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Habitat selection by blue cranes in the Western Cape Province and the Karoo

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Blue cranes *Anthropoides paradiseus* in the agricultural regions of the fynbos biome in the Western Cape Province, South Africa, inhabited cultivated pastures and cereal croplands. In the semi-arid Karoo biome they inhabited natural vegetation. In the Western Cape, harvested cereal fields were highly favoured from November to May when they were available. Fields with growing crops were selected in June when the crop plants were small, but were avoided between July and September when the crops were taller. Cultivated pastures were preferred from July to September and were used less frequently from November to June. Ploughed fields were used in proportion to their availability throughout the year. Natural vegetation and 'miscellaneous' habitats (alien trees, homesteads, smallholdings, vineyards, orchards, and irrigated croplands and pastures along rivers) in the Western Cape were avoided at all times. Patterns of habitat selection by foraging cranes were the same as for cranes involved in other activities. Cranes fed at small-stock feedlots in the Western Cape, especially during the winter. Habitat availability in two different agricultural regions in the Western Cape (along the southern coastal plain and in the Swartland) appeared similar and did not explain the wide difference in crane abundance between the two regions.

Keywords: *Anthropoides paradiseus*, blue crane, habitat, Karoo, Western Cape Province

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Introduction

The blue crane *Anthropoides paradiseus* is endemic to southern Africa and most of its population is restricted to South Africa (Urban, Fry & Keith 1986). It is one of 16 species of birds found in South Africa, that are currently considered globally threatened (Collar, Crosby & Stattersfield 1994). The blue crane was not included as a threatened species in the South African Red Data Book — Birds (Brooke 1984) as it only became of conservation concern subsequent to the publication of that work (e.g. Anderson 1990; Johnson 1992; Vernon, Boshoff & Stratton 1992; Tarboton 1992).

Most cranes are associated with wetlands when breeding, but all species, except the Siberian crane *Grus leucogeranus*, (Archibald, Shigeta, Masumoto & Momose 1981), regularly forage in dryland habitats, especially out of the breeding season (Johnsgard 1983). The blue crane and Demoiselle crane *A. virgo* are unusual as they are entirely independent of wetland habitats throughout the year (Johnsgard 1983). The natural habitat of the blue crane in South Africa is grassland and the ecotonal areas between the grassland and Karoo biomes, i.e. the 'grassy Karoo', a combination of grassland and dwarf shrubland (Maclean 1993). Most species of cranes are also attracted to croplands where they feed mainly on fallen grain (e.g. Sugden, Clark, Woodsworth & Greenwood 1988). Their presence in agricultural areas can bring them into conflict with man (e.g. Walkinshaw 1981). The blue crane has also adapted to feeding in agricultural fields where it can become vulnerable to anthropogenic mortality, either intentionally or inadvertently. It is the threat from poisons in particular in these habitats that is the greatest cause for conservation concern. Indeed the widespread decrease of this species in South Africa has largely been attributed to poisoning (e.g. Tarboton 1992).

The poisoning of blue cranes can occur in three ways (Day 1979; Holtshausen & Ledger 1985; Tarboton 1992; Vernon *et al.* 1992; Scott 1992). It can be intentional and aimed at killing cranes which are causing agricultural damage through eating or trampling crops or foraging on supplementary feed at livestock feedlots. The ubiquitous use of agricultural habitats and incidence of crop damage caused by this species has been noted by numerous observers (Van Ee 1981; Geldenhuys 1984; Johnson & Barnes 1986; Filmer & Holtshausen 1992; Johnson 1992; Stratton 1992; Vernon *et al.* 1992). Poisoning can be inadvertent and aimed at killing other species, such as Egyptian goose *Alopochen aegyptiacus* and spurwinged goose *Plectropterus gambensis*, helmeted guineafowl *Numida meleagris* and rodents, which are causing crop damage or, in the case of the large birds, for food. Alternatively, poisoning can occur during the routine application of insecticides to croplands.

The aim of the present study was to investigate habitat availability and selectivity, including seasonal changes in these aspects, by blue cranes in the agricultural regions of the fynbos biome in the Western Cape Province and in the Karoo biome, both in South Africa. The underlying rationale behind the study was that such information is essential in any efforts to mitigate the dangers faced by the species in agricultural landscapes. Some preliminary results of this study were presented in Allan (1992).

Study areas and methods

The observations on blue cranes used in this study were collected during road transect counts made in the Western Cape and the Karoo during 1988–1993. For the regions where blue cranes were recorded, details of the dates of the counts, the distances covered, and the number of blue crane individuals and groups recorded during each count are presented in Appendix 1. The methods employed during all of the counts were similar. The vehicle was stopped briefly when cranes were seen and details of the time of day, locality, group size, activity, and habitat were recorded. During the stop all cranes visible in the area were considered as part of the same group even if they were relatively widely dispersed. In assessing the use of habitat by cranes, chicks, i.e. less than full size and

incapable of proper flight, were disregarded.

