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Habitat use of raptors in response to anthropogenic land use on Bonaire and Curaçao, Netherlands Antilles

Vincent Nijman[1,2,*], Janet Booij[2], Maarten Flikweert[2], Mansour Aliabadian[2,3], John A. de Freitas[4], Ronald Vonk[2] and Tineke G. Prins[2]

[1]*Oxford Brookes University, School of Social Sciences and Law, Department of Anthropology and Geography, OX3 0BP Oxford, UK; *Corresponding author: E-mail: vnijman@brookes.ac.uk*
[2]*Zoological Museum, University of Amsterdam, PO Box 94766, 1090 GT Amsterdam, The Netherlands*
[3]*Department of Biology, Faculty of Sciences, Ferdowsi University of Mashhad, Mashhad, Iran*
[4]*CARMABI Foundation, Piscaderabaai z/n. P.O. Box 2090, Curaçao, Netherlands Antilles*

Abstract.—We conducted fieldwork on Bonaire and Curaçao, Netherlands Antilles, to assess the distribution and abundance of resident diurnal raptors. In total, seventy-three 1 km² sample plots were selected following a stratified random method and three landscape types were distinguished, i.e. cultivated area, hills and terrace. The diurnal raptors observed were the Crested Caracara *Caracara plancus* (93 records), White-tailed Hawk *Buteo albicaudatus* (37), and the American Kestrel *Falco sparverius* (44 on Curaçao only). In the hills and on the terraces, all species were more abundant on Curaçao than on Bonaire. Caracaras were found significantly more in hills compared to terraces or cultivated land on both islands, as did White-tailed Hawks on Curaçao. The American Kestrel made more use of cultivated area and least of hills. As detection of the raptors did not seem to differ between the landscapes and between the islands, we infer that the observed differences in distribution are a true reflection of their habitat use. Our results suggest that the ongoing urbanization on Curaçao and Bonaire may lead to a decline in the Caracara and the White-tailed Hawk. For the American Kestrel, cultivated areas – including urbanized parts – apparently provide the open area the birds need for hunting.

Keywords.—Caribbean, *Buteo albicaudatus*, *Caracara plancus*, *Falco sparverius*, zoogeography.

Introduction

Aruba, Bonaire, and Curaçao, the Leeward Islands of the Netherlands Antilles, are situated in the South Caribbean Sea some 30-80 km north of Venezuela. The arid islands, covered in xerophytic and thorny bush and sparse woodland (Voous 1983), are ornithologically relatively well explored, and to date some 280 species, including 11 raptors, have been recorded (Voous 1983; Nijman et al. 2005). Yet our knowledge on abundance and distribution of the birds of prey and owls over the islands is restricted and has seldom been quantified (Voous 1955, 1957, 1983; De Boer 1993; however, see Flikweert et al. 2007 and Debrot et al. 2001). In the last decades, the islands have changed from a largely rural economy to one that derives a large part of its income from tourism. The amount of cultivated land has increased, and land use has changed significantly, with for instance less free-ranging goats roaming the countryside. The amount of permanently available freshwater has increased in recent decades, affecting the distribution and abundance of birds (e.g. Prins and Nijman 2005; Nijman et al. 2008). We analyse the distribution and habitat use of resident raptors, i.e. Crested Caracara *Caracara plancus*, White-tailed Hawk *Buteo albicaudatus*, and American Kestrel *Falco sparverius*, on Bonaire and Curaçao based on research conducted in 2003-2006. Focus of this study concerns raptor use of cultivated land compared to more natural areas.

Methods

Fieldwork was conducted in January-May 2003 on Bonaire, August-September 2005 on Curaçao and in July-August 2006

on Curaçao and Bonaire to assess distribution and abundance of the diurnal raptors. Methodology largely followed Nijman (2006): seventy-three 1 km^2 sample plots were selected following a stratified random technique (Bibby et al. 2000), effectively sampling ten percent of the islands (Table 1).Three landscape types were distinguished based upon vegetation maps prepared by De Freitas et al. (2005) and Beers et al. (1997), i.e. cultivated area (including urban areas and suburbs), hills (mostly of volcanic origin) and terrace (limestone). *Saliñas* and beaches were excluded because they covered a relatively small area (although the southern part of Bonaire is taken up largely by an industrial salt factory, essentially turning the area into one large *Saliñas*). To the degree possible, each plot was selected within a large homogenous patch of the landscape type as to avoid possible edge effects. Each plot was visited for six hours, generally between 07.00-10.00 hrs and 15.00–18.00 hrs.

We conducted point counts (Bibby et al. 2000), made from locations from which the landscape could be overlooked to a distance of 1-km and the field of view was 120 degrees (thus plots covered a wedge-shaped area of about one square km). Occurrence of all raptors in the wedge and the time they spent there were recorded. Habitat use for each raptor species was assessed using χ^2 tests, with expected values generated based on a uniform distribution of birds proportional to the amount of each habitat type. In the analysis total time spent in a plot was used as a proxy for abundance, since for all three species linear regressions showed highly significant relationships between the amount of time spent in a plot (log-transformed) and the minimum number of individuals observed on the plot (R^2 between 0.3 and 0.5, F between 9 and 25, $P < 0.01$).

