

SPATIAL DISTRIBUTION OF BIRDS ON THREE ISLANDS IN THE UPPER RIVER PARANÁ, SOUTHERN BRAZIL

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Resumo. – **Distribuição espacial de aves em três ilhas no alto rio Paraná, Sul do Brasil.** – O número e a composição das espécies de aves em três ilhas no alto rio Paraná foram comparados. As ilhas Porto Rico (103 ha) e Mutum (976 ha) sofreram forte desflorestamento, enquanto a ilha Bandeira (14 ha) foi levemente desflorestada. Cinco ambientes foram reconhecidos nas ilhas: florestas, zonas arbustivas, campos abertos, zonas aquáticas e bancos de areia. Um transecto incluindo todos estes ambientes sobre as ilhas foi percorrido mensalmente de Dezembro de 1999 a Setembro de 2000. Foram registradas 113 espécies de aves nas três ilhas: 99 na ilha Mutum, 86 na ilha Bandeira e 82 na ilha Porto Rico. A melhor explicação para o fato do número de espécies da ilha Bandeira ser similar ao das outras ilhas, apesar da sua pequena área, possivelmente é a presença de uma floresta contínua e pouco perturbada sobre a ilha Bandeira, ao contrário das ilhas Mutum e Porto Rico, onde as florestas são fragmentadas. Ilhas bem preservadas, mesmo que pequenas, devem ter prioridade em programas conservacionistas.

Abstract. – The number and composition of bird species on three islands in the upper Paraná river, Brazil, were compared. Porto Rico island, 103 ha, and Mutum island, 976 ha, are highly deforested; Bandeira island, 14 ha, is slightly deforested. Five habitats have been recognized: forests, shrubs, open fields, aquatic areas and sand bars. A transect passing through all the above habitats on the islands was sampled monthly, from December 1999 to September 2000. Birds on the three islands totaled 113 species: 99 on Mutum, 86 on Bandeira, and 82 on Porto Rico islands. The high number of species on Bandeira island, taken its small size, is probably due to the presence on it of a continuous and little disturbed forest. On the contrary, forests on Mutum and Porto Rico islands are fragmented. Well preserved islands, albeit small in size, should have priority in conservation programs. *Accepted 26 May 2003.*

Key words: Paraná river; islands; birds; conservation; southern Brazil.

INTRODUCTION

The semideciduous forests of southern Brazil, as part of the Atlantic forest, present a high number of Neotropical endemic bird species, particularly forest species, but have undergone such intense fragmentation as to make them among the most endangered zoogeographical regions in South America (Stotz *et al.* 1996). The Paraná river, ranking tenth in

discharge in the world, and second in basin drainage in South America (2,800,000 km²), is approximately 3800 km long (Maack 1981). The Paraná river basin has suffered strong human impact (dams building and deforestation). The 250-km river stretch between the mouth of the Paranapanema river (its main affluent) and the town of Guaira PR, Brazil, in the upper Paraná river is the only segment within Brazilian territory which is free from

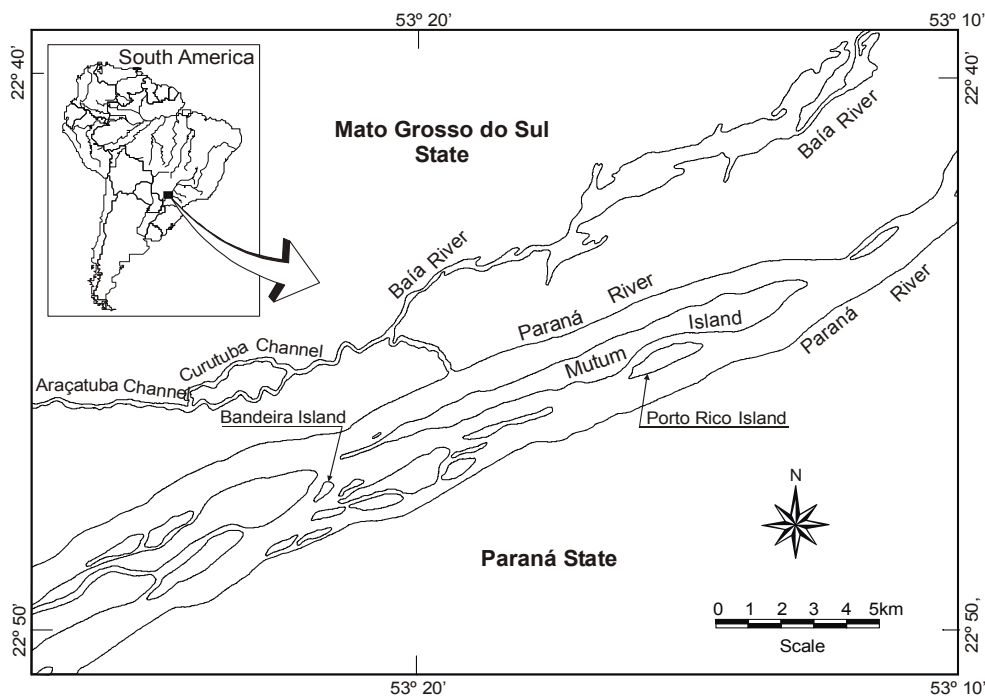


FIG. 1. Paraná river stretch with Mutum, Porto Rico and Bandeira islands.

dams. On the right bank (Mato Grosso do Sul State) of this stretch of the river, there is a fairly well preserved floodplain. On the left bank (Paraná State), with a higher land elevation, semideciduous forests have almost all been transformed into pasture lands.

