

Raptor abundance in south-central Kenya in relation to land-use patterns

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Summary

We conducted nine road surveys for birds of prey from 12 January to 17 March 1990 in Nairobi National Park and in an adjacent area dominated by subsistence agriculture and livestock grazing in southern Kenya. We observed an average of 4.27 raptors/km inside the park and 0.40 raptors/km outside the park ($P < 0.005$). Excluding very abundant species [lesser kestrels (*Falco naumanni*) and vultures; 72.6% of all observations] and species associated with human settlements [black kites (*Milvus migrans*); 8.9% of all observations], raptors were observed more frequently in the park (0.47 raptors/km) than outside the park (0.23 raptors/km) ($P < 0.01$). Although species richness was similar inside (18 species) and outside (22 species) the park, eagles, vultures, and lesser kestrels were seen more frequently inside the park and some infrequently observed species were only seen either inside or outside the park. These results reflect the differences in land-use practices inside and outside of the park, and suggest significant changes in raptor community structure (species richness, density, and species identity) related to human land use.

Key words: human disturbance, Kenya, land use, raptors

Résumé

Nous avons mené par la route neuf comptages des oiseaux de proie, du 12 janvier au 17 mars 1990, dans le Parc National de Nairobi et dans une zone adjacente où l'on pratique une agriculture de subsistance et l'élevage de bétail, dans le sud du Kenya. Nous avons observé une moyenne de 4,27 rapaces/km à l'intérieur du parc et 0,40 rapaces/km à l'extérieur du parc ($P < 0,005$). En excluant les espèces très abondantes (le faucon crécerellette, *Falco naumanni*, et les vautours, 72,6% de toutes les observations) et les espèces associées aux installations humaines (le milan noir, *Milvus migrans*, 8,9% de toutes les observations), on a observé les oiseaux de proie plus souvent dans le parc (0,47 rapaces/km) qu'en dehors (0,23 rapaces/km) ($P < 0,01$). Bien que la richesse en espèces soit comparable dans (18 espèces) et en dehors du parc (22 espèces), les aigles, les vautours et les faucons crécerellettes se rencontrent plus souvent dans le parc, et quelques espèces rarement observées ne se trouvaient que soit dans, soit hors du parc. Ces résultats reflètent les différences entre les pratiques d'utilisation du sol dans et en dehors du parc et suggèrent des changements significatifs dans la structure de la

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communauté des rapaces (richesse en espèces, densité et identité des espèces) liés à l'utilisation humaine du sol.

Introduction

Rapidly changing land-use patterns have accompanied increasing population growth in Kenya and such changes have potential direct and indirect impacts on raptor habitat use. The specific effects of changing land-use patterns on the status of resident and wintering raptors are unknown, although human-caused habitat alteration can influence raptor abundance through direct changes in habitat characteristics (e.g. perch density and distribution—Enderson, 1964; Marion & Ryder, 1975; Stahlecker, 1978; Janes, 1984) or indirectly through impacts on prey abundance and availability (Baker & Brooks, 1981). Increased human density may also increase the potential for direct persecution (Keran, 1981) with resulting changes in behaviour (Knight *et al.*, 1989) and species abundance and diversity (Craighead & Mindell, 1981). Environmental contaminants associated with human settlement (Newton, 1979) and direct persecution (Brown, 1991) also have the potential to influence raptor abundance and distribution.

The objective of our study was to determine how raptor diversity differed in areas of different land-use practices in East Africa. We conducted surveys for birds of prey in Kenya along roads in two areas under distinctly different land-use practices. Surveys were conducted in Nairobi National Park (NNP) and in an adjacent area dominated by subsistence agriculture and livestock grazing. Nairobi National Park represented an area that was relatively free of widespread landscape and habitat change as a result of human activity. A similar area, adjacent to NNP, was dominated by small-scale subsistence agriculture and livestock grazing, the most prevalent land use throughout much of Kenya.

Study areas

We conducted road surveys for resident and wintering birds of prey from January–March 1990 in the NNP and in an area adjacent to the NNP (Fig. 1). Habitats were characterized visually in each study area and categorized after Grunblatt, Ottichilo & Sinange (1989).

