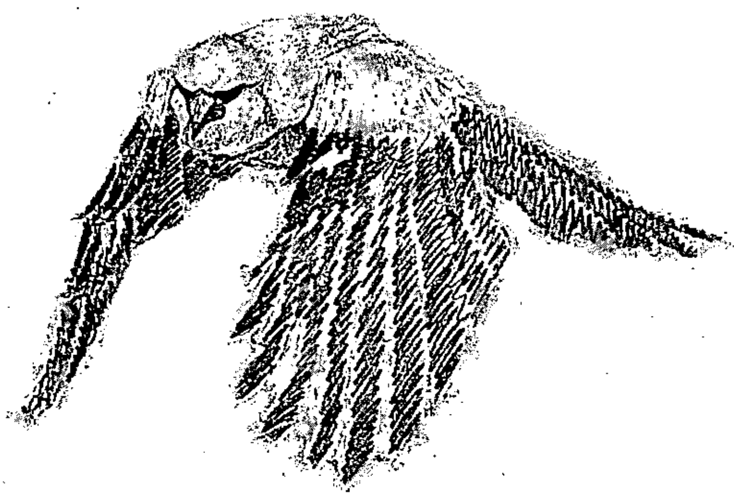
Project Yabello 2005 :
Effect of habitat alteration on Ethiopian endemic birds

A joint expedition to southern Ethiopia by the University of Glasgow and the Ethiopian Wildlife and Natural History Society

Report



Project Yabelo

Sandy Watt
42 Airlie Street, Flat 1/2
Glasgow
G11 9TR
Phone: 07733140334
Email: sandywatt15@yahoo.co.uk

Dear Marianne,

Project Yabelo Expedition 2005
Final Report.

Please find enclosed the final report for Project Yabelo 2005: Effect of habitat alteration on Ethiopian endemic birds. I apologise that this report has taken so long to reach completion. Delays from many of our contributing authors (including myself) due to other commitments, led to even minor changes in the document taking long periods to circulate.

The report details all the work carried out in Ethiopia and the papers that have been prepared for submission by the team. We intend to use any remaining monies to help fund an Ethiopian PhD student through his degree, which will involve further study of the effects of habitat change on the Ethiopian Bushcrow. His work will add to our findings and provide more complete data on this endangered bird, which will lead to a greater understanding of what action is required to protect it.

On behalf of the whole team involved in the project, I wish to thank you for the funding assistance which allowed this project to produce such a wealth of new data. Without this help, which enabled us to add more to the existing information, the future for these endemic bird species is bleak. We were also able to update the species counts on this very important area of Ethiopia, which added much to the value of our work.

Once again I apologise for the delay and I hope you find our report informative.

Yours sincerely,

Sandy

Sandy Watt
Project Yabelo Leader

This report describes the work undertaken by Project Yabelo, a joint expedition to the Yabelo Sanctuary by members of the University of Glasgow and Ethiopian Wildlife and Natural History Society, between July and September 2005. The Ethiopian Wildlife and Natural History Society originally invited us to visit Ethiopia in 2004 and over the following months we developed a project which had three principal aims:

1. To determine the large scale habitat use of the endemic Ethiopian Bush Crow and White-tailed Swallow in the Yabelo Sanctuary and surrounding areas.

2. To determine the fine scale habitat requirements and availability of the habitats for the Ethiopian Bush Crow and White-tailed Swallow from areas in the Yabelo Sanctuary and surrounding areas.

3. Make extensive inventories of bird species' occurrence in the largely unsurveyed Yabelo Sanctuary and surrounding areas.

The results of the project are presented in this report in the format of four papers which will be submitted for publication. The first paper describes the avifauna of the Yabelo Sanctuary and provides semi-quantitative abundance and habitat distribution data on all bird species identified during the project. The second paper gives further details on the distribution and habitat selection of the Ethiopian Bush Crow and the White-tailed Swallow. The third paper presents data on habitat selection by the birds of the Yabelo Sanctuary and the surrounding areas whilst the fourth describes our findings on the ecology of the Ethiopian Bush Crow.

We would like to thank all our sponsors who financially supported the project and to the residents of the Yabelo Sanctuary and the surrounding areas who were always generous, supportive and friendly. We would particularly like to thank all the staff of the Ethiopian Wildlife and Natural History Society who were very helpful throughout the planning of the project and were an integral and vital part of the field work. We highly recommend the Yabelo Sanctuary as a study site to anyone interested in East African natural history - the unique avifauna, the ease of access from Addis Ababa as well as the good local infrastructure makes Yabelo an excellent place to work. We hope that our results further highlight the global importance of the avifauna of Yabelo. In addition, we hope that the unequivocal demonstration of dramatic, ongoing habitat degradation in the Yabelo area provides the impetus for the initiation of further studies into the unique avifauna of this region.

Birds of the Yabelo Sanctuary, Southern Ethiopia

Alexander Watt [1], Richard Mellanby [1], Ben Ross [1], Mengistu Wondafrash [1,2], Mihret Ewnetu [1,3], Claire Spottiswoode [1], Ceclia Broadhurst[1], Robert Critchlow [1], Aman Dadesa[1,4], Tom Deas [1], Chere Enawgaw [1,4], B. Gebremedihin [1,5], Ellie Graham [1], Sarah Maclean [1] & Michael McKean [1]

[1] Project Yabelo, Institute of Biomedical Sciences, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, U.K.

[2] Ethiopian Wildlife and Natural History Society, PO Box 13303, Addis Ababa, Ethiopia.

[3] Ministry of Agriculture and Rural Development, Wildlife Conservation Department, PO Box 10-22-98, Addis Ababa, Ethiopia.

[4] Yabelo Wildlife Sanctuary, PO Box 34, Yabelo, Ethiopia.

[5] Institute of Biodiversity and Conservation, Addis Ababa, Ethiopia.

Please address correspondence to Sandy Watt, Dod Mill, By Lauder, Berwickshire, Scotland, TD2 6SE. E-mail: sandywatt15@yahoo.co.uk

Summary

The Yabelo Sanctuary is the only designated protected area within the ranges of the Ethiopian Bush Crow and the White-tailed Swallow, two of mainland Africa's most restricted range species, but is currently experiencing considerable habitat degradation. This paper describes the findings of a general survey of the avifauna of the Yabelo Sanctuary undertaken over a six week period between July and August 2005. The frequency of sightings and habitat use of the 256 bird species recorded during the study is reported, as well as practical information for visitors.

Introduction

Ethiopia has a rich and diverse avifauna and supports 16 endemic bird species and three endemic bird areas (Fishpool and Evans 2001). The South Ethiopian Highlands is considered to be an endemic bird area (EBA) of critical priority which supports five restricted range species of which two, the Ethiopian Bush Crow (*Zavattariornis stresemanni*) and the White-tailed Swallow (*Hirundo megaensis*), are found within a small area around the Yabelo and Mega regions in southern Ethiopia (Stattersfield et al 1998, Gedeon 2006). The most recent study on the status of the Ethiopian Bush Crow based on roadside counts concluded that the population may have decreased by as much as 80 per cent in the past two decades and, consequently, its status has been upgraded from vulnerable to endangered (Birdlife International 2005a, Borghesio and Giannetti 2005). Very little data is available on the status and distribution of the White-tailed Swallow and it is currently considered to be vulnerable (Birdlife International 2005b).

The only protected area within this EBA is the Yabelo Sanctuary (EWNHS 1996, Fishpool and Evans 2001). Remarkably given its global importance, the Yabelo sanctuary receives little to no active management (see Conservation Prospects, below) and even its boundaries are ill-defined. We were unable to find any clear documentation of them from local officials or any national conservation NGOs. Borghesio and Giannetti (2005) defined the sanctuary east west range from Yabelo itself to 50km east of Yabelo and the north south range from 10km north of Surupa to 30km south of Yabelo. The only assessment of the avifauna of the sanctuary was made in a brief survey in June 1996 which recorded 210 species in the area (Fishpool and Evans 2001). The most common habitat is woodland savannah dominated by species of *Acacia* (*A. tortilis, A. brevispica, A. horrida, A. drepanolobium*), *Terminalia* and *Commiphora* (Borghesio and Giannetti 2005). In addition, small patches of *Juniperus* forest can be found in upland areas, although grazing and logging greatly threaten the persistence of this woodland (Borghesio et al. 2004).

Due to the rapid habitat alteration which is ongoing within the Yabelo Sanctuary, there is a clear need for a thorough survey of the avifauna of the sanctuary and surrounding areas, which was the aim of this study.

Checklist

A species checklist, based on fieldwork undertaken during 43 days between 15 July and 30 August 2005, is shown in Table 1. On any one day, 9-14 observers were in the field (total 418 observer-days) and observations were made from 30 minutes before dawn until about two hours after dusk each day, with the majority of observations being collected within the first three hours after dawn. All daily records of each member of the team were scrutinised by the entire team each evening. Where there was any doubt about the accuracy of the field identification, the record was removed from the final species list.

A total of 256 species was recorded. The species list details the number of days and number of observer-days on which each species was recorded, as well as listing the habitat types used. We emphasise that the species list is unlikely to be a complete, because our cumulative species list did not altogether plateau over the survey period, and we were still recording new species during our last few days (Figure 1). This owed, in part, to the arrival of the first few autumn migrants from the Palearctic.

The survey clearly confirmed that the region around Yabelo and Mega is of critical importance to the Ethiopian Bush Crow (Figures 2,3) and the White-tailed Swallow (Figure 4). The Ethiopian Bush Crow was commonly observed within the *Acacia* scrubland habitat and was normally seen in small groups of birds consisting of either Bush Crows alone or mixed flocks. A large number of bird species were observed to associate with the Ethiopian Bush Crow in mixed flocks including Superb Starlings, Black-capped Social Weavers and White-headed Buffalo Weavers. White-tailed Swallows were also regularly observed during the study period, albeit less frequently and in fewer numbers than the Ethiopian Bush Crow. White-tailed Swallows are usually observed in flight, normally as individual birds or in pairs. White-tailed Swallows were observed in a variety of habitats ranging from *Acacia* scrub to *Commiphora* scrubland to farmland and villages.

A number of other notable species were observed in the Yabelo Sanctuary and in the surrounding area. These include the Lappet-faced Vulture which is currently considered vulnerable due to its small, declining population (Birdlife 2006), and which was observed on 32 of the 43 days of fieldwork in *Acacia* and *Commiphora* woodland and around villages.

Habitats

The Yabelo Sanctuary and adjacent areas contain a number of principal habitat types (Figure 5); these are numbered as they appear in the "habitat" column for each species in the electronic checklist.

1. Farmland: Predominantly maize, wheat and teff. Less common were chickpea and sugarcane. Fields were generally small, often by main roads and frequently contained mature *Acacia* trees.
2. *Acacia* scrubland: Dominated by *Acacia* spp. (primarily *A. drepanolobium*, *A brevispica* and *A. horrida*). This habitat type varied widely from a low density of mature trees with mature savannah grassland to a high density of short trees with little grassland.
3. *Juniper* forest: Dominated by *Juniperus procera*. Logging is a considerable problem within this habitat type (Borghesio et al. 2004). Note that there is no juniper forest within the boundaries of the sanctuary, such as we understand them.
4. *Combretum/Terminalia* forest: Woodland habitat with two dominant species, *Combretum* spp and *Terminalia* spp. Often associated with a small number of acacia trees and scrubland.
5. *Commiphora* scrubland: Frequently also includes *Euphorbia* spp., interspersed with *Acacia* spp.