More than one hundred islands, ranging from less than 10 ha to approximately 2000 ha, are distributed over this river stretch (Stevaux *et al.* 1997). On many islands, where forests once covered the larger part of the land, and other natural habitats covered very small areas, intensive deforestation has created fragmented landscapes (Souza *et al.* 1997). However, a few small islands still maintain continuous non-fragmented forest cover. The island biogeography theory (MacArthur & Wilson 1967) and posterior studies (Moore & Hooper 1975, Forman *et al.* 1976, Galli *et al.* 1976, Connor & McCoy 1979, Willis 1979,

Martin 1981, Wright *et al.* 1985, Wiens 1989, Bierregaard 1990, Anjos & Boçon 1999) have shown that larger islands or larger forest fragments support higher bird species richness than smaller ones. However, other studies have shown that habitat diversity (Williams 1964, Boecklen 1986, Martin *et al.* 1995) and vegetation disturbance (Anjos & Seger 1988, Aleixo & Vielliard 1995, Restrepo *et al.* 1997) also have a strong influence on bird species richness. Therefore, the islands of the Paraná river are appropriate for the study of the influence of area, habitat diversity and vegetation disturbance on bird species richness.

Few ornithological studies have been conducted in the region. Anjos & Seger (1988) recorded 133 species in about 100 ha of mainland and islands. Straube *et al.* (1996) and Straube & Urben-Filho (2002) provided a checklist of birds on the islands and associ-

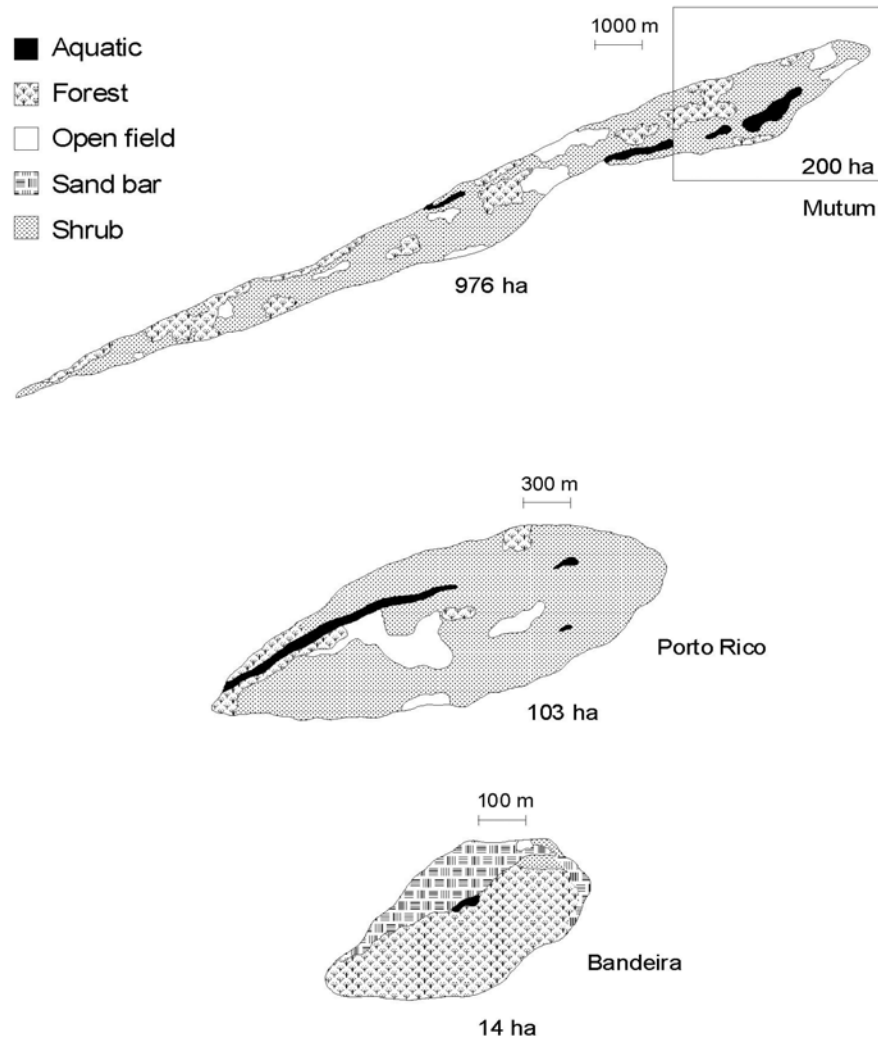


FIG. 2. Habitats on the studied islands, Paraná River, south Brazil. The square indicates sampled area of Mutum island.

ated floodplain between the mouth of the Paranapanema river and Guáira with a total of some 298 species. However, there is no long term study encompassing the bird richness of the islands and the floodplain of the region. This study compares the number and composition of bird species on three islands on the upper Paraná river.

STUDY AREA AND METHODS

Mutum (976 ha), Porto Rico (103 ha) and Bandeira (14 ha) islands lie in the upper Paraná river (between 22°44'S and 22°48'S and 53°21'W and 53°15'W), at an altitude of 230 m a.s.l. (Fig. 1). According to the Köepen's system, the region's climate is classified

TABLE 1. Area (ha) and percentage of habitats on the islands.

