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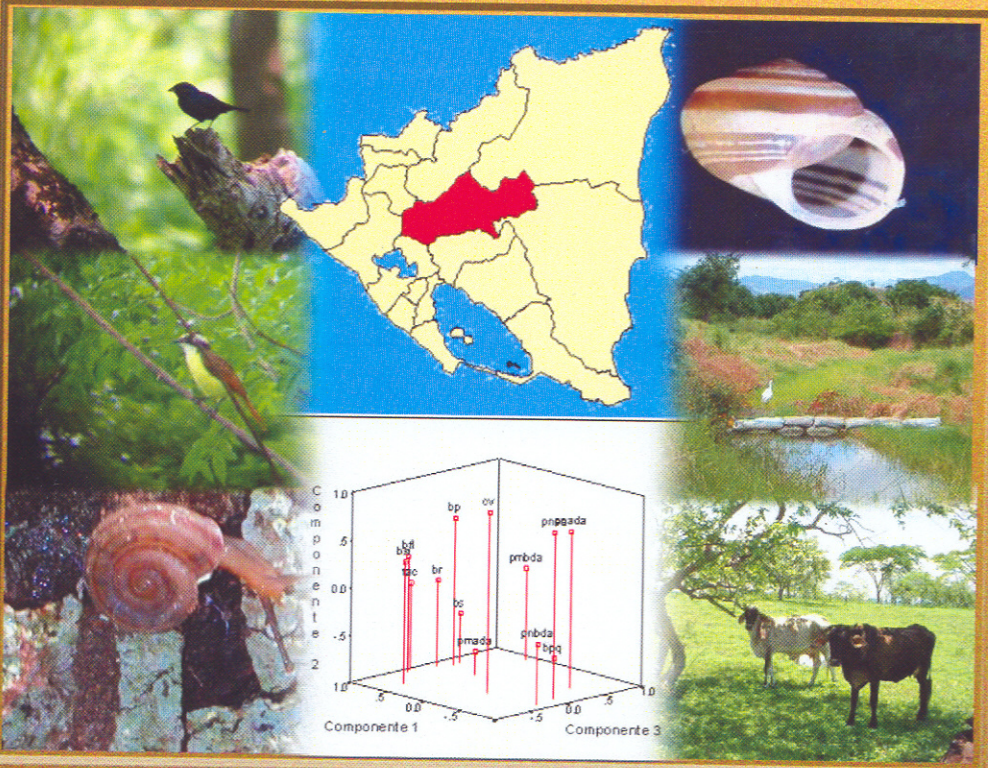

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Developing a Species-based Model for Biodiversity Assessment in an Agricultural Landscape in Nicaragua.

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Key words: Species niche, models, birds, mollusks, trees, Nicaragua.

ABSTRACT

An important effect of cattle raising in Nicaragua has been fragmentation of natural landscapes, mainly forests. On the central region as well as in other parts of the country, fragmented landscapes have originated mostly as a direct effect of deforestation made to explode local forest resources and create new areas for agriculture and cattle raising. Here, we present results of various analyses made, mostly based on information from PËREZ *et al.* (2006) regarding one year of monitoring species composition and community structure on birds, mollusks and trees communities from silvi-pastoral systems of Matiguás and Paiwas, Dpt. of Matagalpa. Our main conclusions are as follows. Land uses show a low number of species strictly associated to them. Land uses with highest number of exclusive birds are Riparian Forests and Primary Forest of Quirragua protected area with six species; Land use type with highest number of mollusk species is Primary Forest of Quirragua protected area with seven species. Beta diversity could be as well considered medium. It means that there are some species exclusive to particular land use types but many species are shared among land use types, given as a result a medium turnover rate. An analysis made in order to assess tolerance to disturbance showed that average values for the birds community are above .5 (ranging from 0, specialist species, to 1, generalists) which means we have more generalist species than specialist ones. Average values for the whole mollusks community are below .5 which means that these taxa are mainly make up of species related to forests. Average values for the trees community are below .5 which means that these taxa are probably relic species proceeding from the pristine forests existing on the area. A similar analysis was conducted utilizing STILES & SKUTCH (1998) forest dependence categories. With those criteria we observed no forest dependent bird species, 95 species were generalists for a 63 % and 56 species are open areas species, comprising 37 % of the total. On mollusks we found six (6) forest dependent species comprising 30 %, 10 generalist species representing 50 % of the total and four (4) open areas species for a 20 %.

RESUMEN

Un efecto importante de la ganadería en Nicaragua ha sido la fragmentación de paisajes que antes eran cubiertos de bosques. En la región central como en otras zonas del país, los paisajes fragmentados en su mayoría se han originado por efectos de la deforestación para explotar los recursos forestales y /o disponer de nuevas áreas para la agricultura y la ganadería. Aquí presentamos los resultados de varios análisis realizados mayormente con base en información de PËREZ *et al.* (2006) en relación con monitoreo de composición y estructura de las comunidades de aves, moluscos y árboles en sistemas silvo-pastoriles de Matiguás y Paiwas, Dpto de Matagalpa. Nuestras conclusiones principales son las siguientes. Los usos de suelo estudiados muestran un bajo número de especies estrictamente asociadas a ellos. Los usos con mayor número de especies de aves exclusivas son los Bosques Riparios y el Bosque Primario del área protegida de Quirragua con seis (6) especies; el uso con mayor número de especies de moluscos es el Bosque Primario del área protegida de Quirragua con siete (7) especies. La diversidad beta puede ser considerada media, esto significa que hay algunas especies exclusivas para ciertos usos de suelo pero muchas especies son compartidas entre varios usos de suelo, dando como resultado una tasa de recambio media. El análisis realizado para evaluar la tolerancia a las perturbaciones mostró valores promedio en las comunidades de aves por encima de 0.5 (oscilando entre 0, especies especialistas, hasta 1, generalistas), lo que significa que tenemos más especies generalistas que especialistas. Para las comunidades de moluscos los valores promedio están por debajo de 0.5, lo que indica que en este grupo predominan las especies especialistas, relacionadas con hábitats cerrados. Las comunidades de árboles se encuentran por debajo de 0.5 lo que podría indicar que son especies relictivas de los bosques prístinos existentes en la zona. Un análisis similar fue realizado utilizando las categorías de dependencia del bosque de STILES & SKUTCH (1998). Con estos criterios no encontramos especies de aves dependientes de bosque, 95 especies fueron generalistas para un 53 % y 56 especies fueron de áreas abiertas para un 37 % del total. En moluscos encontramos seis (6) especies dependientes del bosque comprendiendo el 30 %, 10 especies generalistas representando el 50 % de las especies estudiadas y cuatro (4) especies de áreas abiertas representando el 20 %.

INTRODUCTION

An important effect of cattle raising in Nicaragua has been fragmentation of natural landscapes mainly forests. On the central region as well as in other parts of the country, fragmented landscapes have originated mostly as a direct effect of deforestation made to explode local forest resources and create new areas for agriculture and cattle raising (LEVARD *et al.* 2001, RUÍZ, 2003). Negative impacts of deforestation on important ecological processes have affected among others, dispersion, migration, competition and natural extinction of species, all of them with a great deal of influence on biodiversity at a landscape level (WILCOX, 1980; HARRIS, 1984).

In the present paper we present results of various analyses made, mostly based on information from PËREZ *et al.* (2006) regarding one year of monitoring species composition and community structure on birds, mollusks and trees communities from silvi-pastoral systems of Matiguás and Paiwas, Dpt. of Matagalpa. These data have allowed us to establish management and conservation priorities at local and national levels, as well as enhancing the importance of silvi-pastoral systems as biodiversity reservoirs outside protected areas.

Studied taxa were chosen with the purpose of comparing data taken on three different biological groups, invertebrates with low vagility (mollusks), vertebrates with very high vagility (birds) and trees (sessile).

We conducted a beta diversity analysis as well an analysis of association between species and land-use types. We also included some distribution maps as example of the 60 species distribution maps we made for birds, trees and mollusks.

The framework of this paper was profited for proposing some guidelines for policy support in Nicaragua.

CONTEXT

Location: Nicaragua, with a total surface of 128,000 km^2, is the largest Republic of Central America. It is located among geographical coordinates 10^{o}45' and 15^{o}05´ of latitude north and 83^{o}15´ and 87^{o}40´ of longitude west: limits to the north with Honduras, to the east with the Atlantic Ocean (Caribbean Sea), to the south with Costa Rica and to the west with the Pacific Ocean (Fig. 1). The land surface is 118.358 km^2, since it contains two large freshwater lakes, Lake Managua (1,040 km^2) and Lake Nicaragua (8,200 km^2), which constitute 7.6 % of the national territory. Besides, the country is divided into three main bio-geographic zones (Fig. 2).

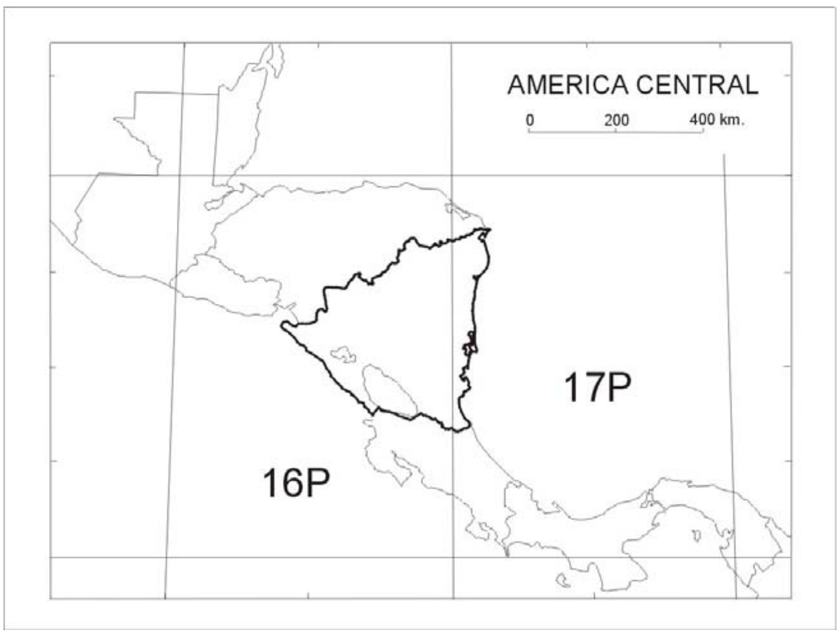


Fig. 1.- Nicaragua in Central America, in UTM notation of 1.000 km^2.

1. Pacific region (38,700 km^2).
2. Central-north region (42,400 km^2).
3. Atlantic region (46,600 km^2).

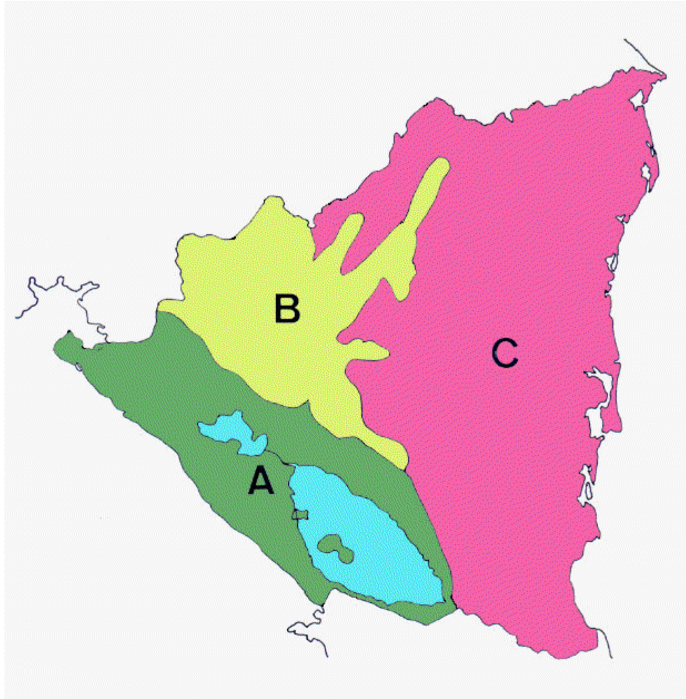


Fig. 2.- The Nicaraguan Pacific slope according to OVIEDO (1993) and INCER (1973) (A); B: Central-North region, C: Atlantic region.

Climate:

Rainfall: In general terms the more rainy months are July, September and October, 90 % of rainfall is recorded between May and October with a small interruption called the "Canícula", between July and August. The total volume of rainfall during the year is estimated on 270 x 10^9 m^3 , of which 13 x 10^9 m^3 (7 %) fall on the Pacific Slope and 259 x 10^9 m^3 (93 %) on the Atlantic region.

In Table 1 there are presented the records from various climate stations all over the country. Abbreviations means: St: Station, CH: Chinandega, S: Augusto César Sandino, RI: Rivas, JU: Juigalpa, CO; Condega, AN; Annual.

Table 1.- Data on rainfall for Nicaragua.

