattle raising--though yautia cultivation typically took all the blame.

Much has changed today to allow a rethinking of yautía as an acceptable cash crop within Zone III. Importantly, large concentrations of cattle are prohibited from the park following their removal from Zone I in 1992. Cattle perform a very different function for a small, multi-purpose farmer from that of a large cattle rancher,2 the incentive to open large expanses of pasture by allowing farmers to burn forest and plant yautia has subsided. Secondly, the park boundaries now appear to be stabilized for the first time in several decades. This, along with a 1996 law banning migratory farming, raises the penalties for such production and makes migratory agriculture less attractive. Thirdly, from field visits to farm plots where yautía is grown in mucuna slash, we have preliminary evidence that yautía might grow as well in Zone III as in Zone I. Thus, slash-mulch farming techniques may compete with slash-and-burn approaches to growing yautia, especially when the high cost of transport from Zone I is considered.

Chemical Free Produce: Another comparative advantage of Zone III is its lack of chemical applications compared to virtually all other arable land in the Dominican Republic. Europeans and North Americans, and to a lesser extent Dominicans themselves, are paying premium prices for organic produce. Our cross-visit to El Tigre National Park in Honduras in 1994 provided a powerful example of how organic produce can be grown in a national park and bring high prices in near-by urban centers. Many producers in Third World countries wish to sell to such markets but are unable to locate soils free of commercial pesticides, herbicides and fertilizers. National park peripheral areas are a good place to look, and allow producers wishing to compete in this market to be certified. This of course contrasts with most CEA lands and farmland elsewhere in the Dominican Republic where chemical application have occurred for many years.

Whereas a growing number of Dominican farmers in and around Zone III are experimenting with alternatives to migratory agriculture, it remains to be seen whether they can support their families by farming intensively on 50-100 HA of Zone III land without using chemicals. We are not recommending a complete ban on chemicals but rather training in their proper use (see below, under Rights and Responsibilities). Sustainable agriculture means diversification and experimentation with environmentally friendly farming techniques, and a prudent approach to chemical additives.

Water: Another comparative advantage of the LHNP region is its abundance of water due to heavy rainfall. This resource translates, thanks to a year-round growing season, into rapid growth of many species. Among these are many species of fruit, many fast-growing tree species with multiple uses (see attached G. Ford's Doctoral thesis), and understory species ranging from cacao and coffee to mushrooms. It may be appropriate, in time, to seek a permit to cut and process timber in the region, taking advantage of fast growing species that thrive on rainfall (the issue will be whether to permit exotic species which meet this description in a national park; recall that Zone III falls within the official PNLH boundaries).

Perhaps the most obvious product resulting from water surpluses is water itself. Like the Spaniards, we view the aquifer under the park, where much of this surplus collects, as among the region's most valuable resources. It can be viewed as both a resource and a commodity. Uncontaminated water from the Los Haitises aquifer, said to be the largest in the country, may one day be tapped by the public or private sector to meet growing water needs elsewhere in the country--domestic, industrial, municipal and agricultural. One way to capture it the monetary value of this resource is to bottle it for sale, an idea that would require a partnership with private sector investor or manufacturer as in the case of Agua Galván in the Dominican Republic or the Coca Cola bottling plant next to Guatemala's Sierra de las Minas National Park. Though such schemes may seem far-fetched to some, recall that residents of Zone III are being asked to forego certain activities because they live near a national park and over a fragile aquifer. It seems equitable that they be subsidized to produce a needed resource fundamental to the health of consumers throughout the nation.

This list of income-generating activities is not exhaustive. Further ideas worthy of consideration are found in the park management plan literature summarized in the final part of this section (e.g., charcoal, minor forest products, ornamental plants and flowers, honey, mushrooms, aquaculture, etc.).

3. Rights and Responsibilities

What should be the rights of families allowed to dwell permanently within Zone III and should people outside the Zone have any rights within it? These are among the two most pressing questions facing PNLH policy makers today. Upon close examination, they consist of three issues which are framed below in terms of rights:

3-a. Access Rights:

According to the Spanish report (AECI, 1991:86) there were an estimated 350 homes in what the Spaniards referred to as the core zone in 1981 (smaller than current Zone I). Several local censuses have occurred since the 1992 military removal of park residents, the most recent of which by the DNP generated a list of nearly 4,300 families (or between 21,000 and 26,000 people, depending on average family size). The following table shows several different distributional results per person and assume an equal distribution of land:

Potential Distribution of Land per Person In PNLH under Various Sets of Assumptions over Time

Reference	Total Area	Population	HA/person or /family
AECI Total Ambito (AECI, 1991:29)	143,500 HA (136 parajes)	37,000 (1981 Census)	3.88HA/person 23.28HA/family
AECI Total Ambito minus AECI core zone (AECI, 1991:29)	122,700 HA (129 parajes)	37,000 (1981 Census)	3.32HA/person 19.90HA/family
AECI Partial Ambito (AECI, 1991:168)	90,600 HA (part of 136 parajes*)	40,431 (1984 est.)**	2.24HA/person 13.44HA/family
AECI Partial Ambito (AECI, 1991:168)	96,500 HA (part of 136 parajes*)	46,870 (1984 est.)**	2.06HA/person 12.36HA/family
Decree 319 1997	85,700 HA (Zone III)	25,800 (1997 DNP Census)	3.32HA/person 19.93HA/family

* Only that land used for migratory agriculture (combination of "bosques aclarados para agricultura migratoria y aclarados con etapas de regeneracion natural y barbecho" under Areas Transformadas," p.168
** Estimate based on assume 3% growth rate/yr. using 1981 census as base year

This table generates five estimates of the land base available to families in the Los Haitises region over time. The Spaniards selected 136 parajes in and around the park as it was defined in the 1980s and found that, based on the 1981 population census, that each family had just over 24 HA of land if no prohibitions were imposed on use of the park for dwelling and extraction. If we reduce this total area by 208 km2 to reflect the original core zone of the park a decade ago, the area available per family remains almost 20 HA. This is generous considering many accounts consider 2-3 HA of level, reasonably good soil to be sufficient to maintain a family of 6 in tropical agriculture. The third row of information uses 1984 land use data reported by the Spaniards. Land that was subject to migratory agriculture, mixed farming/grazing or commercial farming with the 136 parajes was included and amounted to just over 90,000 HA. If this were used as a more accurate figure for potential cultivation (than the 122,700 HA), then the family average would have fallen to 13.44HA. The same calculation is possible for 1989. Here, more land has been cleared but population is also expanded through immigration (Hurricane David, high yautia prices, etc.) and high fertility. The result is that per family area falls to a still generous 12.36HA.

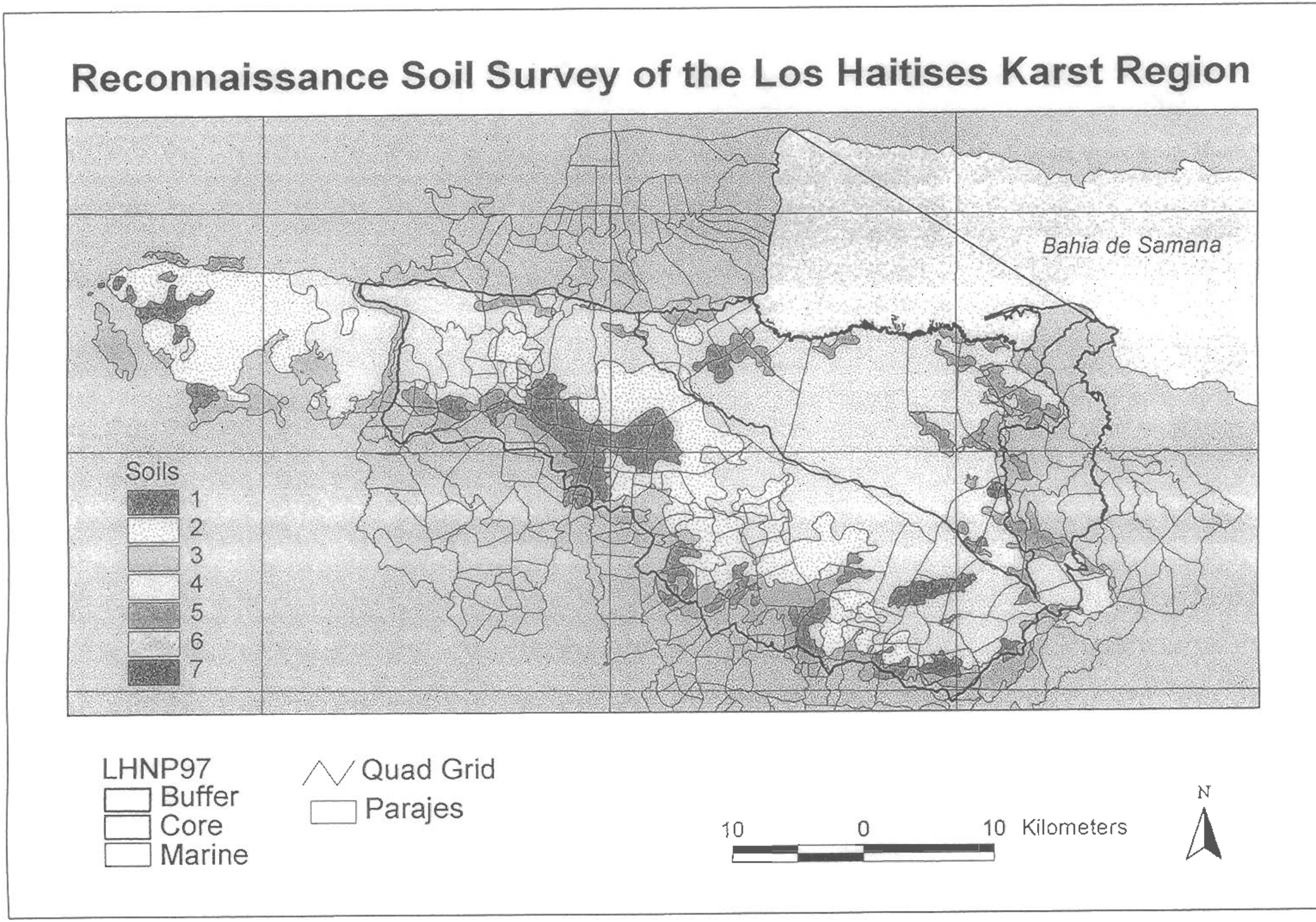
The last line of the table is of the utmost importance. It shifts attention to Zone III of Map 1 (or the internal buffer zone of Decree 319) which measures 85,700 HA and could contain as many as 25,800 people (4,300 families X 6 members per household). These facts yield an average parcel unit of almost 20 HA, the same figure implied in the Spanish Plan after the core of the park was removed from human use. In other words, what the Spaniards found to be operating a decade ago or more is still the reality in terms of potential access to land for those families in and near what was formerly called "buffer zone" and what we are referring to as Zone III. In 1977 the National Parks office carefully checked the regional census of who had a legitimate claim to land within the park based on 1) established dwelling within the park and/or 2) living outside the park but responsible for improvements to land within the park. It can be reasonably certain that all other claims have been addressed through IAD resettlement.[2]

This apparently optimistic situation must be qualified by three important considerations:

First, the above table in every instance makes the false assumption that land is equally distributed among families. In fact, there are some claimants to several thousands of hectares of land within Zone III, meaning that probably the great majority of families will have to be satisfied (if Parques elects not to use a lottery system of land distribution) with a small fraction of the total land shown and consequently a much reduced per family figure. It is not unlikely, based on agricultural land concentration elsewhere in the Dominican Republic, that 5 percent of the owners claimed ownership to at least half of the Zone III farmland (and often the better lands). If this situation is not corrected in PNLH, it means that 42,750 HA will be available rather than 85,700 HA and that approximately 10 HA will be the average size of holding for all other families, assuming they are more or less equally distributed. Some may be pleased with this amount, but bear in mind that the equal distribution assumpition is not currently in effect.

Second, our recently completed soils map (Map 3) of Zone III (done jointly with UNPHU --see below) indicates that some sections of this Zone should not be cultivated or grazed because of 1) steepness, 2) soil type and depth to bedrock, and 3) proximity to groundwater or highly permeable substrate. Our estimate is that at least 20 percent falls within one or more of these categories. Moreover, our land cover maps compiled from aerial photos in 1993-97, like similar imagery compiled by the Spaniards in 1984 and 1989, suggest that there are still forested areas of potentially high biodiversity which should not be altered just because they are in Zone III and not in Zone I.

Third and finally, it is highly advisable for DNP to plan for future as well as present generations. Here we refer to the claims of future generations, the descendants of those families now being allowed to resettle Zone III. If families know that the use rights


Reconnaissance Soil Survey of the Los Haitises Karst Region
Bahia de Samana
Soils
1
2
3
4
5
6
7
LHNP97
Buffer
Core
Marine
Quad Grid
Parajes
10
0
10 Kilometers
N

of their allotments can be inherited, they will be better stewards of the land (and hopefully the park as well) during their lifetime. For these three reasons, the government would be wise *not to distribute all available land in Zone III* and, since it owns the land within the entire park, it can confiscate or buy out the largest owners in order to have more land to distribute evenly among small-holding families. This we believe is advisable for the sake of both current equity and intergenerational equity, that is, to reserve a modest amount of land in Zone III for future generations.

To summarize our calculations indicate that the Dominican Government is in the enviable position of having a "surplus" of land within Zone III, from a subsistence standpoint, to provide for 4,300 families. Given this surplus, the Government can be both generous and fair. We urge a buy-out of large holdings in Zone III to increase resettlement opportunities for small-holders based on the following reasons:

1) the largest holdings tend to focus on cattle production which should be minimized in the park for environmental reasons;
2) small holders are widely known to be more productive than large holders per unit of labor; and
3) a buy-out will prevent the extremes of land concentration on the one hand and minifundia on the other (both have negative environmental consequences).

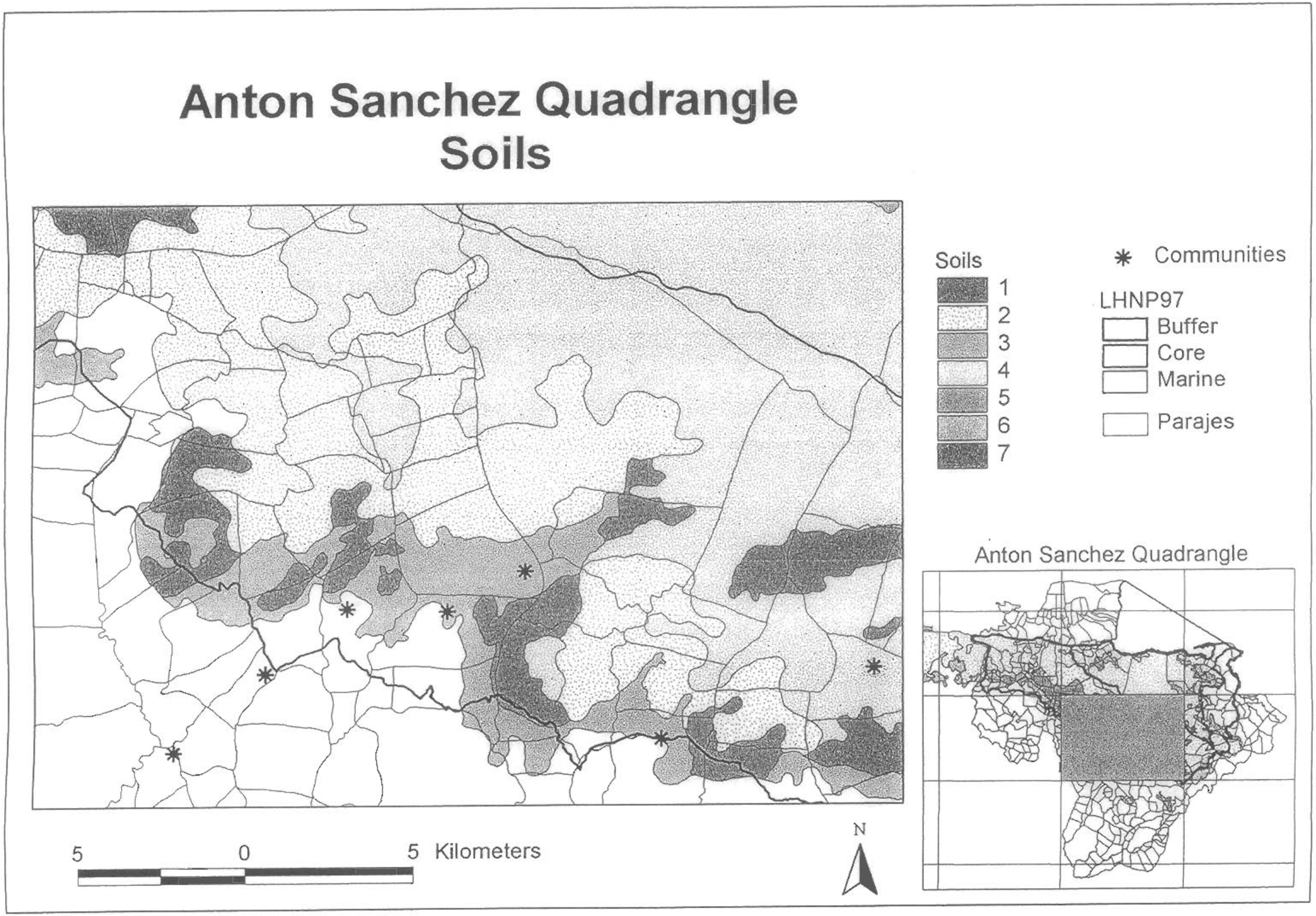
As a general principle, we believe the government should hold some land out of current production land in Zone III for planning flexibility in the future.