Nairobi National Park

Habitats along the survey route through NNP consisted primarily of open treed grassland and open grassland. Less common habitats included tall riparian forest, closed tall forest, and open treed shrubland. The survey route in NNP was approximately 32 km and consisted of dirt roads. Utility poles or other potential artificial perches did not occur along the survey route.

Mixed agriculture/grazing

The second survey area (C98), located roughly 10–15 km east and slightly north of the NNP, was dominated by subsistence agriculture and livestock grazing. The survey route consisted of two sections: 31 km of dirt road without utility poles paralleling the route and 37 km of tarmac road paralleled by utility poles.

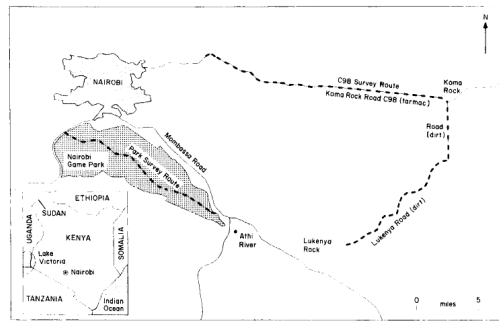
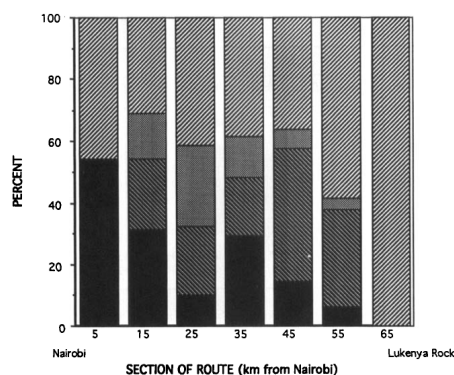


Fig. 1. Location of the study area and survey routes in south-central Kenya where road surveys for wintering birds of prey were conducted from January through March 1990.

Vegetation along the dirt section consisted of approximately one-third open treed grassland, one-third dense low woodland (including small sections of dense low forest), and one-third open treed grassland/open dwarf shrubbed grassland. Vegetation along the tarmac consisted primarily of open grassland and open dwarf shrubbed grassland with occasional small areas of open treed grassland, tall riparian forest and open tall woodland.

Methods

We conducted road surveys for raptors (Fuller & Mosher, 1981; Andersen & Rongstad, 1989) from 12 January to 17 March 1990. During this period, southern Kenya is occupied by both African and Palearctic breeding raptors (Steyn, 1983) and both were present on the study areas. Both study areas (NNP and C98) were surveyed on each outing and the starting point was alternated between ends of the route to control for detectability differences that are associated with different times of day (Fuller & Mosher, 1981). Starting times varied slightly from 1 to 1.5 hours after sunrise. An average of 2.2 hours were required to complete the NNP route compared with an average of 2.8 hours for C98. Speed varied with differing road conditions and averaged 15–20 km h⁻¹. Weather conditions generally consisted of partly to mostly cloudy skies and only one survey was conducted under completely sunny conditions. Occasionally morning fog delayed starting times. Observations were made by two observers from a vehicle. For each raptor observed we stopped and recorded the following data: species, number of birds, perpendicular distance from the road, time, location along the route, age and sex (when possible), activity, and general habitat type. Identification of species was aided



▨ LOW/CATTLE - traditional subsistence agriculture where 0-2 agricultural plots and dwellings were observed along with grazing livestock
 ■ LOW/NO CATTLE - same as LOW/CATTLE but with no livestock observed
 ▩ HIGH/CATTLE - traditional subsistence agriculture where 2-3 agricultural plots and dwellings were observed along with grazing livestock
 □ HIGH/NO CATTLE - same as HIGH/CATTLE but no livestock observed

Fig. 2. Land-use pattern along survey route C98, Kenya, January through March 1990. Land use was assessed visually at locations where raptors were observed along the survey route and assigned to 1 of 4 categories based on the number of dwellings and the presence of livestock (see text). Percent refers to the frequency of locations where raptors were observed within a particular land-use category.

by the use of binoculars, a 20× spotting scope, and regional field guides (Steyn, 1983; Heinzel, Fitter & Parslow, 1984; Arlott & Williams, 1984). When we could not positively identify a bird to species, we indicated so when recording data. A range finder was used to determine perpendicular distance from the road to each raptor seen.