St	E	F	M	A	MY	JU	JL	AG	SE	OC	NO	DI	AN
CH	0	0	9	21	241	289	201	279	415	323	69	14	1861
S	6	0	1	5	135	168	130	160	218	187	64	11	1085
RI	10	5	6	14	154	243	156	206	340	341	108	34	1517
JU	10	3	6	16	121	191	118	159	247	215	83	17	1187
CO	8	2	6	11	112	104	75	83	141	129	29	12	712

Temperature: Highest values have been recorded for the flat lands of the Pacific and Atlantic regions, with temperatures between 35 and 40^o C, and on the other hand, lowest values have been recorded for the high lands of the Central-North region (Jinotega and Matagalpa), with values between 14 and 17^o C (Table 2).

Table 2.- Data on temperature for Nicaragua.

St	**E**	**F**	**M**	**A**	**MY**	**JU**	**JL**	**AG**	**SE**	**OC**	**NO**	**DI**	**AN**
CH	26.3	27.1	30.6	28.8	27.7	26.7	27.0	26.9	26.1	26.0	26.0	25.9	27.1
S	25.4	26.3	27.7	28.6	28.2	26.5	26.4	26.2	26.1	25.9	25.9	25.2	26.5
RI	25.3	25.7	26.9	27.5	27.5	26.4	26.4	26.2	26.1	26.1	26.0	25.1	26.3
JU	25.4	25.8	27.2	27.9	27.6	26.1	26.1	26.0	25.7	25.6	25.9	25.5	26.2
CO	22.3	23.1	22.9	26.2	26.5	24.8	24.3	24.6	24.8	24.6	23.5	22.6	24.3

Humidity: The Pacific region shows a great deal of variation on humidity between the dry season (February, March and April, 67-69 %), with the lowest values, and the rainy season with the highest values on September and October (89 %). The Atlantic region on the other hand has stable high values all over the year (83 % in April to 90 % in August) (Table 3).

Table 3.- Data on humidity for Nicaragua.

ES	**E**	**F**	**M**	**A**	**MY**	**JU**	**JL**	**AG**	**SE**	**OC**	**NO**	**DI**	**AN**
CH	70	67	69	69	82	85	80	84	89	89	84	77	79
S	70	66	65	64	73	83	80	81	83	84	80	75	75
RI	79	76	74	72	78	84	87	83	84	85	87	70	80
JU	74	72	72	73	78	83	83	83	83	82	78	75	78
CO	69	63	59	55	65	75	74	72	76	76	73	69	69

Evaporation: Highest values are seen on the dry season coinciding with warmest months. Lowest values are located on the rainy season coinciding with coldest months.

Table 4.- Data on evaporation for Nicaragua.

ES	E	F	M	A	MY	JU	JL	AG	SE	OC	NO	DI	AN
CH	165	191	226	220	145	117	138	125	109	109	115	139	1779
S	208	230	277	275	231	161	174	170	158	147	155	173	2359
RI	188	192	242	250	198	145	142	139	126	128	129	159	2038
JU	238	207	281	266	194	123	169	148	149	136	178	189	2278
CO	171	193	257	251	215	147	154	146	140	140	137	149	2100

Winds: In Nicaragua predominates winds NE, E and N, with speeds ranging from 2.2 and 5.6 m/s.

MATERIAL AND METHODS

Study site: It is located within the triangle composed of the protected areas of Sierra Quirragua, Cerro Musún and Fila Masigüe to the south (Fig. 3). It encompasses the Comarca of Bulbul, belonging to the Town of Matiguás with UTM coordinates UTM 670165 E, 1417108 N, an extension of 1335 km^2 and a population of 38,584 inhabitants, of which 81 % live on rural areas (INEC, 1995; LEVARD *et al*. (2001); as well as the Comarca of Paiwas, belonging to the Town of Río Blanco, with coordinates UTM 686152 E, 1424706 N, an extension of 700 km^2 and a population of 33,195 inhabitants of which 23,950 (72,15 %) live on rural areas (INIFOM, 2004); both zones belong to the Department (= province) of Matagalpa (Fig. 4A, B).

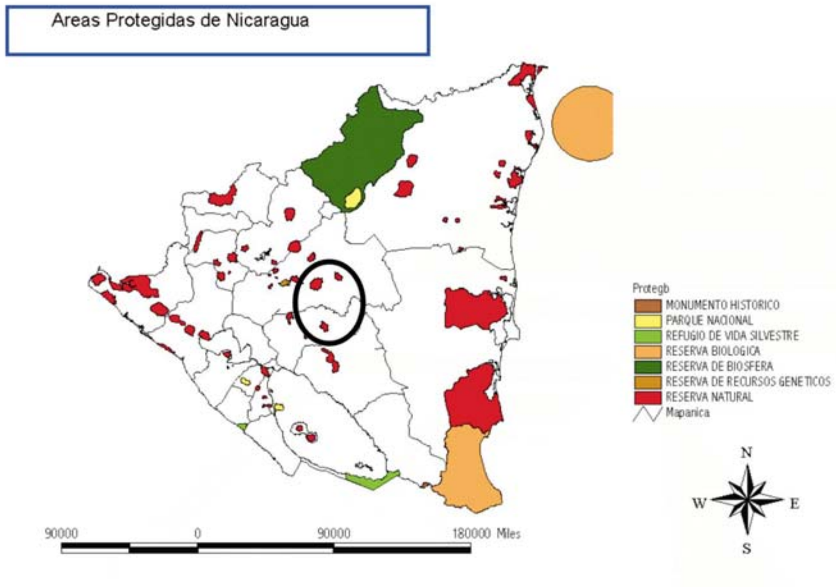


Fig. 3.- The study site located within the triangle composed of the protected areas of Sierra Quirragua, Cerro Musún and Fila Masigüe to the south. Map taken from CBM-MARENA (2001).

Fig. 4.- Department of Matagalpa (in red) in the context of Nicaragua. Other polygons are also departments.

Selection of farms and land-use types: We chose 12 land use types that we consider the most representatives of the Nicaraguan cattle farms, as well as a protected area nearby: Natural pastures with high density of trees (PNA), Natural pastures with low density of trees (PNB), Improved pastures with high density of trees (PMA), Improved pastures with low density of trees (PMB), Pastures without trees (PNS), Fodder banks (BFL), Live fences (CP), Successions (SV) Riparian Forests (BR), Secondary Modified Forests (BSI), Secondary Forests (BS), Primary Forests (BP), Primary Forest of Protected Area (BPQ=BPP).

We made a non-random selection of our sampling farms due to budgetary among other reasons. We chose farms with as many land use types as possible in order to minimize transportation among farms. From that first group selected we made a second level selection in which we considered farms with land use types over an area of 0.7 ha (= 1 manzana), this last level of selection was made for assuring the sampling quadrants to fit within the areas of the land uses chosen.

There were made 10 quadrants on each land use type whenever possible, taking into account the Rule of 10 (GOTELLI Y ELLISON, 2004); in all those quadrants we sampled vegetation and birds. We avoided making replicates of the same land use type on a particular farm, so made a random selection in the case of finding one land use type repeated on the same farm. The centre of the sampling quadrant was located approximately on the centre of the land use type for minimizing the edge effect. Likewise the centre of the quadrant was used as an observation point for bird plot counts.

Vegetation: For the study of vegetation we made quadrants of ca. 20 x 20 m (400 m2) (Fig. 5) according to the criteria of CHIPLEY *et al.* (2003). On the sampled quadrants we identified and counted all trees present. We considered a tree a plant with 10 cm DBH (1.10 m). For identification we used SALAS (1993) and POVEDA & SÁNCHEZ-VINDAS (1999), as well as MOGOT (on line).

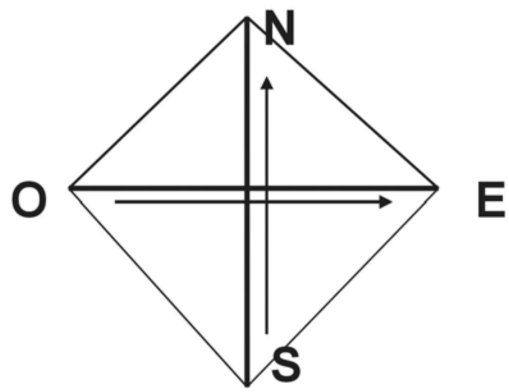


Fig. 5.- Quadrant for monitoring vegetation structure.

Birds: For studying bird communities we made samplings between 6 and 10 am. Observations were conducted from the chosen points within 25 m radio and for a period of 10 minutes (Fig. 6), on each quadrant, as suggested by WUNDERLE (1994). For bird identification and general data on birds we utilized HOWELL & WEBB (1995), STILES & SKUTCH (1998) and AOU (1998).

Fig. 6.- Plot count for monitoring structure of bird communities.

Mollusks: We sampled 50 % of the vegetation quadrants, making a mixed strategy of collecting freely for 20 minutes, making eye revision of the soil litter, rocks, logs, tree trunks, etc., as well as collecting a litter sample on an area of 50 x 50 cm for further revision at the laboratory. Procedures were as usual for this taxonomic group (ALTONAGA, 1988).

We conducted two sampling campaigns, one between March and May 2004, and the second one between July and September of the same year.

For identification of material we utilized PÉREZ & LÓPEZ (2002), as well as material stored at UCACM collections (Colecciones Centro de Malacología y Diversidad Animal de la Universidad Centroamericana).

Analysis of data:

Nomenclature: For species nomenclature we utilized the following contributions:

- Vegetation: SALAS (1993).
- Birds: MARTÍNEZ (2000).
- Mollusks: PÉREZ & LÓPEZ (2002).

For English names of birds we used STILES & SKUTCH (1998), and for plants MOGOT (on line).

Ecoregion: Eco-regions nomenclature was taken from GROVES *et al.* (2000), and OLSON *et al.* (2001). The study site is located on the Central American Atlantic moist forest eco-region, where predominant soil types are Entisols and Oxisols according to FAO-UNESCO (1987) classification.

Preference for habitat and distribution: Data on habitat preference and species distributions have been taken from PÉREZ *et al.* (2004). Distribution maps of species were made using only presence/ absence information; for the synthesis maps we used a three level category in which: 1: rare species, 2: scarce or non abundant species, and 3: abundant species.

We chose a small set of species to include pictures and distribution maps. Pictures given with distribution maps of are either ours in the case of mollusks and living birds or taken from STILES & SKUTCH (1998) in the case of bird drawings. Images of trees were taken from MOGOT (on line).

For further analysis on the relationship between species and land use types we ordered species and abundances considering four major land use types: “Forests”, comprising Primary Forests and Riparian Forests, “Fragments” comprising Live fences, “Secondary forests” comprising Secondary Forests, Secondary Disturbed Forests and Successions, and “Pastures” comprising all Pastures plus Fodder banks. We calculated mean abundances for each species on primary forest and then we obtained the abundance ratio for each species abundance in pastures / abundance in Primary forest; abundance in secondary / abundance in primary.

For this purpose we omitted species which does not exist in Primary Forests. Finally, we truncate at 1 if abundance in disturbed land use types is higher than in primary ones.

A niche analysis can be also performed utilizing forest dependence categories proposed by STILES & SKUTCH (1998), which are the following:

3: Low dependence (Open areas)

3-2 (2.5): Medium to low.

2: Medium (Generalist).

2-1 (1.5): Medium to high.

1: High dependence.

Abundance: Data on species abundance have been taken from PÉREZ *et al.* (2004) and consist of the number of individuals collected at the study site during the previously established period of time.

Density: For calculating species density we utilized the following formula:

$$D = \frac{\text{Total abundance}}{\text{No. quadrants where a species was found x Total area sampled}}$$

Where:

D= Density.

Area of each quadrant= 400 m2.

Soil type: Data related to soil type were taken from RUÍZ (2003) and PONCE (2005).

Beta diversity: We calculated Jaccard and Morisita Horn´s indexes for assessing beta diversity among land-use types. We also made a cluster analysis using Jaccard¨s index and a single linkage strategy.

Guidelines for policy support: We proposed some guidelines for policy support as well cited some conventions and protocols the state of Nicaragua has signed.

For that purpose we have reviewed MILLENIUM ECOSYSTEMS ASSESSMENT. (2005), RIVAS (2005) and we have consulted Marcela Nissen (Director of Biodiversity, MARENA, Nicaragua).

RESULTS

Systematic list of species.

Plants.

Order Fabales

Family Mimosaceae

Albizia caribaea (Urb.) Britton & Rose, Bean (9/ 12 land-use types)

Albizia saman (Jacq.) F. Muell., Bean (11/ 12 land-use types)

Enterolobium cyclocarpum (Jacq.) Griseb., Bean (10/ 12 land-use types)

Leucaena salvadorensis Standl. ex Britton & Rose, Bean (6/ 12 land-use types)

Order Urticales

Family Moraceae

Brosimum alicastrum Sw., Mulberry (4/ 12 land-use types)

Maclura tinctoria (L.) D. Don ex Steud., Mulberry (10/ 12 land-use types)

Order Sapindales

Family Burseraceae

Bursera simaruba (L.) Sarg., Jiñocuabo (8/ 12 land-use types)

Order Rubiales

Family Rubiaceae

Calycophyllum candidisimum, Madroño (4/ 12 land-use types)

Genipa americana L., Coffee (6/ 12 land-use types)

Order Fabales

Family Caesalpinaceae

Cassia grandis L., Bean (8/ 12 land-use types)

Order Urticales

Family Cecropiaceae

Cecropia peltata L., Cecropia (5/ 12 land-use types)

Order Sapindales

Family Meliaceae

Cedrela odorata L., Mahogany (5/ 12 land-use types)

Order Lamiales

Famila Boraginaceae

Cordia alliodora (Ruiz & Pav.) Oken, Borage (11/ 12 land-use types)

Order Fabales

Family Fabaceae

Gliricidia sepium (Jacq.) Kunth ex Walp., Bean (8/ 12 land-use types)

Platymiscium pleiostachium, Coyote (11/ 12 land-use types)

Order Malvales

Family Sterculiaceae

Guazuma ulmifolia Lam., Cacao (11/ 12 land-use types)

Order Malvales

Family Tiliaceae

Luehea candida (Moc. & Sessé ex DC.) Mart., Linden (5/ 12 land-use types)

Order Sapindales

Family Anacardiaceae

Spondias mombin L., Jobo (5/ 12 land-use types)

Order Scrophulariales

Family Bignoniaceae

Tabebuia ochracea (Cham.) Standl., Trumpet-creeper (8/ 12 land-use types)

Tabebuia rosea (Bertol.) A. DC., Trumpet-creeper (11/ 12 land-use types)

Birds.