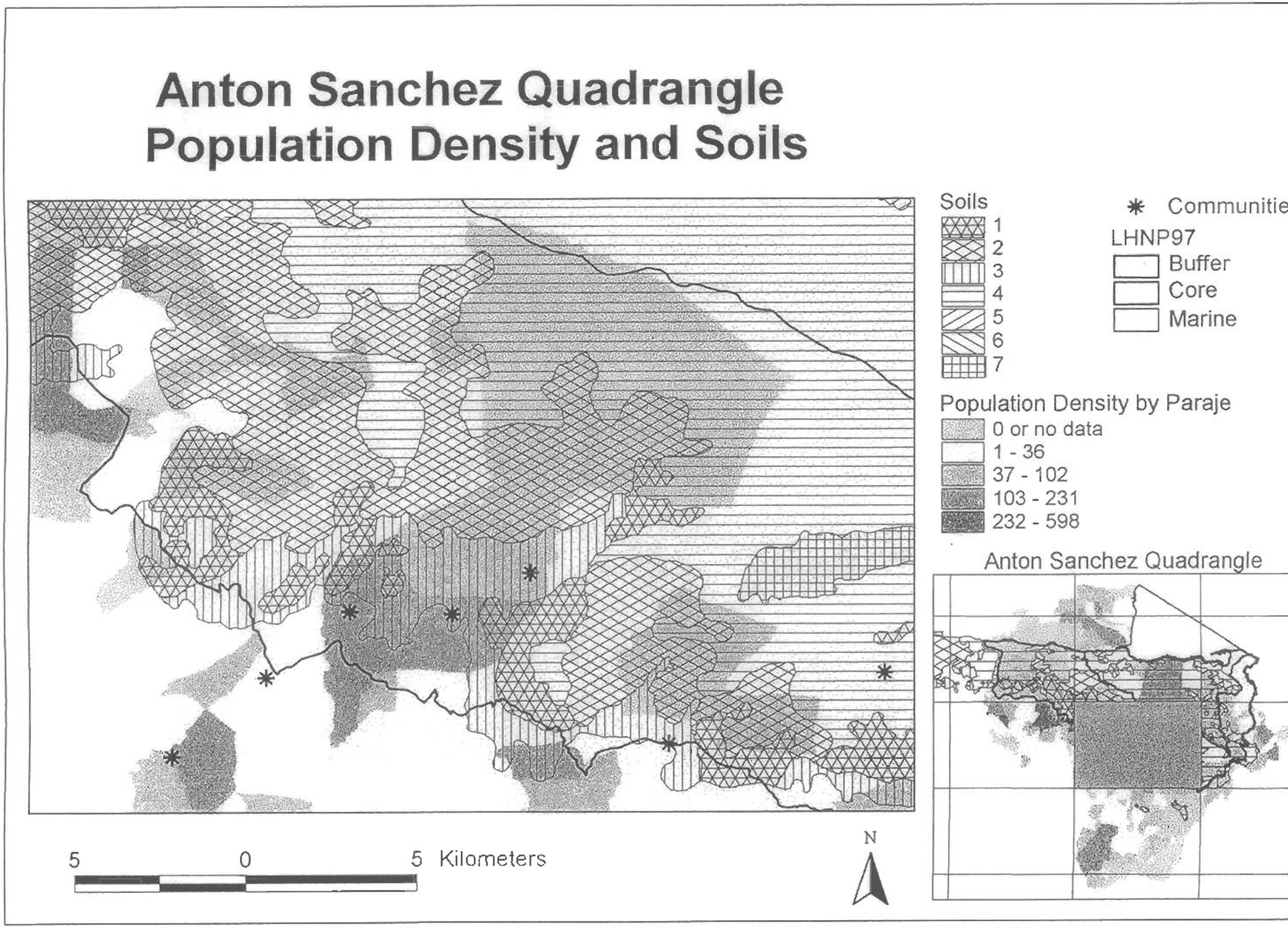
3-b. Use/Improvement Rights

Currently, the Dominican Government asserts sovereign ownership over the entire PNLH, a claim which is strengthened by the fact that the "buffer zone" (Zone III) lies within and not outside of the officially designated park. We have discussed at considerable length certain suggestions on how to impart security through long-term, renewable use rights in our GEF Report of December, 1996. The government has its strongest land use control in its right to recall land if it is abused; title holders should be guaranteed a minimum term of tenure (e.g., 20 years) which would not be interrupted except when "owner" responsibilities are not met (see below). The government will probably want to clarify where if at all the so-called Ley de Mejoras (permitting those who improve public land for agriculture may claim up to 50 tareas/year) applies to PNLH.

As noted above, Zone I should permit only scientific and touristic/recreational uses. Zone III will be a multiple use are, the specific uses of which should be negotiated according to subregions within the zone. Local farmers should have a respected voice in what these uses are. Some subregions exhibit more biodiversity and should permit fewer uses; others, as is shown in Activitiy 2.2.6, are composed of soil units which should not be heavily farmed, if at all. Our soil Capability Analysis in that same section suggest reforestation in some parts of Zone III, an activity which must be carefully considered given that exotic species should not be permitted in a national park no matter how promising they are from an agroforestry standpoint. The soil analysis also contains valuable information on where sink holes are typically found and where, therefore, any human behavior which might contaminate groundwater (Map 3).

We believe, based on the results of our GIS work to date, that restricting parts of Zone III for the reasons just stated will not cause difficulties in managing PNLH. For example, using the Anton Sanchez quadrangle to illustrate our point in detail, we were able to combine both soils map (Map 4) and population densities (Map 5) prior to the 1992


Anton Sanchez Quadrangle
Soils
Soils
1
2
3
4
5
6
7
Communities
LHNP97
Buffer
Core
Marine
Parajes
Anton Sanchez Quadrangle
5
0
5
Kilometers
N


Anton Sanchez Quadrangle
Population Density and Soils
Soils
1
2
3
4
5
6
7
Communitie
LHNP97
Buffer
Core
Marine
Population Density by Paraje
0 or no data
1 - 36
37 - 102
103 - 231
232 - 598
Anton Sanchez Quadrangle
5
0
5 Kilometers
N

removal using GIS (see Map 6). Although Map 6 focuses on the Anton Sanchez quadrangle, the analysis shows tends to be true on a broader scale. This is that farmers tended not to settle in parajes with in Soils Units 4 through 7 where conditions least warrant cultivation.3 Instead, they "voted with their feet" and chose subareas in Zone III which because of the better soils, now seem farsighted. Had all the land in Zone III been allocated for use, some farmers would have been forced to farm the poorer soils and steeper slopes.

3-c. Transfer/Sale/Speculative Rights

There are three uses which should not be permitted in PNLH by anyone. First among these is destruction through poor landuse and overexploitation. To avoid this, land should be allocated through provisional rather than permanent ownership certificates and revoked if abuse takes place. A second prohibited use is sale, either overt or covert. Sale would seem irrelevant without ownership but markets in partial entitlements can also disrupt the normal management of the Park. Absenteeism is a third "use" (misuse) which should be discouraged if not prohibited. Absenteeism means the absence of all family members for more than a year. If a family elects to migrate away from the park, it has every right to do this. It is entitled, in our view, to fair compensation for its improvements adjusted for inflation. This brings us to our final suggestion--a ban on speculation on all parcels in the park. Speculation and absenteeism turn land into a market commodity rather than a factor of production vital to community and family within this zone.

COMANAGEMENT AND ACCOUNTABILITY

In summary, this first section contains suggestions regarding boundaries, economic options, and rights/responsibilities within Zone III. We noted in our December 1996 GEF Report high levels of willingness on the part of current and previous park residents to share responsibility for management of PNLH through co-management with DNP. Just as DNP is accountable to the government for its actions, DNP must hold farmers in Zone III accountable for their behaviors in the Park. This will require controls to assure compliance with whatever management agreement is finally established between local farmers and DNP. We urge that these controls include a unique set of identification cards for participating farmers, performance contracts, and education-based certification.

Identification cards: Identification cards for those families which appear on the 1997 DNP Census and who have not been resettled elsewhere will serve as permits to enter and use Zone III. Anyone in Zone III without such a permit (or something equivalent issued by DPN) would be subject to fine and expulsion.

Performance Contracts: We further urge that card holders and DNP jointly generate performance contracts defining permitted uses and stipulating the basis of removal and suspension of tenure rights for families or individuals not observing the terms of this contract. This joint negotiating process should resolve the following issues as important first steps in the co-managment of PNLH:

- should all families issued Zone III identification cards/use permits sign such contracts?
- should the contract be standardized and apply equally to all families and Zone III users?
- to what extent should the contract be attentive to the concerns of nonfarmers?

Educational Certification: Finally, we urge that educational courses be offered through INFOTEP or similar teaching programs related to required and desired Zone III behaviors. Identification cards should be issued only on completion of this course or within one year of receipt of such cards. Failure to take this training course within this year would terminate use privileges within Zone III. Periodic refresher courses teaching new farming, forest and environmental management skills should be offered by the same institutions in exchange for certification for additional uses in Zone III. We urge three levels of acceptable performance (Farmer-Cooperator; Farmer Extensionist; and Master-Farmer). Farmer identification cards would state each farmer's capacity level and more advanced ID holders would receive recognition and benefits for extra educational effort (e.g., better loan terms from the Banco Agricola, priority involvement in subsidized cross visits and training course, marketing assistance, etc.). Controls administered by the government will elicit optimum behaviors if they combine both incentives and rewards with disincentives and penalties.

II. THREE PLANNING ESSENTIALS

"For many years it was thought that the solution to the problems of protected natural areas was to be found in the elaboration of detailed management plans. Nonetheless, numerous area managers with such planes frequently signaled that these plans were of little or no help. It seems that the panacea of the 1970s was in practice laid aside by the decade of the 1980s. On the other hand, it was observed that some of the protected areas with the best conservation had no formal management plans. In these cases, once every year or two shorter term plans were designed which lacked conceptual components but which contained practical descriptions of how to execute actions or planned works for a given period of time. Thus it was that in the second half of the decade of the 1970s people began to speak of 'operational plans' as a short and mid-term alternative for cases in which a management plan was lacking." Hugo Arnal D., The Nature Conservancy (no date).

In its simplist form, planning is the art of looking ahead and identifying the behaviors needed to survive the future. It is the ability to develop and maintain assorted kinds of capital basic to life. Without this, sustainability--defined as living off interest and conserving capital--is highly unlikely. In other conceptual terms, planning is an arch with three mutually reinforcing "blocks." These blocks are: the ability to balance multiple interests at a regional scale; the ability to include a true cross-section of voices in the planning process regardless of their status and power in society--that is, true participation; and the ability to adapt as circumstances change. Planning is never easy, but attempting to make it easy by ignoring any of these essentials is in the long run counterproductive.

II-a. Balanced Planning

Efforts to balance the needs of the biosphere and the "sociosphere" have become something of a new paradigm in environmental management in recent years. Since at least the early 1980s groups such as IUCN have recognized the importance of integrating human cultural preservation with that of nature (see Section III, below). Numerous spatial schemes for accomplishing balance among legitimate interests now exist. Perhaps the best known is zonation, where certain areas are reserved for strict conservation, others are viewed as appropriate for cooperation among consumptive and conservation interests, and buffer zones are devised to separate the two. The final section of this report reviews Latin American park management literature and draws attention to the balance of interests therein.

In addition to the balancing diverse interests in the park, park managers should attempt to integrate regional and local interests. At the outset of the GEF process in the Domincan Republic, we proposed work which would set PNLH management in a broad regional context. We did this in two ways.

1. We adopted for research and GIS purposes (see Activity 2.2.5) the regional study area or "entorno" used by the Spaniards. This covered 143,500 HA and 136 parajes. In the belief that the Dominican Government would adopt the AECI recommendations for management, we scaled our research to theirs and sought to replicate studies they had initiated and to fill in certain of their omissions. With the latter in mind we undertook the aerial survey of PNLH at 1:20,000 feet in 1993. The motivation was to have current land cover information (vegetation and human use) following the 1992 removal to compare with the land cover analyses presented by the Spaniards for both 1984 and 1989.

Map Unit 4

Taxon	Component %	Slope %	Soil Capability
A	35	60-80	VIIIe
B	25	10-25	IVe
C	30	0-10	IIe
D	10	40-60	VIIe

Map Unit 5

Taxon	Component %	Slope %	Soil Capability
A	30	60-80	VIIIe
B	10	10-25	IVe
D	10	40-60	VIIe
F	50	0-5	IVw

Map Unit 6

Taxon	Component %	Slope %	Soil Capability
G	65	0-5	IIIw
H	25	0-2	Vw
I	10	5-10	IIs

Map Unit 7

Taxon	Component %	Slope %	Soil Capability
J	50	60-80	VIIe
K	50	10-40	VIe

2. The soils analysis discussed earlier in this report, (Map 3 and 4) while not done for the entire study area of the Spaniards, covered the complete karstic plateau which characterizes the "Los Haitises region," including the karstic area west of the Rio Payabo not included in PNLH but serving as a control region for any future comparisons between protected and nonprotected areas of the karst formation . We also performed soils analyses in the Bajo Yuna region north of the karst formation (Laba, 1995) as well as in the vicinity of El Dean to the southwest of it (Tso, 1996). Together, these three soils studies offer a regional overview of soils and substrate which only partially existed previously and are fundamental to regional natural resource planning in the future.

Since the inception of our work we have also taken serious note of the proposal for a Man and the Biosphere Biosphere Reserve advanced by the Centro Para la Conservación y Ecodesarrollo de La Bahia de Samana y su Entorno, Inc. (CEBSE, 1993). PNLH falls squarely within this larger regional vision, constitutes a "core" area within the Biosphere proposal, and is an important terrestrial component of this marine and coastal blueprint. We have operated under the assumption that someday the region might be converted to a Biosphere reserve, a development that would probably welcome a successful conservation experiment in the zoned management scheme of PNLH.

Our most serious failing from the standpoint of regional research, in retrospect, was the absence of a regional analysis of groundwater underlying PNLH. This we did not contract to do but remains an important set of parameters which the Dominican Government should undertake now that the likelihood is high that a population of some 20 to 30 thousand people will be permanently living and working in close proximity to it.

II-b. Inclusionary Planning:

Of the three essential planning components noted, participation is certainly the keystone. The Spaniards avidly agreed with this principle (AECI, 1991:30-35). Prominently displayed in the early section of their important document was support for a participatory approach to planning and management. In the words of its authors, such advocacy

> "...adquiere un protagonismo fundamental cuya necesidad se justifica tanto por el carácter integrador del Plan como en la concurrencia de intereses diversos--y muchas veces antogónicas--entre los distintos organismos y colectivos afectados..."

Authentic public participation is also a sentiment shared by UNDP (1993) and by the World Bank (1992) and of course by a wide spectrum of NGOs. As the Spaniards emphasize, the failure of Proyecto MARENA (1986) can largely be attributed to the project's failure to place public participation at the center of this otherwise appropriate initiative. Participation itself does not guarantee success but its absence is often a sure recipe for failure.

A major obstacle to public participation is the view of some in both the environmental and the planning communities that local people are parochial and that their views will only impede "good" management. Co-management, from this perspective, is apt to clutter the environmental protection agenda with extraneous social and economic concerns. We found repeated evidence that this was not the case. This began with our pre-GEF rapid rural appraisal (1991), several cases studies of resettlement areas (Hughett, 1993) and park-periphery communities (Jacobs, 1996; Gutierrez, 1996), two surveys of area residents in 1993 (Duarte and Stycos, 1993) and 1996 (Lizardo, 1996), as well as detailed ethnographies of the different community types in the region (GEF/Portorreal, 1996/1997).

Below are salient findings from the 1992 and 1996 surveys which, in the main, suggest common interests between environmentalists and local area residents of PNLH. The former (a pilot study of four communities) included 262 adults, 139 men and 123 women. The latter covered 590 residents in 12 communities and was heavily oriented towards male heads of household. Both surveys occurred after the official removal of livestock and many residents of the area, one immediately after it occurred and the other after almost 4 years of government indecision. Together, the two surveys provided insights into the beliefs and behaviors of families removed or anticipating removal from the area to either land reform resettlement projects or to spontaneous neighborhoods adjacent to communities in the region and beyond (Table 1). Despite spacial separation, all families experienced the effects of park expansion on their lives and were cooperative in responding to the questions posed by interviewers.