	Forests	Shrubs	Open fields	Aquatic habitats	Sand bars	Total (ha)
Mutum (total)	205 (21%)	625 (64%)	127 (13%)	19 (2%)	—	976
Mutum (sampling)	40 (20%)	115 (57.5%)	30 (15%)	15 (7.5%)	—	200
Porto Rico	8 (7.7%)	79 (76.7%)	13 (12.6%)	3 (3%)	—	103
Bandeira	9 (64.3%)	1 (7.1%)	0.4 (2.8%)	0.3 (2.1%)	3.3 (23.7%)	14

as Cfa (tropical-subtropical) with an average annual temperature of 22°C (summer average 26°C, and winter average 17°C), and an average annual rainfall of 1500 mm (Eletrosul 1986). The islands are made of clayey sediments, clayey-sandy sediments and sand deposited by the river channel (Stevaux *et al.* 1997). The area lies within the phytoecological region of semideciduous seasonal forest with the local vegetation classified as alluvial semideciduous seasonal forest (Souza *et al.* 1997). Mutum and Porto Rico islands have been heavily deforested, leaving only small forest fragments. Bandeira island is slightly disturbed, but most of its area still has continuous forest (Fig. 2).

Five habitat categories are found on the islands (Souza *et al.* 1997): (1) open fields, without any or with low vegetation cover of plant, such as *Panicum*, *Setaria*, *Paspalum* (Poaceae), *Cyperus* (Cyperaceae) species, *Lippia alba* (Lamiaceae) and *Ageratum conyzoides* (Asteraceae); (2) shrubs, with the predominance of *Palicourea crocea* (Rubiaceae), *Cordia monosperma* (Boraginaceae) and *Solanum evonymoides* (Solanaceae); (3) aquatic areas (lakes, backwaters and bogs), with *Eichhornia crassipes*, *Eichhornia azurea* (Pontederiaceae), *Salvinia auriculata* (Salviniaceae) and *Polygonum acuminatum* (Polygonaceae); (4) forests, whose most common tree species are *Cecropia pachystachya* (Cecropiaceae), *Croton urucurana* (Euphorbiaceae), *Celtis iguanaea* (Ulmaceae), *Inga uruguensis*

(Mimosaceae), *Peschiera australis* (Apocynaceae) and *Ficus obtusiuscula* (Moraceae); and (5) sand bars, present only on Bandeira island (Table 1).

Samplings were conducted from December 1999 to September 2000, and each island was visited monthly. One sampling is equal to one day of field work in which the transect was ran on one island (total of 10 samplings on each island). Once a month, a standard transect was ran on each island in the same direction throughout all pre-established habitats. Samplings always began one hour after sunrise, with an 8-h duration on each island. The transects sampled all areas of the Bandeira and Porto Rico islands. On Mutum island, the transect comprised approximately 200 ha and all habitats were covered. Two other visits were made (in 2 days, totaling eight hours) to sections of the island not covered by the transect. Since no bird species was registered which had not already been detected along the transect, we believe the sampled area is representative of the Mutum island. The observer (MRG) identified each bird encountered along the transect using binoculars, and recorded the habitat in which each bird was sighted or heard. Each species was registered only once in each habitat on a single sampling day, thus, abundance information is not available.

The frequency of occurrence in percentage was calculated for of each species 1) at the

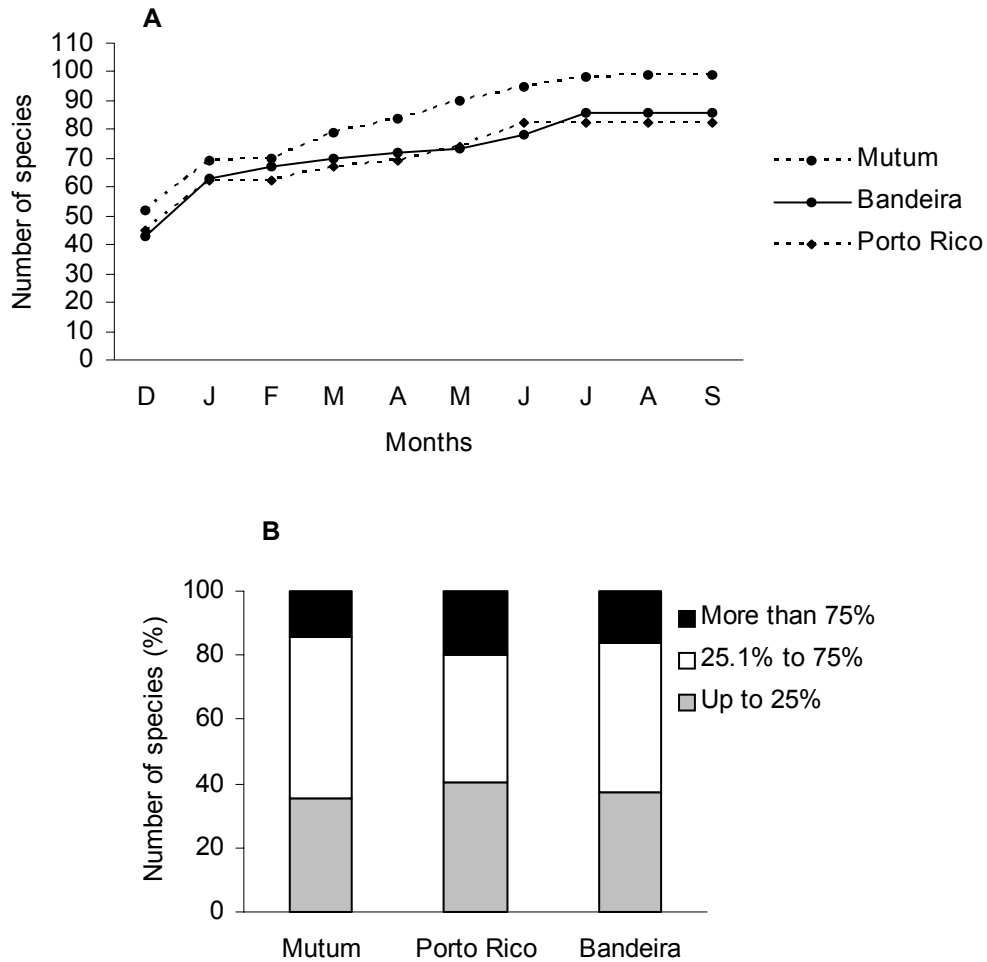


FIG. 3. Monthly cumulative number of bird species on each island (A), and number of species recorded during up to 25%, between 25.1 and 75%, and more than 75% of samplings for each island (B).

