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BIRD DENSITIES ALONG THREE TRIBUTARIES OF THE PARANÁ RIVER IN EASTERN PARAGUAY¹

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RESUMEN. — Densidades lineales de aves en tres afluentes del río Paraná en el Paraguay Oriental. Se realizaron censos de aves (y mamíferos) navegando en canoa a lo largo de 198 km de tres ríos afluentes del río Paraná: Carapá, Itambey y Ñacunday, en el Paraguay oriental. Se presentan datos sobre densidades lineales para aves acuáticas, rapaces, loros y tucanes (y tres especies de mamíferos), en cada río estudiado. No se encontró el amenazado pato serrucho (*Mergus octosetaceus*), un residente anterior de la región, lo que indica que esta especie puede estar ya extinta en el Paraguay.

The Republic of Paraguay is situated within the watersheds of two large rivers: the Paraguay River, which flows southward and divides the country into two distinct regions; and the Paraná River, which forms the southern and eastern border of the country (Fig. 1). The avifauna of the Paraná River watershed of Paraguay, often referred to as the Alto Paraná region, is poorly known. The most significant studies of the area's avifauna were accomplished by Winkelreid Bertoni, an early resident of the area whose many publications were summarized in several major reviews of the birds of Paraguay (Bertoni 1901, 1914, Laubmann 1939, 1940). Since the reviews of Laubmann, the only published information of the region's avifauna includes records of a few species recorded by Partridge (1953), Foster (1987) and Storer (1989), plus a list without supporting documentation published by Perez et al. (1988).

Within the last two decades, the construction of the Itaipú Hydroelectric Dam and a subsequent increase in human immigration has resulted in the extensive flooding of primary forest and the rapid deforestation of large areas in southeastern Paraguay. These anthropogenic changes threaten the survival

of many species of globally endangered animals. However, thus far there have been no systematic attempts at determining the abundance of wildlife in the region. In 1989, we received funding to search for the endangered Brazilian Merganser (*Mergus octosetaceus*) and other endangered birds in eastern Paraguay. Here we report the results of our surveys along three tributaries of the Paraná River. Although our primary focus is on birds, we include data obtained for three species of mammals.

STUDY AREA AND METHODS We censused birds and mammals by canoe along three tributaries of the Paraná River: the Carapá (21-25 July 1989), Itambey (25 August 1989) and Ñacunday (26-27 September 1989) Rivers (Fig. 1). The Carapá River was divided into two transects to facilitate comparisons between upper and lower sections (Fig. 1). Topographic maps published by the Servicio Geográfico Militar (in Asunción) were used to measure (with a planimeter) the length of each transect and the river's gradient (Table 1). In the case of the Carapá I and Itambey transects, we added 5% of the measured length to compensate for the many curves not figured on the maps. During each transect, we estimated the river's minimum and maximum width and the percentage of the river's length in which the banks were covered by forest (Table 1). We also recorded the number of canoes encountered along each transect as a relative measure of the river's use by humans (Table 1). We measured the duration of each transect by watch and calculated the canoe's mean velocity (Table 1).

During each census we recorded all waterbirds, raptors, parrots and toucans (and mammals) observed within 100 m of the river. These groups of birds were the most conspicuous and easiest to count; other species were often hidden in the forest and difficult to census accurately. Censuses were conducted only during the day when visibility was good; no censuses were taken during periods of rain. The linear density of each species along each transect was calculated by dividing the total number of birds observed by 10% of the transect's length (individuals/10 km).

The region's topography is characterized by gentle hills separated by numerous streams and rivers flo-