Table 1: Communities Interviewed in 1992 (•) and 1996(*)

COMMUNITY	# FAMILIES INTERVIEWED
Los Limones (•)(*)	
Majagual (•)(*)	
Gonzalo (•) (*)	
La Altagracia (•) (*)	
Sab. Grande de Boya (*)	
Sanchez (*)	
Bayaguana (*)	
Santo Domingo (*)	
El Catay (*)	
Los Hatillos (*)	
El Dean (*)	
Batay Juan Sanchez (*)	
El Cristal (*)	

There are repeated indications in the following (selected) findings that area residents, whether still in their pre-1992 place of residence or in a new home, know about PNLH, support some or many of its conservation objectives, and wish to be involved in the planning and execution of this conservation. Despite severe hardship as a result of relocation threats and realities, protracted waiting for new land and housing, irregular food rations, uncertain park boundaries, and diminished services of all kinds, community members showed themselves to be remarkably resilient and favorably disposed towards conservation. The major findings were:

1) Attitudes towards conservation:

- Virtually all respondents in 1992 said that wild birds and animals should be protected and 90% disagreed that "felling forests advanced national development." The same percentage favored prohibition on tree cutting to protect forests and almost all concurred that burning put the physical environment at grave risk. In general, there was evidence that respondents would make sacrifices in their former lifestyles if they were spared being relocated.

* A similar question was asked in 1996. The following table compares what household heads believe is harmful to conservation in the park with what they said they actually did prior to 1992. The third column represents what the same respondents feel should be permitted activities in the park. (Core and "buffer zone" were not distinguished in this question.)

Table 2: Conservation Attitudes & Behaviors regarding Park

Community	Harmful to Park	Did before 1992	Should Permit
Hunt animals	90%	16%	--
Fishing in coastal zone	57%	--	--
Burn	98%	--	5%
Cut trees	91%	69%	23%
Deforest	94%	--	94%
Collect firewood	22%	87%	86%
Make charcoal	--	15%	--
Conuco agriculture	38%	97%	72%
Plant fruit trees	6%	97%	98%
Maintain cattle	56%	53%	6%
Collect medicinal plants	--	61%	--
Tourism	--	--	82%

-- = no available data

In general, most respondents agreed (78%) with the statement that people in their communities needed education about how to protect nature (20% disagreed). Pertinent to both conservation and intensification (see #2, below) is the subject of soil loss and infertility. 58% of respondents felt farmers in the park area needed to take better care of their soils; 47% felt that before the 1992 removal infertility was already a problem.

2) **Land tenure, size of holding and intensification of use:**

Almost everyone had some claim to land in the park in 1992, with nearly half dating back 21 years or more. Average parcel size varied enormously (see below), as did means of acquisition. Importantly, two-thirds said they were willing to live with smaller farm parcels; three quarters indicated that 100 tareas was the minimum needed in the region for a family to make an adequate living. Reported average size for all parcels held (sometimes 5 or more) were:

Table 3: Average Size of Holdings and Means of Acquisition (1992)

Community	Ave. Size	Purchased	Inherited	Improved	Other
Los Limones	1186 tareas	63%	9%	22%	6%
Majagual	183 tareas	56%	7%	17%	20%
Gonzalo	472 tareas	47%	0%	31%	22%
La Altagracia	69 tareas	3%	0%	13%	84%

NOTE: INDICATED MEANS OF ACQUISITION DO NOT NECESSARILY APPLY TO ALL TAREAS; A GIVEN FAMILY MAY HAVE SECURED ITS LANDS THROUGH ONE OR MORE TECHNIQUES.

*By 1996, many family heads interviewed said they had no holdings. Somewhat surprisingly, this applied to 16% of those on IAD resettlements (perhaps they took the question to mean lands beyond the resettlement), to 19% of those in nonrelocated communities, and to 31% of those now living in barrios. Almost half (46%) of those who left the park area on their own claimed no holdings, raising the possibility that lack of (or precarious) holdings may have propelled them to leave.

Not only did families lose in terms of quantity, but also in terms of quality. 75% indicated the quality of the land they now worked was worse than that worked before 1992 and, with the exception of those on IAD resettlement projects, majorities in each community group reported feeling less secure about their tenure.

Table 4: Average Size of Holdings and Means of Acquisition (1996)

Community	Ave. Size	Purchased	Inherited	Improved	Other
Resettlements		45%	5%	47%	6%
Park Communities		49%	8%	27%	16%
Self-Relocated		42%	9%	41%	9%
Barrios		36%	3%	56%	5%

NOTE: INDICATED MEANS OF ACQUISITION DO NOT NECESSARILY APPLY TO ALL TAREAS; A GIVEN FAMILY MAY HAVE SECURED ITS LANDS THROUGH ONE OR MORE TECHNIQUES.

Finally, there is the question of what form of ownership is best for conservation of the park. In 1996 respondents felt that conservation would be maximized if park lands pertained to communities (51%), whereas another 26% said this would happen if the land was held by the government. Only 19% though private ownership would yield such an outcome.

3) **The importance of water resources:**

• The majority made a strong connection between ongoing forest cover in the region and adequate rainfall for farming. When asked what services were essential in new relocation centers, water exceeded everything else (see #10, below).

* Homes in resettlement projects differ markedly from all other homes in terms of water availability. 65% of the former enjoy water in the house compared, at the other extreme, to only 1% among those legally remaining in the park (e.g., in Los Limones, Majagual and El Cristal). In these latter communities, half the household water came from a river or a well, that is, from the surface or ground water. When asked the principal problem in their communities, one in five said "water" (this was second only to the problems associated with the government removal of 1992, and ranked more important that lack of employment, services or land scarcity).

4) **Park boundary confusion:**

• Three fourths of respondents said they had never visited the national park even though, on other questions, they seemed more certain of carrying on daily activities in PNLH.

* In 1996, respondents were asked if it was difficult to know where they were in relation to park before the 1992 removal. Less than one in five said it was easy, whereas 70% said it was difficult. After the removal, 82% said it was now more easy to know where the park was (referring, in this case, to the park's core area). Interestingly, those who wish to use the karst topography as a "natural" park boundary (49%) was roughly equal to those who did not (47%).

Household heads were asked if the core and "buffer zone" of the park should be altered. Their responses, arranged by the community type in which they lived, were:

Table 5: Attitudes towards Expanding/Reducing Park Dimensions

Community	Core Zone Reduce	Expand	"Buffer Zone" Reduce	Expand
Resettlements	46%	16%	46%	36%
Park Communities	61%	8%	24%	60%
Self-Relocated	55%	9%	11%	73%
Barrios	44%	26%	7%	75%

5) **Possession of cattle after the 1992 cattle removal:**

• Roughly half the households surveyed had no cattle before 1992.

* After the government removal, only 16% of households claimed to have cattle and the numbers of livestock in these cases were usually one or several.

6) **Dependency on park natural resources**:

• Area residents depend on the park for land, fuel wood, water, subsistence and commercial crops and 90% spend up to 20 days per month in the park. 94% of men and 86% of workmen respondents said that, among other things they would do to remain in the (then-labeled) buffer zone, was complete reforestation (see #3 above). Commercial versus subsistence farming patterns varied greatly by community, as did soils:

Table 6: Subsistence Needs and Related Soil Quality in Park

Community	CROPS "Sold most"	"Consumed most"	SOIL QUALITY "Good"	"Mediocre"	"Bad"
Los Limones	63%	11%	65%	35%	0%
Majagual	33%	25%	58%	33%	9%
Gonzalo	47%	6%	47%	42%	11%

* No data gathered in 1996.

7) **Complaints associated with resettlement:**

• Almost all people interviewed (95%) expected that relocation would undermine their communities and 93% felt they would be worse off personally when moved.

* 92% of the those interviewed in 1996 felt that their families had suffered severely as a result of the 1992 removal; those respondents from non-relocated communities remaining in the park felt the same (89%), suggesting that many traumas accompanied the 1992 intervention and subsequent policies, such as loss of in-park farming and grazing privileges, loss of livelihood and friends, loss of services, etc. When residents were asked to compare their overall welfare now with that prior to 1992, they responded as follows, indicating a precipitous fall in their life chances and quality of life:

Table 7: Overall Welfare Compared, Pre-1992 and 1996

Community	"Better than pre-1992"	"Same as before"	"Worse than pre-1992"
Resettlements	10%	3%	85%
Park Communities	4%	1%	95%
Self-Relocated	4%	1%	96%
Barrios	2%	2%	95%

Even though the Dominican Ley de Mejoras acknowledges improvements as a source of tenure, and therefore worthy of compensation in cases of government confiscation, only 3% of those interviewed claim to have received compensation. In contrast, over 90% had received food rations of some kind since 1992.

8) **Future control of the park:**

• Given the choice between FORESTA, large land owners and their own community leaders, 75% said they would rather rely on their communities (and two-thirds indicated that communities were mostly responsible for their own well-being to date).

* In 1996, 72% said, when asked who could best control PNLH, their own communities. 23% thought FORESTA would do it best. This response, coupled with #2, above, open the possibility that community ownership or control of parklands is foremost on the minds of local inhabitants. It also opens the possibility for co-management of the parks as an acceptable solution to its planning and protection.

9) **Community service needs:**

• Respondents, asked what services were essential if they were relocated, ranked drinking water (87%), electricity (81%),a health clinic (75%), a school (54%), and a church (19%).

* Services were not stressed in questions posed in 1996.

10) Standard of living and employment:

• Housing for most respondents was rudimentary at best. Homes lacked electricity in 3 of the communities and other services, though almost all residents in Majagual and Los Limones felt they were better off than in the communities where they had formerly lived. Living conditions in La Altagracia, the first of the resettlement experiments, were desperate and may have prejudiced other park residents against resettlement efforts to follow.

* Electrical appliances continued to be scarce in the Los Haitises communities except where run from car batteries (e.g., televisions), whereas gas stoves were in over half of all households and in 3/4's of resettlement homes (though gas supplies were infrequent). Principal employment was in agriculture across communities, but those respondents living in barrios or other new sites of their own choosing show strong signs of finding principal work in other occupations (38% and 33%, respectively). Unemployment overall remains low (7%), although park uncertainty has translated into employment uncertainty, and agriculture/cattle raising account for only a slight majority of family earnings, as shown below:

Table 8: % of Total Family Income from Agriculture/Cattle Raising

%	IAD Resettlement	Park Communities	Self-Relocated	Barrio
Majority	51%	54%	63%	53%
Less than 1/2	11%	17%	13%	23%
Very Little	29%	25%	16%	21%
None	8%	4%	7%	2%

11) Reforestation:

• Two questions directly addressed the crucial issue of reforestation. 96% reported that they had been legally permitted to plant fruit trees in the park before 1992 and 94% of all men said they would help reforest the "buffer zone" as a condition for being allowed not to relocate (86% of women answered the same).

* Since 1996 the Dominican Government initiated a national level reforestation plan called "Quiqueya Verde." Of interest is to what extent there is public support for additional tree planting within the park. Some 44% agreed that more trees should be planted, whereas 55% felt there were enough trees in the park. Note that when a similar question was asked but in specific reference to fruit trees, 98% of respondents felt such activities should be permitted in the park (see #1, above).

12) Yautía production:

• When asked what things they would sacrifice to continue living in their homes within the park, 61% of men (and 41% of women) said they would give up yautia production (in 1992, yautia was widely considered the chief motivation for slash and burn agriculture, see for example AECI, 1991).

* In 1996, no questions were asked directly about yautía. Respondents did describe, however, the disadvantages of slash-and-burn agriculture. Whereas 35% of all respondents noted that it abused the soil and reduced the organic layers on the soil surface, and equal proportion said it caused no problems. Importantly, it was those respondents dwelling in park communities not required to relocate that disagree most with this perspective. Here, 45% said it damaged the soil and only 27% defended he position that it caused no problem (or they weren't sure).

II-c. Adaptive Planning

It has been said, quite correctly, that one of the superhuman feats of modern times was placing a man on the moon. It has also been said that such a feat would not have been accomplished through traditional planning wherein one set of calculations was made and the rocket carrying the astronauts was fired from earth. Instead, thousands of adjustments were made along the flight path to keep the projectile in line with the target. The wise way to deal with multiple unknown factors is to plan not to succeed all at once, but to adjust so that "success" is ultimately attainable. It is not an exaggeration to suggest that managing a complicated ecosystem, with many subtleties, unknowns and constantly changing factors (both human and nonhuman) may be as imposing a task as achieving the first moon walk.

This principle of adaptive planning gained recognition in recent years thanks to Hollings (1985) and numerous subsequent contributors (see Geisler, 1993). Their insight went beyond mere planning to the more embracing notion of management. Adaptive management, in their terms, is more than planning. It is a process of on-going, collective learning which defines human behaviors/policies appropriate to a protected area but remains alert to the on-going possibility of changing those behaviors/policies based on what has been learned. The learning is not a random event or, for the most part, unintended. Rather is the result of experiments which are planned and executed to consciously test policies to make sure they serve their intended purpose.

Adaptive management differs from planning, then, in a fundamental way. Planners set goals and either accomplish them or "fail" to accomplish them. Adaptive management planners set goals and then design practical experiments which provide information not previously available. These experiments are an on-going form of public education about how to attain planning goals or how to modify to goals if experimentation indicates they might be unattainable. Change in public policy, if it occurs, happens for systematic reasons, then, which all can observe and evaluate, rather than for political or more random reasons. Planning is not abandoned, but rather recalibrated into shorter time horizons.

Several examples of adaptive management are already evident in or near PNLH, and some are more intentional than others. Consider the use of *land reform and resettlement* to absorb families displaced by government efforts to return the park to its natural condition. In the late 1980s, the Dominican land reform agency (IAD) provided rudimentary land and shelter for some 50 families near Batey Altagracia. That resettlement "experiment" (it lacked a carefully prepared control group) was fraught with problems--soil and water that were contaminated with pesticides, minimal technical assistance to parceleros, little follow-through when it came to completing housing, and virtually no services, to name but a few (Hughett, 1993). By 1995 there had been extensive turnover among farmers at Altagracia, suggesting that conditions there were perhaps no better than the risks taken in the park itself to which many of its land recipients returned. Cornell-

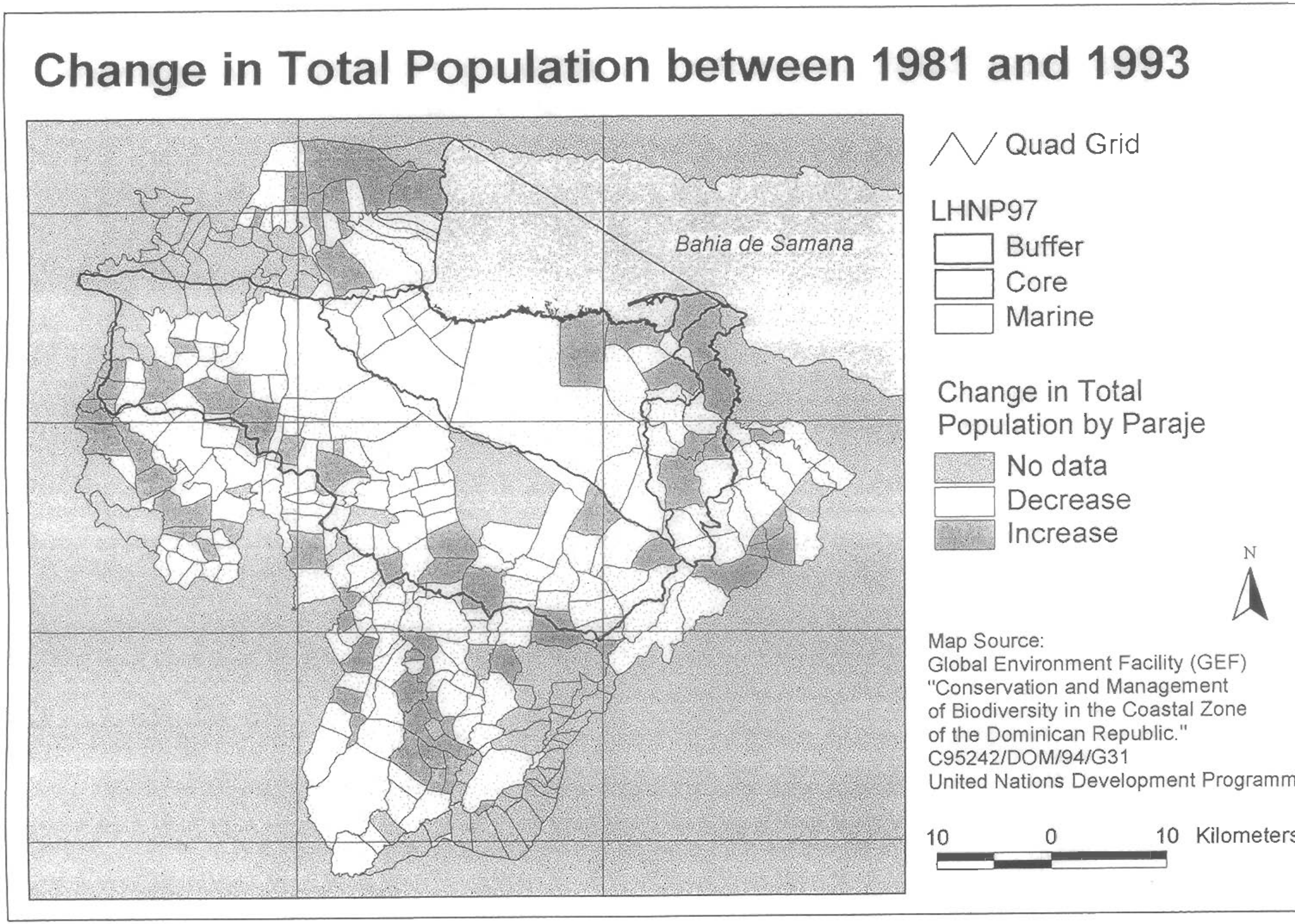
ICDP survey work of Altagracia residents sent a warning: Altagracia residents viewed their living conditions with great skepticism and disapproval (Duarte, Lizardo and Stycos, 1993). Compared to the Aglipo resettlements to the northwest of the Park, Altagracia was a half-hearted effort.