Order Apodiformes

Family Trochilidae

Amazilia rutila, Cinnamon Hummingbird (12/ 12 land-use types)

Order Passeriformes

Family Emberizidae

Arremonops conirostris, Black-striped Sparrow (10/ 12 land-use types)

Volatinia jacarina, Blue-black Grassquit (12/ 12 land-use types)

Order Columbiformes

Family Columbidae

Columbina talpacoti, Ruddy Ground-Dove (11/ 12 land-use types)

Order Cuculiformes

Family Cuculidae

Crotophaga sulcirostris, Groove-billed Ani (12/ 12 land-use types)

Order Passeriformes

Family Parulidae

Dendroica petechia, Yellow Warbler (11/ 12 land-use types)

Order Passeriformes

Family Thraupidae

Euphonia affinis, Scrub Euphonia (11/ 12 land-use types)

Thraupis episcopus, Blue-gray Tanager (10/ 12 land-use types)

Order Passeriformes

Family Dendrocolaptidae

Lepidocolaptes souleyetii, Streaked-headed Woodcreeper (10/ 12 land-use types)

Order Passeriformes

Family Tyrannidae

Myiarchus tuberculifer, Dusky-capped Flycatcher (11/ 12 land-use types)

Myiarchus tyrannulus, Brown-crested Flycatcher (11/ 12 land-use types)

Myiozetetes similis, Social Flycatcher (12/ 12 land-use types)

Pitangus sulphuratus, Great Kiskadee (10/ 12 land-use types)

Todirostrum cinereum, Common Tody-Flycatcher (11/ 12 land-use types)

Tolmomyias sulphurescens, Yellow-olive Flycatcher (11/ 12 land-use types)

Tyrannus melancholicus, Tropical Kingbird (12/ 12 land-use types)

Order Passeriformes

Family Troglodytidae

Thryothorus modestus, Plian Wren (9/ 12 land-use types)

Thryothorus rufalbus, Rufous-and-White Wren (9/ 12 land-use types)

Troglodytes aedon, House Wren (12/ 12 land-use types)

Order Passeriformes

Family Turdidae

Turdus grayi, Clay-colored Robin (12/ 12 land-use types)

Mollusks.

Order Archaegastropoda

Family Helicinidae

Lucidella lirata (Pfeiffer, 1847) (12/ 12 land-use types)

Family Poteriidae

Neocyclotus dysoni nicaragüense Bartsch & Morrison, 1942 (6/ 12 land-use types)

Order Stylommatophora

Family Vertiginidae

Pupisoma dioscoricola (C.B. Adams, 1845) (8/ 12 land-use types)

Order Stylommatophora

Family Succineidae

Succinea recisa (Morelet, 1851) (9/ 12 land-use types)

Order Stylommatophora

Family Ferussacidae

Cecilioides consobrinus Orbigny, 1855 (11/ 12 land-use types)

Order Stylommatophora

Family Subulinidae

Beckianum beckianum (Pfeiffer, 1846) (12/ 12 land-use types)

Leptinaria interstriata (Tate, 1870) (12/ 12 land-use types)

Leptinaria lamellata (Potiez & Michaud, 1838) (12/ 12 land-use types)

Order Stylommatophora

Family Spiraxidae

Euglandina cumingii (Beck, 1837) (11/ 12 land-use types)

Salasiella guatemalensis Pilsbry, 1919 (9/ 12 land-use types)

Order Stylommatophora

Family Helicarionidae

Guppya gundlachi (Pfeiffer, 1839) (7/ 12 land-use types)

Order Stylommatophora

Family Zonitidae

Glyphyalinia sp. (11/ 12 land-use types)

Order Stylommatophora

Family Polygyridae

Praticolella griseola (Pfeiffer, 1841) (5/ 12 land-use types)

Order Stylommatophora

Family Thysanophoridae

Thysanophora caecoides (Tate, 1870) (10/ 12 land-use types)

Thysanophora costaricensis Rehder, 1942 (1/ 12 land-use types)

Thysanophora crinita (Fulton, 1917) (6/ 12 land-use types)

Order Stylommatophora

Family Bulimulidae

Bulimulus corneus (Sowerby, 1833) (12/ 12 land-use types)

Order Stylommatophora

Family Systrophiidae

Miradiscops panamensis Pilsbry, 1930 (9/ 12 land-use types)

Order Stylommatophora

Family Charopidae

Chanomphalus pilsbryi Goodrich & v. d. Schalie, 1937 (Baker, 1922) (4/ 12 land-use types)

Order Stylommatophora

Family Sagdidae

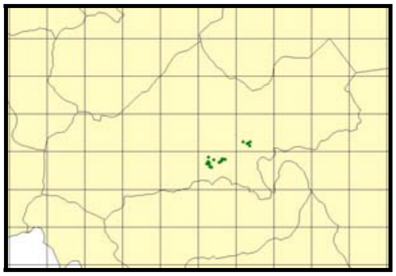
Xenodiscula taintori (2/ 12 land-use types)

Most representative species distributions.

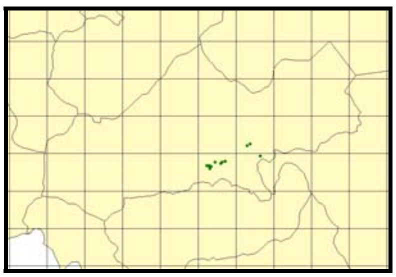
Trees.

Family Mimosaceae

Albizia saman (Jacq.) F. Muell., Bean (11/ 12 land-use types)

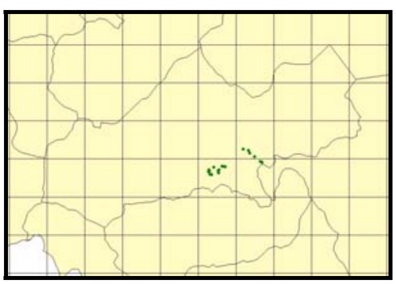


Enterolobium cyclocarpum (Jacq.) Griseb., Bean (10/ 12 land-use types)



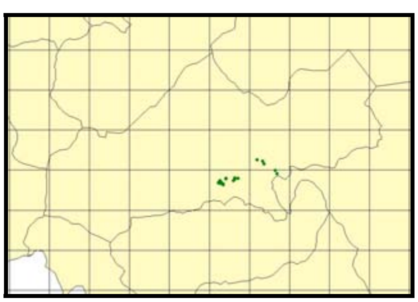
Family Burseraceae

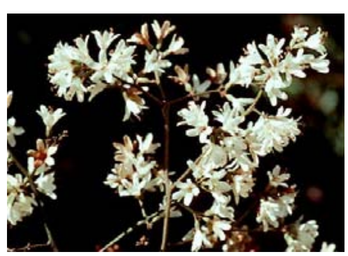
Bursera simaruba (L.) Sarg., Jiñocuabo (8/ 12 land-use types)



Famila Boraginaceae

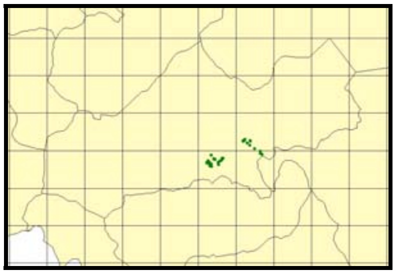
Cordia alliodora (Ruiz & Pav.) Oken, Borage (11/ 12 land-use types)





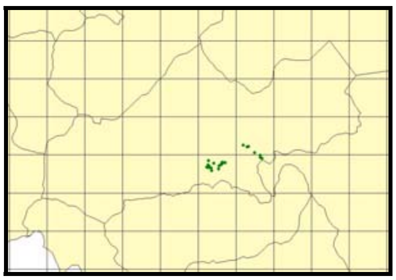
Family Sterculiaceae

Guazuma ulmifolia (L.) Cockerell, 1892 Cacao (11/ 12 land-use types)



Family Bignoniaceae

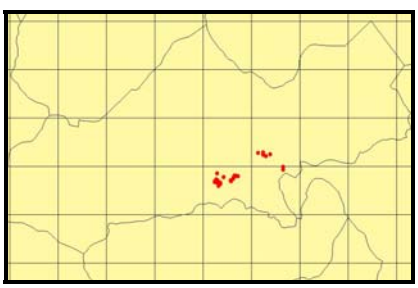
Tabebuia rosea (Bertol.) A. DC., 1838, Trumpet-creeper (11/ 12 land-use types)

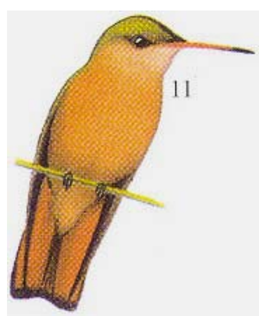


<u>Birds.</u>

Family Trochilidae

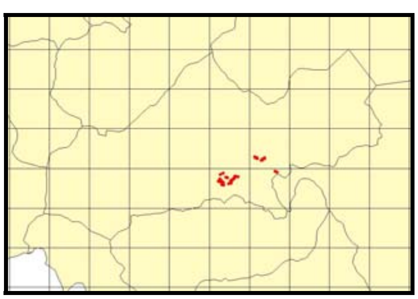
Amazilia rutila, Cinnamon Hummingbird (12/ 12 land-use types)

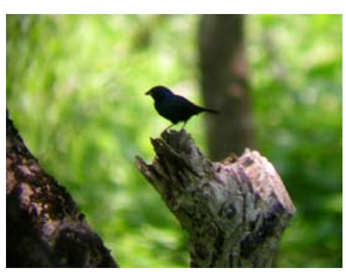




Family Emberizidae

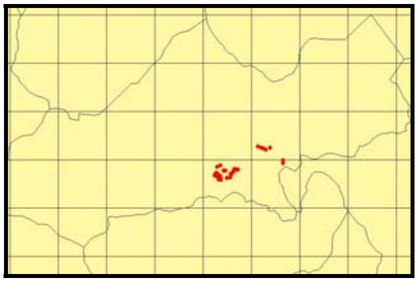
Volatinia jacarina, Blue-black Grassquit (12/ 12 land-use types)





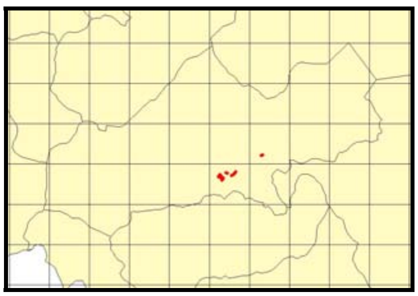
Family Cuculidae

Crotophaga sulcirostris, Groove-billed Ani (12/ 12 land-use types)



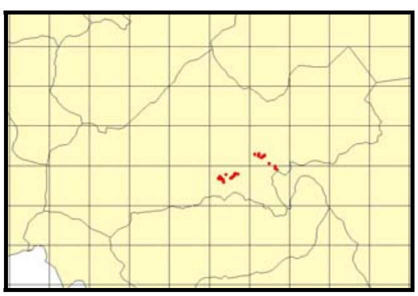
Family Tyrannidae

Pitangus sulphuratus, Great Kiskadee (10/ 12 land-use types)



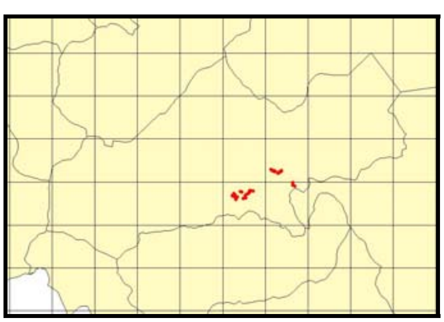
Family Troglodytidae

Troglodytes aedon, House Wren (12/ 12 land-use types)



Family Turdidae

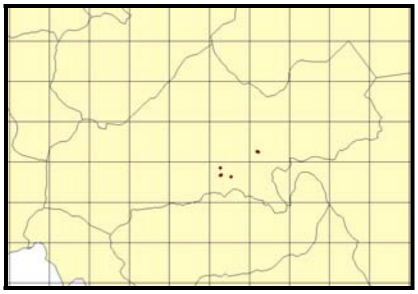
Turdus grayi, Clay-colored Robin (12/ 12 land-use types)

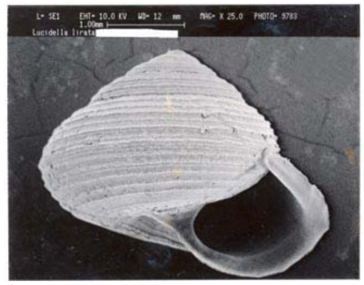


Mollusks.