Access for birders

The town of Yabelo is easily accessible by car along the main road from Addis Ababa to Moyale. The road is in good condition for the majority of the journey and although the journey can be completed in around 8 to 10 hours, Awassa is a convenient and interesting place to break the journey into two more manageable days of driving. Within Yabelo there are a few budget hotels, a weekly market and there are a few basic shops. There is a large motel on the outskirts of Yabelo which has several rooms, some of which have en suite facilities and hot water (Yabelo Motel, PO Box 44, Yabelo, Tel +251 464 460 237). A four wheel drive vehicle is necessary to reach areas of the sanctuary not served by the main Addis to Moyale road (which is good quality tar). Various mammals such as zebra, gazelle, hyena, leopard and bat-eared fox are also present within the Yabelo Sanctuary. For additional information on the Yabelo Sanctuary contact Mengistu Wondafrash (Ethiopian Wildlife and Natural History Society, PO Box 13303, Addis Ababa, Ethiopia. Email ewnhs.ble@ethionet.et). The manager of the Yabelo Sanctuary is Aman Dadesa who is based in Yabelo (Yabelo Wildlife Sanctuary, PO Box 34, Yabelo, Ethiopia. Tel 06-46 00 87).

Conservation prospects

The Yabelo Sanctuary faces many challenges in the short to medium term. Its status as a protected area, nebulous defined as its boundaries are, is very much nominal, and in the past few decades human transformation of the available habitats appears to have accelerated (EWNHS 1996, Borghesio and Giannetti 2005). Pastoralism by Borena herders occurs throughout much of the sanctuary, which is peppered with villages. Borghesio and Giannetti (2005) analysed Landsat images of the region, found that dense bush had greatly increased in the Yabelo Sanctuary from 1986 and 2002, and suggested that this was likely to have resulted from overgrazing by domestic stock, as well as fire suppression and the disappearance of wild herbivores. Based on our field observations and discussions with the local villagers living within the Sanctuary, we concur that overgrazing by domestic animals is undoubtedly a considerable problem. There was a widespread consensus amongst local people that the amount of available grazing land in the Sanctuary has decreased over the past two decades. This appears to have caused, at least in part, an increased amount of cultivation within the Sanctuary, leading to an even more dramatic alteration of the natural habitat. In spite of their apparent tolerance of heavily disturbed areas such as villages, it seems imperative that populations of Ethiopian Bush Crow and White-tailed Swallow in particular are closely monitored to ensure that their small and fragmentary range does not dwindle further still.

Acknowledgements

The authors of the study are very grateful to the BP Conservation Awards Programme, Carnegie Trust, University of Glasgow, Peoples Trust for Endangered Species, Royal Geographical Society, African

Bird Club, Glasgow Natural History Society and Edinburgh Trust 1 for their generous financial support of this project. We are also most grateful to John Ash, Luca Borghesio, Nigel Collar, Yilma Dellelegn and Per Ole Syvertsen for their extremely helpul advice and guidance.

References

Birdlife International (2005a) Species factsheet: *Zavattariornis stresemanni*. Downloaded from http://www.birdlife.org on 23/12/2005

Birdlife International (2005b) Species factsheet: *Hirundo aethiopica*. Downloaded from http://www.birdlife.org on 23/12/2005

Birdlife International (2006) Species factsheet: *Torgos tracheliotus*. Downloaded from http://www.birdlife.org on 23/2/06

Borghesio, L., Giannetti, F., Ndang'ang'a K. And Shimelis, A. (2004) The present conservation status of *Juniperus* forest in the South Ethiopian Endemic Bird Areas. *African Journal of Ecology*. **42,** 137-143

Borghesio, L. and Giannetti, F. (2005) Habitat degradation threatens the survival of the Ethiopian bush crow *Zavattariornis stresemanni*. *Oryx*. **39,** 44-49

EWNHS (1996) Important bird areas of Ethiopia. Ethiopian Wildlife and Natural History Society, Addis Ababa, Ethiopia. pp185-187

Fishpool, L.D.C. and Evans, M.I. (2001) Important bird areas in Africa and associated islands: priority sites for conservation. Eds Fishpool, L.D.C. and Evans, M.I. 1st edition. Newbury and Cambridge, UK: Pisces Publications and Birdlife International.

Gedeon, K. (2006) Observations on the biology of the Ethiopian Bush Crow, *Zavattariornis stresemanni*. Bulletin of African Bird Club. **13,** 178-188

Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. (1998) Endemic Bird Areas of the World. Eds. Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. 1st edition. Burlington Press, Cambridge. pp382-383

Table 1

Species list of birds recorded in the Yabelo Sanctuary and surrounding areas between 15th July and 30th August 2006. The habitat codes are 1 Acacia scrub; 2 Commiphora; 3 Farmland; 4 Juniper forest; 5 Settlement; 6 Compretum-terminalia forest; 7 open water.

Species		Number of days recorded (n=43)	% of days recorded	No. of observer days recorded (n=418)	% of observer days recorded	Habitat
Little Grebe	*Tachybaptus ruficollis*	2	5	4	0.9	7
African Darter	*Anhinga rufa*	1	2	2	0.4	7
Hamerkop	*Scopus umbretta*	10	23	40	10	1,2,3
Grey Heron	*Ardea cinerea*	3	7	26	6	3
Black-headed Heron	*Ardea melanocephala*	5	12	16	9	1,3
Cattle Egret	*Bubulcus ibis*	2	5	8	2	1,3
African Spoonbill	*Platalea alba*	2	5	7	2	7
Hadeda Ibis	*Bostrychia hagedash*	2	5	8	2	1
Sacred Ibis	*Threskiornis aethiopicus*	1	2	6	1	7
Great White Pelican	*Pelecanus onocrotalus*	1	2	3	0.7	7
Abdim's Stork	*Ciconia abdimii*	1	2	2	0.4	1
Knob-billed Duck	*Sarkidiornis melanotos*	2	5	17	4	1
Red-billed Teal	*Anas erythrorhyncha*	2	5	9	2	7
White-faced Whistling Duck	*Dendrocygna viduata*	2	5	4	0.9	7
Egyptian Goose	*Alopochen aegyptiaca*	16	37	87	21	1,3,5
Black-shouldered Kite	*Elanus caeruleus*	34	75	127	30	1,3,5
Black-chested Snake Eagle	*Circaetus pectoralis*	5	12	20	5	1
Bateleur	*Terathopius ecaudatus*	19	44	85	20	1,2,6
Ruppell's Vulture	*Gyps rueppelli*	3	7	16	4	1
Hooded Vulture	*Necrosyrtes monachus*	25	58	78	19	1,2,3,5,6
Lappet-faced Vulture	*Torgos tracheliotus*	32	74	27	6	1,2,5
African White-backed Vulture	*Gyps africanus*	8	19	18	4	1,5
White-headed Vulture	*Trigonoceps occipitalis*	16	37	58	14	1,2,5,6
Egyptian Vulture	*Neophron percnopterus*	4	9	11	3	1,3,5
African Harrier Hawk	*Polyboroides typus*	3	7	11	3	1,7
Eastern Chanting Goshawk	*Melierax poliopterus*	33	77	116	28	1,2,3,5
Dark Chanting Goshawk	*Melierax metabates*	7	16	14	3	1,2
Gabar Goshawk	*Micronisus gabar*	12	28	31	7	1,2
Little Sparrowhawk	*Accipiter minullus*	2	5	5	1	1
Black Sparrowhawk	*Accipiter melanoleucus*	1	2	2	0.4	1
Eurasian Honey Buzzard	*Pernis apivorus*	1	2	2	0.4	1
Augur Buzzard	*Buteo augur*	19	44	41	10	1,2,3,4,5
Verreaux's Eagle	*Aquila verreauxii*	1	2	7	2	1
Tawny Eagle	*Aquila rapax*	35	81	131	31	1,2,3,5,6
Booted Eagle	*Hieraaetus pennatus*	1	2	2	0.4	1
Martial Eagle	*Polemaetus bellicosus*	6	14	16	4	1,2
Long-crested Eagle	*Lophaetus occipitalis*	9	21	26	6	1,5
Secretary Bird	*Sagittarius serpentarius*	8	19	46	11	1
Pygmy Falcon	*Polihierax semitorquatus*	22	51	65	16	1,3,5,6
Lanner Falcon	*Falco biarmicus*	1	2	2	0.4	2
Peregrine Falcon	*Falco peregrinus*	1	2	2	0.4	1
Amur Falcon	*Falco amurensis*	1	2	3	0.7	1
Grey Kestrel	*Falco ardosiaceus*	2	5	4	1	1
Eurasian Hobby	*Falco subbuteo*	1	2	2	0.4	1
Vulturine Guineafowl	*Acryllium vulturinum*	19	44	75	18	1,3
Helmeted Guineafowl	*Numida meleagris*	12	28	42	10	1,3,5