The Dominican Government managed the future round of PNLH resettlement adaptively. Important lessons were learned from Altagracia and made evident in subsequent resettlement projects it established around the park. Though serious problems have plagued them operationally (lack of water, fertile soils, electricity, dependable services), and they seem endlessly delayed in their completion, they remain a great improvement over Altagracia. Where Altagracia barely accommodated 50 families, today the number resettled on IAD asentamientos near the park numbers approaches 2,500 and the quality of life therein is vastly improved over their predecessor. Despite many changes and reforms awaiting attention, IAD periodically takes stock of its field experiences and experiments with new possibilities. We have been pleased to see IAD's recent interest and staff training in various sustainable agricultural techniques, information that is desperately needed by its resettled clientele.

A second instance of adaptive management in process is the *shift throughout the region from extensive to intensive agriculture.* As we note above in discussing the circuitous route by which we arrived at our current collaboration in mulch-based agriculture (Activity 5.2.4), Cornell and its counterparts experimented, revised, and adapted its farming emphasis numerous times. What started as eco-conuco projects heavily dependent on organic agriculture principles has evolved into eco-conuco emphasis integrating a diverse mix of subsistence/commercial cultivation strategies. Some of these are organic, others are less so. Farmers are more apt to lay aside slash-burn farming now that working (and still experimental) alternatives exist on over 50 farms in and near Zone III. More important than the techniques adopted by farmers is the collaborative learning process and farmer-driven experimentation with new plant material, land use practices, cover crops, soil conservation practices, intercropping opportunities and exchange of ideas that has occurred in local training sessions, fèrias and memorias. It is a process that has just begun.

A third example of adaptive management is our step-by-step employment of GIS. Today, as indicated above, we can look at multiple boundary configurations of the entire park and spark constructive thinking by diverse audiences with different views on where the boundaries should be. Or we can examine the coincidence of population clustering in towns or parajes in relation to soil units distributed across our GIS soils map of the karstic area for the years before the government removal of park-based families in 1992 or for the period after this action. This GIS system took years to construct and was a gradual process of collaboration and experimentation between DIRENA, the Instituto Cartografico Militar, UNPHU, Cornell and others. The layers of information which can now be manipulated to render knowledge never before available came from many individual contributions by agencies, technicians and researchers.

An example of this adaptive management process using GIS is seen in Maps 7 and 8. These maps show total population and population change from 1981 to 1993 at the paraje level with respect to the Park. Although the outer boundaries of the park have moved several times in recent years, there has been a high degree of certainty that a core area (Zone I) measuring at least 208 km2 would occur along the coast. Map 7 suggests that, either voluntarily or under threat of eviction, families tended to vacate Zone I (except for near Sabana de la Mar and Valle on the east) in this period, whereas the parajes forming the outer border of Zone III grew. Since until 1996 many of the latter parajes were in fact outside the Park, we can assume that relocating families viewed them as a safe place to settle until the park boundary issue was resolved. Note that when the Park


Change in Total Population between 1981 and 1993
Bahia de Samana
Quad Grid
LHNP97
Buffer
Core
Marine
Change in Total
Population by Paraje
No data
Decrease
Increase
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Map Source:
Global Environment Facility (GEF)
"Conservation and Management
of Biodiversity in the Coastal Zone
of the Dominican Republic."
C95242/DOM/94/G31
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(especially Zone III) expanded again in 1997, it "captured" these growth parajes and made them subjects of whatever laws are applied to PNLH (unless there is adjustment in the outer boundary). Had Zone III been somewhat smaller, as many anticipated, the people in the dark blue parajes would have well positioned to re-enter Zone III when the Government judged it was legal to do so. The broken ring of dark blue parajes represents a holding position by former Park residents, many of them are living in temporary dwellings or with relatives until final boundaries become manifest. Map 9 strongly suggests a housing crisis in the region, probably driven by the park relocation. One sees population increase (Map 8) far in excess of household increase (Map 9), reminding policy makers how eager those families on the DNP Census are to possess land and housing either in Zone III or on an IAD resettlement.

Maps 7 through 9 illustrate the continuing appearance of new information, some more experimental and science-based than others, which can and should influence planning decisions. The long-term success of PNLH depends on planning, particularly adaptive planning. It's fate cannot be left to chance, to random market forces, or to spontaneous political decisions. Indeed, these are the very forces which led to the region's deforestation, migratory agriculture, and indefinite boundaries in the past. Nor should it necessarily be assumed that good planning, as the quote at the beginning of this section indicates, is necessarily found in traditional management plans with long time horizons. Good operational planning means adaptive management, or, as we have emphasized earlier, adaptive co-management.

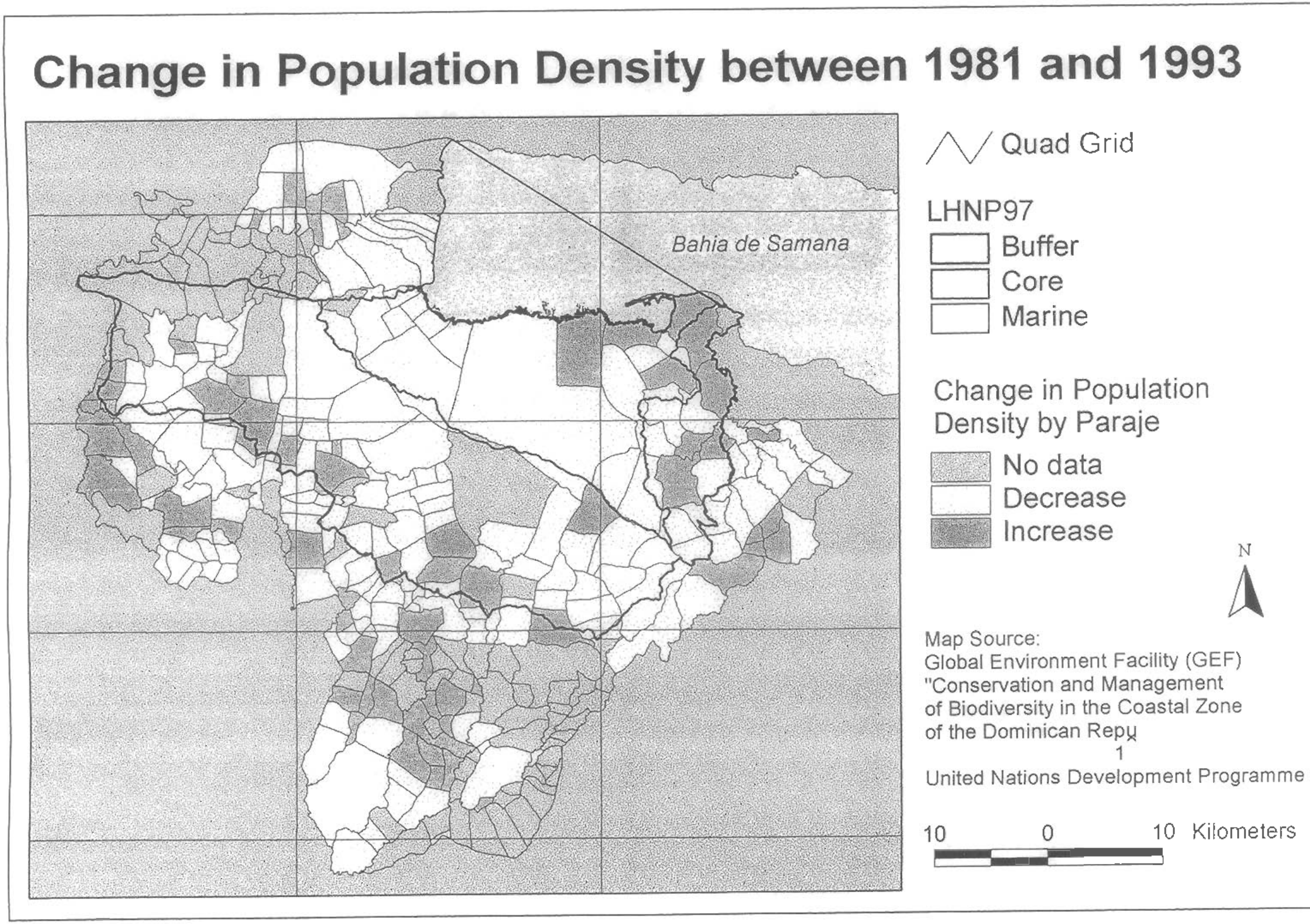
III. Lessons from Other Protected Areas

Introduction:

The following annotated selections were chosen from the published and non-published literature on protected area management, with a primary focus on literature from or about the Latin American and Caribbean regions. They include books, articles and diverse non-governmental unpublished documents such as protected area management plans and master plans, as well as workshop discussions. Four topics were of paramount interest in this search effort because of their immediate relevance to management of Los Haitises National Park in the Dominican Republic. These topics are listed below with a brief explanation of what we mean by each one:

1. Boundaries and zoning, and particularly buffer zones
2. Participation and co-management
3. Regulation of use of land and resources
4. Land allocation and reallocation inside boundaries

<u>Buffer zones</u> are conceptualized in the literature in diverse ways which can be confusing. Some see 'buffering' as a function that occurs outside of park boundaries to ease the transition between a protected area and areas of more intensive human activity (Sayer, 1991; UNEP, 1990). Other sources view them as borders between zones within a protected area and refer to them as in buffer strips and transition zones (Miller, 1982). Still other plans include a "buffer zone" which is generally an area of some form of human activity, as differentiated from a "core" zone where conservation is prioritized and activities heavily restricted. This use of "buffer" zone is most commonly associated with biosphere reserves and is considered a zone unto itself (Miller, 1982). In the 1994 IUCN Guidelines for Protected Area Management Categories, the entire conceptual construct of parks and protected areas is redesigned and redefined. This publication transformed buffer zones into


Change in Population Density between 1981 and 1993
Bahia de Samana
Quad Grid
LHNP97
Buffer
Core
Marine
Change in Population Density by Paraje
No data
Decrease
Increase
N
Map Source:
Global Environment Facility (GEF)
"Conservation and Management
of Biodiversity in the Coastal Zone
of the Dominican Repu
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United Nations Development Programme
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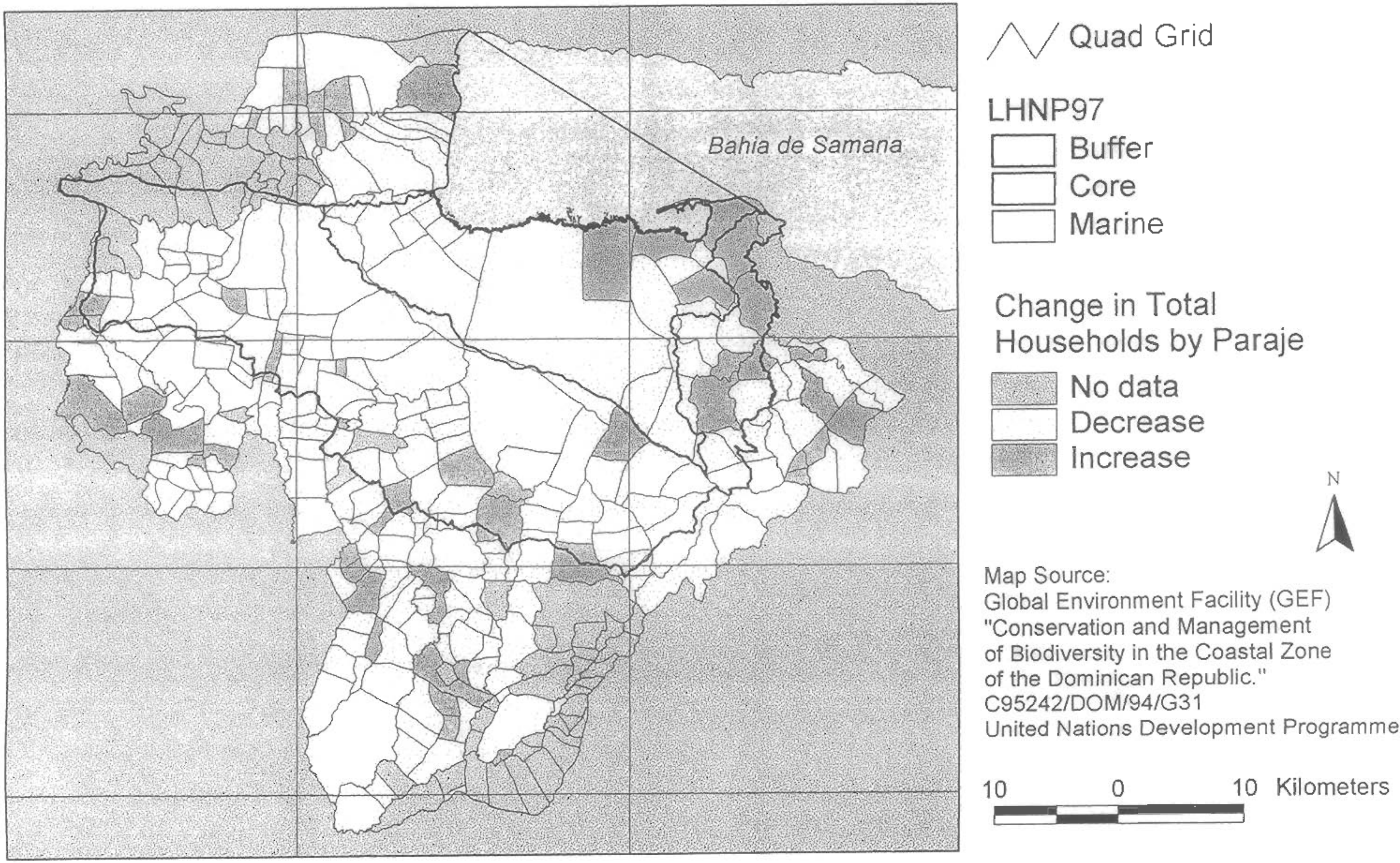
Change in Total Households between 1981 and 1993



separate areas of conservation. Even more recently, the literature considers "buffer zones" as outdated or of little use (WWF, 1997), either because the authors believed development activities therein were failing, they were succeeding but should be phased out of protected area plans, or because definitions of zones and permitted activities therein were thought to be confusing.

With regard to "participation," virtually all of the plans and programs reviewed made mention of the need for community awareness and involvement in protected area planning, management and regulation, with varying degrees of involvement depending on the phase of planning and management. Yet, as mentioned in McNeely (1993), there is little actual literature documenting the record of co-management. The motives for promoting participation ranged from environmental education (to "conscientisize" and get communities to comply with protected area rules) to actual participation in design, implementation, and ongoing monitoring (White, 1994; Renard, 1994). The forms and methods of participation range from surveys of local peoples' attitudes, "participatory mapping" (Conservation International, 1997) to interviewing people about traditional management techniques, and engaging communities in in-depth discussions about conservation and development (e.g. "village dialogues", Messerschmidt, 1985). Still other meanings extend to hiring community researchers and managers, and to inviting communities to select representatives on advisory councils (Renard, 1994; Geoghegan, 1994) with varying degrees of power in selecting management options.

There is little consensus as to what true "comanagement" includes, but it clearly involves actual management in some form by local communities or non-governmental agencies in conjunction with governments, who usually -- but not always (see Geoghegan, 1994 and Renard, 1994, and Mamirauá, 1996) -- are responsible for the regulation and enforcement side of activities (see ProAmbi, 1996). Renard (1994) discusses an ambitious "co-managed" effort in St. Lucia with communities, NGOs, universities and government all taking part in planning for conservation and development activities. As with participation, comanagment is not a standardized concept (Pimbert and Pretty, 1995), and many authors cite the fact that most protected area staff are not trained in methods of involving local communities, and many national policies discourage effective local participation (Poff, 1996; Renard, 1994; S. Miller, 1995; Richards, 1996). Pimbert and Pretty (1995) see the new emphasis on experts and GIS as excluding local knowledge. Collaborative management and adaptive management at the local level are defined and discussed in several pieces (Renard, 1994; White, 1994; Fisher, 1995; Geoghegan, 1994; WWF, 1997).