General data relating to human land-use patterns were also collected for each raptor sitting along C98. We visually assessed the density of agricultural plots, dwellings, and livestock abundance (Fig. 2). The number of agricultural plots and dwellings immediately visible from the road (within approximately 1 km) varied along the survey route. Dwellings generally were occupied by several related families (S. Thomsett, pers. comm.). Except for the heavily populated first 10 km closest to Nairobi, human population and the incidence of livestock herds were lower along the tarmac than along the dirt section of C98 (Fig. 2). Generally 0-1 settlements (a dwelling with surrounding cultivated fields) could be seen from the tarmac section of the road at any given point. Along the dirt section of C98, 1-2 settlements were usually visible and livestock were seen more

Table 1. Summary of birds of prey observed on surveys conducted in Nairobi National Park (Park) and an adjacent settled area (C98) in Kenya from 12 January to 17 March 1990

Survey route	Survey date									
	12 Jan	17 Jan	19 Jan	26 Jan	2 Feb	9 Feb	2 Mar	6 Mar	17 Mar	
Park										
No. of species	6	9	9	5	10	7	9	10	10	
No. of raptors	52	190	133	28	260	67	201	229	71	
Raptors/km ¹	1.62	5.94	4.16	0.88	8.12	2.09	6.28	7.16	2.22	
Raptors/km ²	0.38	0.72	0.41	0.25	0.50	0.34	0.62	0.53	0.47	
C98										
No. of species	9	8	10	7	6	10	8	11	8	
No. of raptors	35	11	24	30	16	36	35	31	27	
Raptors/km ¹	0.52	0.16	0.35	0.44	0.24	0.53	0.52	0.46	0.40	
Raptors/km ²	0.35	0.13	0.15	0.22	0.10	0.37	0.21	0.32	0.22	

¹All raptors.²Excluding black kites (*Milvus migrans*), lesser kestrels (*Falco naumanni*), and vultures (see text).

frequently. Also quite common along the dirt road were sections where no settlements were visible, yet these areas often contained livestock herds, primarily cattle. Rarely were >3 settlements visible immediately adjacent to the survey route and compared to many other areas in Kenya, human population density along this entire route (tarmac and dirt) was not high.

Statistical procedures used to analyse data follow those outlined in Snedecor & Cochran (1980) and Sokal & Rohlf (1980). Surveys were repeated over the same routes throughout the study. Thus we did not randomly sample each study area for raptors, but obtained multiple indices of abundance and species richness along established survey routes. We treated individual surveys as independent replicates when comparing sighting frequency and species richness between study areas.

Results

Twenty-four species of raptors were observed during nine censuses of both survey routes with no significant difference between routes in species richness (paired-*t* = -0.15, *n* = 9, *P* = 0.89) (Tables 1 and 2). As urban scavengers, black kites (*Milvus migrans*) were associated with the city of Nairobi and were observed most frequently on sections of the survey routes near the city. Excluding black kites, the most frequently observed species on both routes were lesser kestrels (*Falco naumanni*) (55%), vultures [primarily white-backed vultures (*Gyps africanus*)] (25%), black-shouldered kites (*Elanus caeruleus*) (7%), and tawny eagles (*Aquila rapax*) (4%) (Table 2). Pale chanting goshawks (*Melierax canorus*) and Montagu's harriers (*Circus pygargus*) were seen only outside the park and bateleur eagles (*Terathopius ecaudatus*) were only observed inside the park.

Raptors were consistently seen more frequently inside the park than along C98. The number of raptors observed per km (species combined) was higher

Table 2. Birds of prey observed on surveys conducted in Nairobi National Park and an adjacent settled area (C98) in Kenya from 12 January to 17 March 1990. A portion of route C98 and all of the route in Nairobi National Park followed dirt roads. The remainder of C98 followed a paved (tarmac) road