Crested Francolin	*Francolinus sephaena*	42	98	230	55	1,2,3,4,5,6
Yellow-necked Spurfowl	*Francolinus leucoscepus*	35	81	153	37	1,2,3,6
Common Quail	*Coturnix coturnix*	4	9	10	2	1
Red-knobbed Coot	*Fulica cristata*	3	7	14	3	7
Kori Bustard	*Ardeotis kori*	8	19	42	10	1,3
Buff-crested Bustard	*Eupodotis gindiana*	8	19	18	4	1,2,3
Black-bellied Bustard	*Eupodotis melanogaster*	12	28	27	6	1,2
White-bellied Bustard	*Eupodotis senegalensis*	28	65	115	28	1,2,3,5,6
Spotted Thick-knee	*Burhinus capensis*	2	5	14	3	1
Somali Courser	*Cursorius somalensis*	4	9	18	4	1,5
Three-banded Courser	*Rhinoptilus cinctus*	8	19	22	5	1
Crowned Lapwing	*Vanellus coronatus*	37	86	191	46	1,2,3,5
Black-winged Plover	*Vanellus melanopterus*	1	2	13	3	1
Spur-winged Plover	*Vanellus spinosus*	3	7	7	2	1
Common Sandpiper	*Actitis hypoleucos*	4	9	14	3	7
Wood Sandpiper	*Tringa glareola*	2	5	4	0.9	7
White-winged Tern	*Chilidonias leucopterus*	1	2	2	0.4	7
Gull-billed Tern	*Sterna nilotica*	1	2	2	0.4	7
Black-faced Sandgrouse	*Pterocles decoratus*	1	2	2	0.4	1
African Olive Pigeon	*Columba arquatrix*	3	7	15	4	4
Speckled Pigeon	*Columba guinea*	41	95	279	67	3,5
Lemon Dove	*Columba larvata*	1	2	3	0.7	4
Ring-necked Dove	*Streptopelia capicola*	43	100	377	90	1,2,3,4,5,6
African Mourning Dove	*Streptopelia decipiens*	17	40	40	10	1,2,3,5,6
Red-eyed Dove	*Streptopelia semitorquata*	37	86	212	51	1,2,3,4,5,6
Laughing Dove	*Streptopelia senegalensis*	31	72	102	24	1,2,3,5,6
European Turtle Dove	*Streptopelia turtur*	1	2	2	0.4	5
Dusky Turtle Dove	*Streptopelia lugens*	8	19	22	5	1,4,5
Emerald-spotted Wood Dove	*Turtur chalcospilos*	17	40	50	12	1,2,4,5,6
Blue Spotted Wood Dove	*Turtus afer*	1	2	1	0.2	4
Namàqua Dove	*Oena capensis*	15	35	37	9	1,2,3
African Orange-bellied Parrot	*Poicephalus rufiventris*	43	100	273	57	1,2,3,5,6
White-cheeked Turaco	*Tauraco leucotis*	6	14	13	3	4
Prince Ruspoli's Turaco	*Tauraco ruspolii*	1	2	5	1	4
Bare-faced Go-away Bird	*Corythaixoides personatus*	13	30	45	11	1,4,5,6
White-bellied Go-away Bird	*Criniferoides leucogaster*	42	98	346	83	1,2,3,4,5,6
Didric Cuckoo	*Chrysococcyx caprius*	1	2	1	0.2	4
Klaas's Cuckoo	*Chrysococcyx klaas*	1	2	2	0.4	1
Red-chested Cuckoo	*Cuculus solitarius*	5	12	9	2	1
White-browed Coucal	*Centropus superciliosus*	27	63	81	19	1,2,3,4,5,6
Pearl-spotted Owlet	*Glaucidium perlatum*	3	7	8	2	1,5
Spotted Eagle Owl	*Bubo africanus*	1	2	1	0.2	1
African Scops Owl	*Otus senegalensis*	1	2	1	0.2	4
Verreaux's Eagle Owl	*Bubo lacteus*	3	7	15	4	1
Donaldson-Smith's Nightjar	*Caprimulgus donaldsoni*	1	2	3	0.7	2
Nubian Nightjar	*Caprimulgus nubicus*	6	14	11	3	1,6
Dusky Nightjar	*Caprimulgus fraenatus*	1	2	6	1	1
White-rumped Swift	*Apus caffer*	4	9	11	3	1
Blue-naped Mousebird	*Urocolius macrourus*	18	42	63	15	1,5,6
Speckled Mousebird	*Colius striatus*	14	33	38	9	1,2,5,6
Hoopoe	*Upupa epops*	18	42	63	15	1,5,6
Black-billed Wood Hoopoe	*Phoeniculus somaliensis*	39	91	63	15	1,5,6
Abyssinian Scimitarbill	*Rhinopomastus minor*	18	42	38	9	1,2,6
Malachite Kingfisher	*Alcedo cristata*	1	2	2	0.4	7
Woodland Kingfisher	*Halcyon senegalensis*	3	7	4	0.9	1
Pied Kingfisher	*Ceryle rudis*	1	2	3	0.7	7

Rufous-crowned Roller	*Coracias naevia*	31	72	100	24	1,3,5
Lilac-breasted Roller	*Coracias caudata*	41	95	198	47	1,3,5
Little Bee-eater	*Merops pusillus*	31	72	119	28	1,2,5
Somali Ostrich	*Struthio molybdophanes*	5	12	14	3	1
Abyssinian Ground Hornbill	*Bucorvus abyssinicus*	18	42	84	20	1,3,6
Von der Decken's Hornbill	*Tockus deckeni*	40	93	222	53	1,2,3,4,5,6
Red-billed Hornbill	*Tockus erythrorhynchus*	43	100	373	89	1,2,3,4,5,6
African Grey Hornbill	*Tockus nasutus*	36	84	153	37	1,2,3,5,6
Eastern Yellow-billed Hornbill	*Tockus flavirostris*	23	53	95	23	1,2,5,6
Hemprich's Hornbill	*Tockus hemprichii*	6	14	17	4	1,2,4,6
Black Throated Barbet	*Bucorvus abyssinicus*	20	47	41	10	1,2,6
D'Arnaud's Barbet	*Trachyphonus darnaudii*	33	77	148	35	1,2,3,5
Red Fronted Barbet	*Tricholaema diademata*	2	5	4	1	1,5
Red and Yellow Barbet	*Trachyphonus erythrocephalus*	12	28	36	7	2,5,6
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*	2	5	4	0.9	4
Red-fronted Tinkerbird	*Pogoniulus pusillus*	15	35	40	10	1,2,3,4,6
Greater Honeyguide	*Indicator indicator*	4	9	7	2	3
Scaly-throated Honeyguide	*Indicator variegatus*	1	2	1	0.2	1
Nubian Woodpecker	*Campethera nubica*	40	93	206	49	1,2,3,4,5,6
Cardinal Woodpecker	*Dendropicos fuscescens*	13	30	28	7	1,3,6
Bearded Woodpecker	*Dendropicos namaquus*	14	33	27	6	1,2,3,5,6
Green-backed Woodpecker	*Campethera cailliautii*	2	5	6	1	1
Flappet Lark	*Mirafra rufocinnamomea*	1	2	2	1	1
Singing Bush lark	*Mirafra cantillans*	7	16	12	3	1,6
Fawn-coloured Lark	*Mirafa africanoides*	2	5	4	0.9	1
Red-winged Bush Lark	*Mirafra hypermetra*	1	2	2	0.4	1
Common House Martin	*Delichon urbicum*	1	2	1	0.2	6
Banded Martin	*Riparia cincta*	1	2	1	0.2	1
Rock Martin	*Hirundo fuligula*	2	5	3	0.7	2
Black saw-wing	*Psalidoprocne pristoptera*	7	16	14	3	1,6
White-tailed Swallow	*Hirundo megaensis*	31	72	171	41	1,2,3,5,6
Lesser striped Swallow	*Hirundo abyssinica*	3	7	13	3	1
Barn Swallow	*Hirundo rustica*	6	14	13	3	1,5
Ethiopian Swallow	*Hirundo aethiopica*	2	5	4	0.9	1
Grassland Pipit	*Anthus cinnamomeus*	4	9	9	2	1
Plain-backed Pipit	*Anthus leucophrys*	1	2	2	0.4	1
White-breasted Cuckoo-Shrike	*Coracina pectoralis*	1	2	1	0.2	4
Mouse-coloured Penduline Tit	*Anthoscopus musculus*	10	23	21	5	1,2,6
Northern Grey Tit	*Parus thruppi*	26	60	76	18	1,2,3,5
Scaly Babbler	*Turdoides squamulatus*	3	7	5	1	1,2,6
White-rumped Babbler	*Turdoides leucopygia*	8	19	16	4	1,4,6
Common Bulbul	*Pycnonotus barbatus*	38	88	139	33	1,2,3,4,5,6
Northern Brownbul	*Phyllastrephus strepitans*	3	7	4	0.9	4
Scaly Chatterer	*Turdoides aylmeri*	1	2	1	0.2	2
Rufous Chatter	*Turdoides rubiginosa*	20	47	42	10	1,3,5
Mountain Thrush	*Turdus abyssinicus*	3	7	11	3	4
Groundscraper Thrush	*Psophocichla litsipsirupa*	2	5	3	0.7	5
Spotted Palm-Thrush	*Cichladusa guttata*	2	5	3	0.7	6
African Thrush	*Turdus pelios*	4	9	5	1	1
Bare-eyed Thrush	*Turdus tephronotus*	1	2	1	0.2	1
White Browed Robin Chat	*Cossypha heuglini*	3	7	7	2	1,4
Common Nightingale	*Luscinia megarhynchos*	1	2	2	0.4	1
White-browed Scrub-Robin	*Cercotrichas leucophrys*	34	75	108	26	1,2,3,5,6
Brown-tailed Rock-Chat	*Cercomela scotrocerca*	1	2	2	0.4	5
Grey Wren-Warbler	*Calamonastes simplex*	23	53	53	13	1,2,3,5,6
Brown Woodland-Warbler	*Phylloscopus umbrovirens*	5	12	12	3	4

Willow Warbler	*Phylloscopus trochilus*	5	12	6	1	2
Banded Parisoma	*Parisoma boehmi*	19	44	38	9	1,2,3,5,6
Rattling Cisticola	*Cisticola chiniana*	30	70	120	29	1,2,3,5,6
Ashy Cisticola	*Cisticola cinereolus*	10	23	17	4	1,2,3,6
Tiny Cisticola	*Cisticola nana*	7	16	12	3	1
Yellow-breasted Apalis	*Apalis flavida*	40	93	202	48	1,2,6
Pale Prinia	*Prinia somalica*	7	16	13	3	1,2,5
Yellow-vented Eremomela	*Eremomela flavicrissalis*	1	2	2	0.4	1
Yellow-bellied Eremomela	*Eremomela icteropygialis*	20	47	61	15	1,2,3,5
Red-faced Crombec	*Sylvietta whytii*	19	44	38	9	1,2,3,6
Grey-backed Camaroptera	*Camaroptera brachyura*	40	93	249	60	1,2,3,4,5,6
African Grey Flycatcher	*Bradornis microrhynchus*	38	88	102	24	1,2,3,5,6
Pae Flycatcher	*Bradornis pallidus*	1	2	1	0.2	1
African Dusky Flycatcher	*Muscicapa adusta*	1	2	2	0.4	1
Northern Black Flycatcher	*Melaenornis edolioides*	8	19	16	9	1,2,6
African Paradise Flycatcher	*Terpsiphone viridis*	16	37	26	6	1,2,4,5
Pygmy Batis	*Batis perkeo*	1	2	2	0.4	1
Black-headed Batis	*Batis minor*	13	30	24	6	1,2,3,6
Grey-headed Batis	*Batis orientalis*	23	53	56	13	1,2,3,6
Taita Fiscal	*Lanius dorsalis*	8	19	16	4	1
Grey-backed Fiscal	*Lanius excubitoroides*	5	12	11	3	3,6
Somali Fiscal	*Lanius somalicus*	8	19	34	8	1
Northern White-crowned Shrike	*Eurocephalus ruepelli*	43	100	237	57	1,2,3,5,6
Northern Puffback	*Dryoscopus gambensis*	8	19	12	3	6
Pringle's Puffback	*Dryoscopus pringlii*	3	7	3	0.7	1
Black-crowned Tchagra	*Tchagra senegala*	3	7	4	0.9	1
Three-streaked Tchagra	*Tchagra jamesi*	7	16	13	3	1,2,3,6
Slate-coloured Boubou	*Laniarius funebris*	40	93	191	46	1,2,3,4,5,6
Tropical Boubou	*Laniarius aethiopicus*	11	26	38	9	1,4,6
Brubru	*Nilaus afer*	29	67	102	24	1,2,3,5,6
Rosy-patched Shrike	*Rhodophoneus cruentus*	43	100	296	71	1,2,3,4,5,6
Grey-headed Bush-Shrike	*Malaconotus blanchoti*	29	67	81	19	1,2,3,4,5,6
Sulphur-breasted Bush-Shrike	*Telophorus sulfureopectus*	16	37	40	10	1,2,3,4,6
Red-naped Bush-Shrike	*Laniarius ruficeps*	5	12	10	2	1,2
White Helmet-Shrike	*Prionops plumatus*	28	65	91	22	1,2,6
Fork Tailed Drongo	*Dicrurus adsimilis*	43	100	298	71	1,2,3,4,5,6
Eastern Black-headed Oriole	*Oriolus larvatus*	37	86	161	39	1,2,3,5,6
Ethiopian Bush Crow	*Zavattariornis stresmanni*	43	100	361	86	1,2,3,5,6
Pied Crow	*Corvus albus*	1	2	1	1	5
Cape Rook	*Corvus capensis*	9	21	12	3	5
Fan-tailed Raven	*Corvus rhipidurus*	39	91	168	40	1,2,4,5,6
Thick-billed Raven	*Corvus crassirostris*	18	42	47	11	5
Superb Starling	*Lamprotornis superbus*	43	100	417	99	1,2,3,5
White-crowned Starling	*Spreo albicapillus*	42	98	256	61	1,2,3,5,6
Ruppell's Glossy Starling	*Lamprotornis purpuropterus*	22	51	64	15	1,3,5,6
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	21	49	47	11	1,2,3,5,6
Red-winged Starling	*Onychognathus morio*	19	44	48	11	1,5
Golden-breasted Starling	*Lamprotornis regius*	25	58	67	16	1,2,6
Wattled Starling	*Creatophora cinerea*	13	30	43	10	3,5
Shelley's Starling	*Lamprotornis shelleyi*	21	49	54	13	1,2,5,6
Variable Sunbird	*Cinnyris venustus*	13	30	30	7	1,2,6
Marico Sunbird	*Cinnyris mariquensis*	37	86	140	33	1,2,3,5,6
Hunter's Sunbird	*Chalcomitra hunteri*	22	51	53	13	1,2,4
Shining Sunbird	*Cinnyris habessinicus*	3	7	3	0.7	1
Tacazze Sunbird	*Nectarinia tacazze*	2	5	4	0.9	1,4
Beautiful Sunbird	*Cinnyris pulchella*	2	5	3	0.7	5