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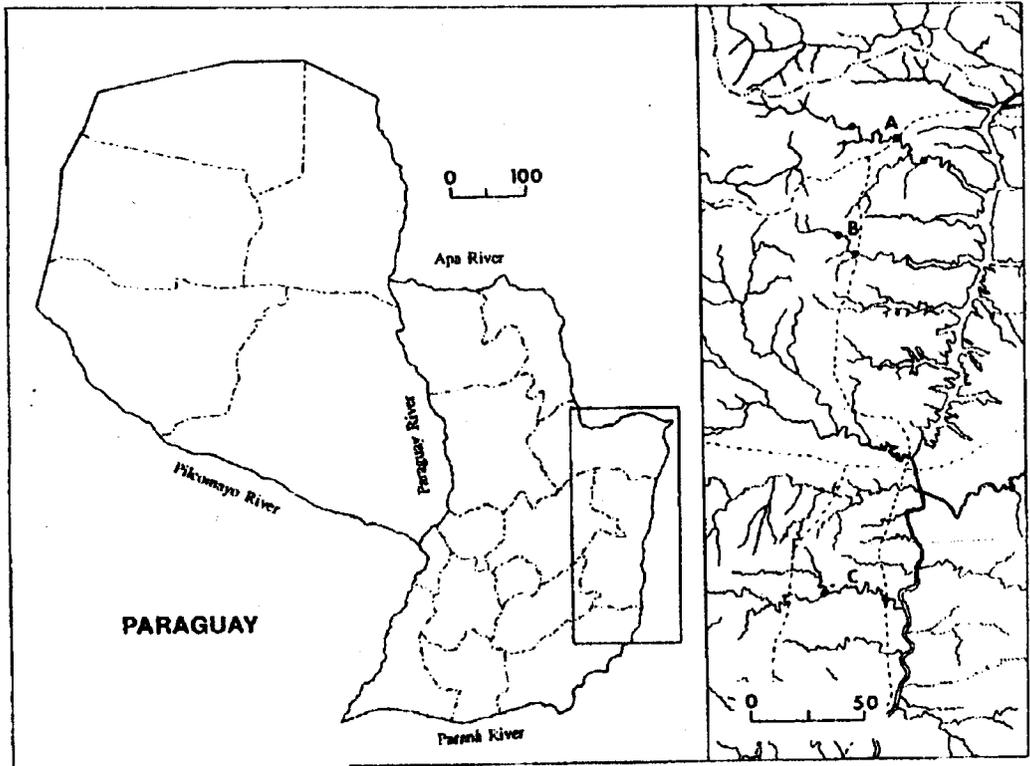


Figure 1: Map of Paraguay showing political departments and major rivers. Circles in the inset represent terminal points for each transect. A = Carapá River; B = Itambeý River; C = Ñacunday River.

wing eastward toward the Paraná River. Of the three rivers navigated during this study (Fig. 1), the Carapá River is the most variable; fast-flowing sections of the river alternate with slow sections, exposed rocks and sand bars are common, and numerous rapids and a few waterfalls are encountered. The navigated portion of the Itambeý River is narrow, serpentine and relatively flat; overhanging branches and log jams are ubiquitous. The Ñacunday River is wide with relatively few curves, and its velocity is fast and relatively constant; exposed rocks, rapids and waterfalls are absent along the navigated portion.

RESULTS AND DISCUSSION The linear densities of 32 species of birds (and 3 species of mammals) varied between transects (Table 2). Of the waterbird species, only the Olivaceous Cormorant (*Phalacrocorax olivaceus*) and Brazilian Duck (*Amazonetta brasiliensis*) appeared most common along the wider portions of the rivers (Carapá II and Ñacunday); the abundance of the other species did not appear to be correlated with river width. Two species of migrant raptors, the American Swallow-tailed Kite (*Elanoides forficatus*) and Plumbeous Kite (*Ictinia plumbea*), were relatively common along the Ñacunday River but were not encountered earlier along the other transects.

We observed four species of birds considered by Collar and Andrew (1988) to be in danger of extinction. One each of the Mantled Hawk (*Leucopternis polionota*) and Orange-breasted Falcon (*Falco rufigularis*) were seen along the lower Carapá River. Fair numbers of Red-capped Parrot (*Pionopsitta pileata*) and Vinaceous-breasted Parrot (*Amazona vinacea*) were seen in forest along both the Carapá and Ñacunday Rivers.

Table 1. Physical characteristics of rivers, number of canoes encounters and mean velocity of canoe during four transects along three tributaries of the Paraná River.

Variable	Transect			
	Carapá I	Carapá II	Itambeý	Ñacunday
Length (km)	55	50	22	71
Width (m)	10-20	15-25	5-15	20-50
Gradient (m/km)	1.1	0.6	0.5	0.4
Forest cover (% along river length)	90	30	90	90
Canoes/10 km	4.0	3.0	0.0	2.3
Mean velocity of canoe (km/hr)	3.6	5.2	2.9	5.9

Table 2. Linear densities (individuals/10 km) of selected bird and mammal species during four transects along three tributaries of the Paraná River. Taxonomy of birds follows Altman and Swift (1989).