Results

The three resident species were frequently observed on all parts of Curaçao whereas on Bonaire the Crested Caracara was the only resident species present in relatively high numbers (Table 1; Figure 1). American Kestrels were not observed on Bonaire and

Table 1. Distribution of survey effort (number of plots) and raptor observations (numbers and total observation time in minutes) over the three landscape types of Bonaire and Curaçao, Netherlands Antilles, 2003-2006.

	Curaçao					Bonaire				
Landscape type	Area in km^2 (% of total)	Plots (N)	Number of Crested Caracaras (time in minutes)	Number of White-tailed Hawks (time in minutes)	Number of American Kestrels (time in minutes)	Area in km^2 (% of total)	Plots (N)	Number of Crested Caracaras (time in minutes)	Number of White-tailed Hawks (time in minutes)
Cultivated	168 (39.3)	8	9 (54)	6 (60)	19 (478)	42 (17.5)	4	0 (0)	0 (0)
Hills	164 (38.5)	11	31 (1093)	16 (336)	15 (199)	79 (32.6)	17	28 (419)	0 (0)
Terrace	88 (20.5)	6	16 (338)	12 (130)	10 (198)	117 (48.3)	27	9 (340)	3 (39)
Other	7 (1.6)	0	-	-	-	4 (1.5)	0	-	-
Total	426 (100)	25	56 (1485)	34 (526)	44 (875)	241 (100)	48	37 (759)	3 (39)

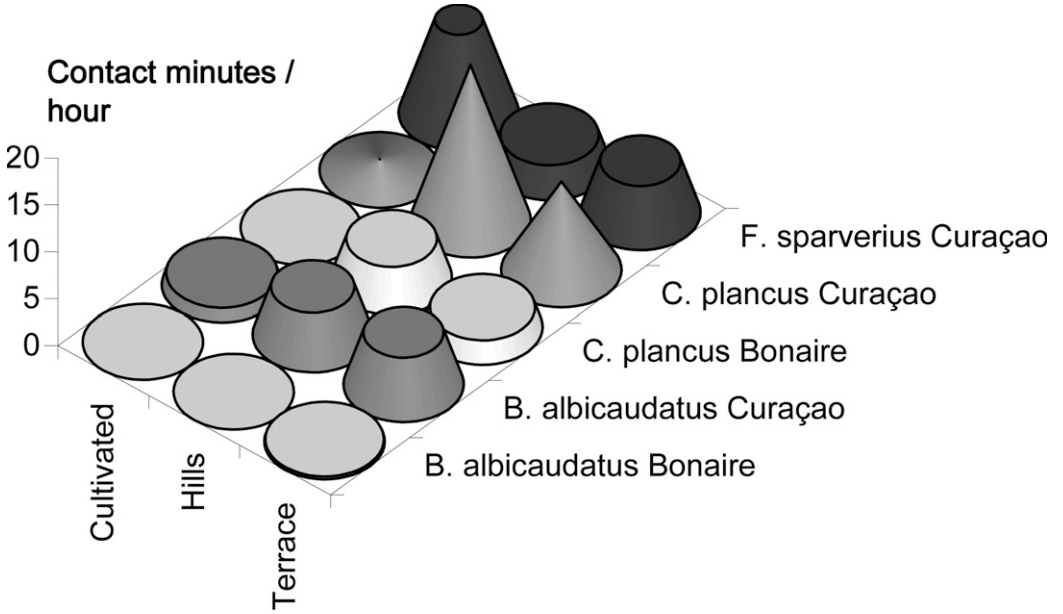

FIG. 1. Frequency of recording three species of raptor (expressed as minutes of contact per observation hour) in three landscape types on the islands of Bonaire and Curaçao, Netherlands Antilles, showing that apart from the American Kestrel *Falco sparverius*, cultivated land is rarely used.

only three White-tailed Hawks were seen (in 2003) in two adjacent plots in the northwest. Overall, encounter rates of resident raptors on Curaçao (1.12 birds hr^{-1}, or 19 contact minutes hr^{-1}) were 6-8 times higher than that on Bonaire (0.14 birds hr^{-1}, or 3 contact minutes hr^{-1}).

In the hills and on the terraces, resident species spent significantly longer periods on plots on Curaçao than on Bonaire (Crested Caracara $\chi^2 > 7.8$, df = 1, $P < 0.005$, for both hills and terraces; White-tailed Hawk $\chi^2 > 15.0$, df = 1, $P < 0.001$ for both hills and terraces). Caracaras used hills more frequently than terraces or cultivated land (time: $\chi^2 = 186.0$, df = 2, $P < 0.001$, and $\chi^2 = 670.0$, df = 2, $P < 0.001$ for Bonaire and Curaçao respectively; numbers: $\chi^2 = 26.7$, df = 2, $P < 0.001$ (Bonaire), and $\chi^2 = 6.6$, df = 2, $P < 0.05$ (Curaçao)). The species was not recorded on cultivated land on Bonaire. White-tailed Hawks on Curaçao spent significantly more time in hill plots and least time on plots in cultivated land ($\chi^2 = 117.0$, df = 2, $P < 0.001$) but in terms of numbers there was no apparent preference ($\chi^2 = 4.1$, df = 2, $P > 0.10$). The three White-tailed Hawks on Bonaire were all recorded above the Middle and Higher terraces, but the scarcity of data did not allow for statistical testing of habitat use. The American Kestrel seemed to have a clear preference for cultivated land over the other two habitat types combined (time: $\chi^2 = 150.2$, df = 1, $P < 0.001$; numbers: $\chi^2 = 3.9$, df = 1, $P < 0.05$).