Eastern Violet-backed Sunbird	*Anthreptes orientalis*	2	5	2	0.4	1
Olive Sunbird	*Cyanomitra olivacea*	1	2	2	0.4	1
Abyssinian White-eye	*Zosterops abyssinicus*	12	28	31	7	1,6
Montane White-eye	*Zosterops poliogaster*	1	2	3	0.7	4
Somali Sparrow	*Passer castanopterus*	1	2	2	0.4	5
Shelly's Rufous Sparrow	*Passer shellyi*	17	40	40	10	1
Swainson's Sparrow	*Passer swainsonii*	27	63	79	19	5
Chestnut Sparrow	*Passer eminibey*	4	9	5	1	1
Yellow-spotted Petronia	*Petronia pyrgita*	14	33	19	5	1,2,3,6
Cut-throat Finch	*Amadina fasciata*	11	26	21	5	1,3,5
White-billed Buffalo-Weaver	*Bubalornis albirostris*	3	7	5	1	1
White-headed Buffalo-Weaver	*Dinemellia dinemelli*	41	95	252	60	1,2,3,5,6
Red-billed Buffalo-Weaver	*Bubalornis niger*	40	93	184	44	1,2,3,5,6
White-browed Sparrow-Weaver	*Plocepasser mahali*	17	40	40	10	1,2,3,5
Donaldson-Smith's Sparrow-Weaver	*Plocepasser donaldsoni*	1	2	2	0.4	1
Black-capped Social-Weaver	*Pseudonigrita cabanisi*	23	53	86	21	1,5
Grey-headed Social-Weaver	*Pseudonigrita arnaudi*	40	93	206	49	1,2,3,5,6
Red-headed Weaver	*Anaplectes rubriceps*	7	16	19	5	6
Village Weaver	*Ploceus cucullatus*	3	7	3	1	1,5
Chestnut Weaver	*Ploceus rubiginosus*	8	19	15	4	1,2,3,6
Southern Masked Weaver	*Ploceus velatus*	12	28	25	6	1,2,3,5
Compact Weaver	*Pachyphantes superciliosus*	1	2	1	0.2	3
Lesser Masked Weaver	*Ploceus intermedius*	7	16	19	5	1
Spectacled Weaver	*Ploceus ocularis*	2	5	3	0.7	4
Red-billed Quelea	*Quelea quelea*	2	5	2	0.4	1,3
White-winged Widow Bird	*Euplectes albonotatus*	1	2	2	0.4	1
Green-winged Pytilia	*Pytilia melba*	3	7	8	2	1
Grey-headed Silverbill	*Odontospiza griseicapilla*	1	2	1	0.2	1
Red-cheeked Cordon-bleu	*Uraeginthus bengalus*	27	63	77	18	1,3,5,6
Purple Grenadier	*Granatina ianthinogaster*	36	84	103	26	1,2,5,6
Yellow-bellied Waxbill	*Coccopygia quartinia*	1	2	2	0.4	1
Black-cheeked Waxbill	*Estrildia erythronotos*	16	37	34	8	1,2
Straw-tailed Whydah	*Vidua fischeri*	31	72	61	15	1,5
Steel-blue Whydah	*Vidua hypocherina*	1	2	1	0.2	1
Pin-tailed Whydah	*Vidua macroura*	4	9	9	0.2	6
African Citril	*Serinus citrinelloides*	2	5	5	1	4
Northern-Grosbeak Canary	*Serinus donaldsoni*	4	9	8	2	1
White-bellied Canary	*Serinus dorsostriatus*	8	19	11	3	5
Reichard's Seedeater	*Serinus reichardi*	1	2	1	0.2	4
Reichenow's Seedeater	*Serinus reichenowi*	16	37	30	7	1,3,5
Golden-breasted Bunting	*Emberiza flaviventris*	1	2	1	0.2	1
Somali Bunting	*Emberiza poliopleura*	14	33	44	11	1,2,3

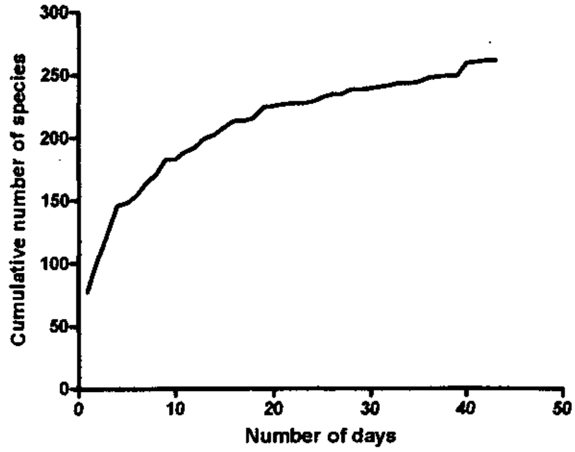


Figure 1 : Cumulative number of bird species observed during the 43 days of field work in the Yabelo Sanctuary and the surrounding areas.

Figure 2 : Ethiopian Bush Crow

Figure 3 : Ethiopian Bush Crow

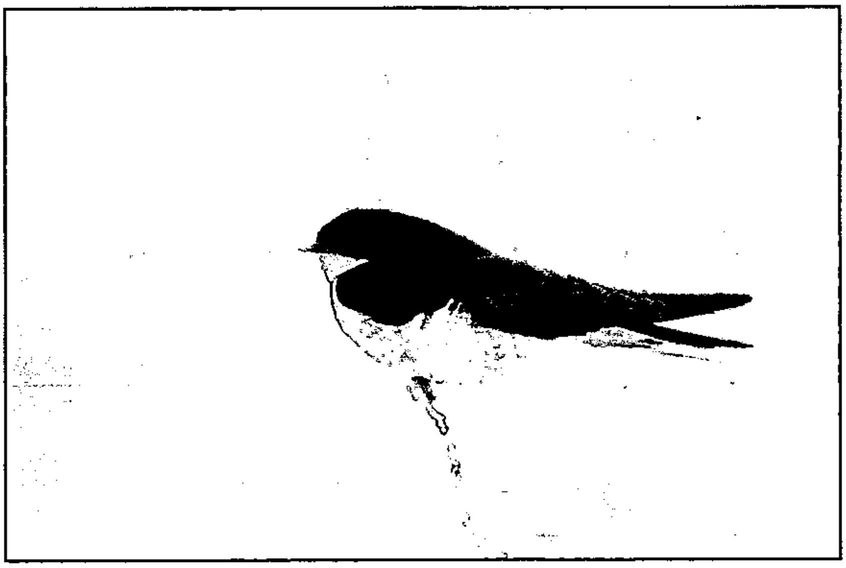


Figure 4 : White-tailed Swallow

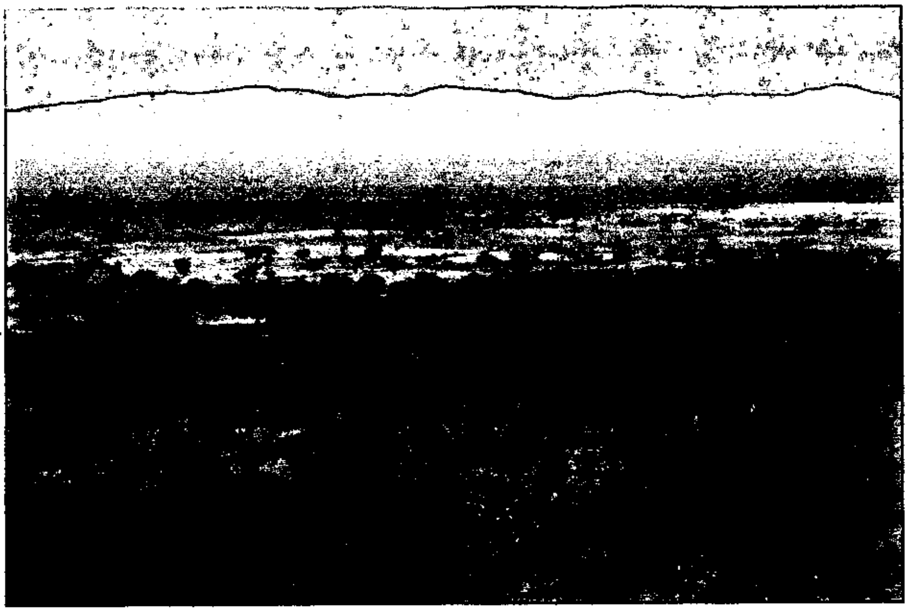


Figure 5 : Image of the typical habitat around the Yabelo region of southern Ethiopia. In the foreground the main trees are *Combretum* and *Terminalia* species whereas *Acacia* species dominate in the in the lowland areas in the middle distance. The density of *Acacia* trees vary from dense woodland to relatively open scrubland. In addition, there are small patches of farmland within the *Acacia* trees.