Species	SITES			
	1	2	3	4
Olivaceous Cormorant				
<i>P. olivaceus</i>	0.2	0.6	0	1.1
Anhinga <i>A anhinga</i>	1.8	1.2	1.8	1.3
Whistling Heron <i>S sibilatrix</i>	0	0.4	0	0
Great Egret <i>C albus</i>	0	0.2	0	0
Green-backed Heron <i>B striatus</i>	0.2	0.4	0	0.1
Green Ibis <i>M cayennensis</i>	0	0	0	0.1
Brazilian Duck <i>A brasiliensis</i>	0	1.4	0	0.6
Muscovy Duck <i>C moschata</i>	2.2	0.6	0.9	0.8
Black Vulture <i>C atratus</i>	0.9	0.6	0	8.5
Turkey/Yellow-headed Vulture	0.4	0.1	0.5	1.7
King Vulture <i>S papa</i>	0.1	0	0	0.1
Swallow-tailed Kite <i>E forficatus</i>	0	0	0	0.6
Plumbeous Kite <i>I plumbea</i>	0	0	0	2.7
Mantled Hawk <i>L polionota</i>	0	0.2	0	0
Great Black-Hawk <i>B urubitinga</i>	0	0.2	0	0.3
Roadside Hawk <i>B magnirostris</i>	0.2	0.8	0.5	0.1
American Kestrel <i>F sparverius</i>	0	0	0	0.1
Orange-breasted Falcon				
<i>F ruficularis</i>	0	0.4	0	0
Bat Falcon <i>F deiroleucus</i>	0	0.2	0	0
Sungrebe <i>H fulica</i>	0.7	0.2	0	0
Southern Lapwing <i>V chilensis</i>	0.4	0.6	2.3	0
Wattled Jacana <i>J jacana</i>	0	0	0.5	0
White-eyed Parakeet				
<i>A leucophthalmus</i>	4.7	11.4	5.0	5.2
Reddish-bellied Parakeet				
<i>P frontalis</i>	1.1	3.0	0	9.6
Red-capped Parrot <i>P pileata</i>	0.4	0	0	2.1
Scaly-headed Parrot				
<i>P maxilliani</i>	0.2	0	0.5	0.3
Vinaceous-breasted Parrot				
<i>A vinacea</i>	0.0	12.4	0	0
Ringed Kingfisher <i>C torquata</i>	0.2	0.2	0.9	0.7
Amazon Kingfisher <i>C amazona</i>	0.9	0.8	1.4	1.0
Green Kingfisher <i>C americana</i>	0.5	0.6	0	0
Chestnut-eared Aracari				
<i>P castanotis</i>	0.4	0.4	0.5	0
Toco Toucan <i>R toco</i>	1.1	0.4	0.9	1.8
MAMMALS				
Capybara <i>H hydrochaeris</i>	0.5	0.4	0	0.1
Otter <i>I longicaudis</i>	0.2	0.4	0	0
Capuchin Monkey				
<i>C apella</i> (groups)	0	0.2	0	0.4

Locations: 1; Carapá I; 2; Carapá II; 3; Itambey; 4; Ñacunday

Although the Carapá and Ñacunday Rivers appeared to have sufficient habitat for Brazilian Mergansers, we were unable to find any. Bertoni (1901) reported this species from the region in the 1890s, but as far as we know, the only sight record this century from Paraguay was by López (1986), who observed one along the Carapá River, Dept. Canindeyú, in February 1984. Because there may not be sufficient habitat remaining in Paraguay to maintain a viable population, the Brazilian Merganser may already be extinct. However, it still survives in

several rivers in Brazil and Argentina (Johnson and Chebez 1985, Collar and Andrew 1988, Bartmann 1988).

The densities of birds reported in Table 2 provide the first data on bird populations within the Alto Paraná region of Paraguay. Because bird populations are excellent indicators of environmental changes (Morrison 1986), additional studies of bird populations in the Alto Paraná region of Paraguay are urgently needed in order to monitor the long term responses of bird populations to changing environmental conditions and to design protected areas large enough to maintain viable populations.

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