Family Helicinidae

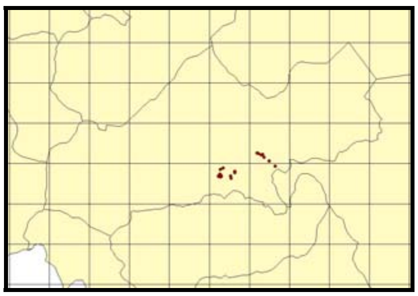
Lucidella lirata (12/ 12 land-use types)

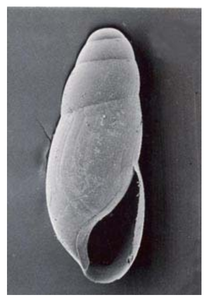




Family Ferussacidae

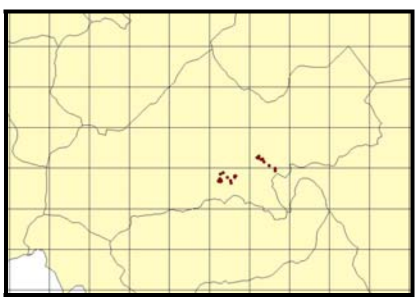
Cecilioides consobrinus (11/ 12 land-use types)



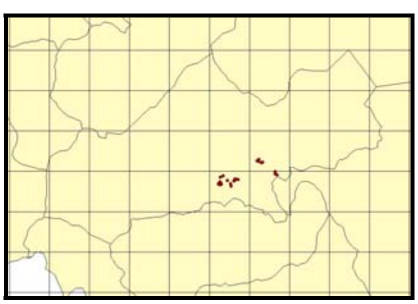


Family Subulinidae

Beckianum beckianum (12/ 12 land-use types)

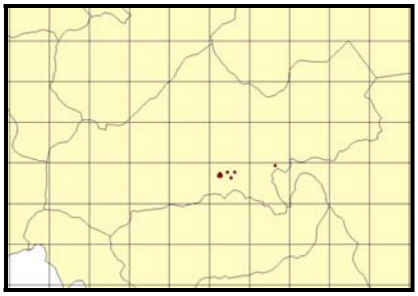


Leptinaria lamellata (12/ 12 land-use types)



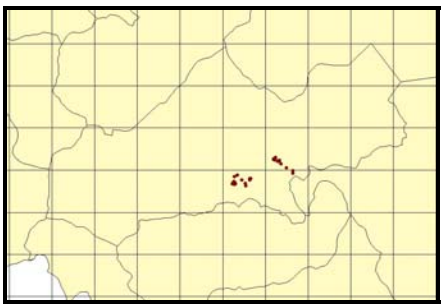
Family Spiraxidae

Euglandina cumingii (11/ 12 land-use types)



Family Bulimulidae

Bulimulus corneus (12/ 12 land-use types)



Synthesis of species distributions.

The general distribution map comprising all three taxa under study and all farms gives an idea of the general trend on the study site where all farms have a species abundance considered scarce, level 2 of the three proposed levels (1, rare, 2, scarce, 3, abundant).

Analysis conducted on each taxon separately leads to the same results on birds, but on mollusks and trees showed a more variable pattern ranging from abundance level 1 to level 2 (Fig 7) in the case of mollusks, and from level 1 to level 3 on trees (Fig. 8). This result agrees with one of the conclusions made by PÉREZ *et al*. (in press) who found both diversity of trees and structural diversity of trees highly correlated to mollusks diversity.

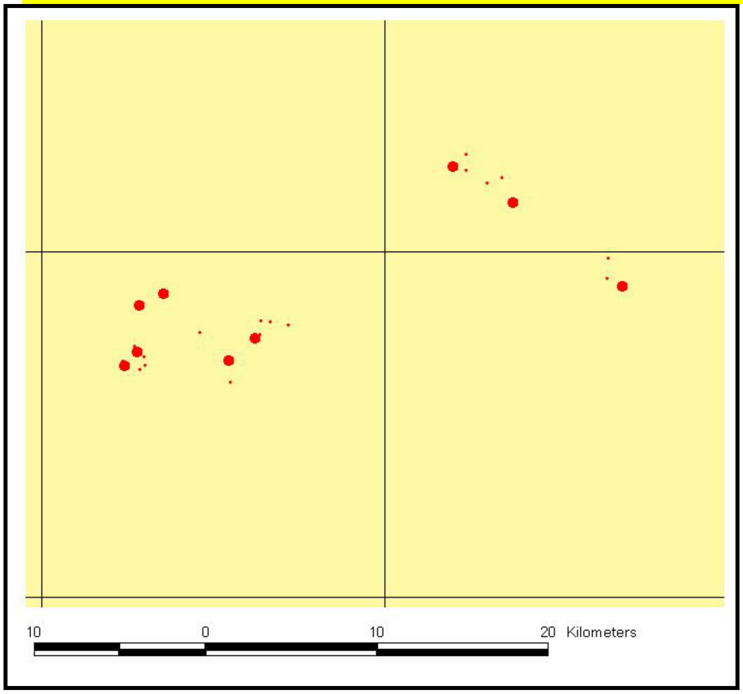


Fig. 7.- Distribution of mollusks on the studied farms. Small circles represent abundance level 1 and larger circles abundance level 2.

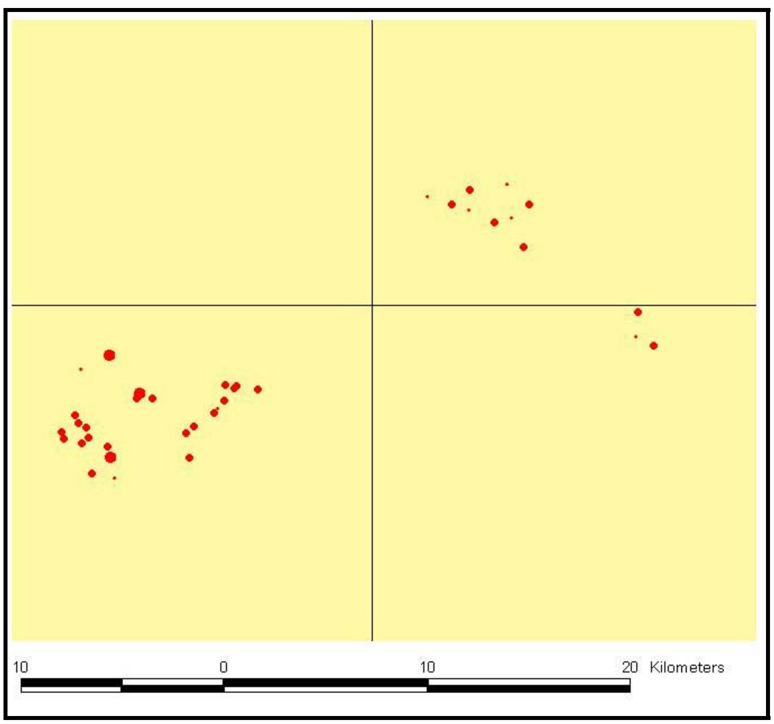


Fig. 8.- Distribution of tree species on the studied farms. Small circles represent abundance level 1, Medium circles abundance level 2 and larger circles abundance level 3.

Abundance.

Abundance values for plants ranged from 9 to 448 individuals, with an average of 94; for birds values ranged from 43 to 425, with an average of 124 specimens and for mollusks, abundances ranged from 78 to 1,712 individuals, with an average of 292 individuals (Table 5).

Table 5.- Abundance of plants, birds and mollusks on the studied land-use types.

Taxa	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Plants	20	439.00	9.00	448.00	93.8500	118.3960	14,017.608
Birds	20	382.00	43.00	425.00	123.7000	99.2918	9,858.853
Mollusks	20	1634.00	78.00	1,712.00	291.6000	380.7508	14,4971.200

Density.

Values of density for plants ranged from 0.01 individuals / m2 to 0.08 individuals/m2, with an average of 0.02; for birds values ranged from 0.02 to 0.35, with an average of 0.09 individuals/m2 and for mollusks, abundances ranged from 0.01 to 0.07 individuals, with an average of 0.02 individuals/m2 (Table 6).

Table 6.- Density of plants, birds and mollusks on the studied land-use types.

Taxa	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Birds	20	.07	.01	.08	2.550E-02	1.905E-02	3.629E-04
Mollusks	20	.33	.02	.35	8.600E-02	8.191E-02	6.709E-03
Plants	20	.07	.01	.07	1.935E-02	1.821E-02	3.317E-04

Species associated to each land-use type.

Birds: Birds associated to particular land use types are presented on fig. 9. Land uses with highest number of exclusive birds are Riparian Forests and the Primary Forest of Quirragua protected area. Land uses with lowest number of exclusive species are Fodder Banks and Natural Pastures with Low Density of Trees, both with one exclusive species respectively.

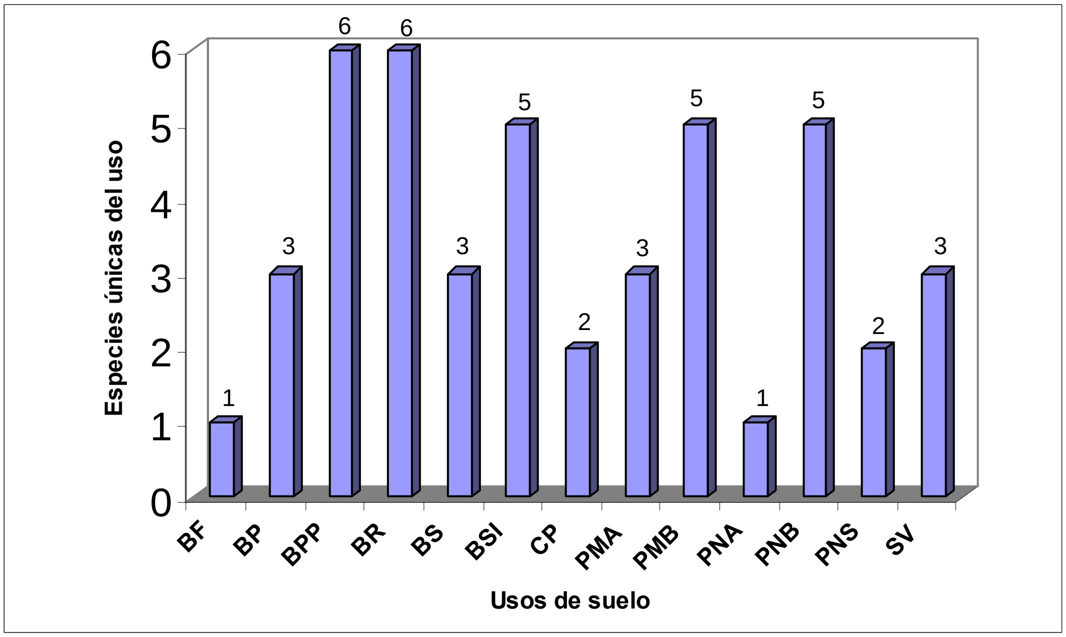


Fig. 9.- Species of birds associated to the studied land-use types.

Mollusks: Mollusks associated to particular land use types are presented on fig. 10. Land use type with highest number of mollusk species is the Primary Forest of Quirragua protected area with seven species, followed by Primary Forests with three species. On Secondary Modified Forests and Pastures of all kinds, there were not found exclusive species of mollusks.

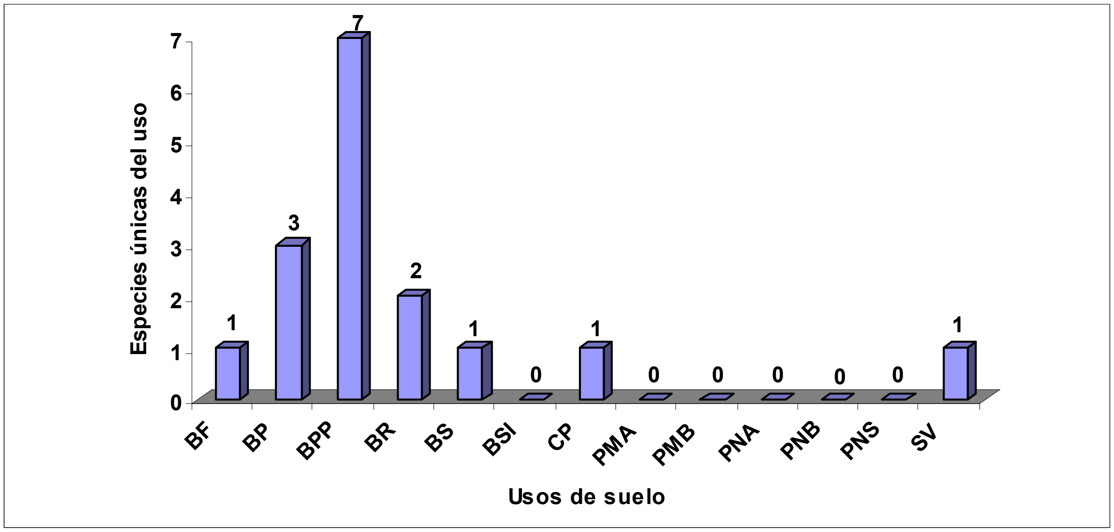


Fig. 10.- Species of mollusks associated to the studied land-use types..