Status, distribution and habitat preference of two south Ethiopian endemics, the White-tailed Swallow *Hirundo megaensis* and Ethiopian Bush-crow *Zavattariornis stresemanni*

R.J. MELLANBY[1], B. ROSS[2], A. WATT[2], M. WONDAFRASH[3], M. EWNETU[4], C. BROADHURST[2], R. CRITCHLOW[2], A. DADESA[5], T. DEAS[2], C. ENAWGAW[4], B. GEBREMEDIHIN[6], E. GRAHAM[2], S. MACLEAN[2], M. MCKEAN[2], N.J. COLLAR[7] & C.N. SPOTTISWOODE[8]

[1] *Immunology Division, Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge, CB2 1QP, U.K.* Email: rjm69@cam.ac.uk

[2] *Project Yabelo, Institute of Biomedical Sciences, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, U.K.*

[3] *Ethiopian Wildlife and Natural History Society, P.O. Box 13303, Addis Ababa, Ethiopia.* Email: ewnhs.ble@ethionet.et

[4] *Ministry of Agriculture and Rural Development, Wildlife Conservation Department, PO Box 10-22-98, Addis Ababa, Ethiopia.*

[5] *Yabelo Wildlife Sanctuary, PO Box 34, Yabelo, Ethiopia.*

[6] *Institute of Biodiversity and Conservation, Addis Ababa, Ethiopia.*

[7] *BirdLife International, Wellbrook Court, Girton Road, Cambridge CB3 0NA, U.K.*, and *Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.* Email: nigel.collar@birdlife.org

[8] *Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.*, and *DST/NRF Centre of Excellence at the Percy FitzPatrick Institute, University of Cape Town, Rondebosch 7701, South Africa.* Email: cns26@cam.ac.uk

Please address correspondence to Claire Spottiswoode, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.,

Summary

The Yabelo–Mega region of southern Ethiopia's Borana zone is remarkable for the presence of two threatened endemic species with overlapping and highly restricted ranges, the White-tailed Swallow *Hirundo megaensis* (Vulnerable) and Ethiopian Bush-crow *Zavattariornis stresemanni* (Endangered). Concern about these species' conservation status has recently increased owing to rapid alterations to their thornbush savanna habitat. This six-week field study aimed to identify the specific habitat preferences of each species, with a view to understanding how they are likely to be affected by these changes, and to providing baseline quantitative abundance data using simple, standardised and repeatable methods. White-tailed Swallows were recorded on an overall 4.7% of transects and point counts, and in all habitats (including villages and farmland) except broadleaved *Combretum–Terminalia* woodland. The only consistent fine-scale predictor of their incidence was the degree of scrub cover, which tended to be lower where swallows were sighted. Bush-crows were recorded on an overall 16.6% of transects and point counts, and like swallows showed a strong preference for thornbush (*Acacia* and *Commiphora*) over broadleaved woodland, and were particularly frequent in the vicinity of villages. Bush-crows were more frequently encountered inside the nominally protected Yabelo Sanctuary, whereas the reverse was true for White-tailed Swallows. Recent concern about dramatic declines in Bush-crow numbers revealed by roadside counts may have been exacerbated by habitat alteration along roads alone, although the species clearly remains under immediate threat from habitat transformation through agricultural expansion, and overgrazing.

Introduction

The White-tailed Swallow *Hirundo megaensis* and Ethiopian Bush-crow *Zavattarionis stresemanni* are puzzlingly restricted to a small area of dry, bushed savanna between the towns of Yabelo, Mega and Arero in southern Ethiopia. They were respectively described in 1942 and 1939, and little has since been determined about their ecological requirements or sensitivity to human activities. Although concerns about habitat change within their tiny range have been expressed for some time (Collar & Stuart 1985, Ash & Gullick 1989, Hundessa 1991), the situation appears likely to have recently substantially worsened owing to a rapid human population influx and the expansion of commercial agriculture around the towns of Yabelo and Mega (Bassi 2002, Borghesio & Giannetti 2005, Gedeon 2006). Moreover, numbers of Ethiopian Bush-crows sighted on road-counts made in 1989, 1995 and 2003 were found to have dramatically declined (Borghesio & Giannetti 2005), causing the species's IUCN status to be changed from Vulnerable to Endangered (BirdLife International 2006).

A possible mechanism contributing to this decline was suggested by satellite imagery showing that over the past two decades there has been a marked increase in vegetation density within the Yabelo Sanctuary (Borghesio & Giannetti 2005). This large, nominally protected area was originally set up to conserve a population of the threatened Swayne's Hartebeest *Alcelaphus buselaphus swaynei*, but also lies in the core of both endemic bird species' ranges. The vegetation changes were speculatively attributed to bush encroachment within the sanctuary owing to overgrazing by Borana pastoralists, fire suppression on a large government-owned cattle ranch which also occupies a considerable portion of the sanctuary, and the disappearance of wild browsers (Borghesio & Giannetti 2005). Such changes are of concern as the Yabelo Sanctuary is the only designated protected area within these species' ranges, although it receives little to no active management and even its boundaries are ill-defined (EWNHS 2001).

The degree to which such large-scale landscape changes have and are likely in future to impact upon the populations of these two species is, however, unknown, as these species' precise habitat requirements are obscure. It has been observed that the White-tailed Swallow's range lies above the 1,500 m altitudinal contour (Collar & Stuart 1985), but no environmental correlate with this elevation is known. Availability of columnar termite mounds, in which the species has been suspected to breed (Benson 1946), may be another consideration, but the only confirmed breeding records come from houses (Holtam 1998). The Ethiopian Bush-crow, recently determined as phylogenetically closest to the Asian ground-jays *Podoces* (Ericson *et al.* 2005), has a noticeably patchy occurrence within its small range (Benson 1946), which may be related to a need for deep, loosely packed soils for foraging and/or to associations with human habitation (Gedeon 2006), but which is manifest by a tendency to select areas with more open terrain (Borghesio & Gianetti 2005).

The aim of this study was hence to assess the distribution, abundance and habitat preferences of the two species. Specifically, we sought to (i) assess the limits of their geographical ranges, (ii) provide, using a simple repeatable methodology, baseline quantitative data on their abundance, (iii) determine which broad-scale habitat types they favoured within the mosaic of different woodland types in the region, (iv) assess within habitat type which fine-scale vegetation characteristics were associated with their presence, (v) determine whether they occurred in association with termite mounds or human habitation (including buildings and livestock), and (vi) assess whether they were commoner inside or outside the Yabelo Sanctuary. We used simple, standardised methods (point counts and line transects, following Bibby *et al.* 2000) which can be easily replicated in future surveys, and which provide two independent estimates of abundance and habitat preference. Additionally, we conducted systematic interviews with local people to assess their view of the Ethiopian Bush-crow and any changes in its abundance.

Methods

Study area

Fieldwork in southern Ethiopia (see inset to Figure 1 for location of study region) was carried out between 15 July and 29 August 2005. This falls outside the breeding season of both the White-tailed Swallow (April-May, Holtam 1998) and the Ethiopian Bush-crow (about March-June, Benson 1946, Collar & Stuart 1985). It is acknowledged that this was not the ideal period, but was constrained by circumstance. Fieldwork was conducted both inside and outside of the Yabelo Sanctuary. The sanctuary's boundaries are ill-defined, but on the advice of the warden (A.D.), in this study we took it to lie between 05°12' and 04°37' N, and 38°09' and 38°35'E. The altitude of the sanctuary varies from 1430 m to 2000 m, and the annual rainfall is around 700 mm, with a principal rainy season between April and May and a smaller, less reliable one in October (EWNHS 1996, 2001). The commonest habitat inside the Yabelo Sanctuary is savanna woodland dominated by various species of thorny acacia (*Acacia tortilis*, *A. brevispica*, *A. horrida*, *A. drepanolobium*) and *Commiphora*, and broadleaved *Terminalia* and *Combretum* (Borghesio & Giannetti 2005). In addition, small patches of juniper (*Juniperus procera*) forest can be found in upland areas just outside the boundaries of the sanctuary, although grazing and logging threaten its persistence (Borghesio *et al.* 2004). The dominant land use is pastoralism by the Borana people, although agriculture has increased in recent years (EWNHS 1996, Borghesio & Giannetti 2005). Additionally, we searched for both study species farther afield along the roads to Moyale (south-east), Konso (west), Agere Maryam (north) and Arero (east) in a qualitative attempt to define its current geographical range limits. At least one day's searching was undertaken in each direction. Bush-crow nests are very conspicuous, and particular effort was made to search for these as an early indicator of the species's presence, and then to search for birds in their vicinity.

Point counts

We undertook a total of 521 systematic point counts. Locations were chosen by randomly selecting a position on a map, and then getting as close as possible to this location on available access roads and tracks. The first three point counts of each morning were taken at 500 m intervals on a bearing perpendicular to the access road, beginning 250 m away from the access track. The next two point counts were then taken at 500 m intervals on a bearing 90 degrees to the first three point counts, followed by two further point counts, if time allowed, on a bearing 90 degrees from the middle two point counts. Each point count was made by 3–6 observers, and a settling period of two minutes was observed before beginning each 15 minute census period. The number of each study species identified with certainty was recorded together with whether they were sighted inside or outside (to a maximum of 250 m) a 25 m radius of the centre of each point count at first detection (Bibby *et al.* 2000). In order to minimise the effect of time and weather conditions on bird detectabilty, point counts were undertaken only between 06h15 and 09h15, and not in unfavourable weather (strong wind or rain).

Line transects

We undertook a total of 789 line transects, grouped in clusters of about 9. Location of each cluster of transects was randomly selected using the same method as for point counts. Each transect segment was 500 m long, and clusters were composed of three groups of three, forming three sides of a rectangle. The start of the first line transect of each session was 250 m away from the access road, at a bearing perpendicular to it. Three line transects were then undertaken on the same bearing. A gap of 250 m on the same bearing was then allowed, before taking another three transects on a 90 degree bearing to the left. After another 250 m gap on the same bearing, a third segment of three transects was taken on a 90 degree bearing to the left of the second segment. Transects were generally carried out in mid-afternoon, and were walked at a constant rate of approximately 2.5 km/h. At every sighting of each study species, the number of individuals seen was recorded, together with the distance of each individual from the transect line at the first observation. We attempted never to record any individual twice, although inevitably this cannot be established with certainty in every case. The location and altitude of the start and finish of each 500 m transect was recorded using GPS.

Habitat assessment

Habitat variables were assessed for the area within a 25 m radius of the centre of each point count (variables 1–7), or midway along each transect (variables 1–6). For line transects, we additionally noted whether houses were present within 200 m of either side of the transect line, and counted the number of termite mounds present within 5 m of either side of the transect line, along its entire length. Habitat assessments were made independently by all observers within the group (N = 3–6), and the median then used in subsequent analyses.

The following variables were assessed. (1) *Habitat type*—one of the following categories: (a) Farmland: intensive agriculture (commonly maize, wheat and tef) (altitudinal range mainly 1,450–1,600 m a.s.l.); (b) *Commiphora* woodland/scrub: >50% *Commiphora* spp. (ca. 1,430–1,800 m a.s.l.); (c) Juniper woodland: >50% *Juniperus* spp. (altitudinal range ca. 1,900–2,100 m a.s.l.); (d) *Combretem–Terminalia* woodland/scrub: >50% *Combretum* and *Terminalia* spp. combined (1,350–1,750 m a.s.l.); (e) acacia woodland/scrub: >50% *Acacia* trees, with a variable amount of scrub (1,300–1,750 m a.s.l.); (f) Villages: three or more houses present within 50 m of the centre of the point count. (2) *Bare earth*; % visible. (3) *Scrub cover*; % ground cover by woody vegetation without a single trunk and with a minimum height of 50 cm. (4) *Sward height*; the average height of grasses. (5) *Canopy cover*; % tree canopy. (6) *Number of trees*; with trees defined as vegetation with a single or double woody trunk at breast height. Trees less than and greater than 6 m in height were counted separately. (7) *Number of termite mounds*.