Habitat availability, in addition to habitat use, was measured during road counts to assess habitat selectivity by blue cranes. In the three Karoo biogeographical regions where cranes were recorded regularly (Central Upper Karoo, Great Karoo and Steytlerville Karoo, Figure 1), which comprise mainly natural vegetation, the total number of kilometres along the road count route within man-altered habitats was recorded and compared with the number of kilometres within natural vegetation. During the road counts in the two Western Cape regions where blue cranes occur, i.e. the southern Cape coastal plain between Bot River and Mossel Bay and the Swartland (Figure 2), which traverse mainly agricultural areas and where the habitat patches are smaller than in the Karoo, the habitat types on each side of the road were recorded at exactly 1-km intervals along the two routes during all road counts except for two of the 15 counts made in the southern Cape study area.

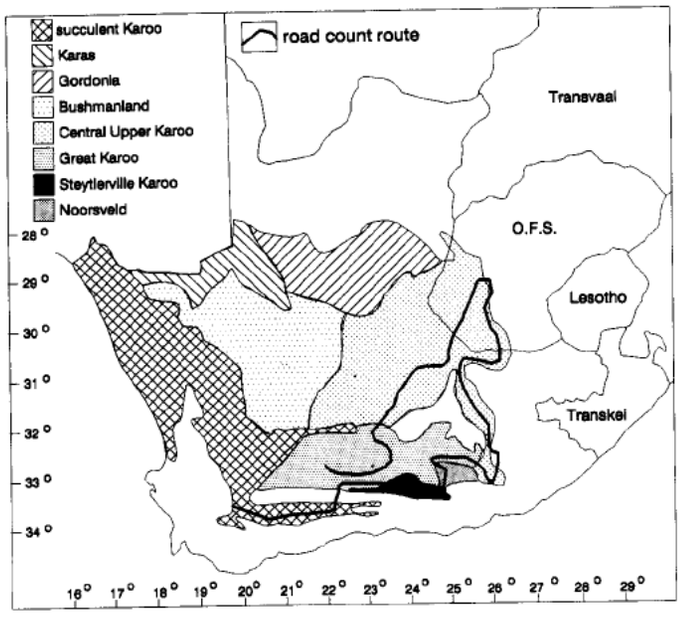

Figure 1 Map showing the various vegetation types comprising the Karoo biome in South Africa (based on Hilton-Taylor & Le Roux 1989). The road transect route followed, from which the observations on blue crane habitat were made, is also shown. In the Karoo, blue cranes are largely restricted to the Central Upper Karoo, Great Karoo and Steytlerville Karoo, and are rare or absent in the other Karoo vegetation types (Allan 1992).

Chi-square goodness of fit tests were used to test the selectivity of habitats by blue crane groups relative to the availability of the habitats. It was not permissible to compare statistically the availability of each habitat with its selection by individual cranes, as the flocking habits of the species resulted in the non-independence of the information relating to each individual (Alldredge & Ratti 1986). It was permissible, however, to compare statistically the selection of habitats by groups of cranes in relation to their availability. Therefore the results of the statistical tests presented here refer to habitat selection by crane groups. Information relevant to both individual cranes and crane groups, however, are presented here to allow comparison with any other studies which may be based only on data for individuals or also for both individuals and groups.

Results

Karoo

In the Karoo, 1950 km of the road count route passed through natural vegetation and only 100 km (4,9%) was through agricultural fields. Eighty-nine per cent of blue crane individuals (n = 423) and 96% of groups (n = 81) were found in natural vegetation and the remainder (48 individuals in three groups) were in agricultural fields (fallow croplands). The number of groups in fields did not differ significantly from the number expected if no habitat selection occurred ($\chi^2 = 0,09$; $p > 0,05$;