island level, as the number of samplings (or days) in which each species was recorded on a particular island, divided by 10 (total number of samplings or days of field work for each island) and multiplied by 100, and 2) at the habitat level, as the number of samplings (or days) in which each species was recorded in one particular habitat on one island, divided by number of samplings (or days) in which it

was recorded on that island, and multiplied by 100. Analysis of variance (one way ANOVA, $P < 0.05$) was used to evaluate whether there was any significant difference between average numbers of species on the islands. Chi-square and contingency table analyses ($\alpha = 0.05$) determined whether there was any significant difference in the numbers of species recorded during up to 25%, between 25.1% to

75%, or more than 75% of samplings on each island or habitat. Similarity regarding the bird species composition of the islands and habitats was estimated by use of the qualitative Sørensen's index: $2j/(a + b)$, where "j" is the number of species common to both sites, "a" is the number of species in site "A", and "b" is the number of species in site "B".

RESULTS

Number of species on the islands. Birds recorded on the three islands totaled 113 species: 99 on Mutum, 86 on Bandeira and 82 on Porto Rico (Appendix 1). These values are statistically similar ($F = 2.43$, $df = 2$, $P > 0.05$), even excluding the 12 species which occurred only on the sand bars of Bandeira island ($F = 3.22$, $df = 2$, $P > 0.05$). Therefore, although the sampling area of each island was different, species richness was similar. On all islands, species-accumulation curves reached an asymptotic plateau (Fig. 3A). The frequency of occurrence of species was statistically similar ($\chi^2 = 2.11$, $df = 4$, $P > 0.05$) on the three islands (Fig. 3B). Highest similarity values occurred between Mutum and Porto Rico (0.84), followed by Mutum and Bandeira (0.81) and Porto Rico and Bandeira (0.76). Excluding the 12 species which occurred only on the sand bars of Bandeira island, the similarity value between Mutum and Bandeira decreased to 0.75, while it increased to 0.78 between Porto Rico and Bandeira.

Species richness according to habitats. The frequency of occurrence of species differed significantly between habitats, on Mutum ($\chi^2 = 35.8$, $df = 6$, $P < 0.05$), Porto Rico ($\chi^2 = 16.6$, $df = 6$, $P < 0.05$) and Bandeira islands ($\chi^2 = 42.6$, $df = 6$, $P < 0.05$) (Fig. 4). On all three islands, the forests presented the highest number of bird species (Appendix 1). However, the four habitat categories of Mutum tended to have roughly the same number of

species ($\chi^2 = 6.89$, $df = 3$, $P > 0.05$), contrary to Porto Rico ($\chi^2 = 19.66$, $df = 3$, $P < 0.05$) and Bandeira ($\chi^2 = 47.98$, $df = 4$, $P < 0.05$) islands (see Appendix 1). Forests also had the highest number of exclusive species (21), followed by aquatic areas (11), shrubs (3), and sand bars (2). Highest similarity values were verified between the forests and shrubs, and between the shrubs and open fields (Table 2). Highest similarity values among the habitats of a same island was obtained between forests and shrubs of Mutum and Porto Rico while, on Bandeira, the highest value was between shrubs and open fields. The forests of Bandeira were less similar to shrubs and open fields than on the other two islands (Table 2).

The highest species richness of forests was recorded on Bandeira island (Appendix 1). Bandeira was the only island for which species richness of forests was significantly greater than that of the habitat with the second highest species number ($\chi^2 = 4.45$, $df = 1$, $P < 0.05$). The same island had the highest proportion of species recorded in more than 75% of samplings, and the least proportion occurring in no more than 25% of forest samplings (Fig. 4). Based on contingency table, the species richness of Bandeira and Porto Rico forests appeared as high as that of Mutum forests, in spite of the fact that forests are smaller on Bandeira and Porto Rico ($\chi^2 = 14.08$, $df = 1$, $P < 0.05$ and $\chi^2 = 12.71$, $df = 1$, $P < 0.05$, respectively). When the forests of the Bandeira and Porto Rico islands are taken into account, species richness appears related to the size of the forest ($\chi^2 = 0.0001$, $df = 1$, $P > 0.05$).