In addition, we recorded time, altitude and GPS coordinates, and whether the site lay inside or outside of the Yabelo Sanctuary boundaries (this last information was only recorded when A.D. was confident of position in relation to the boundaries). On the basis of the number of point counts or transects carried out in each habitat type, the sampled area comprised approximately 60% *Acacia* woodland, 20% *Commiphora* woodland, 10% *Combretum–Terminalia* woodland, 7% farmland and 3% villages.

Opportunistic sightings

We also recorded all sightings of each study species outside the time spent undertaking point counts and line transects. On each occasion, we recorded the number of individuals concerned and their activity, as well as the habitat type (see above) within a 25 m radius from the location of the initial sighting, and whether or not any houses were present within a 250 m radius of the initial sighting.

Assessment of attitudes of local people towards the bush-crow

Interviews with representatives from villages inside and outside the Yabelo Sanctuary were undertaken throughout the eight-week study period. In an effort to gather information from a broad geographical area and to avoid pseudoreplication, only one interview was undertaken in each village. Representatives from each village were randomly selected and ranged from young females looking after their family to male village elders. After introducing ourselves and describing the background to the project, we asked for permission to conduct a brief, verbal semi-structured interview. The standardised interview consisted of a series of questions and an opportunity was given at the end of the interview for the respondent to offer their own additional comments. The interview was conducted in Borana by A.D., who then translated the answers to Amharic to an interpreter who subsequently translated the responses into English.

Statistical analyses

We assumed that all point counts and line transects were statistically independent, thus ignoring any spatial clustering, but results (not shown) were similar when using the means of each cluster of counts or transects as data points. When the response variable was binary (presence/absence of species), we used general linear models (GLMs), with binary error structure and a logit link function (Crawley 2002), or with normal error distributions when the response variable was continuous (sighting distances). When the predictor was discrete (e.g. inside or outside the Yabelo Sanctuary), the statistical significance was tested using chi-squared tests. Percentage cover of bare earth, scrub, and canopy were arcsine square-root transformed before analysis, and distance of sightings from the transect line were log-transformed. We used GLMs to explore the relative importance of different fine-scale predictors of bush-crow incidence, because for this species there were many such possible predictors. Statistical analyses were carried out in the R environment (R Development Core Team 2006).

Results

White-tailed Swallow

Overall incidence and group size

During 43 days of fieldwork, we recorded White-tailed Swallows on a total of 100 occasions (comprising 168 individual birds); all are plotted in Figure 1. Of these, 25 were during point counts, 36 were during line transects, and 39 were opportunistic (neither). Swallows were usually sighted singly, but occasionally in groups of up to 6 individuals (mean group size of 39 opportunistic sightings = 1.6 individuals).

Geographical and altitudinal range

The geographical range limits at which White-tailed Swallows were recorded during the survey were as follows: northern extreme: 05°07′59″N 38°17′01.5″E, 18 km north of Yabelo on the road to Agere Maryam; southern extreme: 03°52′22.7″N 38°40′17.1″E, 49 km south-east of Mega on the road to Moyale; eastern extreme: 04°44′17.3″N 38°40′47.5″E, 55 km east-south-east of Yabelo on the road to Arero; western: 04°57′04.3″N 38°08′13.7″E, 7 km north-east of Yabelo. No White-tailed Swallows were seen between each of these points and (respectively) Agere Maryam, Moyale, Arero, Yabelo or along the road towards Konso, in spite of at least one day's observation in each case. The altitudinal range at which White-tailed Swallows were recorded was 1,319–1,763 m (mean 1,523 m, of 99 sightings with altitudinal data).

Broad-scale habitat use

White-tailed Swallows were sighted on 25 of 521 point-counts, and on 37 of 789 line transects (see Figure 2 for locations of the latter). The probability of encountering at least one swallow on a given point-count or transect, according to broad-scale habitat type, is shown in Figure 3 (note that sample sizes of transects in juniper woodland and villages were too small – 7 and 2 respectively – to allow proportions to be calculated with any accuracy). In spite of the broad confidence intervals necessitated by the relatively rare incidence of sightings, it is clear that swallows were most frequently sighted in the two types of thornbush habitat (*Acacia* and *Commiphora*), and in man-modified habitats (farmland and villages). They were never recorded in broad-leaved *Combretum–Terminalia* woodland, and were scarce in *Juniperus* woodland.

To investigate whether these differences are likely to be real or influenced by variation in detectability among habitat types, we examined the maximum distance at which bush-crows were first cited per transect. This was noted only for line transects. Swallows were sighted at distances of up to an estimated 120 m from the transect line (mean 33 m). Among those three habitats in which White-tailed Swallows *were* recorded (see Figure 3B), there were no significant differences in the distances at which individuals were first sighted (R^2 = 0.014, $F_{2,33}$ = 0.23, P = 0.80). This suggests that variation in sighting probability among habitats is unlikely to be an artefact of detectability.

The absence of swallows from broadleaved *Combretum–Terminalia* woodland is unlikely to be related to the absence of termite mounds or buildings, as the number of termite mounds along transects and point counts did not differ between this woodland type and the two types of thornveld (transects: $F_{1,728}$ = 0.092, P = 0.76; point counts: $F_{1,389}$ = 0.706, P = 0.40), and nor did the presence or absence of houses (transects: $F_{1,554}$ = 3,41, P = 0.065; no data for point counts).

Of the 39 opportunistic sightings of White-tailed Swallows, 26 were in *Acacia* woodland, 6 in *Commiphora* woodland, 4 in villages, 2 in farmland and one over open water. On all but one occasion the birds were observed in flight. Houses were present within 250 m in 15 of 37 sightings.

Fine-scale habitat use

We analysed finer-scale predictors of swallow incidence for the transects and point counts made in *Acacia* woodland only, because this was the habitat type with the largest sample size. It would be inappropriate to pool all habitat types in such an analysis, because they may differ qualitatively in ways that are not related to the fine-scale measures we quantified. For example, swallows were completely absent from broadleaved *Combretum–Terminalia* woodland (see above), in spite of its structural similarity to *Acacia* woodland.

Summary statistics for each *Acacia* habitat characteristic along transects and during point counts where White-tailed Swallows were sighted, and those where they were not, are given in Table 1. There were few consistent predictors of White-tailed Swallow incidence. The strongest pattern was for scrub cover, which tended to be lower both along transects and during point counts where swallows were sighted, compared to those where they were not (Figure 4). There was also a trend for tree cover to be sparser on transects where swallows were sighted. None of the other habitat variables listed above was related to White-tailed Swallow incidence, when examined either in a bivariate manner (Table 1) or in a multivariate GLM (results not shown). A pattern that could not be revealed by the habitat characteristics we measured was the swallows' apparent preference for low-lying, open river valleys.

Does the Yabelo Sanctuary affect abundance?

Relative numbers of encounters inside and outside of the putative borders of the Yabelo Sanctuary, for each of the two thornbush woodland types, are reported in Table 3. White-tailed Swallows tended to be more frequently sighted outside the sanctuary than inside it, although these differences were only statistically significant for line transects in *Acacia* woodland, and point counts in *Commiphora* woodland.

Ethiopian Bush-crow

Geographical and altitudinal range

The geographical range limits at which Ethiopian Bush-crows were recorded during the survey were as follows: northern extreme: 05°07'34.8"N 38°18'21.3"E, 22 km north-east of Yabelo near the road to Agere Maryam (near the village of Surupa); southern and eastern extreme: 03°52'23"N 38°40'17"E, 49 km south-east of Mega on the road to Moyale; eastern extreme on the road to Arero: 04°47'50.4"N 38°32'31.3"E, 50 km from Yabelo; western extreme: 04°53'14.5"N 38°06'52.7"E, 1 km east of Yabelo on the road to Konso. No bush-crows were seen between each of these points and (respectively) Agere Maryam, Moyale, Arero and Yabelo or on the road towards Konso, in spite of at least one day's observation in each case. The altitudinal range at which bush-crows were recorded was 1,303–1,784 m (mean 1,541 m, of 214 sightings with altitudinal data).

Broad-scale habitat use

Ethiopian Bush-crows were observed in 116 of 521 point counts (22.3%) and 101 of 790 line transects (12.8%) (latter plotted in Figure 5). They were recorded in all of the main habitats found in the Yabelo region with the exception of juniper forest, and were scarce in broadleaved *Combretum–Terminalia* woodland (Figure 6; note that sample sizes of transects in juniper woodland and villages were too small – 7 and 2 respectively – to allow proportions to be calculated with any accuracy). Of the two thornveld woodland types, in both point counts and line transects bush-crows were slightly more commonly encountered in *Commiphora* than in *Acacia* woodland. Bush-crows were strongly associated with human habitation, as shown by their being recorded on three-quarters of all point counts in villages, and were also not uncommonly seen in farmland. Note that the lack of transect data for villages is simply because transects were too long to be conducted exclusively in villages; bush-crow incidence in relation to the presence of human habitation near transects is reported below.

To investigate whether these differences are likely to be real or influenced by variation in detectability among habitat types, we examined the maximum distance at which bush-crows were first sighted per transect. This was noted only for line transects. Bush-crows were sighted at distances of up to an estimated 200 m from the transect line, but the mean distance was 50 m. Among those three habitats in which bush-crows *were* recorded (see Figure 6B), there were no significant differences in the distances at which individuals were first sighted ($R^2 = 0.017$, $F_{2,99} = 0.83$, $P = 0.44$). This suggests that variation in sighting probability among habitats is unlikely to be an artefact of detectability.

Fine-scale habitat use

We analysed finer-scale predictors of bush-crow incidence for the transects and point counts made in *Acacia* woodland only, as for swallows. Summary statistics for *Acacia* habitat characteristics are given in Table 2. Scrub and canopy cover was sparser, grass height was lower, and there tended to be less bare earth present where bush-crows were sighted compared to where they were not, but of these there were statistically significant bivariate differences only in the case of the first two (Figure 7). However, because these several potential predictors of bush-crow incidence could be inter-related, a multivariate approach was necessary. GLMs revealed that, when all possible predictors were considered simultaneously, the only statistically significant predictors of bush-crow incidence along transect lines were low scrub cover (slope ±SE = -0.06 ±0.02, $Z = -3.44$, $P < 0.001$), and the presence of houses (slope ±SE = 1.09 ±0.34, $Z = 3.19$, $P = 0.001$). During point counts, by contrast, predictors were limited areas of bare earth (slope ±SE = -0.03 ±0.01, $Z = -3.29$, $P < 0.001$), low sward height (slope ±SE = -0.03 ±0.01, $Z = -2.63$, $P = 0.009$), and few trees over the height of 6 m (slope ±SE = -0.18 ±0.09, $Z = 0.09$, $P = 0.036$).