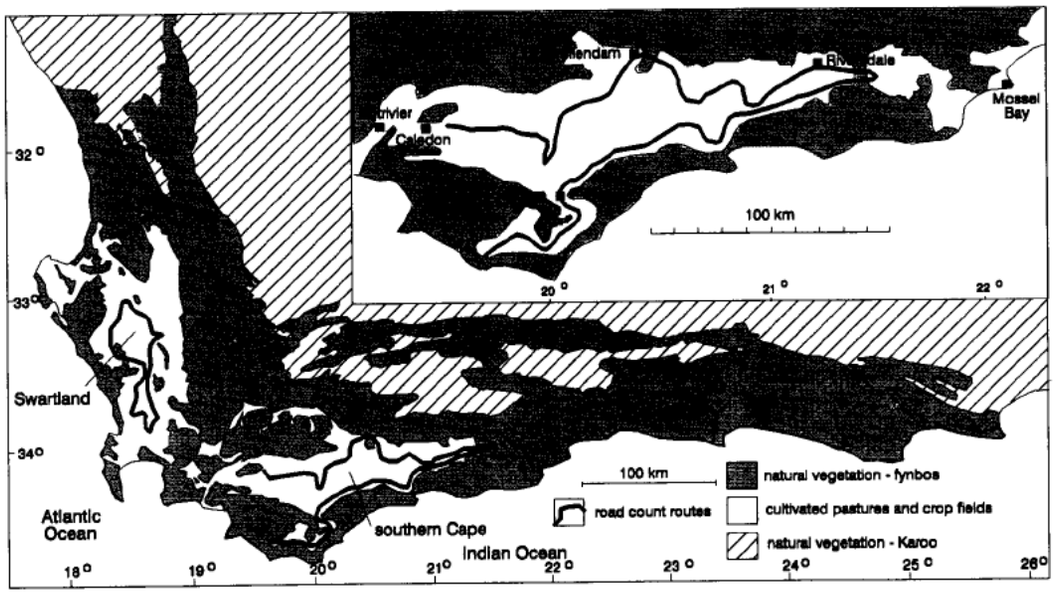

Figure 2 Map showing the fynbos biome in South Africa and the large areas now cleared for cultivated pastures and cereal croplands (after Moll & Bossi 1983). The two road transect routes followed, from which the observations on blue crane habitat were made, are also shown. The inset shows details of the southern Cape study area and transect route.

d.f. = 1) but the number of individuals found in agricultural fields was relatively high.

Southern Cape

In the southern Cape, the available habitats were more diverse and varied seasonally according to crop-farming practices. Four broad habitat types were identified: (a) cultivated dry-land pastures of grasses, scattered lucerne plants, etc. ('pastures'); (b) agricultural croplands, mainly cereal crops, e.g. wheat, oats, barley, etc. ('fields'); (c) natural vegetation, i.e. fynbos, renosterveld and strandveld (Moll & Bossi 1983); and (d) a 'miscellaneous' category encompassing alien trees, homesteads, smallholdings, vineyards, orchards, and irrigated croplands and pastures along rivers. The relative proportions of the study area covered by each habitat type were: pastures — 46,3%, fields — 33,6%, natural vegetation — 11,3% and 'miscellaneous' — 8,8% (Figures 3 & 4, Appendix 2). The fields consisted of three types depending on the stage of the crop-farming cycle: harvested fields, fields with growing crops, and recently ploughed fields. Recently ploughed fields

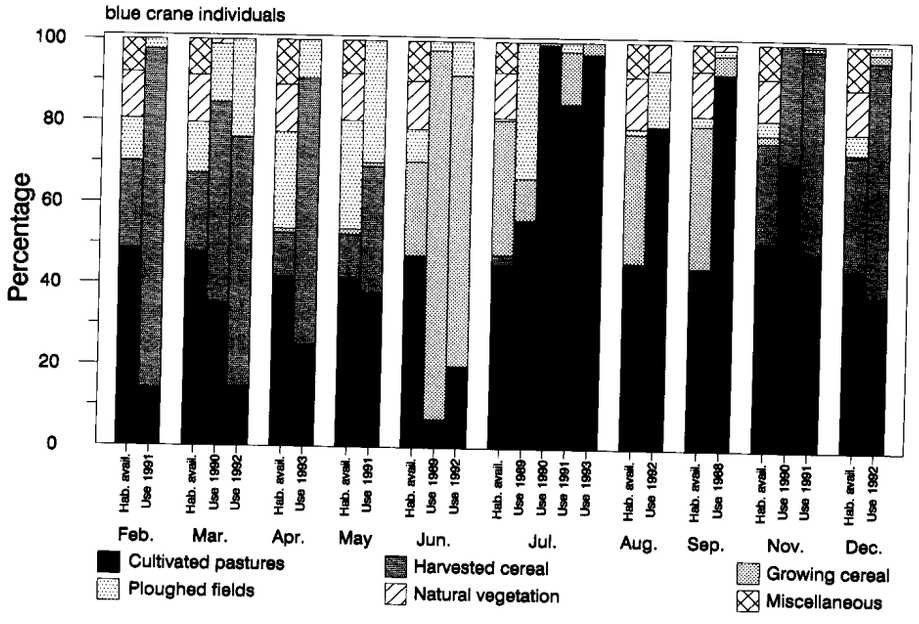

Figure 3 Availability and use of six habitats by blue crane individuals in the southern Cape, data presented separately for each month. 'Percentage' on the y-axis refers to the percentage of available habitat per month (first column) and to the percentage of individual blue cranes recorded occupying each habitat during each count in each month (subsequent columns).