There is some evidence of a counter-trend in some conservationist circles against ongoing involvement of local communities in protected areas and against most income-generating activities in buffer zones. Rather than stating outright that communities should be excluded entirely from consideration, supporters of this view mention the need to be careful about designing overly ambitious or 'misguided' development plans which actually divert attention from and potentially damage conservation goals (WWF, 1997; Bayley et al, 1991; Kramer et al, 1997). Kramer et al (1997) represent the return-to-preservationist emphasis predicated on the many failures of involving local people in conservation efforts. In practice, there are many differing levels of 'intervention' outlined in protected areas management plans, ranging from community education to actual development of income-generating activities and, sustainable alternatives to relieve pressure on the resource base. Poff (1996) outlines a vision of peoples' participation which emerges from the 1992 World Parks Congress and other sources that retain an emphasis on the essential role of local people and protected areas. Participation advocates often cite the dangers of failed development projects and the difficulties of unprepared staff and unfriendly policy environments.

Most of the literature searched does not discuss relocation and reallocation issues, but only restriction of use within protected areas or development projects with communities and individuals within protected areas. Participatory zoning is discussed in the Mamirauá Management Plan (Sociedade Civil Mamirauá, 1996). Many authors cite the need for improved coordination between government sectors and ministries with regards to protected areas (Geoghegan, 1994; Poff, 1996), and increased coordination with the agrarian sectors of government could improve land allocation issues related to and relieving pressure on protected areas. (See Cornell's December GEF report for further treatment of this issue).

The Many MJeanings of Management Plannning

The "management plans" for different protected areas follow no single format, and range from the very general (brief outlines of goals) to the very specific (month-by-month activities to be accomplished). "Master plans" are a popular format. They outline overall planning, objectives, goals and principles as well as zoning and activity targets (e.g. OTS, 1991; Fundación Charles Darwin, 1992; Fundación Defensores de la Naturaleza, 1992). These activities are sometimes referred to as "Annual Operating Plans." There are also "Management programs" such as in the biosphere reserve in Mexico (Instituto Nacional de Ecologia, 1995), with specific management plans according to species, resource, or activity planned. And some documents discuss a "Management Strategy" and then have a "Management Plan," such as in the Parks in Peril program document on La Paya National Park in Colombia (Nature Conservancy, 1991). One of the weaknesses in many of the "plans" is that they do not include information on activities carried out previous to the plan, or evaluation/analysis of how things are expected to turn out following implementation; they are merely statements of intent without much before-and-after context for the reader.

Many authors cite the need for better policy environments for management planning (McNeely and Thorsell, 1991; Pimbert and Pretty, 1995; Renard, 1994; Richards, 1996; White et al, 1994;) including national protected area systems (IUCN, 1994; McNeely, 1993), national biodiversity planning (Miller and Lanou, 1995), and better training of staff to work with communities and development (Torres Angeles, 1992; S. Miller, 1995). Numerous authors cite the difficulty of having diverse government sectors not communicating or cooperating (particularly parks, agriculture, forest, wildlife, and planning divisions). These authors also cite problems in the policy context as it relates to protected areas, ranging from limited funding and lack of government will to implement policies on the books (Richards, 1996; Pimbert and Pretty, 1995), to a lack of mechanisms to allow government sectors to work together. Other problems include lack of policies which include local people in planning and managing protected areas, and national economic policies which encourage poor land use practices or which cause migration of poor people to protected fragile land and resource areas.

In the end, what role can protected areas play in local and regional or national development (Poff, 1996)? The view of many of the authors is clear. Include protected areas in national plans for conservation with development by improving co-management efforts between local communities, NGOs and governments. Universities, both foreign and domestic, can be facilitators of this process (Geoghegan, 1994; Poff, 1996), or "experts" who reverse the top-down approach to conservation planning and management (Poff, 1996), or providers of knowledge, research suggestions and certain kinds of technical/extension assistance.

GEF-PNUD/ONAPLAN

Conservación y Manejo de la Biodiversidad en la Zona Costera de la República Dominicana

PROYECTO BIODIVERSIDAD

Oficina Nacional de Planificación
Secretariado Técnico de la Presidencia
Programa de las Naciones Unidas para el Desarrollo
Fondo para el Medio Ambiente Mundial

INFORME FINAL

Subcontrato Los Haitises

Area de Proyecto:

Parque Nacional Los Haitises

Implementa:

Universidad de Cornell (CIIFAD)

Doc 2/4 – **Anexo 5**
Books and Articles
Diciembre 1997

BOOKS AND ARTICLES:

1. **Fisher, R.J. 1995. Collaborative Management of Forests for Conservation and Development. Issues in Forest Conservation Series. Switzerland:IUCN/WWF.**

Summary: Fisher differentiates between "co-management of protected areas" and "collaborative forest management" on state land apart from protected areas. The emphasis on cases reviewed is Asian, especially Nepal and India although there is mention of cases in other parts of the world. Fisher reminds us of the many issues in collaborative resource management such as the role of ngo's, equity and gender, the diversity of local groups and institutions, land tenure issues in conservation and development, the role of government as policeman and as community developer, etc. Buffer zones mentioned and portrayed as potentially problematic due to increased pressure on those areas where pressure would have been spread out previously. This is essentially an overview piece with no new information or analysis.

2. **Furze, Brian, Terry de Lacy and Jim Birckhead. 1996. Culture, Conservation and Biodiversity. Chichester:Wiley and Sons.**

Summary: This volume is mainly concerned with culturally-sensitive local development and conservation initiatives and has a useful section on the use of social sciences for informing principles and processes of community consultation. The last section of the book deals with local level management of resources and has many useful examples of co-management and biosphere reserves. While drawing heavily on Sayer's (see Sayer, 1991) discussion of buffer zones, the biosphere reserve examples give a good level of detail of management arrangements and zones. For example, in one biosphere reserve, the "core" zone was renamed the "conservation zone" and the "buffer" zone has two "maintenance" zones. Maintenance zone A allowed for minimal access, for preservation of flora and fauna, while Maintenance zone B allowed for limited development. Then the "transition" zone which allowed for more permissive levels of development was renamed the "development" zone. This zone is used as a model for sustainable economic activities, based on the use of environmental knowledge gained from the other zones.

3. **Geoghegan, Tighe and Valerie Barzetti, (eds.) 1994. Protected Areas and Community Management, in series Community and the Environment: Lessons from the Caribbean, No. 1. St. Lucia:Panos Institute and CANARI.**

Summary: This booklet contains four brief case studies from Carribbean island communities, three of which are summarized here: The first case tells how a local NGO in St. Vincent instituted a multi-faceted consciousness-raising campaign, including popular theater, Freirian educational techniques, primary and secondary education and adult education programs regarding the need for preserving a 200-year old forest reserve. In addition, literacy, employment creation, personal and community development and resource management training programs were instituted. Some village members participated in collecting household data on the importance of the reserve. Other communitites instituted watchdog groups to protect the reserve. Self-help infrastructure improvement projects were also undertaken such as creating a community center, a water system, a solid waste management program and road improvement, since part of the pressure on the reserve was due to the need to exploit forest resources following an unemployment crisis in the early 1970s. The second case is in Jamaica, in the Blue

Mountain/John Crow Mountain National Park. A large project with funding from USAID, the Govt. of Jamaica, and technical assistance from the Nature Conservancy, is part of a national project including a protected areas system plan, a national Conservation Data Center, a Trust Fund for the national parks, and creation of national parks legislation. A four-part strategy for the Park will be implemented by LACs, or Local Advisory Committees in the major communities in and around the park. LACs are voluntary committees formed by farmers, teachers, young people and other community organization leaders, and the meetings are often attended by representatives from government agencies. The strategy includes early involvement of communities in designing park goals; conflict resolution; community strengthening of organizational capabilities; and the securing of practical economic benefits including sustainable income generating projects. A community outreach program is also part of the larger project, with environmental education, educational audio-visual packages, radio and television public relations and brochures. Communities around the park participate in a buffer zone function acting as "watch dogs" for the park's resources. The third case relates St. Lucia's efforts to institute a national System of Protected Areas, a participatory planning process which legally institutionalized participation of local communities in selecting and managing protected areas. The National Trust (a governmental agency) and a regional NGO, CANARI, put together 20 public workshops to invite communities to participate in the process of setting up a co-managed national protected areas system. Management responsibility will be transfered to local organizations, and provisions in the National Trust Act will require local consultation in park planning and management. All of the above case studies are extremely brief but indicate innovative methods and goals.

4. Harrison, Jeremy. 1992. "Protected Area Management Guidelines." in <u>Parks (IUCN)</u>. Vol. 3 (2). October.

Summary: This extremely summarized document informs that 15 guideline documents have been proposed to be developed and disseminated based on the World Parks Congress. They are listed here and include "involving local people in protected area management," "the preparation of protected area systems plans," and "integrating demographic variables in the planning and management of protected areas" among others. In addition, 9 guidelines are summarized which are results of a conference on tourism which are relevant only to transnational border-area parks.

5. IUCN. 1994. <u>Guidelines for Protected Area Management Categories</u>. Gland, Switzerland:IUCN.

Summary: This is a trilingual publication. The Guidelines were affirmed by Recommendation 17 of the 1992 IVth World Congress on National Parks and Protected Areas at Caracas, Venezuela and the present volume is the revised result. Definition of a protected area: "An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." The ten categories of protected areas listed by the 1978 world congress were rewritten to be only six and to be defined by management objective, recognizing that different countries have different labels for protected areas. The categories are defined and a number of examples are given internationally of where different protected areas would fall within the new classification system (four examples are from Latin America). The new system represents a gradation of human intervention and defines "primary, secondary and potentially applicable" management objectives. Management categories should be selected based not on the

efficacy of management practices but on the management objective originally implied in the legal creation of the Protected Area.

<u>The new categories are</u>:

I -- Strict Protection
II -- Ecosystem Conservation and Recreation (formerly National Parks)
III -- Conservation of Natural Features
IV -- Conservation through active management
V -- Landscape/seascape conservation and recreation
VI -- Sustainable use of natural ecosystems

<u>The management objectives are</u>:

--scientific research
--wilderness protection
--preservation of species and genetic diversity
--maintenance of environmental services
--protection of specific natural/cultural features
--tourism and recreation
--education
--sustainable use of resources from natural ecosystems
--maintenance of cultural/traditional attributes

Under the new system, it is not clear whether Los Haitises would be a "National Park" (category 2) or actually a combination of categories 4 and 5; although countries may have their own names for protected areas but these areas would be classified internationally with the new system. Mentioned is the fact that 84 percent of national parks in South America have significant resident human populations, and according to the document "some of these might be more appropriately placed in another category."

Recommendations regarding buffer zones: At least 3/4 of the area should be managed for the primary purpose; and, "...where one area is used to "buffer" or surround another, both their categories should be separately identified or recorded."

6. Kramer, Randall, Carel van Schaik and Julie Johnson, (eds.) 1997. <u>Last Stand: Protected Areas and the Defense of Tropical Biodiversity</u>. New York/Oxford: Oxford University Press.

Summary: A collection of papers from a 1993 Duke University workshop discussing biodiversity and protected areas in the tropics, indicative of the conservation biology "backlash" against managed use of protected areas. The editors begin by noting that in the history of the "park movement in the tropics," "what began as protection of habitat through the exclusion of people has transformed into sustainable use of biological resources. This new emphasis provides local control of important resources and greater income, but does it conserve habitat and species?" They argue for a "renewed focus on protected areas as the primary storehouse of biodiversity." The authors argue that particularly for tropical rainforests, high diversity means species rarity and slow species life histories, making species in this ecosystem especially vulnerable to human intervention. They argue that "the upshot of (the) new emphasis on sustainability rather than protection has been a reduced commitment to protected areas." They also cite the change in view of the role of parks and a heightened interest in the plight of indigenous people as contributing to the problem. Note the short history of the idea of use in protected areas (p. 5) and the percentages of community development projects in conservation initiaties (p.6). The authors state that the "compromise" of projects improving socioeconomic status of people in or near protected areas "in which buffer zones adjacent to protected areas are created for limited extractive and productive uses, have largely failed to maintain the integrity of the protected cores, although some have succeeded in improving the livelihood of the local people." In sum, state the authors, "Locally...there is a conflict between conservation and development."

Other chapters of particular interest discuss social threats and root causes of threats to protected areas (ch.4) , a chapter on compensation to locals (ch. 9), user rights (7), and ICDP successes and failures (5).

In chapter 5, Brandon states that "the entire concept of sustainable use has been based on the ecological fallacy and on utopian thinking" and that "international conservation organizations have gone a long way toward promoting the myth that development and the conservation of biodiversity are compatible." She identifies obstacles to devolution of management to local communities. (pp. 101-103). She defines Parks, ICDPs and "locally managed reserves" as three conceptually distinct types of protected area. Brandon notes that "there are virtually no examples where buffer zones have achieved their goals."

There are few case studies in detail here for our purposes, but most useful to note is the tone and message of the book: hearty skepticism of the concept of conservation and development being compatible in protected areas, particularly for the end of conserving biodiversity.

7. McNeely, Jeff and Jim Thorsell. 1991. "Guidelines for Preparing Protected Area System Plans." in Parks (IUCN), Vol. 2(2), July.

Summary: "Protected Area System Plans" are proposed, as a prelude to a workshop in the 1992 Parks Congress. Recommends creation of a national protected area system plan for each country, which "relates protected areas to national conservation objectives, social and economic development, the needs of modern society and the health of the rural landscape," as a means to earning public support for protected areas. Many countries, including Brazil, Chile, Costa Rica and Peru (and others on other continents) have plans for national systems and regional system reviews have been prepared for IUCN for Tropical Asia, Oceania, and Sub-Saharan Africa. Recommends a debate, with a "broad cross-section of society," on national objectives for the protected area system, resulting in establishing specific objective for each protected area, and assignation of a management category, recognized in national legislation, for each protected area. Recommends developing a system for identifying priorities for improving the management of protected areas in the system. The protected areas should be part of a coherent national land use policy since most threats to the protected area system originate outside the protected area boundaries. Sees protected areas as part of regional landscapes. Buffer zones are recommended. Recommends using the system planning process to build collaboration with other sectors such as forestry, fisheries, agriculture, energy, tourism, research, etc. Recommends identifying necessary changes in legislation and administrative structures for protected areas including "measures to give local people increased responsibility for contributing to protected management." In additional to planning the protected area system, there should be mechanisms for reviewing progress and modifying the plan, as part of the management process.

This piece is an overview piece with little more detail than offered here. There is a table on page 8 of a sample "table of contents" of a Protected Area System Plan. Of intermediate relevance to our objectives.

8. McNeely, Jeffrey A. (ed.) 1993. <u>Parks for Life: Report of the IVth World Congress on National Parks and Protected Areas, 10-21 February 1992, Caracas, Venezuela</u>. IUCN, Gland, Switzerland.

Summary: The document contains 23 one-page recommendations stemming from the 49 workshops of the Congress. Workshop summaries and conclusions are the remainder of the publication, approx. 1-2 each. An "Action Plan" is outlined which is something of a template, but each country needs it own Action Plan, based on a national system plan. The "Caracas Declaration" appears and in a main heading states that "the establishment and effective management of networks of national parks and other areas in which critical natural habitats, fauna and flora are protected must have high priority and must be carried out in a manner sensitive to the needs and concerns of local people." The Introduction and Major Protected Area Issues mention sustainable development as being contributed to by protected areas (as concluded at the Earth Summit), mentioning briefly the necessity of working in the larger context of sustainable development, the need for regional planning and the need for inclusion of local people: "Local patterns of land and sea tenure, income inequities among rural people, denial of the rights of indigenous peoples to land and resources, inappropriate interest and exchange rates, inequities in the commodities trade, and agricultural subsidies can all have major influences on the success of a protected area. Such factors can seldom be addressed effectively by the protected area manager..."

Of particular interest are Recommendation 6: People and Protected Areas; Recommendation 15: Development Planning and Natural Resource Use; Workshops 1.2, 1.3, 1.4 (economics, people, and community-based resource management); Workshops III.1 (regional planning); III.9 (buffer zones); and site management workshop IV.4. : "Each site should have a management plan covering information, evaluation, intention and actions. A set of policies or objectives (interim plan) should be prepared before the final plan is written. A plan should be an iterative process -- action, monitor, new action to be followed annually." Plans should be simple, working documents. Buffer zones are recommended, with corridors joining them, on page 21 in the Action Plan template. Also discussed in some of the workshops.