β Diversity or heterogeneity among land-use types.

Birds: Values of calculated indexes (Table 7) show medium level of similarity, thus Beta diversity could be as well considered medium. It means that there are some species exclusive to particular land use types but many species are shared among land use types, given as a result a medium turnover rate.

The above statement can be better visualized with the cluster analysis conducted among land uses (Fig. 11), based on Jaccard similarity index. Cluster obtained shows the formation of two major groups, one composed of species from Primary Forest of Quirragua protected area and other composed of all other land use types. In the last group it can be seen the existence of three groups; one composed of all forest land uses and Improved Pastures with Low Density of Trees, another formed by Pastures with No Trees, and a third one composed of Pastures, Fodder Banks, Successions and Live Fences.

Table 7.- Similarity indexes of Morisita Horn and Jaccard for birds on each land-use type (Calculated with EstimateS version 6.1, Colwell, R).

No.	Land-use	Average	
		Morisita/Horn	Jaccard
1	BF	0.63	0.51
2	BP	0.37	0.41
3	BPP	0.07	0.08
4	BR	0.51	0.48
5	BS	0.50	0.47
6	BSI	0.52	0.48
7	CP	0.59	0.49
8	PMA	0.65	0.51
9	PMB	0.59	0.43
10	PNA	0.62	0.50
11	PNB	0.59	0.47
12	PNS	0.48	0.34
13	SV	0.55	0.48
Average		**0.51**	**0.43**

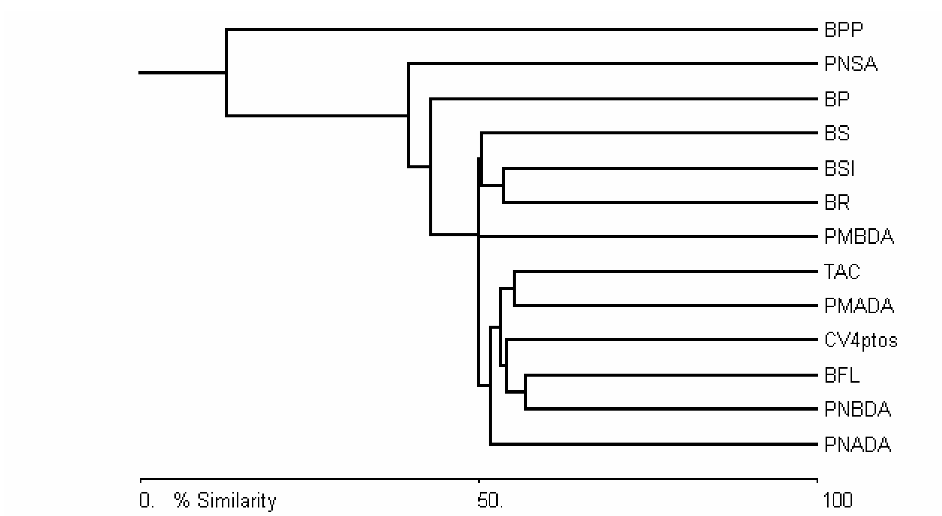


Fig. 11.- Dendrogram of similarity among land-use types considering presence and absence of bird species.

Mollusks: In the case of mollusks similitude among land uses is lower, thus Beta diversity is higher (Table 8).

Cluster analysis performed using Jaccard similarity index (Fig. 12) also shows, as in the case of birds, the formation of two major groups, one composed of species from Primary Forest of Quirragua protected area and other composed of all other land use types. Within the second group there are two more or less well defined ones, one of them composed of BSI, PMBDA, PNADA and Live Fences and another comprising the remaining land use types.

Table 8.- Similarity indexes of Morisita Horn and Jaccard for mollusks on each land-use type (Calculated with EstimateS version 6.1, Colwell, R).

No.	Land-use	Average	
		Morisita/Horn	Jaccard
1	BF	0.73	0.50
2	BP	0.33	0.42
3	BPP	0.55	0.27
4	BR	0.62	0.43
5	BS	0.53	0.47
6	BSI	0.71	0.44
7	CP	0.71	0.39
8	PMA	0.67	0.43
9	PMB	0.64	0.38
10	PNA	0.75	0.50
11	PNB	0.67	0.49
12	PNS	0.61	0.39
13	SV	0.32	0.48
Average		**0.60**	**0.43**

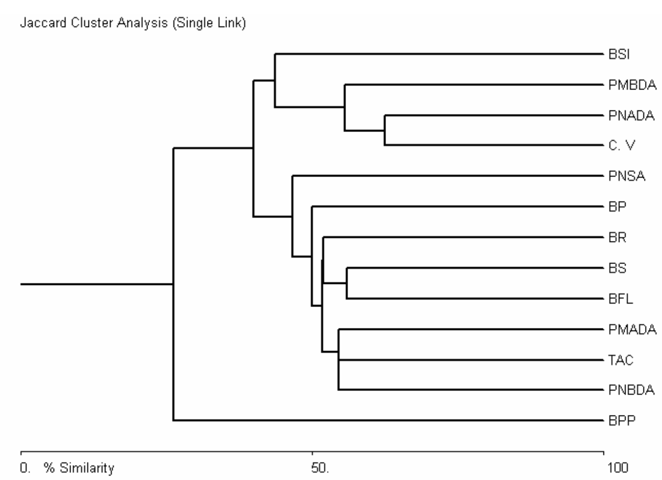


Fig. 12.- Dendrogram of similarity among land-use types considering presence and absence of mollusks species.

Plants: Our data for plants is strongly influenced by management, however our results can bring some light to some aspects other than alpha diversity and species richness. In the case of plants similitude among land uses is low, thus Beta diversity is higher (Table 9).

Table 9.- Similarity indexes of Morisita Horn and Jaccard for plants on each land-use type (Calculated with EstimateS version 6.1, Colwell, R).

No.	Land-use	Average	
		Morisita/Horn	Jaccard
1	BF	0.51	0.30
2	BP	0.27	0.20
3	BR	0.34	0.21
4	BS	0.40	0.26
5	BSI	0.51	0.23
6	CP	0.17	0.29
7	PMA	0.50	0.27
8	PMB	0.57	0.21
9	PNA	0.57	0.27
10	PNB	0.54	0.24
11	PNS	0.00	0.00
12	SV	0.52	0.35
Average		**0.41**	**0.24**

Cluster analysis performed using Jaccard similarity index (Fig. 13), and considering only arboreal vegetation show a quite complex pattern. There are three land use types behaving as independent entities, these are Pastures without Trees, Primary Forests and Primary Forest of Quirragua protected area. The first may be due to the scarcity of trees present in the land-use, the other two because they might contain a pool of species not existing any more on other land-uses. However, a similar behavior should be expected for the Riparian Forests since they are also a primary use.

The remaining land-uses make up two groups, one encompassing BF, PMB, PMA, PNA, SV and PNB and the other BR, CP and BS.

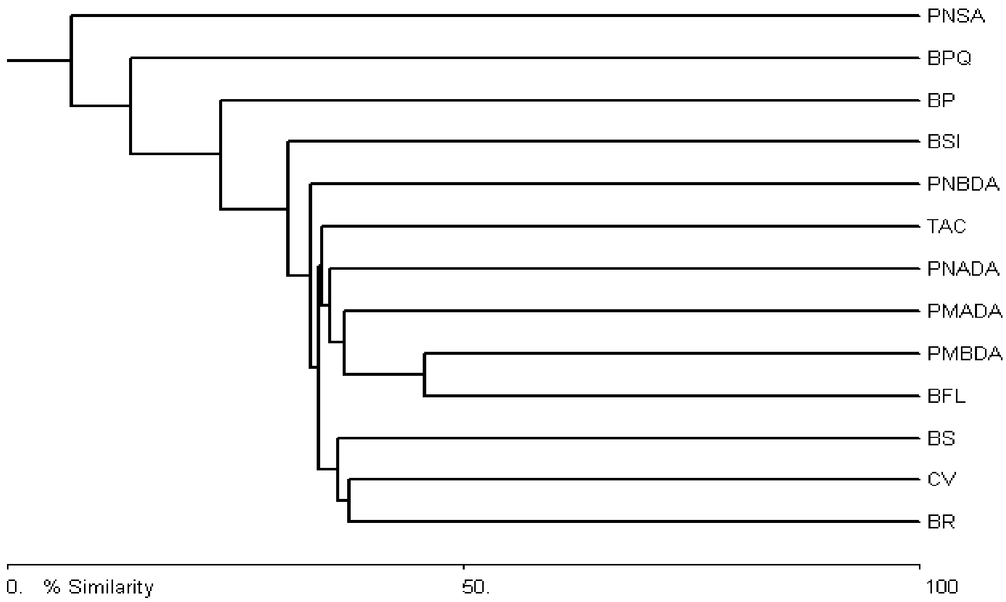


Fig. 13.- Dendrogram of similarity among land-use types considering presence and absence of bird species.

Tolerance to disturbance.

A further analysis was made in order to assess tolerance to disturbance. For that purpose we lumped all land use types categories into three major ones. These are, A: Primary Forests, Primary Forest of Protected Area and Riparian Forests; B: Pastures of different types, and C: Live fences, Successions and Secondary Forests. In general terms it can be pointed out that species with low values are clearly associated to primary forests and species with values of 1 or closer are generalist species.

Birds: Regarding birds results are shown in table 10. Two of our chosen species, *Crotophaga sulcirostris* and *Columbina talpacoti* are generalist species with a value of 1, on the other hand there are species such as *Dendroica magnolia* and *Melanerpes pucheran*i, associated to forest types showing tolerance values of 0. Average values for the whole community are above .5 which means we have more generalist species than specialist ones.

Table 10.- Ratios of bird species tolerance to disturbance for major land-use types. PF: Primary forests; P: Pastures; FSF: Fragments of Secondary Forests. Tolerance category: G, generalist; F: Forest; OA: Open areas.

Species	Major land-use types			Ratios		Species average	Toleran-ce category
	PF	P	FSF	P/PF	FSF/PF		
	Averages	Averages	Averages				
Amazilia cyanura	3.0	2.3	5.0	0.8	1.0	0.9	**G**
Amazilia rutila	12.0	10.3	7.3	0.9	0.6	0.75	**G**
Amazilia saucerrottei	1.0	2.5	2.8	1.0	1.0	1	**OA**
Amazilia tzacatl	5.0	5.3	5.8	1.0	1.0	1	**OA**
Amazona albifrons	20.0	9.3	5.0	0.5	0.3	0.4	**G**
Aratinga nana	4.0	16.4	5.0	1.0	1.0	1	**OA**
Arremonops conirostris	2.0	10.2	19.3	1.0	1.0	1	**OA**
Asturina nitida	1.0	4.0	2.8	1.0	1.0	1	**OA**
Attila spadiceus	4.0	1.0	2.0	0.3	0.5	0.4	**G**
Brotogeris jugularis	20.0	4.6	26.0	0.2	1.0	0.6	**G**
Bubulcus ibis	12.0	13.7	0.0	1.0	0.0	0.5	**G**
Calocitta formosa	19.0	10.8	6.8	0.6	0.4	0.5	**G**
Camptostoma imberbe	1.0	3.3	1.5	1.0	1.0	1	**OA**
Campylorhynchus rufinucha	7.0	6.2	5.3	0.9	0.8	0.85	**G**
Caprimulgus vociferus	1.0	0.0	0.0	0.0	0.0	0	**F**
Capsiempis flaveola	1.0	0.0	0.0	0.0	0.0	0	**F**
Caryothraustes poliogaster	11.0	0.0	0.0	0.0	0.0	0	**F**
Cathartes aura	2.0	3.0	2.0	1.0	1.0	1	**OA**
Catharus aurantirostris	1.0	0.0	0.0	0.0	0.0	0	**F**
Cercomacra tyrannina	5.0	0.0	4.7	0.0	0.9	0.45	**G**
Ceryle torquata	1.0	0.0	0.0	0.0	0.0	0	**F**
Chiroxiphia linearis	14.0	0.0	14.0	0.0	1.0	0.5	**G**
Chloroceryle americana	2.0	1.0	1.0	0.5	0.5	0.5	**G**
Colinus leucopogon	16.0	0.0	0.0	0.0	0.0	0	**F**
Columba flavirostris	2.0	3.7	6.0	1.0	1.0	1	**OA**
Columbina minuta	2.0	2.3	1.5	1.0	0.8	0.9	**G**
Columbina talpacoti	2.5	17.2	7.3	1.0	1.0	1	**OA**
Contopus cinereus	4.5	7.8	7.0	1.0	1.0	1	**OA**
Contopus virens	1.0	1.3	3.0	1.0	1.0	1	**OA**