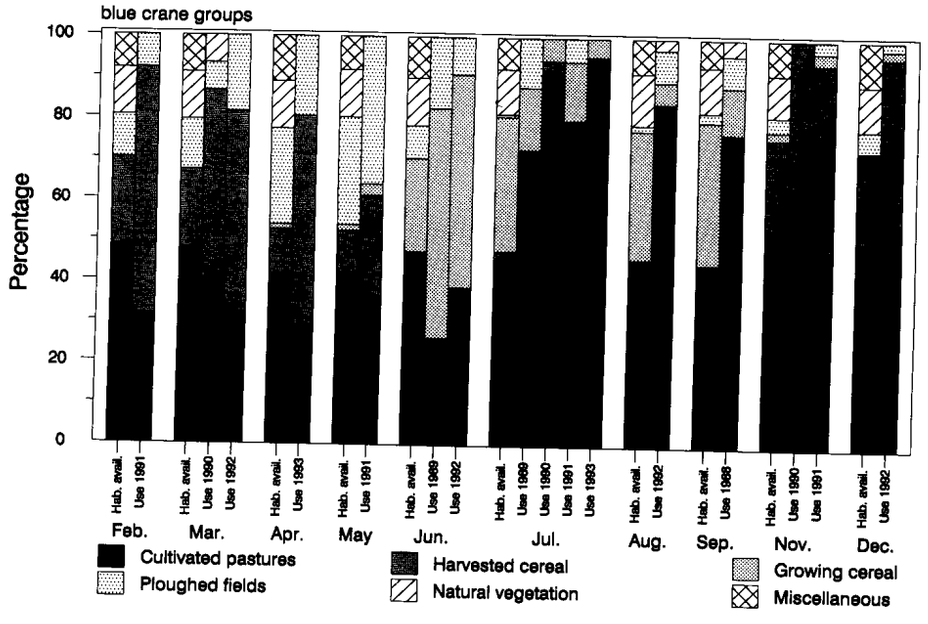

Figure 4 Availability and use of six habitats by blue crane groups in the southern Cape, data presented separately for each month. 'Percentage' on the y-axis refers to the percentage of available habitat per month (first column) and to the percentage of blue crane groups recorded occupying each habitat during each count in each month (subsequent columns).

were most common during April and May, the sowing season, but were also present throughout the rest of the year at lower frequencies (Figures 3 & 4, Appendix 2). Fields with growing crops were present mainly between June and September, in the period immediately following sowing. Harvested fields ('stubble fields') were present mainly from November to March, with some remaining during April and May.

Blue cranes in the southern Cape were highly selective in their use of these various habitats. Although only the significance of habitat selection by crane groups could be tested, the patterns of habitat selection by individuals and groups were similar (Figures 3 & 4, Appendix 2).

The areas included in the 'miscellaneous' category were avoided completely (Table 1, Figures 3, 4 & 5). Natural vegetation also was avoided and only 86 blue cranes in four groups, out of a sample of 7216 cranes in 574 groups, were found in this habitat. Harvested fields were highly favoured throughout the period November to May when they were available. Fields with growing crops were selected during June, when the crop plants were small, but were avoided from July to September, when the plants were taller. There was no obvious pattern to the use of ploughed fields, which were both available and used throughout the year. When the data from ploughed fields for all months were pooled, this habitat was used in proportion to its availability. Cultivated pastures were also available and used throughout the year, but were used more than expected from July to September and less than expected between November and June.

These patterns of habitat selection cannot be equated with the selection of foraging areas as the activity of the blue cranes was not taken into account and some cranes fed from feedlots established by farmers for small stock (Merino sheep). Therefore some cranes may have been attracted to the habitats for activities other than foraging and may also have been attracted to the food at feedlots rather than in the surrounding habitat. In addition, some cranes were present at some sites to drink from livestock water troughs and small dams rather than for foraging. In order to investigate the selection of foraging habitats by crane groups, analysis was restricted to groups which were foraging away from feedlots. This analysis showed that habitat selection by foraging crane groups was the same as habitat selection by all groups combined (Table 1).

Blue cranes were observed feeding at feedlots on 51 occasions. Most of these (40) were in pastures, five were in harvested fields, four were in ploughed fields, one was in a field with growing crops, and one was in natural vegetation. Most observations of cranes at feedlots (42) were made during the winter (May–August), and a relatively high proportion of cranes were observed at feedlots during this period (1360/5192; 26,2%).

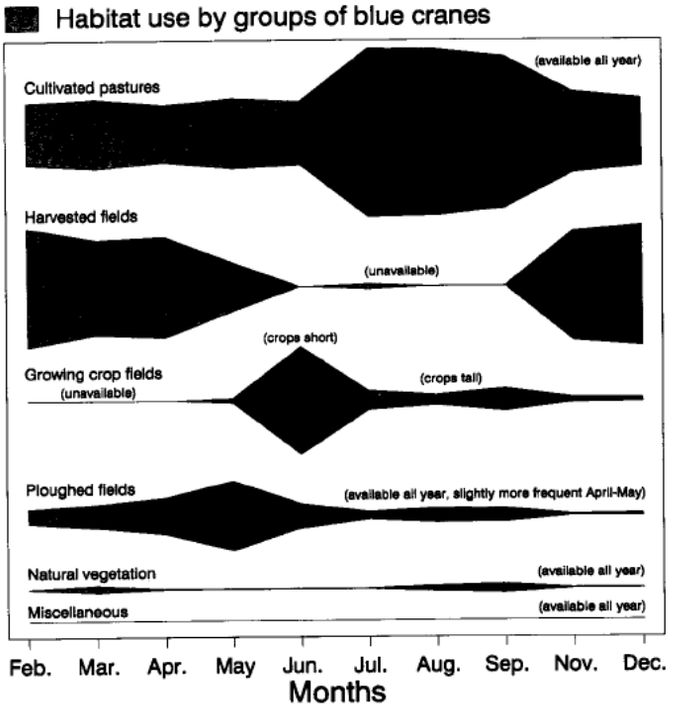

Figure 5 Summary of use by and availability of six habitats to blue cranes in the southern Cape.