Attitudes of local people towards the Ethiopian Bush-crow

Sixty villages were visited and interviews were undertaken with a representative from each village. Permission to undertake an interview was granted by everyone who was approached. Forty-seven of the 60 respondents were able to recognise the Ethiopian Bush-crow from a choice of pictures from a field guide. This subset was then asked if its population had increased, decreased or stayed the same over the past 20 years: 66% stated the population had increased, 15% that it had decreased, 13% that it had stayed the same, and 6% had no opinion. The species's habitat was given as *Acacia* scrub (34% of respondents), villages and *Acacia* scrub (32%), farmland (11%), open and grazed areas (11%), farmland and villages (4%), open forest (2%), farmland and *Acacia* (2%), villages (2%) and unknown (2%). Of the 58 people who replied to the question 'Are you aware of the limited range of the Ethiopian Bush-Crow?', 69% stated that they were unaware, and 31% stated that they were aware.

Does the Yabelo Sanctuary affect abundance?

Relative numbers of encounters inside and outside of the putative borders of the Yabelo Sanctuary, for each of the two thornbush woodland types, are reported in Table 3. Bush-crows, by contrast to White-tailed Swallows, tended to be more frequently encountered inside the sanctuary than outside it: there was a significant such difference for point counts in *Acacia* woodland, and for line transects in *Commiphora* woodland. Note that owing to the number of tests involved, there is an elevated risk of obtaining statistically significant results by chance; if sequential Bonferroni correction for multiple testing (Rice 1989) were applied to these results, only the last-mentioned would remain statistically significant ($P = 0.024$).

Discussion

Geographical range: comparison with previous studies

The geographical limits found in this study for both species largely confirmed previous reports (Benson 1942, Collar & Stuart 1985, Ash & Gullick 1989, Syvertsen & Dellelegn 1991), although some minor differences were found. We saw no White-tailed Swallows as far north as Benson did in 1942 (18 km *vs* 50 km north of Yabelo), but we found them at a similar distance south (49 km *vs* 50 km south-east of Mega). The latter site was also our south-easterly limit for Bush-crows, which to the best of our knowledge is an extension of about 24 km from the previously known range (Collar & Stuart 1985). Since the present study, White-tailed Swallows have been sighted on several occasions in the Negele area, about 120 km north-east of the previously known range (Gabremichael *et al.* MS). There is clearly now a need to survey the Negele area and to search for any intermediate populations.

Habitat preference

Because this survey was conducted during the non-breeding season, it is possible that the habitat preferences we detected may not apply at the most critical times of year. This is perhaps most likely to be a concern for the White-tailed Swallow, some sightings of which may have been of birds in transit between foraging areas, rather than indicating any consistent habitat choice.

However, certain strong habitat preference did emerge during the non-breeding season. The Yabelo-Mega area contains a mosaic of woodland types, with *Juniperus* and *Combretum–Terminalia* largely occurring at higher altitudes, and *Acacia* and *Commiphora* generally at lower ones, but with much interdigitation and patchiness. The incidence of both study species was similarly patchy, and depended on additional factors at a finer scale. Both species entirely avoided broadleaved *Combretum–Terminalia* woodland, as well as (not unexpectedly) *Juniperus* woodland/forest, and were most frequently sighted in the two thornbush woodland types (respectively dominated by *Acacia* and *Commiphora* spp.), as well as in farmland and around villages.

The possibility that differences in visibility between habitats generated the observed patterns can probably be excluded, because there was no difference among habitats in the maximum distance at which swallows were sighted. Moreover, swallows are aerial foragers and bush-crows are gregarious and vocal, suggesting that they were unlikely to have been systematically overlooked. The reasons why both species avoid *Combretum–Terminalia* woodland remain unknown, although differences in habitat structure, and for bush-crows substrate (given that they prefer loose rather than stony soil for foraging: Gedeon 2006) are possibilities. Although *Combretum–Terminalia* was not a strikingly more occluded habitat in terms of tree numbers, scrub cover was higher than in the two thornveld types (mean±SE = 25.2±1.9%, vs. 16.7±0.6 and 18.4±1.0 for *Acacia* and *Commiphora* respectively), as was canopy cover (mean±SE = 14.0±1.3%, vs. 7.9±0.4 and 4.3±0.7 respectively), which might well help account for their avoidance of it.

Within the most extensively sampled woodland type where they *were* observed (*Acacia* woodland), for both species the most consistent fine-scale predictor of their occurrence was the density of scrub. White-tailed Swallows were more likely to be recorded in areas with low scrub cover (Figure 3), and there was also a strong trend for sightings to be more frequent in areas with fewer trees. This pattern was well supported by both transect and point data, which were collected independently and at different times of day, suggesting that it is likely to be robust. Similarly, bush-crows were more likely to be recorded where scrub cover was relatively low, although other predictors associated with open areas and human habitation also emerged, the former lending support to the broader-scale observations of Borghesio & Gianetti (2005). Although one of the most distinctive features of the landscape in the Yabelo-Mega region is its abundance of tall, columnar termite mounds, we found no particular association between them and either species's incidence. However, it is possible that swallows may associate more strongly with them during the breeding season if, as suspected by Benson (1946), they are used as nesting sites.

A predictor of bush-crow occurrence that did not strongly emerge from these quantitative analyses was the presence of tall trees. This may be because of the scale of our methods, or because of seasonal effects; yet it seems difficult to deny their importance. The canopies of tall *Acacia* trees are used as nest sites by bush-crows, at a height of 2.5–10 m from the ground (Gedeon 2006), as well as often providing shade for Borana villages; we discuss this association in more detail below.

Use of man-modified habitats

Both species were largely tolerant of or appeared actively to prefer heavily man-modified habitats. White-tailed Swallows were most commonly observed in villages during point counts (Figure 2A), and in farmland on line transects (Figure 2B). Farmland might provide an open habitat favourable for foraging, and areas around human habitation might have higher food availability owing to the presence of flies attracted by domestic livestock. Away from villages we found no particular association between swallows and buildings, although these may turn out to be important determinants of its occurrence when breeding.

Bush-crows showed an even stronger association with human habitation. They were observed during nearly 70% of point counts made in villages, and during transects in *Acacia* habitat there was a positive association between the presence of bush-crows and presence of houses near the transect line. Furthermore, bush-crows were observed in 18% of point counts and in 6% of line transects in farmland habitat. Here too the mechanism may be food availability, since the loose soil of ploughed areas was favoured for foraging, and another common foraging method involved lifting livestock dung to pick at larvae beneath it (Gedeon 2006, pers. obs.). Tall trees were also favoured as sites for villages owing to the shade they provide, as well as being favoured as nesting sites for bush-crows (nests are also used for roosting, Gedeon 2006). This may also be an important mechanism behind the association between bush-crows and humans.

Is the Yabelo Sanctuary serving to protect either species?

White-tailed Swallows tended to be less common inside the sanctuary's nominal borders than outside, whereas the opposite was true for Ethiopian Bush-crows. This result was not consistently strong across habitats (*Acacia vs Commiphora* woodland) and methods (point counts *vs* transects), but statistically significant differences in incidence were found in two of four tests for each species. It is difficult to infer what factors might be responsible, since the same data were used to estimate each species's habitat preference, and in the multivarate analyses we could not detect an effect of sanctuary occurrence independent of the other habitat variables investigated. At the very least, however, our results could be interpreted to suggest that the vegetation changes that have differentially affected the Yabelo Sanctuary in recent years (Borghesio & Gianetti, 2005) have not had a disproportionately dire impact on bush-crows within it, although they may have affected White-tailed Swallows.

What habitat differences currently exist between the sanctuary and outlying areas? During this survey we found that tree number and canopy cover in *Acacia* woodland within the sanctuary were higher, and that scrub cover within *Commiphora* woodland was lower (Mellanby *et al.* unpubl. data), which broadly echoes Borghesio & Gianetti's (2005) findings based on remotely sensed data. This was also consistent with the opinion of 75% of local Borana inhabitants interviewed, who considered that there had been a decrease in available grazing in recent years (Mellanby *et al.*, in prep.). It is unclear why such differences between land inside and outside the Yabelo Sanctuary should have developed, given that there is seemingly no enforcement of sanctuary regulations, and evidence of overgrazing (such as bare earth and rill and gully erosion) was commonplace on either side of its assumed borders; Borghesio & Gianetti (2005) suggested that fire suppression may have played a role.

Has either species changed in abundance?

Any trend in the population size of the White-tailed Swallow is hard to assess given the absence of preceding surveys, although there are some qualitative indications that the population density could be lower than in previous reports. During the 43 days of fieldwork involved in this study, comprising over 3,500 observer hours, White-tailed Swallows were sighted on 100 separate occasions, comprising 168 individuals – or about one sighting per 35 hours of observation, admittedly not all in appropriate habitat. This can be compared with an assessment that the bird was 'common' in 1941 (Benson 1942), and with a report of 15–20 White-tailed Swallows per day along the 60 km road from Yabelo to Mega in 1971 (Collar & Stuart 1985), and 14 individuals along a 35 km section of this road in 1989 (Ash & Gullick 1989). There is hence some indication, albeit very anecdotal, that the species might now be rarer than it once was. The standardised and straightforward census reported in this study could be repeated in future to allow a quantitative assessment of any population trend. However, we must emphasise that our survey took place during the non-breeding season, and local densities may differ when the species is nesting. Although we currently have no information about post-breeding dispersal, recent sightings of White-tailed Swallows accompanied by immatures from near Negele (Gabremichael *et al.* MS), 120 km to the north-east of the study area, may provide an indication that the species might not be as sedentary or range-restricted as previously thought.

The Ethiopian Bush-crow was recently uplisted from Vulnerable to Endangered (BirdLife International 2006), on the basis of an 80% decline in the species's density implied by roadside counts performed over a two-decade period (Borghesio & Gianetti 2005). While the occurrence of habitat change in large parts of the species's range is beyond doubt (Bassi 2002, Borghesio & Gianetti 2005, Gedeon 2006), the conclusions possible from comparing roadside counts over a period of time are more questionable. Roadside habitats are vulnerable to change, particularly transformation into farmland, but also erosion and overgrazing as they are used as routes to move large numbers of livestock. Changes in population density along roads may therefore not reflect the species's entire range. Although qualitative, it is also interesting to note that two-thirds of local farmers and/or herders we interviewed considered that the bush-crow's population had increased, and only a minority thought it had decreased. Repeated robust censuses over its entire range would be very helpful to detect any change in the species's abundance. We are reluctant to use the quantative data gathered in this study to extrapolate to any absolute population estimates, owing to the evidently patchy and specific nature of their preferred habitat within its broader range, combined with a lack of information on this habitat's incidence beyond those areas accessible from roads and tracks.

Conservation prospects

The past decade has seen a considerable increase in human population and dramatic changes in land use in the Yabelo region, specifically the expansion of commercial agriculture (reviewed by Bassi 2002), and this trend seems likely to continue. Do this study's findings shed light on the resilience of White-tailed Swallow and Ethiopian Bush-crow in the face of such changes? We found that White-tailed Swallows were, at worst, no less common around habitation and cultivation than outside it, suggesting that the species may be tolerant of a degree of human-induced environmental change within its range. Habitat use might, however, differ seasonally, and a survey during the breeding season would reveal more about the species's critical habitat requirements for nesting and foraging. Such evidence as is available suggests nonetheless that while the White-tailed Swallow is tolerant of human land use, it remains scarce and local, and deserves monitoring.