Crotophaga sulcirostris	5.5	57.2	27.0	1.0	1.0	1	**OA**
Cyanocorax morio	22.0	9.6	10.0	0.4	0.5	0.45	**G**
Cyclarhis gujanensis	6.5	3.2	5.5	0.5	0.8	0.65	**G**
Dendrocincla homochroa	1.0	0.0	0.0	0.0	0.0	0	**F**
Dendroica castanea	1.0	1.0	10.0	1.0	1.0	1	**OA**
Dendroica magnolia	6.0	0.0	0.0	0.0	0.0	0	**F**
Dendroica pensylvanica	3.3	2.4	5.3	0.7	1.0	0.85	**G**
Dendroica petechia	15.0	16.5	13.5	1.0	0.9	0.95	**G**
Dryocopus lineatus	1.0	2.5	1.7	1.0	1.0	1	**OA**
Elaenia flavogaster	4.0	4.7	3.3	1.0	0.8	0.9	**G**
Elanoides forficatus	5.0	1.0	3.0	0.2	0.6	0.4	**G**
Empidonax albigularis	1.0	2.0	1.3	1.0	1.0	1	**OA**
Empidonax flavescens	2.0	1.0	0.0	0.5	0.0	0.25	**G**
Empidonax flaviventris	6.0	4.4	6.0	0.7	1.0	0.85	**G**
Euphonia affinis	19.0	15.4	9.0	0.8	0.5	0.65	**G**
Euphonia gouldi	2.0	0.0	0.0	0.0	0.0	0	**F**
Euphonia hirundinacea	8.0	2.6	5.3	0.3	0.7	0.5	**G**
Euphonia luteicapilla	4.5	7.5	4.5	1.0	1.0	1	**OA**
Habia fuscicauda	10.0	0.0	16.0	0.0	1.0	0.5	**G**
Herpetotheres cachinnans	3.0	0.0	1.0	0.0	0.3	0.15	**G**
Hylocharis eliciae	1.0	2.3	0.0	1.0	0.0	0.5	**G**
Hylocichla mustelina	2.0	0.0	1.7	0.0	0.8	0.4	**G**
Hylophilus decurtatus	5.7	2.5	7.5	0.4	1.0	0.7	**G**
Icterus galbula	5.0	7.8	9.0	1.0	1.0	1	**OA**
Legatus leucophaius	2.0	0.0	0.0	0.0	0.0	0	**F**
Lepidocolaptes souleyetii	6.0	6.6	10.0	1.0	1.0	1	**OA**
Leptotila cassinii	1.0	0.0	1.5	0.0	1.0	0.5	**G**
Leptotila verreauxi	1.0	2.0	2.7	1.0	1.0	1	**OA**
Megarhynchus pitangua	4.0	3.7	2.3	0.9	0.6	0.75	**G**
Melanerpes hoffmannii	14.0	6.3	6.8	0.5	0.5	0.5	**G**
Melanerpes pucherani	2.0	0.0	0.0	0.0	0.0	0	**F**
Melozone leucotis	2.0	0.0	3.5	0.0	1.0	0.5	**G**
Mionectes oleagineus	1.0	0.0	1.5	0.0	1.0	0.5	**G**
Mniotilta varia	1.7	0.0	2.0	0.0	1.0	0.5	**G**
Myiarchus tuberculifer	9.5	6.4	6.0	0.7	0.6	0.65	**G**

Myiarchus tyrannulus	5.5	7.3	6.8	1.0	1.0	1	**OA**
Myiodynastes luteiventris	6.0	3.6	3.5	0.6	0.6	0.6	**G**
Myiozetetes granadensis	2.0	0.0	0.0	0.0	0.0	0	**F**
Myiozetetes similis	11.0	20.0	6.0	1.0	0.5	0.75	**G**
Myrmornis torquata	6.0	0.0	0.0	0.0	0.0	0	**F**
Nyctibius griseus	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Nyctidromus albicollis	3.0	0.0	2.0	0.0	0.7	0.35	**G**
Ortalis cinereiceps	4.0	6.0	0.0	1.0	0.0	0.5	**G**
Oryzoborus funereus	1.0	4.3	0.0	1.0	0.0	0.5	**G**
Pachyramphus polychopterus	1.0	4.8	5.3	1.0	1.0	1	**OA**
Parula pitiayumi	6.0	1.5	3.0	0.3	0.5	0.4	**G**
Phaethornis longuemareus	1.5	1.0	1.5	0.7	1.0	0.85	**G**
Phaethornis superciliosus	4.0	0.0	1.0	0.0	0.3	0.15	**G**
Piaya cayana	1.0	1.8	1.5	1.0	1.0	1	**OA**
Piculus rubiginosus	2.0	1.5	2.5	0.8	1.0	0.9	**G**
Piranga olivacea	1.0	1.0	0.0	1.0	0.0	0.5	**G**
Piranga rubra	5.0	2.2	2.3	0.4	0.5	0.45	**G**
Pitangus sulphuratus	2.0	8.8	5.7	1.0	1.0	1	**OA**
Psaracolius montezuma	13.7	3.8	2.3	0.3	0.2	0.25	**G**
Pteroglossus torquatus	8.0	1.5	3.5	0.2	0.4	0.3	**G**
Ramphastos sulfuratus	12.5	4.0	1.0	0.3	0.1	0.2	**G**
Ramphocaenus melanurus	2.0	0.0	3.7	0.0	1.0	0.5	**G**
Saltator coerulescens	7.0	5.0	11.5	0.7	1.0	0.85	**G**
Saltator maximus	10.0	6.0	7.3	0.6	0.7	0.65	**G**
Seiurus aurocapillus	6.0	0.0	1.0	0.0	0.2	0.1	**OA**
Setophaga ruticilla	6.0	4.0	3.5	0.7	0.6	0.65	**G**
Tangara lavinia	7.0	0.0	0.0	0.0	0.0	0	**F**
Tapera naevia	3.0	2.0	2.7	0.7	0.9	0.8	**G**
Thamnophilus doliatus	11.0	6.0	20.8	0.5	1.0	0.75	**G**
Thraupis abbas	2.0	5.3	2.8	1.0	1.0	1	**OA**
Thraupis episcopus	19.0	17.2	18.7	0.9	1.0	0.95	**G**
Thryothorus maculipectus	1.0	0.0	3.0	0.0	1.0	0.5	**G**
Thryothorus modestus	14.0	6.2	19.0	0.4	1.0	0.7	**G**
Thryothorus rufalbus	29.5	5.3	19.0	0.2	0.6	0.4	**G**
Tityra semifasciata	7.0	5.3	7.3	0.8	1.0	0.9	**G**

Todirostrum cinereum	12.5	19.3	17.0	1.0	1.0	1	**OA**
Tolmomyias sulphurescens	12.0	6.2	10.3	0.5	0.9	0.7	**G**
Troglodytes aedon	10.0	33.2	24.3	1.0	1.0	1	**OA**
Trogon melanocephalus	11.0	5.7	6.0	0.5	0.5	0.5	**G**
Trogon violaceus	1.0	1.5	1.0	1.0	1.0	1	**OA**
Turdus assimilis	3.0	2.0	0.0	0.7	0.0	0.35	**G**
Turdus grayi	33.0	10.8	15.3	0.3	0.5	0.4	**G**
Tyrannus melancholicus	8.0	25.7	8.8	1.0	1.0	1	**OA**
Vermivora chrysoptera	3.0	0.0	0.0	0.0	0.0	0	**F**
Vermivora peregrina	8.0	12.3	8.3	1.0	1.0	1	**OA**
Vireo flavifrons	3.0	6.5	4.8	1.0	1.0	1	**OA**
Vireo flavoviridis	2.0	1.3	3.3	0.7	1.0	0.85	**G**
Vireo olivaceus	21.0	7.4	12.3	0.4	0.6	0.5	**G**
Volatinia jacarina	13.5	67.3	43.8	1.0	1.0	1	**OA**
Wilsonia canadensis	3.0	1.0	4.5	0.3	1.0	0.65	**G**
Wilsonia citrina	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Wilsonia pusilla	2.0	1.0	0.0	0.5	0.0	0.25	**G**
Averages				**0.6**	**0.7**	0.65	**G**

As we mentioned earlier, a more or less similar analysis can be performed utilizing forest dependence categories proposed by STILES & SKUTCH (1998). With those criteria we observed no forest dependent species, 95 species were generalists for 63 % and 56 species are open areas species, comprising 37 % of the total (Table 11).

Table 11.- Forest dependence according to STILES & SKUTCH (1998). Dependence categories are: OA: Open Areas, G: Generalists, F: Forest species.

Scientific name	**Forest dependence**	**Forest dependence**	**Dependence category**
Bubulcus ibis	3	3	**OA**
Mycteria americana	3	3	**OA**
Coragyps atratus	3	3	**OA**
Cathartes aura	3	3	**OA**
Elanoides forficatus	2	2	**G**
Asturina nitida	2	2	**G**

Caracara plancus	3	3	**OA**
Herpetotheres cachinnans	2	2	**G**
Ortalis cinereiceps	2, 3	2.5	**G**
Columbina inca	3	3	**OA**
Columbina minuta	3	3	**OA**
Columbina talpacoti	3	3	**OA**
Columba flavirostris	3	3	**OA**
Leptotila cassinii	2, 3	2.5	**G**
Leptotila verreauxi	2, 3	2.5	**G**
Aratinga nana	2, 3	2.5	**G**
Brotogeris jugularis	3	3	**OA**
Amazona albifrons	2	2	**G**
Amazona autumnalis	2	2	**G**
Piaya cayana	2, 3	2.5	**G**
Tapera naevia	3	3	**OA**
Morococcys erythropygus	2, 3	2.5	**G**
Crotophaga sulcirostris	3	3	**OA**
Tyto alba	2	2	**G**
Otus cooperi	2	2	**G**
Pseudoscops clamator	2	2	**G**
Nyctibius griseus	2, 3	2.5	**G**
Caprimulgus vociferus	2, 3	2.5	**G**
Chordeiles acutipennis	3	3	**OA**
Amazilia rutila	2, 3	2.5	**G**
Amazilia tzacatl	3	3	**OA**
Amazilia cyanura	2, 3	2.5	**G**
Amazilia saucerrottei	2, 3	2.5	**G**
Archilocus colubris	3	3	**OA**
Eupherusa eximia	2	2	**G**
Phaethornis longuemareus	2, 3	2.5	**G**
Phaethornis superciliosus	2	2	**G**
Anthracothorax prevostii	3	3	**OA**
Trogon melanocephalus	2	2	**G**
Trogon violaceus	2, 3	2.5	**G**
Chloroceryle americana	2, 3	2.5	**G**
Pteroglossus torquatus	2	2	**G**

Ramphastos sulfuratus	2	2	**G**
Melanerpes hoffmannii	2, 3	2.5	**G**
Piculus rubiginosus	2	2	**G**
Dryocopus lineatus	2, 3	2.5	**G**
Sittasomus griseicapillus	2	2	**G**
Lepidocolaptes souleyetii	2, 3	2.5	**G**
Dendrocinchla homocroa	1, 2	1.5	**G**
Thamnophilus doliatus	2, 3	2.5	**G**
Cercomacra tyrannina	2, 3	2.5	**G**
Myrmornis torquata	1, 2	1.5	**G**
Camptostoma imberbe	2	2	**G**
Camptostoma obsoletum	2, 3	2.5	**G**
Mionectes oleagineus	2	2	**G**
Elaenia flavogaster	3	3	**OA**
Todirostrum cinereum	2, 3	2.5	**G**
Tolmomyias sulphurescens	3	3	**OA**
Contopus cinereus	3	3	**OA**
Contopus virens	2, 3	2.5	**G**
Empidonax albigularis	2, 3	2.5	**G**
Empidonax flaviventris	2	2	**G**
Empidonax flavescens	2	2	**G**
Empidonax minimus	2, 3	2.5	**G**
Attila spadiceus	2	2	**G**
Myiarchus tuberculifer	2, 3	2.5	**G**
Myiarchus tyranulus	2, 3	2.5	**G**
Myiarchus cinerascens	2, 3	2.5	**G**
Myiarchus nuttingi	2	2	**G**
Myiarchus crinitus	2	2	**G**
Pitangus sulfuratus	3	3	**OA**
Megarhynchus pitangua	2, 3	2.5	**G**
Myiozetetes similis	3	3	**OA**
Myiodynastes luteiventris	2, 3	2.5	**G**
Tyrannus melancholicus	3	3	**OA**
Tyrannus forficatus	3	3	**OA**
Tyrannus savana	3	3	**OA**

Pachyramphus polychopterus	2, 3	2.5	**G**
Tityra semifasciata	2, 3	2.5	**G**
Chiroxiphia linearis	2	2	**G**
Manacus candei	2	2	**G**
Cyclarhis gujanensis	2, 3	2.5	**G**
Vireo flavifrons	2	2	**G**
Vireo flavoviridis	3	3	**OA**
Vireo olivaceus	3	3	**OA**
Hylophilus decurtatus	2, 3	2.5	**G**
Calocitta formosa	2, 3	2.5	**G**
Cyanocorax morio	3	3	**OA**
Hirundo rustica	3	3	**OA**
Procnes chalybea	3	3	**OA**
Campylorhynchus rufinucha	2, 3	2.5	**G**
Thryothorus rufalbus	1, 2	1.5	**G**
Thryothorus modestus	3	3	**OA**
Thryothorus maculipectus	3	3	**OA**
Troglodytes aedon	3	3	**OA**
Polioptila albiloris	2, 3	2.5	**G**
Ramphocaenus melanurus	2, 3	2.5	**G**
Hylocichla mustelina	1, 2	1.5	**G**
Turdus grayi	3	3	**OA**
Turdus assimilis	2	3	**OA**
Catharus aurantirostris	2, 3	2.5	**G**
Vermivora peregrina	2, 3	2.5	**G**
Vermivora chryspotera	2	2	**G**
Parula pitiayumi	2	2	**G**
Dendroica petechia	3	3	**OA**
Dendroica pensylvanica	2, 3	2.5	**G**
Dendroica magnolia	2, 3	2.5	**G**
Dendroica fusca	2	2	**G**
Dendroica castanea	2, 3	2.5	**G**
Dendroica towsendi	2, 3	2.5	**G**
Dendroica discolor	2, 3	2.5	**G**
Mniotilta varia	2	2	**G**
Setophaga ruticilla	2, 3	2.5	**G**