Table 1 Summary of the patterns of selection of six habitat types by blue crane groups in the southern Cape. Data presented separately for all groups (All) and for groups recorded actively foraging and away from feedlots (Foraging)

				All		Foraging	
Habitat	Availability		Selection	χ^2	p*	χ^2	p*
Cultivated	all year	Jul.–Sep.	positive	59,21	<0,001	34,37	<0,001
pastures		Nov.–Jun.	negative	10,13	<0,01	5,39	< 0,05
Harvested	Nov.–May		positive	164,27	<0,001	74,62	<0,001
fields							
Growing	Jun.–Sep.	Jun.	positive	26,23	<0,001	8,37	<0,01
cereal		Jul.–Sep.	negative	31,38	<0,001	20,51	< 0,001
Ploughed	all year		neutral	0,11	n.s.	0,13	n.s.
fields							
Natural	all year		negative	57,17	<0,001	25,38	<0,001
vegetation							
Miscellaneous	all year		negative	49,52	<0,001	22,51	<0,001

* $d.f.$ = 1 in all Chi-square goodness of fit tests

Swartland

The patterns of habitat availability in the Swartland, i.e. pastures — 34,9%, fields — 46,9%, natural vegetation — 1,6% and 'miscellaneous' — 16,5%, were similar to those in the southern Cape (pastures — 46,3%, fields — 33,6%, natural vegetation — 11,3% and 'miscellaneous' — 8,8%), the former region having more fields and 'miscellaneous' habitats and less pastures and natural vegetation. The types of crops in the two areas were also similar, i.e. largely cereal crops, and the fields consisted of harvested fields, fields with growing crops and ploughed fields, the relative proportions of which depended on season. Too few blue cranes were recorded in this region for any meaningful analysis of habitat use, i.e. 74 individuals in 8 groups (10 individuals in three groups in pastures, seven individuals in three groups in fields with growing cereal crops and 57 in two groups in ploughed fields).

Discussion

There was a clear difference in habitat selection by blue cranes in the Karoo and in the southern Cape. In the Karoo, although there may have been some selection for the few agricultural fields, the vast majority of the cranes occurred in natural vegetation. In the southern Cape, agricultural fields and pastures were used almost exclusively and natural vegetation was avoided. This avoidance of natural vegetation in the southern Cape strongly accords with other evidence (Allan 1992, 1993) that the blue crane is a relatively recent colonizer in this region, following the establishment of extensive agriculture. Winterbottom (1978) commented that the avifauna inhabiting the agricultural areas of the fynbos biome are characteristic of grasslands and not of the indigenous vegetation of this biome.

Geldenhuys (1984) reported that blue cranes in the Orange Free State (grassland and Karoo biomes) favoured areas of natural vegetation and harvested maize fields, where fallen grain was fed on, but that they were regularly found in a wide variety of other agricultural croplands. Filmer & Holtshausen (1992), reporting on a survey from throughout the South African range of the species, found that 46% of blue crane records came from natural vegetation and the remainder were from cultivated pastures and croplands, especially maize and wheat fields.

Harvested fields were probably the most favoured habitat in the southern Cape because fallen grain is a common food item in these fields. This was not confirmed during the present study, however, as neither diet nor food availability was investigated. It is an apparent paradox that the influx of large numbers of blue cranes into the southern Cape in the winter (Appendix 1, see also Allan 1992, 1993) occurs at the time when the most highly favoured habitat, harvested fields, is scarce.

The apparent selection of pastures between July and September by blue cranes in the southern Cape may have been partly because of the scarcity of the other three favoured habitats, i.e. harvested fields, fields with small growing crops and ploughed fields (Figures 3 & 4, Appendix 2), at that time, rather than because of any active selection of pasture habitats. In addition, most feedlots, which were fed from mainly in the winter, were in pastures, partially explaining the highly significant selection for this habitat at that time. However, analysing this factor by examining data only from birds foraging away from feedlots still resulted in a significant selection for pasture habitats during the winter. The relatively high proportion of cranes found at feedlots suggests that they represented an important food supply.

The finding that blue cranes in the Karoo are largely independent of croplands for foraging suggests that this population is unlikely to be threatened by poisoning. Blue cranes, however, are believed to have extensive seasonal and nomadic movements (e.g. Siegfried 1985; Johnson & Barnes 1986; Allan 1993). Cranes from the Karoo, therefore, could be vulnerable to poisoning if they wander out of this region or move to the relatively restricted areas with croplands (usually irrigated). The information from the southern Cape confirms that the species relies heavily on croplands in this area and is therefore vulnerable to poisoning there. It is particularly during the period March to July, when the croplands are sown or support short growing crops which attract foraging cranes, that the birds are most likely to be intentionally or inadvertently poisoned. In addition, this study highlights the attraction of cranes to livestock feedlots situated in pastures in the southern Cape; this can bring them into conflict with farmers, who may respond by intentionally poisoning the birds (Scott 1992).