Highest species richness in shrubs and open fields were recorded on Mutum and Porto Rico islands (Appendix 1). However, considering the size of the area occupied by shrubs on each island, species richness of Bandeira shrubs resulted higher when compared to Mutum ($\chi^2 = 57.22$, $df = 1$, $P < 0.05$) and Porto Rico ($\chi^2 = 40.61$, $df = 1$, $P <$

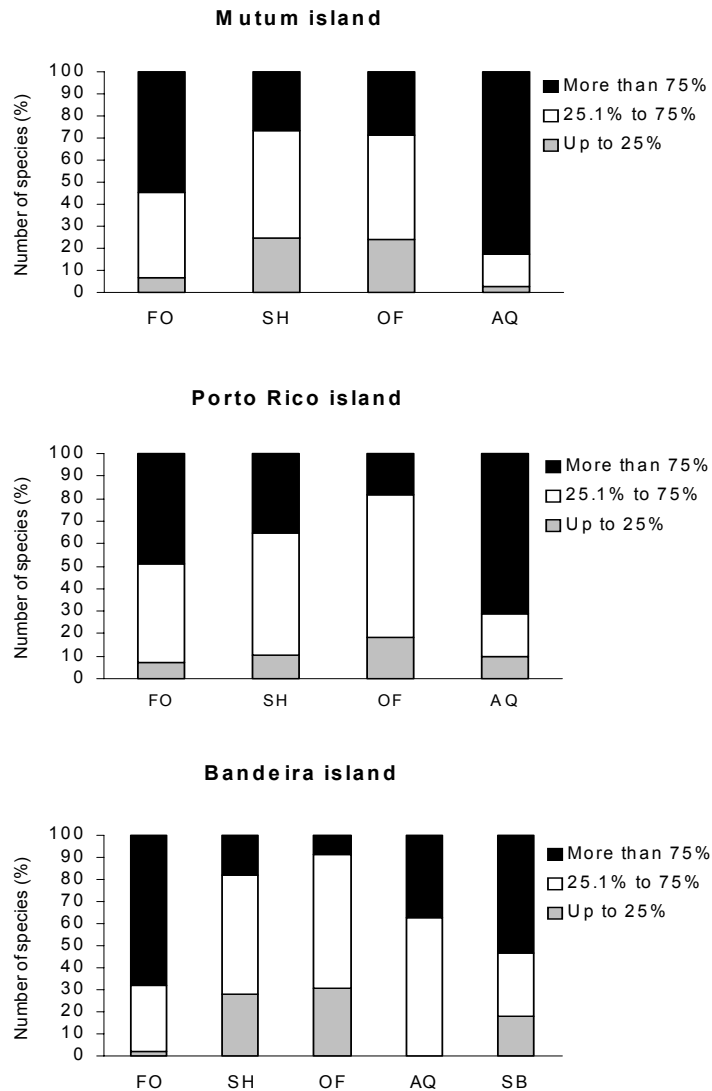


FIG. 4. Number of species recorded during up to 25%, between 25.1 and 75%, and more than 75% of samplings of each habitat for Mutum, Porto Rico and Bandeira islands. FO: forests, SH: shrubs, OF: open fields, AQ: aquatic habitats, and SB: sand bars.

0.05) ones. The same occurred with the small open fields of Bandeira. In spite of the fact that these habitats are much smaller on Bandeira island, the number of species did not decrease significantly.

Nevertheless, the use of shrubs and open fields on Bandeira island, based on the frequency of occurrence of species during the samplings, was significantly less than that of forests of the same island ($\chi^2 = 29.52$, $df = 2$

TABLE 2. Similarity index among different habitats.

		Forests	Shrubs	Open fields	Aquatic habitats	Sand bars
All three islands	Forests		0.72	0.56	0.21	0.21
	Shrubs			0.72	0.22	0.26
	Open fields				0.20	0.28
	Aquatic habitats					0.54
Bandeira island	Forests	0.62		0.40	0.05	0.22
	Shrubs			0.64	0.12	0.26
	Open fields				0.06	0.27
	Aquatic habitats					0.27
Mutum island	Forests	0.73		0.56	0.08	
	Shrubs			0.71	0.16	
	Open fields				0.11	
Porto Rico island	Forests	0.69		0.52	0.13	
	Shrubs			0.66	0.14	
	Open fields				0.20	

$P < 0.05$). The proportion of species which have been recorded during more than 75% of samplings in shrubs and open fields was somewhat less on Bandeira than on the other two islands (Fig. 4).

The species number in aquatic areas seem to be related to the size of the areas, as the χ^2 test (Contingency table) showed when Mutum was compared to Porto Rico ($\chi^2 = 1.83$, $df = 1$, $P > 0.05$), and as the small number of species on Bandeira island demonstrated with its extremely restricted area of this habitat (Appendix 1). Higher proportion of species occurring in more than 75% of samplings in this habitat was recorded on Mutum island (Fig. 4).

DISCUSSION

The richness of 113 bird species on the three islands is much lower than the 298 species recorded for the 250 km of river and floodplains of the Upper Paraná river (Straube *et al.* 1996, Straube & Urben-Filho 2002), possibly because of the intense human disturbance and lower natural habitat diversity on the islands than on the associated floodplains.

The total number of species on the three islands (total of 317 ha) is close to that recorded by Anjos & Seger (1988) from a much smaller area (133 species; 100 ha) in the same geographic region. However, Anjos & Seger (1988) sampled mainly the mainland, which commonly supports higher bird richness than islands in a same geographical region (MacArthur & Wilson 1967, Blondel 1991).

The three islands, despite their very different sizes, presented a similar number of species. When similar habitats were compared between the islands, the contingency table test showed that the number of species did not increase in accordance with the size of the habitat, except in aquatic environments. Variations in the number of species parallel to the size of an habitat were found particularly when highly homogeneous forest fragments or islands were compared (Moore & Hooper 1975, Forman *et al.* 1976, Galli *et al.* 1976, Connor & McCoy 1979, Martin 1981, Anjos & Boçon 1999). However, when islands with different habitat diversity and vegetation disturbance are compared, the influence of the size of an habitat area on the number of spe-

cies appears to decrease (Boecklen 1986, Martin *et al.* 1995, Warburton 1997). The fact that the three islands had similar frequency of occurrence of species is an indication that the proportion of species either sporadically and commonly recorded is about the same on the three islands. Mutum and Porto Rico islands are very similar in terms of landscape, presenting a mosaic of habitats. Bandeira island, on the contrary, still has a continuous forest, and this difference in the landscape possibly explains its lower similarity in bird species composition with the other islands.