Seiurus aurocapillus	2	2	**G**
Geothlypis poliocephala	3	3	**OA**
Geothlypis aequinoctialis	3	3	**OA**
Wilsonia citrina	2	2	**G**
Wilsonia canadensis	2, 3	2.5	**G**
Basileuterus rufifrons	2	2	**G**
Habia fuscicauda	2	2	**G**
Piranga rubra	2, 3	2.5	**G**
Piranga olivacea	3	3	**OA**
Ramphocelus sanguinolentus	3	3	**OA**
Ramphocelus passerinii	3	3	**OA**
Thraupis episcopus	3	3	**OA**
Thraupis abbas	3	3	**OA**
Tangara lavinia	2	2	**G**
Tangara larvata	3	3	**OA**
Euphonia hirundinacea	2, 3	2.5	**G**
Euphonia affinis	2	2	**G**
Euphonia luteicapilla	2, 3	2.5	**G**
Euphonia gouldi	2	2	**G**
Cyanerpes cyaneus	2	2	**G**
Volatinia jacarina	3	3	**OA**
Sporophila torqueola	3	3	**OA**
Sporophila aurita	3	3	**OA**
Melozone leucotis	2, 3	2.5	**G**
Tiaris olivacea	3	3	**OA**
Arremonops conirostris	2, 3	2.5	**G**
Oryzoborus funereus	3	3	**OA**
Saltator maximus	3	3	**OA**
Saltator coerulescens	3	3	**OA**
Caryothraustes poliogaster	2	2	**G**
Sturnella magna	3	3	**OA**
Icterus spurius	3	3	**OA**
Icterus galbula	2, 3	2.5	**G**
Icterus dominicensis	3	3	**OA**
Dives dives	3	3	**OA**

Amblycercus holosericeus	3	3	**OA**
Quiscalus mexicanus	3	3	**OA**
Psaracolius montezuma	2, 3	2.5	**G**

Mollusks: Ratios for mollusks are shown in Table 12. Among our chosen species, *Bulimulus corneus* and *Praticolella griseola* are generalist species with a value of 1, however there are species like *Helicina* sp. and *Xenodiscula taintori*, closely related to forest types showing tolerance values of 0. Average values for the whole community are below .5 which means that these taxa are mainly made up of species related to forests.

Table 12.- Ratios of mollusk species tolerance to disturbance for major land-use types. PF: Primary forests; P: Pastures; FSF: Fragments of Secondary Forests.

Species	**Major land-use types**			**Ratios**			**Tolerance Cate-gory**
	PF	**P**	**FSF**	**P/PF**	**FSF/PF**	**Species average**	
	Averages	**Averages**	**Averages**				
Beckianum beckianum	150.5	29.3	76.3	0.2	0.5	0.35	**G**
Biomphalaria havanensis	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Bulimulus corneus	74.0	202.7	94.0	1.0	1.0	1	**OA**
Cecilioides consobrinus	98.7	24.2	40.7	0.2	0.4	0.3	**G**
Chanomphalus pilsbryi	23.5	1.0	45.0	0.0	1.0	0.5	**G**
Drepanostomella pinchoti	13.5	0.0	10.5	0.0	0.8	0.4	**G**
Drymaeus sulphureus	48.5	0.0	2.0	0.0	0.0	0	**F**
Euconulus pittieri	4.5	1.7	3.7	0.4	0.8	0.6	**G**
Euglandina cumingii	5.5	14.2	7.0	1.0	1.0	1	**OA**
Gastrocopta servilis	5.0	5.0	0.0	1.0	0.0	0.5	**G**
Glyphyalinia sp.	57.5	20.4	25.8	0.4	0.4	0.4	**G**
Guppya gundlachi	46.7	3.5	5.7	0.1	0.1	0.1	**G**
Habroconus trochulinus	3.0	0.0	0.0	0.0	0.0	0	**F**
Hawaiia minuscula	1.0	1.7	1.0	1.0	1.0	1	**OA**
Helicina sp.?	5.0	0.0	0.0	0.0	0.0	0	**F**
Helicina sp.2 "amarilla"	6.0	0.0	5.0	0.0	0.8	0.4	**G**
Lamellaxis gracilis	3.0	3.0	1.0	1.0	0.3	0.65	**G**
Lamellaxis micra	3.0	6.5	8.3	1.0	1.0	1	**OA**

Leptinaria interstriata	27.3	29.0	20.3	1.0	0.7	0.85	**G**
Leptinaria lamellata	13.0	20.5	20.8	1.0	1.0	1	**OA**
Lucidella lirata	87.0	19.0	97.0	0.2	1.0	0.6	**G**
Microconus wilhelmi?	3.0	0.0	0.0	0.0	0.0	0	**F**
Miradiscops "curvata"	1.5	2.0	13.3	1.0	1.0	1	**OA**
Miradiscops opal	15.0	2.7	1.0	0.2	0.1	0.15	**G**
Miradiscops panamensis	24.0	7.8	18.5	0.3	0.8	0.55	**G**
Neocyclotus dysoni nicaraguense	25.0	0.0	7.3	0.0	0.3	0.15	**G**
Opeas pumilum	14.0	1.7	1.0	0.1	0.1	0.1	**G**
Orthalicus princeps	6.0	0.0	0.0	0.0	0.0	0	**F**
Praticolella griseola	1.0	70.0	2.7	1.0	1.0	1	**OA**
Pseudosubulina sp.	2.0	0.0	0.0	0.0	0.0	0	**F**
Punctum burringtoni	1.0	0.0	0.0	0.0	0.0	0	**F**
Pupisoma dioscoricola	61.5	3.6	7.0	0.1	0.1	0.1	**G**
Radiodiscus sp.	17.0	0.0	0.0	0.0	0.0	0	**F**
Salasiella guatemalensis	27.3	7.0	22.0	0.3	0.8	0.55	**G**
Spiraxis sp. "L1"	27.0	1.0	0.0	0.0	0.0	0	**F**
Spiraxis sp. "L2"	6.3	0.0	3.0	0.0	0.5	0.25	**G**
Streptostyla turgidula	19.0	0.0	0.0	0.0	0.0	0	**F**
Striatura meridionalis	6.0	0.0	0.0	0.0	0.0	0	**F**
Strobilops strebeli guatemalensis	1.0	0.0	0.0	0.0	0.0	0	**F**
Subulina sp.	9.0	0.0	0.0	0.0	0.0	0	**F**
Succinea guatemalensis	1.0	0.0	0.0	0.0	0.0	0	**F**
Succinea recisa	1.0	14.0	2.3	1.0	1.0	1	**OA**
Thysanophora caecoides	14.5	33.5	5.5	1.0	0.4	0.7	**G**
Thysanophora costaricensis	78.0	0.0	0.0	0.0	0.0	0	**F**
Thysanophora crinita	6.0	4.0	56.0	0.7	1.0	0.85	**G**
Thysanophora hornii	4.0	3.5	7.0	0.9	1.0	0.95	**G**
Thysanophora plagioptycha	8.5	3.0	5.0	0.4	0.6	0.5	**G**
Trichodiscina coactiliata	2.0	0.0	0.0	0.0	0.0	0	**F**
Xenodiscula taintori	91.0	0.0	4.0	0.0	0.0	0	**F**
Averages				**0.3**	**0.4**	0.35	**G**

For mollusks, we conducted the same analysis utilizing forest dependence categories proposed by STILES & SKUTCH (1998). Results were as follows (Table 13). With those criteria we found six (6) forest dependent species comprising 30 %, 10 generalist species representing 50 % of the total and four (4) open areas species for a 20 %. As can be noticed the number of forest associated species is high on this taxon suggesting this is a good indicator at this level despite we made the analysis considering only the twenty chosen species instead of the whole community inventory as in the case of birds.

Table 13.- Forest dependence according to STILES & SKUTCH (1998). Dependence categories are: OA: Open Areas, G: Generalists, F: Forest species.

Scientific name	**Forest dependence**	**Dependence Category**
Beckianum beckianum	1	**F**
Bothriopupa conoidea	1	**F**
Bulimulus corneus	2	**G**
Ceciliodes consobrinus	2	**G**
Drymaeus discrepans	1	**F**
Euglandina cumingii	1	**F**
Gastrocopta geminidens	2	**G**
Glyphyalinia indentata	2	**G**
Guppya gundlachi	2	**G**
Habroconus trochulinus	1	**F**
Huttonella bicolor	3	**OA**
Lamellaxis micra	2	**G**
Leptinaria lamellata	2	**G**
Lucidella lirata	1	**F**
Miradiscops opal	2	**G**
Miradiscops panamensis	2	**G**
Patricolella griseola	3	**OA**
Subulina octona	2	**G**
Succinea guatemalensis	3	**OA**
Thysanophora caecoides	3	**OA**

Trees: Ratios for plants are shown in Table 14. Among our chosen species, *Albizia caribea* and *Albizia saman* are generalist species with a value of 1 or close to it. However there are species like *Leucaena salvadorensis* with values close to 0 and *Senna* sp., among others, closely related to forest types showing tolerance values of 0. Average values for the whole community are below .5 which means that these taxa are mainly made up of species related to forests, or in other words individuals of species remaining from the pristine forests of the area.

Table 14.- Ratios of plant species tolerance to disturbance for major land-use types. PF: Primary forests; P: Pastures; FSF: Fragments of Secondary Forests.

Species	**Major land-use types**			**Ratios**			**Dependence Category**
	PF	**P**	**FSF**	**P/PF**	**FSF/PF**		
	Averages	**Averages**	**Averages**			**Species avera-ges**	
Acacia centralis	1.0	0.0	0.0	0.0	0.0	0	**F**
Acacia collinsii	3.0	0.0	1.0	0.0	0.3	0.15	**G**
Albizia caribea	4.0	7.3	6.3	1.0	1.0	1	**OA**
Albizia saman	6.5	4.8	5.0	0.7	0.8	0.75	**G**
Anacardium excelsum	1.0	0.0	2.0	0.0	1.0	0.5	**G**
Annona purpurea	1.0	1.0	1.0	1.0	1.0	1	**OA**
Aspidosperma megalocarpon	2.0	0.0	0.0	0.0	0.0	0	**F**
Asteraceae sp. 1	7.0	0.0	0.0	0.0	0.0	0	**F**
Astronium graveolens	4.0	1.0	1.0	0.3	0.3	0.3	**G**
Bauhinia sp.1	3.0	0.0	0.0	0.0	0.0	0	**F**
Bauhinia ungulata	15.0	0.0	0.0	0.0	0.0	0	**F**
Bixa orellana	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Brosimum alicastrum	8.0	0.0	6.5	0.0	0.8	0.4	**G**
Bursera simarouba	3.0	2.0	48.8	0.7	1.0	0.85	**G**
Calycophyllum candidisimum	1.5	0.0	3.0	0.0	1.0	0.5	**G**
Casearia aculeata	1.0	0.0	5.5	0.0	1.0	0.5	**G**
Cassia grandis	5.5	2.7	4.0	0.5	0.7	0.6	**G**
Cecropia peltata	13.0	2.0	6.0	0.2	0.5	0.35	**G**
Citrus sinensis	3.0	2.0	5.3	0.7	1.0	0.85	**G**