In the 1992 World Parks Congress, participatory planning and co-management were mentioned and emphasized in many, indeed the great majority of sessions, as evidenced by this document. The most frequently mentioned reasoning for doing so is to garner support from local communities and to preserve cultural diversity. It was also noted that little documentation existed on co-management and the IUCN would try to assemble such documentation. Recommendations were made to increase government commitment to inclusion and strengthening of ngo's and local communities in planning and management, as well as training of protected area personnel in participatory techniques. In addition, inclusion of protected areas into regional economic planning and development is recommended. Most of the workshop summaries are too superficial to be of much use.

The IUCN calls for governmental commitment to inclusion of communities. This implies a national-level commitment, with guidelines; local/regional implementation guidelines and training; mechanisms for inclusion of communities. There is a generalized absence of guidelines for participatory planning and co-management for these levels.

9. **Messerchmidt, Donald A. 1985** "Local Participation in Park Resource Planning and Management." in People and Protected Areas in the Hindu Kush-Himalaya: Proceedings of the Workshop on the Management of National Parks and Protected Areas in the Hindu Kush-Himalaya, May 6-11, 1985, Kathmandu.

Summary: Indigenous management systems reflect longstanding local systems of social organization and custom. Human resources, in particular "extrinsic cognitive" resources such as knowledge systems, beliefs, attitudes and values (economic, aesthetic, and spiritual) are all a part of our sociocultural resources needed to be preserved and used. Participation of local people occurs in three potential phases, before, during and after park or protected area establishment. Conservation education, in a two-way process, is key in the first phase. Participatory procedures that are formal, legalised and elaborate such as in Western countries are often inappropriate in non-Western countries. The "village dialogue" method has been used successfully in the Himalaya. A planning team is composed of local villagers, development authorities, and technical people; one goal is for local individuals or groups to take on specific management tasks and roles on a long-term basis. A meeting is held in which villagers and leaders state their needs and in which they examine priorities of the district and of the nation.

Local advisory groups and management committees or councils can be established. Cooperatives can be formed for investment in support services necessary for running the park.

Conflict resolution can be approached through an annual meeting of a forum of community leaders (villagers, school teachers, and leaders) who meet at park headquarters to discuss needs of the communities and of the park. Park staff must explain park policy.

This article presents this information in a sketchy manner with few details and relies heavily on referencing the 1984 McNeely volume on National Parks based on the 1982 World Congress, as well as literature on Nepal. (This is the only non-Latin American literature in the bibliography but was chosen to demonstrate that participation methods have been developed which are culturally appropriate and culturally specific in other regions of the world.)

10. **Miller, Kenton. 1982. Planning National Parks for Ecodevelopment: Methods and Cases from Latin America, Vols. I and II. Ann Arbor: Univ. Michigan. (Also available in Spanish).**

Summary: This material, largely based on material from the mid-1970's, is a source for both theory and practical planning and management applications for national parks in Latin America. It represents an early example in the literature on the need to address human needs and the necessity of genuinely incorporating local participation in the planning process of parks, the need for incorporating parks into national plans for development (and "ecodevelopment"), as well as a comprehensive historical perspective on parks in Latin America. Numerous examples of Latin American parks and their planning and activities are given, as well as reprints of excerpts of national plans and international and regional conventions on parks.

Chapter one provides a conceptual framework for managing wildland resources; chapter two provides a comprehensive history of national parks in Latin America; chapter three offers a framework for planning national parks including coverage of boundary and conflict issues; chapter four traces a history of park planning in Latin America; chapters five and six offer practical methods for park and national park system planning; chapter seven discusses strategic implementation of park plans and park systems; chapter eight focuses on development of human and institutional managerial capacity; chapter nine offers some cross-culturally relevant examples from Africa; and chapters ten through twelve focus on problems facing national park management in Latin America, international programs and assistance, international conventions and agreements, and strategies for regional and global cooperation.

Basic steps for planning are outlined, including selection of an objective, laying out of various means, calculation of costs and benefits, choice of best means, implementation, analysis, evaluation based on the objective, and replanning. Individual, group and team planning are defined. Different levels of planning are outlined, including overall land-use plans, systems plans for national park networks, conceptual plans for each park unit, a management program, and construction, design and detailed plans for each park, including specific projects. Miller warns against overspecialization within park services and within the planning process, since this limits the feedback within planning which should ideally be multidisciplinary and iterative. There are steps for designing management and development programs, training of personnel, and structure of programs and personnel. A management "concept" is recommended to guide management and development program decisions.

The concept of buffer 'zones' is challenged with regard to national parks; instead, buffering is seen as a function, not a zone in itself; buffering establishes a transition from one land use to another. Miller suggests internal buffering between zones within a park (scientific zone, tourism zone, etc.), as well as buffering of the park boundary from external land uses and influences. A park's boundary should follow topographic formations, should be rounded, and gradients of land use to adjacent lands should be gradual. Practical issues such as ease of patrolling should affect boundary decisions, and care should be taken not to cut across ecotones.

However, buffer zones are considered actual zones when included in a biosphere reserve concept. The buffer zone would actually be a large area surrounding a core or natural zone; the core zone is to be used for baseline studies, while the buffer zone would be managed for research, education and training activities, as well as limited manipulation including timber, hunting, fishing, and grazing; other zones include restoration zones, to reclaim land damaged by human activity, and a stable cultural zone, where managed land use practices would be allowed that are not harmful to the environment. Several possible models for biosphere reserves and multiple use conservation areas are diagrammed.

There is little discussion of actual human occupation of national parks and the conflicts and planning and management difficulties posed by this.

11. Miller, Kenton and Steven M. Lanou. 1995. <u>National Biodiversity Planning: Guidelines Based on Early Experiences Around the World</u>. Washington, D.C.; Nairobi; Gland, Switzerland: World Resources Institute, United Nations Environment Programme and the World Conservation Union (IUCN).

Summary: This is intended in part as a "how-to" manual for governments with illustrative examples from around the world, for national biodiversity planning after the Convention on Biological Diversity was signed in 1992. There are three case studies from Latin America:

<u>The Chilean</u> National Biodiversity Action Plan: A National Commission on Environment was created in 1990, with a Council Directorate made up of 10 ministries; a Framework Environmental Law was created in 1994 by Congress to give CONCAMA a

mandate to develop environmental legislation, coordinate government environmental activities and advise the President. A biodiversity action plan was developed for 1992 with the help of experts from governmental, university and NGO groups. Meetings were held in each of the 13 administrative regions of the country to discuss the biodiversity action plan.

The Mexican Country Study on Biodiversity: In 1992 the National Commisssion of the the Knowledge and Use of Biodiversity (CONABIO) was created. It is a high-level Ministry commission. Emphasis is on gathering of raw data for the country study, to be used as baseline information and for planning purposes; there is a segment called "National Capacity" which includes a section assessing human resource capabilities "including the indigenous and peasants point of view" (p. 115).

The Costa Rican Country Study on Biodversity: Costa Rica has a National Conservation Strategy (ECODES) and a Forestry Action Plan (PAF) from 1988; a Country Study on Biodiversity (1992) and a Strategy for the System of National Conservation Areas (SINAC) (1993). The Ministry of Natural Resources, Energy and Mines was the lead agency. The SINAC was an "internal planning process" of the Planning dept. of the National Parks Service, "providing the technical and financial analysis of the management and capacity needs for biodiversity within the protected areas under the new concept of decentralized administration and the local community involvement (sic)." (p.123) While there is no one formal document, there is a *de facto* National Biodiversity Strategy, with principles in different sectors of management planning; the creation of INBio is part of this as is the "evolution of the national protected areas into a landscape-scale system of "conservation areas." (p.124).

These are all largely national-level planning strategies intended to coordinate different public and private sector efforts for sustainable development and specifically protection and potential use of biodiversity resources. While the recommendations for developing biodiversity strategies seem to include potential for including local community participation, none of the Latin American plans seemed to do so. In addition, those steps recommended seem to emphasise "traditional knowledge" and "indigenous peoples participation," seeming to relegate or delete other local community participation. Monitoring and evaluation recommendations also include the gathering of information on human community issues, but do not seem to include any mechanisms which are participatory in either gathering or use of data. "Management" seems, as elsewhere, to apply to biotic resources and not to include any participatory concept; meetings are suggested to inform locals of how important biodiversity is. What may be useful as illustration in this book is that it recommends to both gather data on and include local communities in national planning.

12. Miller, Susan. 1995. "Ecological processes and local uses in the National Park Armando Bermudez, Dominican Republic." In Caribbean Geography, 6(2):112-127.

Summary: This is a condensed version of research done for the author's master's thesis. The study focuses on the town of Diferencia, a community that participated in the Plan Sierra, an ngo plan to change farming systems from shifting to permanent cropping. Both plant and social data were collected and analyzed with the conclusion that including the local communities in the decisionmaking regarding technical and use control measures would be advantageous to conservation efforts. Survey results show local communities favor increased involvement in decisionmaking but are otherwise hostile to and dislike (54%) the Park's existence. 69% of local residents utilize the park resources and plants illegally. Women had much more favorable attitudes towards the park than men. A large number of respondents suggested changes in buffer zones and clarification of access rights in buffer zones. Suggestions were made by local area residents to increase reforestation and agricultural intensification outside the Park. Research was done on diversity in coffee plots and forest plots, with high diversity in "abandoned" coffee plots (return of natural forest species plus agricultural species). On a landscape level, there is a fragmented 'protected' forest with high deforestation levels outside the Park, previous deforestation within the Park, and continued small clearings in a *de facto* buffer zone in the Park periphery. It is suggested that agroforestry projects be increased outside the park, and the Plan Sierra project is a useful model. The role of park guards was particularly cited as needing reform, to be more amenable and less of a 'vigilante' enforcement group. Several references in the literature on buffer zones are cited.

13. Pimbert, Michel and Jules Pretty. 1995. Parks, People and Professionals. Putting "Participation" into Protected Area Management. UNRISD Discussion Paper 57. Geneva, London and Gland: UNRISD, IIED and WWF.

Summary: This discussion paper asserts that national parks and protected areas have not been successful instruments for long-term conservation in developing countries and that as currently conceived and implemented, they are often discredited in the eyes of local people. Institutional and policy frameworks which support co-management need to be developed in developing countries. The authors argue for greater diversity, democracy and decentralization in the approach to conservation, and against coercion, control and centralization. The authors contend that in the post-UNCED era, conservation biologists, ecologists and "normal" professionalism have been reconfirmed as the best way to conserve biodiversity on a global scale. One of the central messages of UNCED, they say, is "that the world is to be saved by more and better managerialism." The authors take issue with this position, finding that the lack of inclusion of local people in conservation and development planning and implementation has an overall negative effect on conservation, from encouraging sabotage by locals to the ignoring of benefits of traditional knowledge and stewardship. They argue that rather than "blueprint" managerial approaches which are non-flexible and do not include local people, a "process" oriented approach is desirable, as part of a "new professionalism" which encourages decentralized decisionmaking. Not only do they encourage "participation," but also a paradigm shift away from a "positivist-rationalist" approach towards one which encourages a new conservation science which takes into account the dynamism of ecosystems and of man's presence in them. Worsening economies tend to encourage continued use of the existing conservative conservation paradigm. The concept of participation is typologized and the authors assert that only "functional participation" (see attached typology) is adequate for inclusion of local communities in protected area design, management and evaluation. The authors state that "policy and technical measures that combine protected area management with socio-economic development in surrounding "buffer" zones have often tended to be top down, centralized, underfunded, and of an ad hoc and short-term nature."

This paper brings together and references a wide array of recent literature and thinking on the issue of involvement of local people in conservation and development in protected areas. While not detailed enough to provide recommendations for use of specific methods and techniques, it references most of the main participatory methods available and makes a strong argument, with numerous brief examples from around the world, for their use.

14. Pye-Smith, Charlie and Grazia Borrini Feyerabend with Richard Sandbrook. 1994. <u>The Wealth of Communities: Stories of Success in Local Environmental Management</u>. London: Earthscan.

Summary: These descriptive examples are not about protected areas but offer examples of communities and ngos involved in agro-environmental management. See Chapter summaries on Costa Rica and Ecuador:

<u>Costa Rica: San Miguel Association for Conservation and Development</u>

An NGO called Asociacion ANAI gives financial, technical, scientific and administrative expertise for communities to work out non-destructive ways of making a living from CR's forests. It worked on CR's Caribbean coast with ASACODE: Asociacion San Migueleña de Conservacion y Desarollo - which was founded in 1988 by 11 village heads of household. The association is made up of 20 households and member households participate in sustainable selective logging on an artesanal basis. Trees are cut by chainsaw and all parts are used, meaning more cash in both the short and long run for peasant landowner members than if they sold trees to logging companies. The association also has a 70-hectare farm for a native species replanting project partially financed byANAI and the IUCN. While some biologists were brought in for training campesinos in germination and replanting, w/ANAI funds, the focus now is on the association members themselves doing the research and replanting and technology transfer (bringing in other peasants and showing them how to plant native species). Ecotourism attempts at the farm have focused on ngo and academic groups interested in the farm. Village nurseries established in 25 villages by ANAI in the region got community organizing off the ground and helped to sensitize people about the need for diversification. Key individuals were identified and small concrete activities and projects were initiated which could be successful. ANAI now gives revolving loan funds. Communities need at least one highly motivated family to get successful initiatives off the ground like ASACODE. ANAI also helped create a regional association, APPTA, to coordinate buying, processing and marketing of agricultural and forestry goods. National laws regarding forests are outdated and based on a time when the state was the owner of forests, where now most are privately owned. Laws favor large commercial exploitation and disfavor small artesanal exploitation. Trees cannot be used as collateral to raise loans. Permits for tree felling are given only to individuals making collective forest management difficult.

<u>Ecuador: Licto and Salinas Communities</u>

The Ecuadorian Center for Agricultural Services-CESA- is a large ngo supporting peasant farmers to learn about soil recuperation. Technical advice and tools were offered but only sparingly and only for traditional methods. Tools (hoes and shovels) and seeds donated to communities enabled them -- mostly women -- to organize a "minga," a traditional form of collective work, once a week, to perform a wide variety of necessary community work, and in this case, break up hard soil and add organic material, eventually to do green mulch plantings of lentils and oats, and then barley and maize. Communal plots were done first, and now private plots are having mingas for soil recuperation also. CESA also sent doctors to take care of children and helped in the construction of irrigation works. CESA does not promote its own agenda or promote any new structures, letting communities form their own groups and agendas; CESA's role is one of stimulating communities to get together to discuss issues and needs. // In another (Andean) community, Salinas, the Salesian Mission, with a charismatic father, helped develop over 20 years numerous community projects, first by creating producer cooperatives which were formed for a cheese factory, a wool-weaving industry, handicraft shops, bakery, mill, charcoal production, carpentry workshops, pork industry, women's sweater production, fish ponds, chocolate factory, and more. The cooperatives all together form the Union de Oragnizaciones Campesinas de Salinas. The Father started by planting trees. The Mission secured free technical advice, loans, and training fellowships. All profits are reinvested for the community good rather than being distributed to individuals who receive only their salary for their work or pay for goods. Forested areas have been planted by a Youth Group associated with the Mission and a national forestry company who provided seedlings, but there have been some difficulties in managing the pine forests, particularly financial to cover tools and skilled labor. Inter-American Foundation provides some support. In another project, an industrial diesel dryer was bought to dry mushrooms, collected by anyone who wishes, mostly the poorest community members, but the loan for the dryer has yet to be paid back since too many mushrooms are produced for the national market but not enough for the international market. Foreign volunteers are helping to improve quality and marketing.

15. Renard, Yves 1994 Community Participation in St. Lucia, in series Community and the Environment: Lessons from the Caribbean, No. 2. St. Lucia: Panos Institute and CANARI.

Summary: In the early 1980s a regional NGO proposed development of a planning process and subsequent conservation and development plan for the southeast coastal region of St. Lucia, encompassing some protected areas and fragile resource zones, and including compatible urban and industrial development. A two-year participatory planning process was undertaken with wide participation of community groups, ngos, government agencies, school groups, and others. An Advisory Committee was formed of these actors and performed specific consultations and reviews of projects and recommendations. Community participation (fishermen, other local users, tourism professionals, teachers, and students) included data gathering, local knowledge use for proposal development, distribution of research results, and in analysis and formulation of recommendations. Some projects began implementation before the completion of the overall plan, in order to maintain the momentum of the participatory approach. The author notes that the "full range of participatory instruments" was not used, in part because they were only being discovered during the process and in part because full participation was not always possible or desirable. The final plan submitted to the Ministry of Planning included a land use plan with precise zoning, and provided for the growth of tourism, urban and industrial uses, along with specific projects for each site and resource.

Several case studies are then described which outline implementation activities including management plans and development activities for a nature reserve, a fishing community, collectors of fuelwood in a mangrove area, and harvesters of sea moss. Communities participated in formulation and enforcement of management plans including restriction of access to sites, zoning of sites, and harvesting limits and seasons. A number of development activities were completed with community participation, including creation of a fishing landing, improving marketing facilities, community education regarding resource use, development of a Local Fisheries Management Authority, development of a fuelwood plantation, sea urchin management and harvesting, and a seamoss farming project. Several of these projects then became demonstration projects for other sites in the region. The author notes that the co-management arrangements for each of the specific situations (sea urchins, mangroves, fuelwood plantation, reef fisheries, and a nature reserve) had to be tailored to those circumstances and that there is no one model.