Species ¹	Park	C98			Total
		dirt	tarmac	total	
Lesser kestrel (<i>Falco naumanni</i>)	706	11	18	29	735
Vultures ²	320	2	14	16	336
Black-shouldered kite (<i>Elanus caeruleus</i>)	34	25	36	61	95
Tawny eagle (<i>Aquila rapax</i>)	45	9	5	14	59
Auger buzzard (<i>Buteo augur</i>)	3	7	7	14	17
Secretary bird (<i>Sagittarius serpentarius</i>)	12	0	3	3	15
Martial eagle (<i>Polemaetus bellicosus</i>)	10	2	1	3	13
Pale chanting goshawk (<i>Melierax canorus</i>)	0	8	3	11	11
Long-crested eagle (<i>Lophotus occipitalis</i>)	7	3	1	4	11
Bateleur eagle (<i>Terathopius econdatus</i>)	9	0	0	0	9
Gabari goshawk (<i>Micronis gabari</i>)	3	2	0	2	5
Montagu's harrier (<i>Circus pygargus</i>)	0	5	0	5	5
Pallid harrier (<i>Circus macrourus</i>)	2	2	0	2	4
Steppe eagle (<i>Aquila nipalensis</i>)	2	0	2	2	4
African marsh harrier (<i>Circus ranivorus</i>)	1	1	1	2	3
African hawk eagle (<i>Hieraaetus fasciatus</i>)	0	3	0	3	3
Black-breasted snake eagle (<i>Circaetus pectoralis</i>)	0	3	0	3	3
Greater kestrel (<i>Falco rupicoloides</i>)	0	3	0	3	3
European marsh harrier (<i>Circus aeruginosus</i>)	0	1	1	2	2
Gymnogene (<i>Polyboroides typus</i>)	0	1	1	2	2
Lanner falcon (<i>Falco biarmicus</i>)	0	2	0	2	2
Steppe buzzard (<i>Buteo buteo</i>)	2	0	0	0	2
Black sparrowhawk (<i>Accipiter melanoleucus</i>)	1	0	0	0	1
Osprey (<i>Pandion haliaetus</i>)	1	0	0	0	1
Unidentified eagles	3	0	0	0	3
No. of species	16	18	13	20	24
Total raptors	1161	90	93	183	1344

¹Sightings of black kites (*Milvus migrans*) are not included (see text).

²Primarily white-backed vultures (*Gyps africanus*).

inside the park ($\bar{x}=4.27$ raptors/km) than outside ($\bar{x}=0.40$ raptors/km) (paired- $t=4.23$, $n=9$, $P=0.0029$). Excluding black kites, lesser kestrels (57% of all observations inside the park), and vultures (26% of all observations inside the park), the number of raptors observed per km remained higher inside the park ($\bar{x}=0.47$ raptors/km) than outside ($\bar{x}=0.23$ raptors/km) (paired- $t=3.53$, $n=9$, $P=0.0078$). Lesser kestrels and vultures were seen more frequently inside the park and together comprised >83% of all raptors sighted. Sightings of four eagle species [tawny, steppe (*Aquila nipalensis*), bateleur, and martial (*Polemaetus bellicosus*)] numbered 66 in the park (0.229 eagles/km) compared with only 19 seen on C98 (0.031 eagles/km). Likewise, vulture observations numbered 320 in the park (1.11 vultures/km) in contrast to only 16 along C98 (0.026 vultures/km).

The dirt section of C98 was most directly comparable with the survey route inside the park. Vegetation, topography, road type, and route length were

similar. In addition, both routes lacked utility poles that may have potentially influenced raptor distribution and abundance in relation to the route. Raptors (species combined) were consistently seen more frequently along the park route ($\bar{x}=4.27$ raptors/km) than along the dirt portion of C98 ($\bar{x}=0.32$ raptors/km) (paired- $t=4.28$, $n=9$, $P=0.0027$). Excluding black kites, lesser kestrels, and vultures, raptors observed per km remained higher inside the park ($\bar{x}=0.469$ raptors/km) than outside ($\bar{x}=0.28$ raptors/km) (paired- $t=2.20$, $n=9$, $P=0.059$). Species richness in the park (17 species observed, $\bar{x}=7.8$ species/survey) was similar to species richness along the dirt section of C98 (18 species, $\bar{x}=5$ species/survey), although six species observed in the park were not observed along the dirt section of C98 and eight species observed along the dirt section of C98 were not observed inside the park (Table 2). Vultures, lesser kestrels, and eagles were observed more frequently inside than outside the park.