Taking into account the amount of area covered by the three different habitat types on the two islands, on an 'average' square kilometer in Curaçao one can expect to see about 5.1 raptors during a six-hour watch, whereas the same effort on Bonaire yield around 0.75 raptors. Moreover, the distribution of raptors over the habitat types differs significantly between the two islands (numbers: $\chi^2 = 8.9$, df = 2, $P < 0.02$) with for instance relatively more raptors in the hills and less on the terraces in Bonaire compared to Curaçao.

DISCUSSION

Bonaire and Curaçao are neighboring tropical islands with a similar climate and vegetation (Voous 1983), yet the raptor community on the islands is strikingly different.

Encounter rates with resident raptors on Curaçao are up to eight times higher than those on Bonaire, and apart from American Kestrel on Curaçao, cultivated land seemed especially devoid of raptors. The American Kestrel, which is abundant on Curaçao, was not seen by us on Bonaire. The species has previously been reported on the island (e.g. Hartert 1893; Hellmayer and Conover 1949; Phelps and Phelps 1951; Ligon 2007), but these sightings were assumed to be migrant Merlins, *Falco columbarius*, by Voous (1955, 1983). Nijman et al. (2005), however, argued that the few sightings of the Kestrel (mainly singles) on Bonaire may refer to first year birds dispersing from nearby islands or to migrants from northern regions.

The abundance of White-tailed Hawks on Bonaire is low compared to Curaçao. Historically, the species has been considered rare and restricted in its distribution to the north-west of the island (Voous 1955) and in the past was recorded breeding on the islet of Klein Bonaire, off Bonaire's west coast (Rutten 1931). De Boer (1993) estimated that only two pairs were present on Bonaire, a view that closely corresponds to our observations. On Curaçao, the White-tailed Hawk, with an estimated number of 5 pairs in 1952, has been considered rare (Voous 1955). In the early 1990s it was estimated that a total of 10 pairs were found on the island (De Boer 1993), whereas we recorded a total of 34 individuals on 18 plots, and numerous sightings away from our plots. Accounting for areas not included in our study (e.g. the entire southeastern part which comprises inaccessible private land), suggests that at least 15-20 pairs may be present on the island. Although it appears that the species may have increased in numbers over the last decades, possibly in response to a change in land use as recorded for other birds on the island (Prins and Nijman 2005), the species was rarely recorded in cultivated areas.

Although grossly similar in climate and vegetation, Bonaire consistently receives less rainfall than Curaçao (504 v. 567 mm annually), has a lower plant diversity (Beers et al. 1997), less permanently available water (Hulsman et al. 2008) and less vegetation cover. Based on vegetation data from nearby Aruba (Versteeg and Ruiz 1995) and sediment data from Curaçao (Klosowska et al. 2004) in pre-Columbian times Curaçao, and probably also Bonaire, had a significant forest cover (cf. Terpstra 1948). Until the beginning of the 20th century, Bonaire was an important exporter of charcoal to Curaçao and Aruba (Beers et al. 1997), deforestation associated with charcoal making is still evident in the composition and age of the island's current natural vegetation. The lower abundance of raptors as well as the smaller numbers of species on Bonaire compared to Curaçao may be due to its smaller size (and flatter topography), a higher percentage of less productive terrace landscape which may limit prey availability, possibly more severe historical persecution of birds of prey, or a combination of the above.

As detectability of the raptors did not seem to differ between the landscapes and between the islands, we infer that the observed differences in distribution are a true reflection of their habitat use. As such habitat use did not differ between Curaçao and Bonaire for the Crested Caracara and White-tailed Hawk. On both islands these species were least seen in cultivated land. For the Caracara, these results are in contrast with findings on the species in Mexico (Rodriguez-Estrella et al. 1998) which may reflect differences in land use between the two countries. In Florida, on the other hand, cultivation of dry prairie has been related to a decline of the Caracara (Layne 1985). Our results suggest that the ongoing urbanization on Curaçao and Bonaire may contribute to past and future declines in the Caracara and the White-tailed Hawk on the Leeward Islands as well. For the American Kestrel, towns apparently provide the open area the birds need for hunting: similar to the situation in Mexico (Rodriguez-Estrella et al. 1998) the Kestrel was mostly observed in the cultivated areas of Curaçao. Urbanization is therefore not likely to affect this species negatively.

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