The most remarkable result of this study is the number of species on the very small Bandeira island being similar to that of the other two islands. Williams (1964) stated that the increase in the number of species according to the size of an area depends on habitat diversity. Bandeira island has sand bars, a habitat type lacking on Mutum and Porto Rico. Sand bars certainly contributed to the species richness of Bandeira. Indeed, on Bandeira, twelve species were recorded exclusively on sand bars. However, 10 of these species were recorded in other habitats of the other islands. Only Collared Plovers (*Charadrius collaris*) and Black Skimmers (*Rynchops niger*) occurred exclusively on the sand bars. Excluding these 12 species, richness remained statistically similar on the three islands. Therefore, the species richness of Bandeira island might be due to factors other than the presence of an extra habitat.

Bird species richness increased in accordance with habitat succession, from sand bars, to open fields, to shrubs, with a peak in the forests on all the islands, as verified by Willson (1974) in Champaign-Urbana, USA, and by Anjos *et al.* (1997) in the Tibagi River basin, Brazil. Forests also presented the highest number of exclusive species. However, the highest species richness in forests was encountered on Bandeira island. On this

island, the forest is continuous and well preserved while, on the other two islands, it has suffered intense fragmentation. Several studies have reported a decrease in bird species richness following the fragmentation of continuous forests due to low dispersion between fragments (Simberloff & Abelle 1982, Bierregaard 1990, Terborgh *et al.* 1997), microhabitat loss (Aleixo & Vielliard 1995, Restrepo *et al.* 1997), food decrease (Willis 1979), increase in predation and competition (Wilcove & Robinson 1990), and edge effect (Lovejoy *et al.* 1986, Wilcove *et al.* 1986, Bierregaard 1990, Sisk *et al.* 1997). Forest specialist species are more susceptible to habitat fragmentation (Blondel 1991) and, in sites where there is a mosaic of small forest fragments and open areas, generalists species predominate, as commonly verified in southern Brazil (Gimenes & Anjos 2000, Krugel & Anjos 2000, Anjos 2001). In summary, the forest on Bandeira island presented a richer and more differentiated avifauna than the forests on the other islands, and thus resulted in higher overall richness of bird community on this island.

As stated by Martin *et al.* (1995), habitat heterogeneity and forest integrity might be more important than the size of an area in predicting the number of species found on islands. Small islands with almost unaltered forests should have priority in conservation programs over larger but extremely altered ones.

ACKNOWLEDGMENTS

This study had the financial support of the CNPq (National Research Council, Brasília) and the Curso de Pós-Graduação em Ecologia de Ambientes Aquáticos Continentais (Universidade Estadual de Maringá). MRG received M.Sc. scholarship from CAPES and LdA received a Research Productivity grant from CNPq (350054/95-9). A. da Silva and S. Rodrigues helped in field work. Comments of

two anonymous reviewers improved substantially the manuscript.

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APPENDIX 1. Frequency of occurrence percentages of bird species at the habitat level (FO: forest, SH: shrub, OF: open fields, AQ: aquatic, and SB: sand bar) and the island level (FQ) on the three islands. Taxonomy and nomenclature according to Sick (1997) and common names according to Narosky & Yzurieta (1987).

	Mutum (200 ha)					Porto Rico (103 ha)					Bandeira (14 ha)						
	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	SB	FQ	
Neotropic Cormorant (<i>Phalacrocorax brasilianus</i>)				100	50				100	60					100	70	
Anhinga (<i>Anhinga anhinga</i>)				100	10										100	20	
White-necked Heron (<i>Ardea cocoi</i>)				100	60				100	60							
Great Egret (<i>Casmerodius albus</i>)				100	80				100	10				50	100	20	
Snowy Egret (<i>Egretta thula</i>)				100	70				100	30					100	100	
Striated Heron (<i>Butorides striatus</i>)				100	30				100	50				100		20	
Black-crowned Night-Heron (<i>Nycticorax nycticorax</i>)	100			50	20												
Rufescent Tiger-Heron (<i>Tigrisoma lineatum</i>)				100	40				100	10							
Green Ibis (<i>Mesembrinibis cayennensis</i>)				100	10												
Roseate Spoonbill (<i>Platalea ajaja</i>)				100	10										100	10	
Wood-Stork (<i>Mycteria americana</i>)				100	40										100	10	
Maguari Stork (<i>Ciconia maguari</i>)				100	50												
Jabiru (<i>Jabiru mycteria</i>)				100	20												
Blake Vulture (<i>Coragyps atratus</i>)	66.6	16.6	16.6		60	100	25			40	100				50	40	
Turkey Vulture (<i>Cathartes aura</i>)		20	20	80	50	100				10							
White-faced Tree-Duck (<i>Dendrocygna viduata</i>)				100	40				100	20			33.3		33.3	100	30
Muscovy Duck (<i>Cairina moschata</i>)			66.6	33.3	30	33.3			66.6	30			50	100		20	
Brazilian Duck (<i>Amazonetta brasiliensis</i>)		20		100	50				100	30			50	100		20	
Everglade Kite (<i>Rostrhamus sociabilis</i>)				100	40				100	40							
Roadside Hawk (<i>Bupornis magnirostris</i>)	50	66.6			60	100				10			100			10	
Great Black Hawk (<i>Buteogallus urubitinga</i>)		100			10												
Crane Hawk (<i>Geranospiza caerulescens</i>)													100			20	
Yellow-headed Caracara (<i>Milvago chimachima</i>)	100				10												
Crested Caracara (<i>Polyborus plancus</i>)	66.6	66.6		33.3	30	33.3	66.6			30	66.6	66.6			33.3	30	
Limpkin (<i>Aramus guarauna</i>)				100	70				100	20	50	50		50	50	20	
Wattled Jacana (<i>Jacana jacana</i>)				100	90				100	100							
Southern Lapwing (<i>Vanellus chilensis</i>)		10	90	80	100		10	100	50	100				11.1	100	90	

APPENDIX 1. Continuation.