The adaptation by blue cranes to regions with intensive farming parallels the situation reported for many other crane species. For example, Reinecke & Krapu (1986) describe how the sandhill crane *G. canadensis* has adapted to exploiting a combination of croplands and natural and cultivated pastures in an agricultural landscape. They suggest that, in such regions, habitats providing animal-protein foods are likely to be the limiting resource, rather than habitats providing plant foods. Several other studies report extensive use of man-made habitats by cranes (Lovvorn & Kirkpatrick 1982; Alonso, Alonso & Veiga 1984; Krapu, Facey, Fritzell & Johnson 1984; Iverson, Vohs & Tacha 1985, 1987; Sugden *et al.* 1988; Khachar, Patankar, Gaekwad, Mundkur, Pravez & Naik 1991; McIvor & Conover 1992).

The slight differences between the southern Cape and the Swartland in the relative abundance of the four major habitat types do not explain the large difference in the abundance of blue cranes between the two areas (Appendix 1, see also Allan 1993). This dichotomy in patterns of abundance between the western and southern parts of the Western Cape agricultural region is shown by several other large terrestrial birds, i.e. blackheaded heron *Ardea melanocephala*, white stork *Ciconia ciconia*, Stanley's bustard *Neotis denhami*, karoo korhaan *Eupodotis vigorsii*, and black crow *Corvus capensis* (Hockey, Underhill, Neatherway & Ryan 1989), all of which are common in the southern Cape but are less common or absent in the Swartland.

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References

ALLAN, D.G. 1992. Distribution, relative abundance and habitat of the blue crane in the Karoo and the south-western Cape. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter, Southern African Crane Foundation, Durban. pp. 29–46.

ALLAN, D.G. 1993. Aspects of the biology and conservation status of the blue crane *Anthropoides paradiseus*, and the Ludwig's *Neotis ludwigii* and Stanley's *N. denhami stanleyi* bustards in southern Africa. M.Sc. thesis, University of Cape Town, pp. 1–242.

ALLDREDGE, J.R. & RATTI, J.T. 1986. Comparison of some statistical techniques for analysis of resource selection. *J. Wildl. Manage.* 50: 157–165.

ALONSO, J.A., ALONSO, J.C. & VEIGA, J. 1984. Winter feeding of the crane in cereal farmland at Gallocanta, Spain. *Waterfowl* 35: 119–131.

ANDERSON, S. 1990. South Africa's national bird is endangered. *Afr. Wildl.* 44: 363.

ARCHIBALD, G.W., SHIGETA, Y., MATSUMOTO, K. & MOMOSE, K. 1981. Endangered cranes. In: Crane research around the world: Proceedings of the International Crane Symposium at Sapporo, Japan in 1980 and papers from the World Working Group on cranes, International Council for Bird Preservation, (eds) J.C. Lewis & H. Masutomi (eds), International Crane Foundation, Baraboo, Wisconsin, pp. 1–12.

BROOKE, R.K. 1984. South African Red Data Book — Birds. *S. A. Natn. Sci. Progr. Rept* 97: 1–213.

COLLAR, N.J., CROSBY, M.J. & STATTERSFIELD, A.J. 1994. Birds to watch 2. The world list of threatened birds. *Bird Life Conservation Series* 4: 1–407.

DAY, D.H. 1979. Report on the Crane Study Group for 1978/79. *Bokmakierie* 31: 61– 62.

FILMER, R.J. & HOLTSHAUSEN, G.R. 1992. The southern African crane census, 1985/1986. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter, Southern African Crane Foundation, Durban. pp. 132–153.

GELDENHUYS, J.N. 1984. The status of cranes (Aves: Gruidae) in the Orange Free State. *S. Afr. J. Wildl. Res.* 14: 15–18.

HILTON-TAYLOR, C. & LE ROUX, A. 1989. Conservation status of the fynbos and Karoo biomes. In: Biotic diversity in southern Africa: concepts and conservation, (ed.) B.J. Huntley, Oxford University Press, Cape Town. pp. 202–223.

HOCKEY, P.A.R., UNDERHILL, L.G., NEATHERWAY, M. & RYAN, P.G. 1989. Atlas of the birds of the southwestern Cape. Cape Bird Club, Cape Town.

HOLTSHAUSEN, G. & LEDGER, J. 1985. Southern African crane census. *Bokmakierie* 39: 196–199.

IVERSON, G.C., VOHS, P.A. & TACHA, T.C. 1985. Habitat use by sandhill cranes wintering in western Texas. *J. Wildl. Manage.* 49: 1074–1083.

IVERSON, G.C., VOHS, P.A. & TACHA, T.C. 1987. Habitat use by mid-continent sandhill cranes during spring migration. *J. Wildl. Manage.* 51: 448–458.

JOHNSGARD, P.A. 1983. Cranes of the world. Indiana University Press, Bloomington.

JOHNSON, D.N. 1992. The status of cranes in Natal in 1989. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter, Southern African Crane Foundation, Durban. pp. 20–28.

JOHNSON, D.N. & BARNES, P.R. 1986. The Natal crane census. *Lammergeyer* 37: 40–49.

KHACHAR, S., PATANKAR, H.R. GAEKWAD, A., MUNDKUR, T., PRAVEZ, R. & NAIK, R.M. 1991. Wintering cranes in Gujarat State, India. In: Proceedings 1987 International Crane Workshop, (ed.), International Crane Foundation, Baraboo, Wisconsin. pp. 327–333.