Discussion

We were able to compare species richness and relative abundance of raptors in Kenya in adjacent areas under very different land-use pressures, although our study design did not allow us to experimentally test for an influence of human settlement on raptor diversity. As indexed by sighting frequency, raptor abundance inside NNP was significantly higher than in the adjacent area dominated by subsistence agriculture and livestock grazing (C98). Several species commonly sighted inside the park (lesser kestrels, vultures, and eagles) were relatively rare outside the park.

Raptor density and diversity are influenced by changes in habitat that accompany human land-use pressures (Brandl, Utschick & Schmidtke, 1985; Siegfried, 1968) and raptors and other birds experience impacts at the population and community level as a result of human habitat disturbance (Thiollay, 1984; Fanshawe & Bennun, 1991). In rural areas grazed by domestic livestock the original vegetative cover may be altered, potentially affecting abundance and distribution of prey species, which in turn influence raptor diversity and density (Baker & Brooks, 1981; Liversidge, 1984). The impact of cultivation is greater still because this form of land use involves a nearly complete replacement of original vegetation (Brown, 1980) and often includes the use of agricultural chemicals potentially toxic to raptors and other vertebrates (Siegfried, 1968). In Kenya, agricultural chemicals are often misused as local farmers either overlook or find difficulty in understanding application instructions (Brown, 1980; Thomsett, 1988). Thiollay (1984) also suggested that human hunting pressure, primarily through impacts on prey populations, influences raptor density and diversity.

The extent of negative impact resulting from habitat alteration varies according to differing ecological requirements of different raptor species (Brown, 1980). Large raptors, such as eagles and vultures, were observed less frequently outside the park, indicating that these species may be differentially affected by human activity related to subsistence agriculture and livestock grazing. Smaller raptors generally occupy smaller territories and may not be affected as severely as large raptors by habitat destruction or alteration. However, in our study areas, lesser kestrels were observed less frequently outside the park compared to

inside the park ($\chi^2=128.97$, $df=1$, $P<0.005$), similar to the pattern observed for larger raptors.

The abundance and distribution of large trees may have influenced the abundance of eagles and vultures along C98 and in NNP. Tree density seemed similar on both routes but we observed a distinct lack of large acacia fever trees (*Acacia xanthoploea*) outside the park. Within the park, eagles and vultures were observed perched in large trees and historically vultures and lesser kestrels have used these trees as communal roosts (S. Thomsett, pers. comm.). Large trees are necessary as perching, nesting, and roosting sites for many raptors (Janes, 1984; Brandl *et al.*, 1985) and the distribution of suitable trees may influence the distribution of raptors.

Although we did not measure abundance of prey along survey routes, herbivores and game birds seemed less abundant outside the park. Reduced availability of prey and carrion likely affects raptor distribution and habitat use (Phelan & Robertson, 1977; Wakeley, 1978; Baker & Brooks, 1981; Bechard, 1982), and wildlife populations in much of Kenya have been influenced by human settlement, with some species suffering significant population reductions. Declines in populations of potential prey species and the subsequent replacement of wildlife by livestock may result in some eagle species preying on livestock, which in turn prompts direct persecution of raptors by livestock owners (Boshoff & Vernon, 1984; Brown, 1991). In Kenya, direct persecution often takes the form of nest destruction, killing of nestlings, trapping, poisoning, and shooting.

Much remains to be studied to determine the influence that varying land-use practices have had and will continue to have on East African raptors. Our results however, corroborate the concerns of Thomsett (1988), who reported a decline in Kenya of previously common species such as black-shouldered kites, auger buzzards (*Buteo augur*), and long-crested eagles (*Loghaetus occipitalis*). Additional study is needed to determine the contribution of various factors related to land-use practices that influence raptor distribution and abundance in East Africa.

Acknowledgments

Dr David Sorley generously assisted in data collection and Mr Simon Thomsett offered advice throughout the study, assisted in data collection, and provided criticism that improved earlier drafts of the manuscript. Drs M. G. Henry, L. L. Kinkel, and R. L. Knight critically reviewed previous drafts of the manuscript, and P. F. McInnes reviewed the final draft. We also thank Dr Hussein Adan Isak, Department of Ornithology, National Museum of Kenya, for his support during the project.

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(Manuscript accepted 22 December 1992)