	Mutum (200 ha)					Porto Rico (103 ha)					Bandeira (14 ha)					
	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	SB	FQ
Collared Plover (<i>Charadrius collaris</i>)															100	50
Lesser Yellowlegs (<i>Tringa flavipes</i>)				100	10										100	40
South American Stilt (<i>Himantopus himantopus</i>)				100	60										100	70
Large-billed Tern (<i>Phaetusa simplex</i>)				100	30										100	70
Yellow-billed Tern (<i>Sterna superciliaris</i>)				100	10										100	20
Black Skimmer (<i>Rynchops niger</i>)															100	20
Picazuro Pigeon (<i>Columba picazuro</i>)	100	28.5	14.2		70	100	30	30		100	100	12.5			12.5	80
Pale-vented Pigeon (<i>Columba cayennensis</i>)											100	25				40
Eared Dove (<i>Zenaida auriculata</i>)	37.5	50	87.5		80	62.5	50	37.5		80	71.4	28.5	14.2			70
Picui Ground-Dove (<i>Columbina picui</i>)	44.4	55.5	77.7		90						100					10
Ruddy Ground-Dove (<i>Columbina talpacoti</i>)	90	100	50		100	60	100	40		100	62.5	75	12.5		12.5	80
Scaled Dove (<i>Scardafella squammata</i>)	66.6	33.3			30		100			10						
White-tipped Dove (<i>Leptotila verreauxi</i>)	100				10	100				20	100					30
White-eyed Parakeet (<i>Aratinga leucophthalmus</i>)	50	50	50		40	100	50	25		40	100	33.3	33.3			30
Blue-winged Parrotlet (<i>Forpus xanthopterygius</i>)	57.1	42.8	14.2		70	66.6	44.4	33.3		90	66.6	16.6	50			60
Scaly-headed Parrot (<i>Pionus maximiliani</i>)	100	25	50		40	50	50	50		20	100	50	50			20
Smooth-billed Ani (<i>Crotophaga ani</i>)	20	100	10		100	33.3	77.7	44.4	11.1	90	33.3	100				30
Guira Cuckoo (<i>Guira guira</i>)		66.6	33.3		30		100	50		60		100	100			10
Striped Cuckoo (<i>Tapera naevia</i>)							100			20						
Burrowing Owl (<i>Speotyto cunicularia</i>)			100		10									88.8	66.6	90
Pauraque (<i>Nyctidromus albicollis</i>)	100				10	100				40						
Little Nightjar (<i>Caprimulgus parvulus</i>)		100			30		100			20		100				10
Planalto Hermit (<i>Phaethornis pretrei</i>)	100				10	100				20						
Gilded Sapphire (<i>Hylocharis chrysura</i>)	50	50			60	66.6	33.3			30	100	50				20
Ringed Kingfisher (<i>Ceryle torquata</i>)				100	20				100	40						
Amazon Kingfisher (<i>Chloroceryle amazona</i>)				100	20				100	10	20			40	40	50
Green Kingfisher (<i>Chloroceryle americana</i>)				100	20				100	10				66.6	33.3	30
Rufous-tailed Jacamar (<i>Galbula ruficauda</i>)											100					20
White-barred Piculet (<i>Picumnus cirratus</i>)	50		75		40	100	33.3			30	50	50	50			20