KRAPU, G.L., FACEY, D.E., FRITZELL, E.K. & JOHNSON, D.H. 1984. Habitat use by migrant sandhill cranes in Nebraska. *J. Wildl. Manage.* 48: 407–417.

LOVVORN, J.R. & KIRKPATRICK, C.M. 1982. Field use by staging eastern greater sandhill cranes. *J. Wildl. Manage.* 46: 99–108.

MACLEAN, G.L. 1993. Roberts' birds of southern Africa. John Voelcker Bird Book Fund, Cape Town.

McIVOR, D.E. & CONOVER, M.R 1992. Sandhill crane habitat use in northeastern Utah and southwestern Wyoming. Proceedings of the North American Crane Workshop 6: 81–84.

MOLL, E.J. & BOSSI, L. 1983. Vegetation of the fynbos biome. Directorate of Surveys and Mapping, Mowbray.

REINECKE, K.J. & KRAPU, G.L. 1986. Feeding ecology of sandhill cranes during spring migration in Nebraska. *J. Wildl. Mana ge.* 50: 71–79.

SCOTT, A. 1992. Overberg Crane Group news. *The Crane* 3 (2): 3–5.

SIEGFRIED, W.R. 1985. Relative abundance of cranes (Gruidae) in the Cape Province. *Ostrich* 56: 101–103.

STRETTON, W.S. 1992. Some thoughts on the decline of the blue crane and the role of the farmer in its conservation. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter, Southern African Crane Foundation, Durban. pp. 111–114.

SUGDEN, L.G., CLARK, R.G., WOODSWORTH, E.J. & GREENWOOD, H. 1988. Use of cereal fields by foraging sandhill cranes in Saskatchewan. *J. Appl. Ecol.* 25: 111–124.

TARBOTON, W.R. 1992. Extent and reasons for population declines in South Africa's three crane species. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson & M.J. Porter, Southern African Crane Foundation, Durban. pp. 117–118.

URBAN, E.K., FRY, C.H. & KEITH, S. 1986. The birds of Africa. Vol. 2. Academic Press, London.

VAN EE, C.A. 1981. Status of the blue crane in South and Southwest Africa. In: Crane research around the world: Proceedings of the International Crane Symposium at Sapporo, Japan in 1980 and papers from the World Working Group on cranes, International Council for Bird Preservation, (eds) J.C. Lewis & H. Masutomi (eds), International Crane Foundation, Baraboo, Wisconsin. p. 259.

VERNON, C.J., BOSHOFF, A.F. & STRETTON, W.S. 1992. The status and conservation of cranes in the Eastern Cape Province. In: Proceedings of the First Southern African Crane Conference, (eds) D.J. Porter, H.S. Craven, D.N. Johnson and M.J. Porter, Southern African Crane Foundation, Durban. pp. 47–72.

WALKINSHAW, L.H. 1981. The sandhill cranes. In: Proceedings of the International Crane Symposium at Sapporo, Japan in 1980 and papers from the World Working Group on cranes, International Council for Bird Preservation, (eds) J.C. Lewis & H. Masutomi (eds), International Crane Foundation, Baraboo, Wisconsin. pp. 151–162.

WINTERBOTTOM, J.M. 1978. Birds. In: Biogeography and ecology of southern Africa, (ed.) M.J.A. Werger, Junk, The Hague. pp. 949–979.

Appendix 1 The dates and number of kilometres travelled on the road counts through the three regions of the Karoo where blue cranes were encountered and in the two Western Cape study areas and the number of blue crane individuals and groups counted on each transect

Region	Date	No. km	No. inds	No. groups
Karoo				
Central Upper Karoo	Jul. 1988	1 172 km	105	6
	Nov. 1988	1 132 km	7	5
	Mar. 1989	1 146 km	24	6
	Jul. 1989	1 158 km	153	13
	Total	**4608 km**	**289**	**30**
Great Karoo	Jul. 1988	658 km	6	2
	Nov. 1988	647 km	9	5
	Mar. 1989	651 km	30	2
	Jul. 1989	643 km	7	3
	Total	**2599 km**	**52**	**12**
Steytlerville Karoo	Jul. 1988	219 km	5	3
	Nov. 1988	211 km	12	6
	Mar. 1989	215 km	16	7
	Jul. 1989	215 km	53	8
	Total	**857 km**	**86**	**24**
Karoo total		*8064 km*	*427*	*66*
Western Cape				
Swartland	Dec. 1991	283 km	0	0
	Jul. 1993	236 km	12	4
	Total	**519 km**	**12**	**4**
Southern Cape	Sep. 1988	483 km	314	30
	Jun. 1989	509 km	568	21
	Jul. 1989	563 km	532	32
	Mar. 1990	576 km	241	25
	Jul. 1990	564 km	760	35
	Nov. 1990	588 km	248	47
	Feb. 1991	583 km	261	38
	May 1991	605 km	599	35
	Jul. 1991	596 km	648	34
	Nov. 1991	584 km	226	37
	Mar. 1992	581 km	227	41
	Jun. 1992	580 km	639	39
	Aug. 1992	591 km	1 183	39
	Dec. 1992	593 km	117	52
	Apr. 1993	588 km	442	41
	Total	**8584 km**	**7005**	**546**
Western Cape total		*9103 km*	*7017*	*550*
Karoo & W. Cape Total		**17 167 km**	**7444**	**616**