Failures, difficulties and obstacles were seen as part of the learning process. Several were identified. First, the transition from participatory planning to participatory management and actual implementation had to be recognized and fuller responsibility assumed by the regional NGO, CANARI. In part, this was due to a lack of coordination among government agencies for implementation. In addition, government agencies often resisted the transference of authority and responsibility to local communities for resource management. Also, while informal structures were adequate during the participatory planning phase, formal structures for community responsibility were seen as necessary for implementation; without formal structures, mobilization was not sustained. Finally, the entire regional project, including the many varied activities, required a long time period (10 years) and continued funding, to learn from its successes and mistakes and to develop regional and international linkages and support. The project areas described will be incorporated into a new National Park encompassing the entire region of the case studies, and the activities will be allowed to continue. This park concept is part of St. Lucia's recently released national plan for a System of Protected Areas.

The project's own analysis concluded that 1) it is necessary to formalize the allocation of responsibilities and expected benefits of each of the partners in a co-management regime; 2) users must be properly organized for their interests to be represented and respected and to better negotiate management agreements and enforce joint regulations; 3) there is a reluctance of government agencies to permit a formal transfer of management authority and responsibility to communities; 4) there is a need for inter-departmental coordination to address resource management and environmental issues; 5) the usefulness and relevance of community-based management approaches and the use of popular knowledge of resources in modern management activities can be demonstrated in the field with the help of NGOS, which must have structured activities; 6) co-management efforts must take into account social and economic factors and promote benefits to local people with new economic activities, which take into account occupational multiplicity and the variety of resource use strategies used by the social stratum involved, and users must be consulted in the selection and design of the new activities.

This document provides a useful overview of an ambitious regional approach to participatory conservation and development and in particular to multiple participatory planning and co-management strategies.

16. Richards, M. 1996. "Protected areas, people and incentives in the search for sustainable forest conservation in Honduras," in <u>Environmental Conservation</u>, 23(3):207-217.

Summary: Attitudes and incentives of people living around protected areas are widely considered to constrain successful management of these areas. Two contrasting protected areas in Honduras, a Biosphere Reserve of high biodiversity rain forest, and a cloud forest providing essential environmental services to the capital city, are analyzed in terms of their management problems and the strategies used for their protection. The response at national level to the issues raised in these case studies is then assessed, focusing on the impact of government policies, legal changes affecting land tenure and use, and the role of state institutions in protected area management. The case studies indicate that while the non-government organizations (NGOs) have tried to promote a more participatory approach to conservation (with mixed success), the government has tried to follow a more regulatory approach but without the resources and political will to implement it effectively. Opportunities to provide positive incentives for protection have been missed. The participatory approach has also been complicated by policies and land legislation which have sent out negative or ambiguous signals to local communities. Above all, the case studies show how critical local attitudes are to the achievement of conservation objectives, and demonstrate the need for positive economic incentives. (From author's summary).

17. **Sayer, Jeffrey. 1991. Rainforest Buffer Zones. Gland:IUCN.**

Summary: This volume is structured around discussion of 34 selected case studies from around the world (13 from Latin America) of protected areas and buffer zones. While the author acknowledges that there have been many failures of buffer zone activities and projects in the 1980s, (similar to failed integrated rural development projects in the 1960s and 1970s), there have also been some successes and they are represented in this book. Buffer zones are defined as "A zone, peripheral to a national park or equivalent reserve, where restrictions are placed upon resource use or special development measures are undertaken to enhance the conservation value of the area." The best examples, states the author, are not buffer zones with short-term aid projects, but those which have initiatives taken by local community groups and resource managers, and many of the best buffer zone initiatives have been based upon ad hoc arrangements between local officials and populations. Sayer recommends that national or regional planning agencies should help to coordinate administrative agreements between different government sectoral agencies (agriculture, forestry, parks) for land adjoining protected areas. Buffer zone management can be facilitated if land is titled to the state, but if smallholders are already using the land close to protected area boundaries, it is desirable they be given secure title to this land; land laws should favor retention of forest on private land and not make clearance a prerequisite for land tenure. Buffer zone development projects should be undertaken only when there is a probability that they will have support for ten to fifteen years. Detailed technical plans for buffer zone projects are not desirable; projects should be based on intense dialogue with local communities with ongoing input of technical expertise available. Many projects, in particular agroforestry projects, in the 1980s were too highly detailed and structured to attract international aid but were not practicable or sustained.

The level of detail in the case studies does not provide information for prescribing specific activities for buffer zone management, but rather highlights principles in successful and failed buffer zones. Of interest is the broad range of arrangements from those which are formal, government-oriented, official and legislated, to those which are informal and work with private holders and groups.

18. **Torres Angeles, Mirriam. 1992. "Public Involvement in Huascarán World Heritage Site, Peru," in Parks (IUCN), 3(3):20-22. December.**

Summary: A large National Park in Peru sought, ten years after its creation, to include local user groups in creating and refining a management plan. 45% of the park's area is used for grazing, intensive tourism and hydropower. User groups include local communities within the park, only two of which have been granted legal title, 36 organized grazing groups, mining and hydropower interests. Other institutions in urban areas (Lima) were also consulted. First, a proposal for a management plan was distributed via a letter to rural and urban groups. The proposal was discussed with these groups in 7 workshops. Basic problems were identified as being a lack of selection process for projects, lack of environmental impact assessment, lack of funds, and the need for grazing agreements. A survey was also distributed, with radio publicity, but this was poorly coordinated by park staff. But survey results showed that the local resident groups, while needing greater understanding about the management plan, understood environmental conservation issues and would be willing to participate and reach agreements that would accrue real benefits to them. The Agrarian Unit became involved and set up a planning team. The La Molina National University held training sessions with park staff and professionals. After this 2 year process, a final seminar on the management plan was held in 1990. The author emphasizes the need for technical training of park staff, including enhanced communication with park users, as well as ensured implementation and ensured funding for implementation, or else the confidence of the resident users will be undermined. More workshops were supposed to be held than were held due to lack of funding. The article is brief and a more in-depth discussion of the participation methods would be helpful.

19. White, Alan et al (eds.). 1994. Collaborative and Community-Based Management of Coral Reefs. Hartford:Kumarian Press.

Summary: This volume brings together six case studies of experiences in collaborative and community-based reef management in Asia, the Caribbean and the United States. The authors state that communities rarely will take responsibility for managing resources if it is not clear how they will benefit from management, and they must have clearly defined roles designed to be effective. Interventions needed before communities can perform in these roles effectively include research and documentation of popular knowledge of resources and traditional management systems; definition and establishment of legal instruments formalizing community responsibility; involvement and representation of community members in planning and decisionmaking; and organization, training, financing, legal counsel and technical assistance to build community institutions. In order to catalyze a collaborative and community-based management program, the authors suggest the following phases which are common to the successful cases: 1) Preparation, including proposal writing, gathering of preliminary field data, making personal and institutional linkages; 2) Integration into the community, including making contact with community leaders, attending meetings, answering questions, and introducing the concept; 3) Community education and research, including nonformal education methods such as small groups and one-on-one contact, regarding the ecology of the area and resource management rationales. Local knowledge should be solicited and shared. Participatory research can contribute to baseline data; 4) Formation of core management groups, from existing community institutions when possible. These groups can participate in community education programs and must ultimately take responsibility for initial implementation of management strategies; 5) Definition of management strategies and objectives, with the core group, and definition of implementation roles; 6) Implementation of management strategies and formalization of responsibility and authority, including recognizing the core group and its mandate, tenurial rights, ceremonies, feedback from community members, and initiation of new projects such as tourism, agriculture or small businesses. 7) Replication and extension of the program to other communities, by the core group; this is important to enhance credibility at the original site; 8) Evaluation and adjustment of management efforts, including discussing project results, holding evaluation meetings, planning for the next phase, and modifying any formal agreements necessary with the community and outside organizations. Monitoring of effects of management on the environment is crucial for communities to see the effects of management and to revise management.

The authors note that there must be a policy environment which can open up the political space necessary for stakeholders to actually have a say in collaborative management schemes. Government agencies can monitor and evaluate the effectiveness of community-based management initiatives and participate in joint regulation, including delegating enforcement responsibility to local communities or directly enforcing when necessary. Government agencies can also provide arbitration for disputes between communities.

NON-GOVERNMENTAL ORGANIZATION (UNPUBLISHED) DOCUMENTS:

1. Bayley, Peter et al. 1991. "Environmental Review of the Pacaya-Samiria National Reserve in Peru and Assessment of Project." Prepared for: Washington, D.C.:The Nature Conservancy.

Summary: This is an assessment of the "Employment and Natural Resource Sustainability Project" funded by USAID in the Pacaya-Samiria National Reserve in Peru, providing both an environmental assessment but also a viability assessment of the project in the reserve and in the neighboring buffer zone done by expert consultants. The Project is a series of experiments in small-scale development and environmental and socio-economic monitoring and research, working with local communities. The Project's explicit philosophy or rationale is to promote sustainable renewable resource exploitation within the reserve by surrounding communities, so that it is in their interest to respect regulations and defend the Reserve; the second is to promote alternative income generation through agriculture and fisheries programs outside the Reserve. The author of the assessment warns against too much promotion of the second since it may attract migration from other regions to the buffer zone of the Reserve, and concludes that increased income generation projects outside the Reserve should only be attempted in a later phase of the Project. Other recommendations include institution of an ongoing monitoring program for fish yields and for critical wildlife species, as well as water level and rain gauging, with university students and other governmental and nongovernmental institutions. Also, the assessment recommends feasibility studies for harvesting of particular wildlife species, while recognizing that its recommendations may not be acceptable to traditional harvesters. A number of development and educational activities are recommended, including specific improved technologies for fish and crop marketing and storage (smoking, vacuum packing, etc.), changes in fishery management including suspension of certain regulations and closed seasons, recruitment of local Reserve Guards, and redesign of the institutional structure controlling regulation and enforcement in the Reserve, to improve cooperation among various government agencies (fisheries, wildlife, agriculture). Despite being a natural scientist (aquatic science), the author of the assessment acknowledges that "the success of the project probably depends more on an intimate knowledge of and sensitivity towards the human culture than an *a priori* understanding of the environment." Thus, each ecological (species or ecosystem) assessment also includes discussion of resource use and regulation, including an understanding of the relative value of hunted and fished products including skins and turtle eggs, to residents of communities around the reserve. Local communities have already begun efforts at regulation and enforcement of fisheries, and the Project assessment encourages continuation and support of these efforts. In general, the assessment suggests limited, slow development projects which do not overstimulate expectations of residents, promote cash obtention or requirements over subsistence (thus stimulating exploitation of high-value illegal product extraction), or attract outsiders to migrate there.

This assessment provides an excellent example of using expert scientific knowledge on wild and semi-wild species to understand and guide local resource use and regulation.

2. Conservation International. 1997. "Demarcación de Tierras Comunales y Mapas de Recursos para la Conservación de Diversidad Biológica: Parque Nacional de Madidi y Area de Uso Integral, Bolivia." (In Spanish).

Summary: Conservation International's proposal for activities in the Madidi National Park, Bolivia describes a project for participatory mapping of the park and multiple use area. The area is being heavily logged illegally and several wood and bird species are threatened as is ecotourism potential. The project proposes to empower the local communities to protect the area and to use it sustainably. CI will support demarcation of the area, including use rights to resources and zoning, as well as collect information on traditional knowledge of natural resources and develop practical tools for sustainable use activities. CI will work with the Bolivian government and the local communities to do this. First a Participatory Rural Appraisal will be conducted, along with participatory mapping to help resolve conflicts and to show traditional knowledge of the land, environment, and to evaluate land titles and resource use. This will be followed up by workshops, first with one community and then spreading to others, on how to create technical maps. Community leaders selected by the communities will be trained in the use of GPS and equipped for a series of expeditions. Definitive maps for demarcations and for resource use will then be created. In addition a zone of Ecotourism will be developed nearby with small businesses, with the intention of replication to other communities in the region. The total time period for the mapping phase of the project will be 1.5 years. This document is extremely condensed but shows an innovative use of participatory mapping for demarcation and for internal use zoning with a major international ngo as collaborator.

3. Fundación Charles Darwin Para Las Islas Galapagos. 1992. "Plan Maestro de la Estación Científica Charles Darwin." Galapagos, Ecuador. (In Spanish).

Summary: This document is a "Master Plan" which describes the current status and history of the Charles Darwin Scientific Station in the Galapagos, general lines of action including research conducted (environmental and social), publications generated, training, education, institutional development, work with other organizations, administration, planning and evaluation, zoning, and regional, national and international strategies related to the station. It is largely an internal document meant to help plan the direction of the Scientific Station in its administration and development in the short, medium and long term, in particular regarding definition of objectives, administration, infrastructure and personnel, financing, institutional cooperation, and land use zoning. It also, however, sets out specific policies and guidelines for species monitoring and research. Internal workshops were conducted with station personnel and a Planning Team guided the work.

The Scientific Station assists in the management of the National Park of the Galapagos. A Management Plan for the Park was prepared in 1973 and revised in 1984, and additionally a Marine Resource Reserve created there in 1986 had its Management Plan approved in 1992. The Scientific Station works with the National Park Service of the Galapagos to develop Annual Operating Plans.

The zoning for the lands owned by the Foundation Charles Darwin includes a "Natural Zone" with two subzones for Extensive and Intensive Scientific Use; an "Experimental Zone" in which scientific manipulation is allowed; a "Public Use Zone," for public visitation, education and tourism; and a "Special Use Zone," with four subzones as follows: Areas of Access and Public Passage; an area for the physical plant of the National Park Service of the Galapagos; an operations area for the physical infrastructure of the

Scientific Station; and an area for the housing of employees, students and visiting researchers.

4. Fundación Defensores de la Naturaleza. 1992. "Plan Maestro 1992-1997, Reserva de la Biosfera Sierra de las Minas." Guatemala. (In Spanish).

Summary: This is a relatively short, summarized document, developed with the NGO (author) and approved by the National Council of Protected Areas (CONAP) of Guatemala which outlines the "Master Plan" for the Biosphere Reserve Sierra de las Minas. It briefly mentions the physical, socioeconomic and biological aspects of the Reserve; and it gives the guidelines for management objectives of the reserve, the administrative structure, discusses the zones and boundaries, and briefly outlines the "management programs" for protection, research, environmental education, tourism, timber resources, sustainable livestock systems, and land settlements. The zones are described as the "Zona Núcleo", with preservation, research and limited ecotourism objectives; and the "Zonas de Uso Múltiple o Sostenible, de Amortiguamiento y de Recuperación" which are defined as forestry use, areas of use for residents and recuperation of degraded forest habitat, respectively.

5. Instituto Nacional de Ecologia. 1995. "Programa de Manejo, Reserva de la Biósfera Alto Golfo de California y Delta del Río Colorado." Mexico, D.F.: INE/SEMARNAP. (In Spanish.)

Summary: This is a management program for a biosphere reserve which is 2/3 marine and 1/3 terrestrial. The reserve forms part of the national system of protected areas in Mexico and also is part of a region benefitted by the Mexico/U.S. "Frontier XXI" program which integrates conservation research and monitoring programs with environmental programs for urban areas such as water treatment. Approximately 17% is denominated the "zona núcleo" (core zone) and 83% the "zona de amortiguamiento" (buffer zone or zone of influence). Seventeen marine and terrestrial species are prohibited from capture indefinitely. Among the objectives of the program of the reserve are regulation of productive activities in the area, promotion of sustainable economic and administrative activities for resident communities, environmental education, and in general protection of critical habitat and species. Eleven "environmental subsystems" were identified, mapped and codified. Three broad levels of use are defined, including "protection," with heavily regulated and limited use; "protection with active use," with low impact fishing and collecting allowed, and where specific management programs should be developed; and "usage with control" ("aprovechamiento con control") where productive activities are allowed, including commercial fishing and tourism, but an integrated management program which diminishes their impact is instituted, including development of a tourism management plan and development of alternative fishing activities, technologies and markets. By working with the commercial fishing industry in helping to develop it, the management program hopes to order and control its development in a sustainable manner.

The second part of the management program outlines in detail the short-, medium- and long-term objectives and activities of the program, such as dates of fishing of particular species, development of specific management programs for each marine resource, including rules for foreign fishing and embarcation points, and plans for developing impact studies and other programs such as conflict resolution. The environmental education program outlined has the most explicit plan for community participation, notable particularly in the design phase of the program, with development of didactic materials, including information regarding traditional resource use, with the local communities.

Environmental education is seen as a continuous process without an end point. As part of the program local residents will be trained to work within the reserve in conservation management, education and tourism. There is also a plan for community participation in activities concerning protection of the core protected zone, but this is not detailed.