	Mutum (200 ha)					Porto Rico (103 ha)					Bandeira (14 ha)					
	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	SB	FQ
White-wedged Piculet (<i>Picumnus albosquamatus</i>)	100				30		100			10	100					40
White Woodpecker (<i>Melanerpes candidus</i>)			100		10		100	100		10						
Yellow-fronted Woodpecker (<i>Melanerpes flavifrons</i>)						100				10	100					40
Little Woodpecker (<i>Veniliornis passerinus</i>)	100	100			10		100			20	50	50				20
Green-barré Woodpecker (<i>Colaptes melanochloros</i>)	100				10	60	40			50	100	20				50
Field Flicker (<i>Colaptes campestris</i>)			100		10	25	37.5	50		80						
Barred Antshrike (<i>Thamnophilus doliatus</i>)	100	14.2			70	71.4	85.7			70	70	40				100
Rufous-capped Antshrike (<i>Thamnophilus ruficapillus</i>)											100					20
Plain Antvireo (<i>Dysithamnus mentalis</i>)	100				40	100				30	100					10
Large-billed Antwren (<i>Herpsilochmus longirostris</i>)	100				30	100				40	100					60
Rufous Hornero (<i>Furnarius rufus</i>)	40	40	90		100	50	70	70		100	90	70	60			100
Sooty-fronted Spinetail (<i>Synallaxis frontalis</i>)	100				20						100					10
Rusty-backed Spinetail (<i>Cranioleuca vulpina</i>)											100					10
Greater Thornbird (<i>Phacellodomus ruber</i>)	77.7	55.5			90	6.6	55.5	44.4		90	85.7	7.1				70
White-eyed Foliage-Gleaner (<i>Automolus leucophthalmus</i>)											100					10
Red-billed Scythebill (<i>Campylorhynchus trochilirostris</i>)	100				10						100					20
Southern Beardless Tyrannulet (<i>Camptostoma obsoletum</i>)	100				10	100				20	100					50
Yellow-bellied Elaenia (<i>Elaenia flavogaster</i>)	80	20	20		50	50	100			40	100					40
Large Elaenia (<i>Elaenia spectabilis</i>)	100	42.8	28.5		70	83.3	16.6	16.6		60	75	25	37.5			80
White-crested Tyrannulet (<i>Serpophaga subcristata</i>)	75	25	25		40	60	20	20		50	100	16.6	16.6			60
Common Tody-Flycatcher (<i>Todirostrum cinereum</i>)	100	10			100	90	60			100	100	40				100
White-headed Marsh-Tyrant (<i>Arundinicola leucocephala</i>)				100	10											
Pied Water-Tyrant (<i>Fluvicola pica</i>)				100	20	100				10						
Cliff Flycatcher (<i>Hirundinea ferruginea</i>)	66.6	66.6			30						100					40
Cattle Tyrant (<i>Machetornis rixosus</i>)	25	50	50		40		62.5	75		80		40	40		40	50
Fork-Tailed Flycatcher (<i>Tyrannus savana</i>)	33.3	100	33.3		30	50	100			20	75	25	25		25	40
Tropical Kingbird (<i>Tyrannus melancholicus</i>)	100	83.3	66.6		60	85.7	85.7	57.1		70	71.4	100	57.1			70
Variegated Flycatcher (<i>Empidonomus varius</i>)	100	50	100		20	100				10	100					20
Three-striped Flycatcher (<i>Conopias trivirgata</i>)	50	25		25	40	100				20	66.6	33.3				60

APPENDIX 1. Continuation.

	Mutum (200 ha)					Porto Rico (103 ha)					Bandeira (14 ha)					
	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	FQ	FO	SH	OF	AQ	SB	FQ
Streaked Flycatcher (<i>Myiodynastes maculatus</i>)	100				30	100	33.3			30	100					20
Vermilion-crowned Flycatcher (<i>Myiozetetes similis</i>)		100			10	50	50			20	100					20
Great Kiskadee (<i>Pitangus sulphuratus</i>)	33.3	100	55.5	66.6	90	80	60	70	40	100	100	33.3	33.3		22.2	90
White-winged Swallow (<i>Tachycineta albiventer</i>)			100		10				100	80					100	50
Brown-chested Martin (<i>Phaeoprogne tapera</i>)		33.3	66.6	33.3	30	16.6	33.3	33.3	33.3	60	50	25	50			40
Rough-winged Swallow (<i>Stelgidopteryx ruficollis</i>)	100	100			20	100				10	66.6				33.3	30
Black-capped Mock Ingthrush (<i>Donacobius atricapillus</i>)				100	20											
House Wren (<i>Troglodytes aedon</i>)		100			30	6.6	33.3			30		100				30
Rufous-bellied Thrush (<i>Turdus rufiventris</i>)	100				10						100					60
Pale-breasted Thrush (<i>Turdus leucomelas</i>)	100	66.6	44.4		90	62.5	62.5	12.5		80	100	20				100
Chalk-browed Mock Ingbird (<i>Mimus saturninus</i>)	20	100	20		50	22.2	77.7	66.6		90	44.4	100	22.2		11.1	90
Orange-headed Tanager (<i>Thlypopsis sordida</i>)						100		100		10	100					20
Hooded Tanager (<i>Nemosia pileata</i>)	66.6	33.3			30	50	50			40	100					30
Sayaca Tanager (<i>Thraupis sayaca</i>)	37.5	75	37.5		80	6.6	66.6			30	50	25	50			40
Palm Tanager (<i>Thraupis palmarum</i>)	75	25			40	100				10	100					10
Silver-beaked Tanager (<i>Ramphocelus carbo</i>)	85.7	28.5	28.5		70	66.6	16.6	33.3	16.6	60	100	12.5				80
Purple-throated Euphonia (<i>Euphonia chlorotica</i>)						100				10						
Violaceous Euphonia (<i>Euphonia violacea</i>)						100				10						
Burnished-buff Tanager (<i>Tangara cayana</i>)	100				10											
Chestnut-vented Conebill (<i>Conirostrum speciosum</i>)	100				10						100					50
Rufous-collared Sparrow (<i>Zonotrichia capensis</i>)		50	100		20		100			10						
Saffron Finch (<i>Sicalis flaveola</i>)							100			30		60	40			50
Blue-black Grassquit (<i>Volatinia jacarina</i>)	40	100	60		50			100		20						
Lined Seedeater (<i>Sporophila lineola</i>)	75	25	25		40	50	50			40	100					10
Double-collared Seedeater (<i>Sporophila caerulea</i>)			100		30		50	50		20						
Yellow-billed Cardinal (<i>Paroaria capitata</i>)	25	50	50		80	25	75	25		40	66.6	33.3	50			60
Epaulet Oriole (<i>Icterus cayanensis</i>)	100				10	100				20	100					30
Shiny Cowbird (<i>Molothrus bonariensis</i>)	71.4	57.1	71.4		70	40	40	80		50	87.5	37.5	25			80
Total of species	57	49	38	35		53	48	27	21		60	39	23	08	28	