Cochlospermum vitifolium	1.0	0.0	3.5	0.0	1.0	0.5	**G**
Coffea arabica	16.0	0.0	0.0	0.0	0.0	0	**F**
Coralillo	1.0	0.0	0.0	0.0	0.0	0	**F**
Coralillo verde	2.0	0.0	0.0	0.0	0.0	0	**F**
Cordia alliodora	6.0	41.0	27.3	1.0	1.0	1	**OA**
Cordia bicolor	3.0	2.0	2.0	0.7	0.7	0.7	**G**
Croton draco	14.5	0.0	1.0	0.0	0.1	0.05	**G**
Cuipil	3.0	0.0	0.0	0.0	0.0	0	**F**
Cupania sp.	6.0	2.5	7.3	0.4	1.0	0.7	**G**
Curatella americana	2.5	0.0	3.0	0.0	1.0	0.5	**G**
Cuscana	6.0	0.0	1.0	0.0	0.2	0.1	**G**
Enterolobium cyclocarpum	3.0	3.2	3.8	1.0	1.0	1	**OA**
Erythrina fusca	1.0	0.0	4.8	0.0	1.0	0.5	**G**
Ficus goldmanii	1.0	0.0	0.0	0.0	0.0	0	**F**
Ficus sp.	1.0	0.0	0.0	0.0	0.0	0	**F**
Genipa americana	4.0	3.3	1.5	0.8	0.4	0.6	**G**
Gliricidia sepium	17.0	4.3	17.5	0.3	1.0	0.65	**G**
Guaiacum sanctum	1.0	1.0	3.0	1.0	1.0	1	**OA**
Guazuma ulmifolia	35.5	32.2	54.0	0.9	1.0	0.95	**G**
Inga goldmanii	6.0	1.0	2.0	0.2	0.3	0.25	**G**
Inga sp.	15.0	0.0	0.0	0.0	0.0	0	**F**
Inga vera	3.5	3.0	2.0	0.9	0.6	0.75	**G**
Lauraceae	3.0	0.0	0.0	0.0	0.0	0	**F**
Leucaena leucocephala	1.0	1.0	1.0	1.0	1.0	1	**OA**
Leucaena salvadorensis	12.0	1.0	3.7	0.1	0.3	0.2	**G**
Licania platypus	3.0	0.0	0.0	0.0	0.0	0	**F**
Luehea candida	2.5	1.0	3.5	0.4	1.0	0.7	**G**
Lysiloma sp.	4.0	1.0	2.0	0.3	0.5	0.4	**G**
Lysiloma sp2.	5.0	0.0	0.0	0.0	0.0	0	**F**
Maclura tinctoria	6.0	1.0	5.0	0.2	0.8	0.5	**G**
Mangifera indica	1.0	2.0	2.0	1.0	1.0	1	**OA**
Meliaceae sp.	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Myroxylon balsamum	4.5	0.0	2.0	0.0	0.4	0.2	**G**
Ocotea sp.	4.0	0.0	12.0	0.0	1.0	0.5	**G**
Persea americana	4.0	0.0	10.0	0.0	1.0	0.5	**G**

Pisonia sp.	1.0	0.0	5.0	0.0	1.0	0.5	**G**
Pithecellobium bipinnatum	1.0	0.0	0.0	0.0	0.0	0	**F**
Platymiscium pleiostachium	6.5	13.8	17.0	1.0	1.0	1	**OA**
Pouteria sapota	1.0	0.0	0.0	0.0	0.0	0	**F**
Prestonia mexicana	1.0	0.0	0.0	0.0	0.0	0	**F**
Rubiaceae	1.0	0.0	0.0	0.0	0.0	0	**F**
Sapindaceae sp.	2.0	0.0	0.0	0.0	0.0	0	**F**
Schizolobium parahyba	1.0	1.0	2.0	1.0	1.0	1	**OA**
Senna sp.	1.0	1.0	1.0	1.0	1.0	1	**OA**
Senna sp2	1.0	0.0	0.0	0.0	0.0	0	**F**
Simarouba glauca	1.0	0.0	0.0	0.0	0.0	0	**F**
Sombra de armado	1.0	0.0	0.0	0.0	0.0	0	**F**
Spondias mombin	2.5	2.0	18.5	0.8	1.0	0.9	**G**
Stemmadenia obovata	2.0	0.0	3.0	0.0	1.0	0.5	**G**
Tabebuia ochracea	2.0	5.0	3.7	1.0	1.0	1	**OA**
Tabebuia rosea	7.0	25.4	17.5	1.0	1.0	1	**OA**
Tamarindo del atlantico	2.0	0.0	0.0	0.0	0.0	0	**F**
Terminalia oblonga	1.0	0.0	1.0	0.0	1.0	0.5	**G**
Trichilia hirta	1.0	1.0	1.0	1.0	1.0	1	**OA**
Trichilia sp.	65.0	0.0	1.0	0.0	0.0	0	**F**
Unknwn1	1.0	0.0	0.0	0.0	0.0	0	**F**
Urera baccifera	23.0	0.0	2.0	0.0	0.1	0.05	**G**
X	9.0	0.0	0.0	0.0	0.0	0	**F**
X1	1.0	0.0	0.0	0.0	0.0	0	**F**
X2	5.0	0.0	0.0	0.0	0.0	0	**F**
Zanthoxylum setulosum	10.0	0.0	1.0	0.0	0.1	0.05	**G**
Zanthoxylum sp.	2.0	0.0	0.0	0.0	0.0	0	**F**
Averages				**0.3**	**0.5**	0.4	**G**

DISCUSSION

General analysis:

In 1983 forest cover for the country was estimated on 76,668 km^2. In the year 2000, national forest cover was estimated on 55,977 km^2. From these data we can calculate a forest cover loss all over the country of approximately 20,691 km^2, transformed mostly in agricultural lands and human settlements. This means that in 17 years, Nicaragua has lost 27 % of the total forest cover it had, which represents an annual land use conversion rate of 1.6 % (MARENA, 2001).

The development of agricultural activities is the primary cause of the agricultural frontier advance and it has caused the creation of small forest patches dispersed on different zones with the consequent loss of connectivity. According to MURCIA (1995) forest fragmentation is the replacement of large areas of native forest for other ecosystems, leaving patches or islands separated from the main forest block. Fragmentation, according to this author, has two major components:

- Reduction and loss of different habitat types on a natural landscape,
- Separation of the remnant habitat into smaller and isolated patches,

both contributing to the progressive decrease of biodiversity (HARRIS, 1984). WILCOX (1980) pointed out that meanwhile forest fragmentation takes place, the size of fragments is still decreasing, and isolation is still increasing, making up the so called “island habitats”. This process would facilitate differential extinction of one or more species and the differential preservation of others (HARRIS, 1984).

Previous data existing for Matiguás watershed (MORALES *et al*. 2002) (Fig. 12), show a clear regression of forest cover over the area between 1981 and 1987. In this sense, it is of great importance taking into account that according to PÉREZ *et al*. (2003) the most important variable, in a first level of analysis, related to animal diversity on silvo-pastoral systems is forest cover.

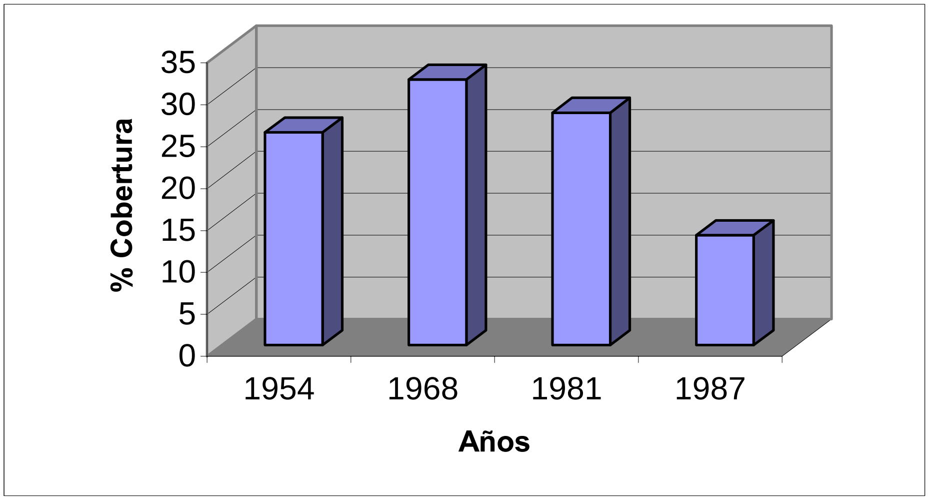


Fig. 12.- Variation of forest cover percentage on Matiguás watershed (MORALES *et al.* 2002).

Species richness and composition:

Regarding vegetation, the number of individuals recorded by PÉREZ *et al.* (2006) at the study site (2,724 individuals for a total of 91 species in 4,9 ha), is considered to be relatively high in comparison to the results obtained by other studies conducted on cattle production systems in the Dry Forest of Costa Rica, where 5,896 individuals for a total of 101 species in 834 ha were recorded (VILLANUEVA *et al.* 2003). This result suggests that despite the high deforestation rate existing at our study site, bird diversity is higher than the one existing in silvo-pastural systems of Costa Rica. Other important results are the ones by KINDT *et al.* (2004) who obtained around 54 tree species in farms studied by them on the districts of Vihiga and Kakamega, west of Kenia, Africa.

In the case of birds, our data on bird diversity can be considered high, having a total of 151 species and 3,575 individuals recorded. Values given by ACOSTA & MUJICA (1988) on various Cuban primary forests total 43 species, meanwhile data from ESTRADA & ESTRADA (1997) in Los Tuxlas, México, with a much higher sampling effort, are of 79 species.

The values obtained by NARANJO (2004) on some silvo-pastoral systems in Colombia range from 19 to 57 species. Data from VÍLCHEZ *et al.* (2004) in Rivas, Nicaragua, mention 83 bird species. Other results from PÉREZ *et al.* (2004) on silvo-pastoral systems of Choluteca, Honduras were of 17 species and from La Cruz, Costa Rica they recorded also 17 species. PERIS & MASA (1992) found some 43 species in farms of Salamanca province, Spain; a similar outcome obtained by ACOSTA & MUJICA (1988) on Cuban forests, which means farms can host similar species richness as primary forests, however, species composition might not be the same as pointed put by PÉREZ *et al.* (2006), but this fact is not discussed by the cited authors.

As mentioned by PÉREZ & LOPEZ (1995) when studying some taxon at a community level it should be kept in mind the variable composition together with species richness or diversity, otherwise we could have large numbers of widespread species with low biological value. Instead, we might be interested in having a "medium size" community made up of species related to primary forests.

It should be also pointed out that all previously mentioned results, although very important and valuable, should be observed with caution since they proceed from studies in which sampling efforts haven´ t been even.

Regarding mollusks, data on species richness can be considered between medium and high. It is mentioned that species richness values on mollusks communities range from 5 to 12 species (SOLEM & CLIMO 1985), with sometimes higher values of 20 to 30 species (PÉREZ *et al.* 1996), and occasionally values of over 50 species in some outstanding localities (SOLEM & CLIMO, 1985; PÉREZ & LÓPEZ, 1995).

Data on either species richness or diversity for this taxonomic group are scarce for natural ecosystems (PÉREZ *et al.* 1996), and almost non-existent for agro-silvo-cultural systems (PÉREZ *et al.* 2004). Information regarding species niche, particularly analyses on species assemblages related to open or disturbed areas versus species associated to forested areas are also very scarce in the scientific literature and the existing one is mostly related to bird communities, so our data on mollusks is pioneer for the field and or landscape ecology.

GUIDELINES FOR POLICY SUPPORT

According to M.E.A (2005) and Marcela Nissen (Pers. Com.) the following guidelines for policy support should be implemented in the country in the short and medium terms in order to make a sustainable use and conservation of the national biodiversity.

1. Guidelines with a primary goal of conservation include the following:

- Protected areas.
- Species protection and recovery measures for threatened species.
- Ex situ and in situ conservation of genetic diversity.
- Ecosystem restoration.

2. Guidelines with a primary goal of sustainable use include the following:

- Payments and markets for biodiversity and ecosystem services.
- Incorporating considerations of biodiversity conservation into management practices in sectors such as agriculture, forestry, and fisheries.
- Capture of benefits by local communities.

3. Integrated guidelines that address both conservation and sustainable use that could be further strengthened include the following:

- Increased coordination among multilateral environmental agreements and between environmental agreements and other international economic and social institutions.
- Public awareness communication and education.
- Enhancement of human and institutional capacity for assessing the consequences of ecosystem change for human well-being and acting on such assessments.
- Increased integration of guild responses.

Many of the responses designed with the conservation or sustainable use of biodiversity as the primary goal will not be sustainable or sufficient, however, unless other indirect and direct drives of change are addressed and enabling conditions are established.

NICARAGUA ON THE GLOBAL CONTEXT

According to RIVAS (2005) the State of Nicaragua has signed and endorsed the following international conventions and protocols:

1. Climate change convention (CNNUCC) (13.06.1992).
2. Convention on biological diversity (CDB) (13.06.1992).
3. United Nations Convention on desertification (UNCOD) (17.06.1994).
4. CITES (3.03.1973).
5. RAMSAR convention for wetlands (1971).
6. Protocol of Montreal (16.09.1987).

CONCLUSIONS

1. General abundance of taxa is considered to be scarce (level 2 of the proposed scale), although there are variations on mollusks and trees.
2. Land uses show a low number of species strictly associated to them. Land uses with highest number of exclusive birds are Riparian Forests and Primary Forest of Quirragua protected area with six species; Land use type with highest number of mollusk species is Primary Forest of Quirragua protected area with seven species.
3. Beta diversity could be as well considered medium. It means that there are some species exclusive to particular land use types but many species are shared among land use types, given as a result a medium turnover rate.
4. A further analysis was made in order to assess tolerance to disturbance. Average values for the bird community are above .5 (ranging from 0, specialist species, to 1, generalists) which means we have more generalist species than specialist ones. Average values for the whole mollusk community are below .5 which means that these taxa are mainly made up of species related to forests. Average values for the tree community are below .5 which means that these taxa are mainly composed of species related to forests.
5. A similar analysis was conducted utilizing STILES & SKUTCH (1998) forest dependence categories. With those criteria we found no forest dependent bird species, 95 species were generalists for a 63 % and 56 species are

open areas species, comprising 37 % of the total. On mollusks we found six (6) forest dependent species comprising 30 %, 10 generalist species representing 50 % of the total and four (4) open areas species for a 20 %.

6. We proposed some guidelines for policy support trying to comprise some with the purpose of conservation, some intended to making sustainable use of natural resources and some trying to integrate both.

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