Appendix 2 The availability of six different habitat types in the southern Cape and their use by blue cranes. The habitat availability data are presented separately for each month and the information on habitat use by blue cranes is presented separately for every month during which data were collected. The sample sizes in the final column refer to the number of data points used in assessing habitat availability, and the number of blue crane individuals and groups recorded during each month, respectively

Month	% cultivated pastures	% harvested cereal	% growing cereal	% ploughed fields	% natural vegetation	% miscellaneous	*n*
February							
Available habitat	**48,6**	**21,4**	**0,1**	**10,4**	**11,4**	**8,0**	**1119**
Use 1991—individuals	14,2	83,3	–	2,5	–	–	240
Use 1991—groups	31,6	60,5	–	7 ,9	–	–	38
March							
Available habitat	**47,8**	**19,4**	**–**	**1293**	**11,6**	**8,9**	**2086**
Use 1990 —individuals	35,3	49,2	–	14,3	1,2	–	252
Use 1992 —individuals	14,7	61,3	–	24,0	–	–	217
Use 1990 —groups	40,0	46,6	–	6,7	6,7	–	30
Use 1992 —groups	31,6	50,0	–	18,4	–	–	38
April							
Available habitat	**41,9**	**10,8**	**1,0**	**23,7**	**11,5**	**11,1**	**1318**
Use 1993 —individuals	25,0	65,5	–	9,5	–	–	432
Use 1993 —groups	29,3	51,2	–	19,5	–	–	41
May							
Available habitat	**41,4**	**10,9**	**1,4**	**2696**	**11,5**	**8,2**	**1336**

Appendix 2 The availability of six different habitat types in the southern Cape and their use by blue cranes. The habitat availability data are presented separately for each month and the information on habitat use by blue cranes is presented separately for every month during which data were collected. The sample sizes in the final column refer to the number of data points used in assessing habitat availability, and the number of blue crane individuals and groups recorded during each month, respectively (Continued)

Month	% cultivated pastures	% harvested cereal	% growing cereal	% ploughed fields	% natural vegetation	% miscellaneous	*n*
Use 1991 —individuals	37,9	31,2	0,9	30,0	–	–	641
Use 1991 —groups	36,1	25,0	2,8	36,1	–	–	36
June							
Available habitat	**46,8**	**0,5**	**23,0**	**8,0**	**11,7**	**10 90**	**1384**
Use 1989 —individuals	7,0	–	90,7	2,3	–	–	572
Use 1992 —individuals	20,1	–	71,5	8,4	–	–	676
Use 1989 —groups	26,1	–	56,5	17,4	–	–	23
Use 1992 —groups	38,6	–	52,3	9,1	–	–	44
July							
Available habitat	**45,2**	**2,4**	**33,1**	**0,6**	**11,1**	**7,6**	**2080**
Use 1989 —individuals	56,3	–	10,2	33,5	–	–	531
Use 1990 —individuals	99,1	0,2	0,7	–	–	–	548
Use 1991 —individuals	84,8	–	12,9	2,3	–	–	599
Use 1993 —individuals	97,1	–	2,9	–	–	–	444
Use 1989 —groups	72,7	–	15,2	12,1	–	–	3
Use 1990 —groups	91,7	2,8	5,5	–	–	–	36
Use 1991 —groups	80,0	–	14,3	5,7	–	–	35
Use 1993 —groups	95,5	–	4,5	–	–	–	22
August							
Available habitat	**45,9**	**–**	**31,7**	**1,4**	**12,6**	**8,4**	**1244**
Use 1992 —individuals	79,2	–	0,3	13,8	6,7	–	1181
Use 1993 —groups	84,2	–	5,3	7,9	2,6	–	38
September							
Available habitat	**44,8**	**–**	**35,1**	**2,3**	**11,1**	**6,7**	**984**
Use 1988 —individuals	92,5	–	4,7	1,4	1,4	–	294
Use 1988 — groups	76,9	–	11,5	7,7	3,9	–	26
November							
Available habitat	**51,4**	**24,5**	**1,9**	**3,6**	**10,2**	**8,4**	**2230**
Use 1990 —individuals	70,7	29,3	–	–	–	–	266
Use 1991 —individuals	48,4	50,2	0,9	0,5	–	–	221
Use 1990 —groups	40,0	60,0	–	–	–	–	50
Use 1991 —groups	42,8	51,4	2,9	2,9	–	–	35
December							
Available habitat	**44,9**	**27,8**	**0,5**	**5,1**	**10,9**	**10,8**	**1360**
Use 1992—individuals	38,2	57,8	2,0	2,05	–	–	102
Use 1992 —groups	34,7	61,2	2,1	2,05	–	–	49