6. Nature Conservancy, The. 1991. "La Paya National Park, Colombia." Washington, D.C..

Summary: This is one of many summarized documents that the Nature Conservancy has describing parks that it works with in Latin America as part of the Parks in Peril program, and it contains a management strategy and management plan. Biological significance, socioeconomic factors, and threats to the park are first outlined. The "Management Strategy" then outlines the key institutions, including NGOs, government agencies and international donors, which will work with the park to develop and implement projects for managing the park. International funds from USAID will be administered by a Colombian NGO, Fundación Natura, to hire and train project staff, construct park facilities, develop the park patrol, trail system and community extension efforts. The Colombian national parks agency, INDERENA, will provide technical, logistic and financial support as well for implementation of management and will provide direct project oversight. The 'Management Strategy' then outlines conservation goals and strategies, such as guideline development of sound land use practices such as sustainable agriculture and extractive resource areas, solidification of park infrastructure and zoning, community extension and environmental education programs for local communities, applied studies on soil and crop management, flora and fauna inventories, wildlife management and socioeconomic indicator studies, and control and elimination of deforestation, stock and exogenous grasses in the core areas of the park. The park director, an agronomist and a rural sociologist will be hired to train new park guards. A buffer zone area will have an "integrated management plan" which will promote the national park philosophy and environmental awareness in local communities. The agronomist and rural sociologist will work to develop extension for alternative land uses. Effects on local communities will be negative in the short run as resource use is controlled, but long term effects will be positive with protection of watersheds, minimizing flooding of agricultural and pasture land, limiting soil loss and river sedimentation and reduction of agricultural chemicals into the water system. The "Management Plan" is a brief outline, for year one and two, with approximately 5 specific action items per quarter. For example, Year One, First Quarter, includes hiring four park guards and two boat operators, technical training for the Park Director, purchase of three boats, identification and preparation of site for two ranger cabins, and travel of the Parks in Peril coordinator to the park to coordinate activities with the Park Director. The Second Year Management Plan is only an initial outline with five items proposed, such as hiring of the agronomist, more purchase of materials, boundary posting, environmental monitoring and evaluation of indigenous land uses.

This document, and the many others similar to it, are useful in revealing how the Nature Conservancy approaches the Parks in Peril program in Latin America with other institutions, and how management is conceptualized and proposed to be implemented. It would be interesting to see follow-up documents which describe whether activities were actually carried out and how successful they were, particularly the community extension activities.

7. OTS (Organization for Tropical Studies). 1991. "Master Plan for the Management and Development of the La Selva Biological Station of the Organization for Tropical Studies." Costa Rica.

Summary: This is a revised "master plan" for the La Selva Biological Station which outlines: the goals of the OTS, the purposes of the Station, establishes usage limits, and gives guidelines for resolution of researcher grievances; proposes goals and guidelines for research at the station; gives specific regulations for research such as collection procedures, plot location and marking, canopy access, etc.; gives rules for introduction of exotic organisms; describes the zones of the area; guidelines for habitat management, database management, and provides plans for relationships with other actors such as universities, the Costa Rican government, and others; and gives a long term plan for facilities development at the station. There is no apparent participation of the surrounding residents in the development of the plan or presence on the Advisory Committee, despite mention in the introduction that is is pointless to initiate long-term monitoring of animal or plant population without ruling out effects of deforestation in the surrounding region outside the station's boundaries.

Zoning is accomplished via discussion in the Advisory Committee, made up of experts. Zoning includes an "ecological reserve" (formerly "pristine"); "low-impact areas" (formerly "natural") for limited research; "high-impact areas" (formerly "experimental") for high manipulation research projects, including pasture land, secondary forest, abandoned cacao, and moderately-disturbed primary forest; "OTS habitat management areas," such as the arboretum and trails; and "developed areas," where there are buildings including research shelters.

La Selva retains an explicit and close relationship with national park service guards, who assist in controlling illegal hunting and fishing. Forest trial projects seek to have collaboration with the forest service. Research permits must be obtained from the National Park Service. Permits are required for wildlife research from the wildlife service. La Selva's staff is responsible for maintaining an ongoing environmental education program for surrounding communities, in order to attempt to reduce illegal hunting pressure and incursions of squatters.

8. Poff, Cathryn. 1996. "Protected Area Management Options for the Next Century." New Haven: Yale University. (Prepared for IUCN Comission on National Parks and Protected Areas-CNPPA?). Draft.

Summary: The primary objectives of the study are to assess the trends in management arrangements in protected areas; to identify capacities of various groups involved in managing protected areas; to identify what actions can be taken to strengthen those capacities; to distill learning from implementation of protected area management options; and to identify the key ingredients of successful options as well as potential pitfalls of some approaches that fall short of goals.

The author notes a general trend towards decentralization of management to regional and local levels, and generally increased involvement of NGOs, community groups, academic institutions and private sector interests. Most survey respondents saw an increase and trend towards collaborative management. Based on a survey of 1,600 governmental agencies and CNPPA members, the management roles that governments, NGOs and community-based groups can best perform were outlined as following:
<u>Government</u>: enforcing protected area policies; approving management plans; preparing management plans; natural resources inventory; training staff; providing financial resources.

NGOs: Involving locals in implementing management plans; involving locals in preparing management plans; coordinating among managing groups; natural resources inventories/monitoring; social assessment/monitoring.
Community-Based Groups: involving locals in implementing management plans; involving locals in preparing management plans; social assessment/monitoring; managing tourism/recreation.

The author recommends increased efforts to increase and study private sector investment and involvement in protected areas. Following the study, a number of case studies are annexed which illustrate comanagement of protected areas, including examples from Australia, Kenya (Campfire), the Parks in Peril program of Latin America, Belize, Vanuatu, the Maya Biosphere Reserve, Kutai in Indonesia. There is also an annex which shows the methods used in the study's survey and additional results, broken down by respondent group and by world region. For example, the survey showed respondents predicted that governments will in the near future increase communication with local residents, and increase coordination among managing groups.

This document represents literature which charts, foresees and recommends increased comanagement and real involvement of local communities in protected area management.

9. ProAmbi. 1996. "Plan de Manejo para el Refugio Nacional de Vida Silvestre Gandoca-Manzanillo (RNVS-GM)." Vols. I,II and III. Costa Rica: Programa de Estudios Ambientales, Escuela de Biologia, Universidad de Costa Rica, and Ministerio del Ambiente y Energia (MINAE). (In Spanish.)

Summary: This is an extensively documented Management Plan for the National Wildlife Refuge Gandoca-Manzanillo in Costa Rica, a "mixed" reserve which is 80% privately owned and 20% state land. This is a very carefully laid out, detailed and complex Plan which seems to set a precedent for the region.

A National Conservation System was proposed in CR in 1995 and the Ministry of Environment and Energy was restructured. The activities of several government departments (e.g. forestry, wildlife and parks) are subsumed and thus more coordinated with regards to planning and management. As a result of numerous conflicts and complaints regarding the RNVS-GM, it was chosen as the first site to receive a Management Plan under the new Ministry. Three lines of diagnostics were done to create the Plan, one biophysical, one socioeconomic, and one institutional. The methodologies used for the first two were based on Rapid Ecological Appraisal methods, while for the last a methodology of Objective Oriented Project Planning (Planificacion de Proyectos Orientada a Objectivos - ZOPP) was used as well as a "FODA" analysis ("fortalezas, oportunidades, debilidades, amenazas").

Management recommendations are structured to contain general and specific objectives ("what"), deadlines ("when"), and activities ("how"). Activities are presented in levels from general (regional or global), to subregional to local. Annual Operating Plans implement the Management Plan. A more active participation of civil society is recommended in the Plan, including creation of "Zone Support Committees" (Comités Zonales de Apoyo) in addition to an Advisory Committee (Comité Asesor). 16 discussion sessions, eight meetings and 4 open workshops were conducted with the public before the Management Plan recommendations were made.

Volume I introduces the area, methods and details the objectives and timeline. Volume II outlines 15 distinct zones with distinct management recommendations. The zones are generally divided by habitat/geographic type. Within each zone, recommendations are made for recommended uses, conditional uses, property holding sizes, population density, agricultural uses (much subsistence agriculture allowed), livestock (usually subsistence), and forest use. A text discussion of each zone is presented, along with a graphic "box" format summarizing the permitted/suggested uses.

10. Sociedade Civil Mamirauá, et al. 1996. "Mamirauá Management Plan." Brasília: SCM, CNPq, IPAAM.

Summary: This is a document prepared for public distribution describing Brazil's largest protected flooded forest wetland in the Amazon, which also has a strong component of working with 60 resident, traditional "caboclo" communities and is well-known in Brazil for being innovative and successful. The area's status was changed in 1996 from Ecological Station to 'Sustainable Development Reserve' to incorporate the work with resident communities. The communities participate in research, monitoring, extension and protection. The Mamirauá Project was initiated in 1992, and consists of five program components: Core Operations, or administrative and operational activities; Terrestrial Systems, with research on caimans, hunting, timber extraction, forest and fauna surveys, and seed dispersion; Aquatic Systems, with studies in limnology, the fish market, biology of commercial and ornamental fishes, and aquatic mammals; Socio-Economic and Community Participation, with extension efforts in environmental education, health, economic issues and community organization; and Databases, which organize the GIS data of the Project.

The communities were organized into nine self-selected "sectors" each of which has a coordinator and two representatives which attend annual 'General Assemblies' with local and national government representatives, NGO and researchers, as well as regular community meetings, at which management decisions are discussed and voted on. Decisions have been made by the communities to close the core area to outside resource users; to develop a zoning scheme which classifies the lakes into strict protection, subsistence, or commercial (community) fishing; to allocate other lakes to outside resource users (urban area fishermen), and to prohibit timber extraction in sensitive areas bordering lakes. Support for enforcement of these decisions is given by the Brazilian government environmental agency, IBAMA. Additional zoning suggestions were developed by the expert scientist research team and include a 'protection' zone (in lieu of a strictly prohibitive core zone), bird rookeries zone, an eco-tourism zone, freshwater turtle zone, and a caiman zone. All of the zones were discussed with and approved by the resident communities. Specific uses in these zones were discussed and approved, such as hunting and fishing methods and prohibition of taking endangered species. A Coordinating Council is being created which will have resident community members as well as outside members of the Project team. The Project has extensive extension goals, including a public health unit, education, economic production, and training of community leaders and monitors, including community environmental monitors.

This document is more of a public relations document and summary of the project than an actual management plan. The participatory zoning approach and participatory monitoring are of particular interest.

11. United Nations Environment Programme (UNEP). 1990. <u>Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region</u>. From Conference of Plenipotentiaries Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region, Kingston, 15-16 January.

Summary: Of particular interest is Article 6 of the Protocol, which is reproduced here:

<u>Planning and Management Regime for a Protected Area</u>
1. In order to maximize the benefits from a protected area and to ensure the effective implementation of the measures set out in Article 5 (Protection Measures), each Party shall adopt and implement planning, management and enforcement measures for protected areas over which it exercises jurisdiction and sovereign rights. In this regard, each Party shall take into account the guidelines and criteria established by the Scientific and Technical Committee and which have been approved by the meetings of the Parties.
2. Such measures should include:
a) the formulation and adoption of appropriate management guidelines for protected areas;
b) the development and adoption of a management plan that specifies the legal and institutional framework and the management and protection measures applicable to the area;
c) the conduct of scientific research and monitoring of ecological processes, user impacts, habitats, species, populations and activities aimed at improved management;
d) the development of public awareness and education programmes for users, decision-makers and the public to enhance their appreciation and understanding of the protected areas and the objectives for which is was established;
e) <u>*the active involvement of local people and enterprises, as appropriate, in the planning and management of the protected area, including assistance to, and training of local inhabitants who may be affected by the establishment of the protected area*</u>; (emphasis added here)
f) the adoption of measures, including mechanisms for generating revenues for financing the development and effective management of protected areas and facilitating programmes of mutual assistance;
g) contingency plans for responding to incidents that could cause or threaten damage to the protected area including its resources;
h) the establishment of procedures to permit, regulate or otherwise authorize activities compatible with the objectives for which the protected area was established; and
i) the establishment of a management capacity, especially trained personnel, as well as appropriate infrastructure.
Also, <u>Article 8</u> is of interest:
<u>Establishment of Buffer Zones</u>
Each Party to this Protocol may, as necessary, strengthen the protection of a protected area by establishing, within areas in which it exercises sovereign rights and jurisdiction, one or more buffer zones in which activities are less restricted than in the protected area while remaining compatible with achieving the purposes of the protected area.

12. World Wildlife Fund. 1997 "Lessons from the Field: A Review of World Wildlife Fund's Experience with Integrated Conservation and Development Projects, 1985-1996." Final Draft Report. Washington, D.C.: WWF.

Summary: A workshop of WWF-US was held to review the progress of working with ICDPs. Three "generations" of ICDPs were identified: a first generation in the 1970s and 80s which worked with compensation projects in buffer zones; these cash or other compensation schemes such as schools and health posts were seen as unwieldy and unrelated to conservation objectives while not actually involving residents in participatory management decisionmaking. A second generation is identified as coming into its own in the 1990s which includes projects focusing on rights and responsibilities in resource management, of local communities and working with a variety of stakeholders. Some collaborative management arrangements occur here and promote "active community participation", build community capacity, and conduct feasibility assessments of economic activities. Policy reform is worked on to empower local communities. A third generation of ICDPs may be arriving which includes a broader "landscape approach" to conservation. Examples of the three generations are shown in a box on page 6. 10 recommendations resulting from the workshop are discussed in the rest of the document. Adaptive Management is described superficially on page 29: "Under adaptive management, conservation organizations and their partners create, implement, and monitor plans, feed the results back into implementation, and modify the project as necessary. ...a process of rigorous self-evaluation is particularly important...An adaptive management approach can also be applied to project processes, such as managing institutional roles, relationships and alliances, and identifying and integrating stakeholders, as these factors are not static. This approach assumes that project plans cannot address all the relevant variables or anticipate all the consequences and complexities of environmental management." Collaborative management is discussed on page 35. Collaborative management involves formal and informal agreements between government and rural communities regarding access to resources; "The development of effective collaborative management agreements requires government to endorse the concept and provide political support for the demanding process of negotiating agreements." There must be mechanisms for collaboration, identification of priority resources and levels of extraction, formal rules for resource use among different stakeholders, and monitoring of resource use. Community stakeholders must have skills, knowledge, and authority to negotiate. This approach should not be undertaken without a supportive policy environment and adequate time, skills, and other resources. Steps for a collaborative management process are outlined on page 36.

Buffer zones are mentioned peripherally and seen as outdated.

13. World Wildlife Fund. 1996 "The Enabling Environment for ICDPs: Policies, Institutions, and Ethical Dilemmas at Local, National and International Levels," Workshop III of the ICDP Review, May 5-9, Syria, Virginia. Final Draft Report. Washington, D.C.:WWF.

Summary: This workshop was largely focused on guiding WWF engagement in policy issues, therefore mainly an internal discussion. There was little actual discussion of real participation of protected area-dwellers, except the 5 principles suggested by Sandy Davis for engagement with indigenous peoples: listening and sharing; transparency; attempts to reach consensus; formalized agreements; and adaptive management. Of the four case studies presented, the Latin American case did not involve an ICDP/PA. Overall, of little or no relevance to our objectives unless we want to include a policy angle. Of possible greater interest could be the other workshops in the WWF series, mentioned in this report: Workshop II, "Local Knowledge, Values and Social Oragnization: Foundations for Biodiversity Conservation," Nov. 12-19, 1995, Palawan Island , Philippines; and Workshop IV "Measuring Conservation Impact in ICDPs," Dec. 4-8, 1996, Arusha, Tanzania; and Workshop I "Linking Conservation and Human Needs: Creating Economic Incentives," April 30-May 6, 1995, Yucatan, Mexico.

Conclusion:

Our research repeatedly comes to the conclusion that a special moment is at hand in the history of PNLH and the Dominican Republic. With one of the highest ratios of protected landscape in the world, at least on paper (see GEF Report, December 1996), the social consequences are equally dramatic. These areas are not social vacuums, but cultural landscapes with social networks, communities and fabrics. There is little hope that, even if the Presidential Decree (#319) passed in 1997 ratifies the special conservation status of this area, the same government will have the financial means to pay for mapping, servicing, and enforcing these units, not to mention environmental education, restoration, regulated ecotourism and infrastructure. The only way to accomplish large-scale conservation with social implications is to incorporate local people as allies in the product and process of conservation.

In our view, the time is appropriate for an approach to conservation which encourages rather than denies the role of local residents and users of the LHNP landscape. With respect to people, regardless of their education or social position, the park's future should be inclusionary rather than exclusionary. This does not presume that everything necessary for successful park management is currently known or understood, but rather that many management adaptations will be required in the years ahead to maintain a balance between human and biophysical interests. We view these adaptations as a sign of healthy planning and collaborative learning by all parties rather than failure, compromise or setback.

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