Ethiopian Bush-crows appeared actively to prefer a level of human land use. Specifically, they seem to be attracted to Borana pastoralist villages owing to the presence there of tall *Acacia* trees and livestock, and actively feed in adjacent ploughed fields. However, this gives no grounds for optimism concerning the species's likely prospects in the face of human population increase around Yabelo, as the expansion of commercial agriculture involves clearance of tall trees, which is currently occurring on a substantial scale (Bassi 2002, Gedeon 2006). Concomitantly, it seems probable that the dense bushlands avoided by this species will continue to increase at the expense of more open savannas, given the lack of native ungulates and intensity of cattle grazing both inside and outside of the Yabelo Sanctuary. Hence, the patches of habitat favoured by the Ethiopian Bush-crow, characterised by short grass, a low density of bushes, presence of tall trees, and loosely packed soil (this study; also Gedeon 2006) seem likely to diminish in the near future. Although the species's population decline in recent years may not have been as dramatic as feared by Borghesio & Gianetti (2005), we recommend that the species retain its current IUCN threat status of Endangered, and continue to receive close monitoring.

Although the majority of local people were able to identify the bush-crow, few were aware of its limited geographical range. As conservation slowly rises up the political agenda in Ethiopia, opportunities should be sought to develop park management plans and a community-based approach to conservation as seen in other areas (Jacobs & Schloeder 2001) that will result in desired habitat management. At the same time, and in order to inform conservation and management decisions, there is a clear need to monitor changes in the population density and distribution of the White-tailed Swallow and Ethiopian Bush-crow and changes to their habitats, as well as more detailed and precise ecological studies in order to determine their requirements. We strongly encourage further surveys, based at least in part on the methods presented in this paper, to examine how White-tailed Swallows and Ethiopian Bush-crows are responding to environmental change in the Yabelo region over time.

Acknowledgements

We are very grateful to the BP Conservation Awards, University of Glasgow, Carnegie Trust, People's Trust for Endangered Species, Royal Geographical Society, Percy Sladen Memorial Fund, African Bird Club, Glasgow Natural History Society and Edinburgh Trust for financial support this project. NJC and CNS's contribution was supported by Julian Francis and BirdLife International. We are also very grateful to Luca Borghesio, John Ash and Per Ole Syvertsen for their excellent advice and guidance during the development of the project, to Suhel Quader for statistical advice, and to all the local guides and drivers involved in the fieldwork. The project would not have been possible without initial assistance from Yilma Dellelegn Abebe, to whom we are very grateful.

References

Ash, J. S. & Gullick, T. M. (1989) The present situation regarding the endemic breeding birds of Ethiopia. *Scopus* 13: 90-96.

Bassi, M. (2002) The making of unsustainable livelihoods: an ongoing tragedy in the Ethiopian drylands. *Policy Matters* 10: 7-12.

Benson, C. W. (1942) A new species and ten new races from southern Abyssinia. *Bull. Brit. Orn. Club* 63: 8-19.

Benson, C. W. (1946) Notes on the birds of southern Abyssinia. *Ibis* 88:287-306.

Bibby, C. J., Burgess, N. D., Hill, D. A. & Mustoe, S. H. (2000) *Bird census techniques*. London: Academic Press.

BirdLife International (2006) Species factsheet: *Hirundo megaensis*. Downloaded from http://www.birdlife.org on 13/07/2006.

Borghesio, L., Giannetti, F., Ndang'ang'a K. & Shimelis, A. (2004) The present conservation status of *Juniperus* woodland in the South Ethiopian Endemic Bird Areas. *African J. Ecol.* 42: 137-143.

Borghesio, L. & Giannetti, F. (2005) Habitat degradation threatens the survival of the Ethiopian bush crow *Zavattariornis stresemanni*. *Oryx* 39: 44-49.

Catry, P., Mellanby, R. J., Sulieman, S., Anderson, N., Armitage, M., Constant, G., Heaney, V., Hughes, M. & McKean, M. (2000) Habitat selection by terrestrial birds on Pemba Island (Tanzania) with particular reference to six endemic taxa. *Biol. Conserv.* 95: 259-267.

Collar, N. J. & Stuart, S. N. (1985) *Threatened birds of Africa and related islands*. Cambridge, U.K.: International Council for Bird Preservation.

Crawley, M. J. (2002) *Statistical computing: an introduction to data analysis using S-Plus*. Chichester: John Wiley & Sons.

EWNHS (1996) *Important Bird Areas of Ethiopia*. Addis Ababa: Ethiopian Wildlife and Natural History Society.

EWNHS (2001) Ethiopia. In L. D. C. Fishpool and M. I. Evans, eds: *Important Bird Areas in Africa and associated islands: priority sites for conservation*. Newbury and Cambridge, UK: Pisces Publications and BirdLife International (BirdLife Conservation Series No. 11).

Gabremichael, M. N., Fishpool, L., Forsyth, E., Lewis, A., Pain, D., Thomas, R. & Spottiswoode, C. MS. Occurrence of the White-tailed Swallow *Hirundo megaensis* near Negele, Ethiopia.

Gedeon, K. (2006) Observations on the biology of the Ethiopian Bush Crow. *Bull. African Bird Club* 13: 178-188.

Holtam, J. (1998) Nesting of the White-tailed Swallow *Hirundo megaensis*. *Scopus* 20: 58-60.

Hundessa, T. (1991) Survival status review of the Ethiopian bush crow (*Zavattariornis stresemanni* Moltoni, 1938) in the Borana area, Ethiopia. *Walia* 13: 9-13.

R Development Core Team (2006) *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Rice, W. R. (1989) Analyzing tables of statistical tests. *Evolution* 43: 223-225.

Stattersfield, A. J., Crosby, M. J., Long, A. J. & Wege, D. C. (1998) *Endemic Bird Areas of the World*. Cambridge, U.K.: BirdLife International.

Syvertsen, P. O. & Dellelegn, Y. (1991) The status of some bird species endemic to south Ethiopia. *Scopus* 15: 30-34.

Venables, W. N. & Ripley, B. D. (2002) *Modern applied statistics with S*. New York: Springer-Verlag.

Zar, J.H. (1996) *Biostatistical analysis*. Upper Saddle River, N.J.: Prentice-Hall Inc.

Table 1. *Acacia* woodland habitat characteristics (means ±SE) along line transects where White-tailed Swallows were present ($N = 23$) or absent ($N = 501$), and during point counts where they were present ($N = 15$) or absent ($N = 265$).

	Transects		Point counts	
Habitat characteristic	Swallow recorded	Swallow not recorded	Swallow recorded	Swallow not recorded
Bare earth (%)	32.1 ±4.1	30.1 ±0.9	24.5 ±4.9	27.7 ±1.2
Scrub cover (%)	10.6 ±2.6	16.9 ±0.6	7.9 ±3.0	15.5 ±0.7
Sward height (cm)	12.1 ±2.3	11.5 ±0.5	18.4 ±3.9	15.8 ±0.9
Canopy cover (%)	3.7 ±1.8	8.1 ±0.4	4.6 ±2.4 [1]	8.7 ±0.6 [2]
Number of trees < 6 m high	14.0 ±5.2	20.7 ±1.1	21.9 ±6.2	21.9 ±1.5
Number of trees > 6 m high	0.52 ±0.77	1.87 ±0.17	0.60 ±0.60	1.55 ±0.14
Number of termite mounds	1.6 ±0.4	1.6 ±0.1	0.14 ±0.17 [1]	0.41 ±0.04 [3]

[1] Sample size was 14; [2] sample size was 250; [3] sample size was 254.

Table 2. *Acacia* woodland habitat characteristics (means ±SE) along line transects where Ethiopian Bush-crows were present ($N = 65$) or absent ($N = 459$), and during point counts where they were present ($N = 62$) or absent ($N = 218$).

	Transects		Point counts	
Habitat characteristic	Bush-crow recorded	Bush-crow not recorded	Bush-crow recorded	Bush-crow not recorded
Bare earth (%)	29.3 ±2.3	30.3 ± 0.9	23.4 ± 2.1	28.7 ± 1.3
Scrub cover (%)	11.0 ± 1.0	17.5 ± 0.6	13.7 ± 1.7	15.5 ± 0.8
Sward height (cm)	9.6 ± 1.1	11.8 ± 0.5	13.5 ± 1.7	16.7 ± 1.1
Canopy cover (%)	5.5 ± 1.0	8.2 ± 0.4	6.4 ± 0.9 [3]	9.0 ± 0.7 [1]
Number of trees < 6 m high	15.8 ± 2.4	21.0 ± 1.2	23.7 ± 3.2	21.4 ± 1.6
Number of trees > 6 m high	1.5 ± 0.5	1.8 ± 0.2	1.1 ± 0.2	1.6 ± 0.2
Number of termite mounds	1.9 ± 0.2	1.5 ± 0.1	0.1 ± 0.1 [3]	0.4 ± 0.0 [2]

[1] Sample size was 212 ; [2] sample size was 216; [3] sample size was 52.

Table 3. Sightings of each species inside and outside the boundaries of Yabelo Sanctuary (YS) in each kind of thornbush habitat during point counts and line transects.

	Acacia				*Commiphora*			
	Point counts		Line transects		Point counts		Line transects	
	Present	Absent	Present	Absent	Present	Absent	Present	Absent
White-tailed Swallow:								
Inside YS	7	171	7	261	0	39	6	74
Outside YS	8	87	14	171	5	40	2	58
	$P = 0.13$		$P = 0.015$		$P = 0.011$		$P = 0.28$	
Ethiopian Bush-crow:								
Inside YS	48	130	33	235	14	25	26	54
Outside YS	14	81	28	157	10	35	7	53
	$P = 0.018$		$P = 0.39$		$P = 0.17$		$P = 0.003$	

Legends to figures

Figure 1. Map of study region showing all 100 sightings of White-tailed Swallows, whether recorded during point counts, line transects, or opportunistically.

Figure 2. Map of study region showing locations of all transect clusters (each composed of about nine 500 m individual transects, see Methods) and White-tailed Swallows incidence within them.

Figure 3. Probability of encountering a White-tailed Swallow per (A) point count or (B) line transect in different broad-scale habitat types. Error bars show 95% confidence intervals for proportions (calculated according to Zar 1996), and numbers above each bar indicate total numbers of counts or transects in that habitat.

Figure 4. Scrub cover at sites where White-tailed Swallows were recorded, compared to those where they were not. The statistical results come from a bivariate GLM with presence/absence of swallows as the response variable.

Figure 5. Map of study region showing locations of all transect clusters (each composed of about nine 500 m individual transects, see Methods) and Ethiopian Bush-crow incidence within them.

Figure 6. Probability of encountering an Ethiopian Bush-crow per (A) point count or (B) line transect in different broad-scale habitat types. Error bars and data labels are as for Figure 2.

Figure 7. Scrub and canopy cover at sites where Ethiopian Bush-crows were recorded, compared to those where they were not. These were the only statistically significant predictors of bush-crow incidence when analysed in a bivariate fashion (GLM with presence/absence of bush-crows as the response variable); see Results for multivariate results.

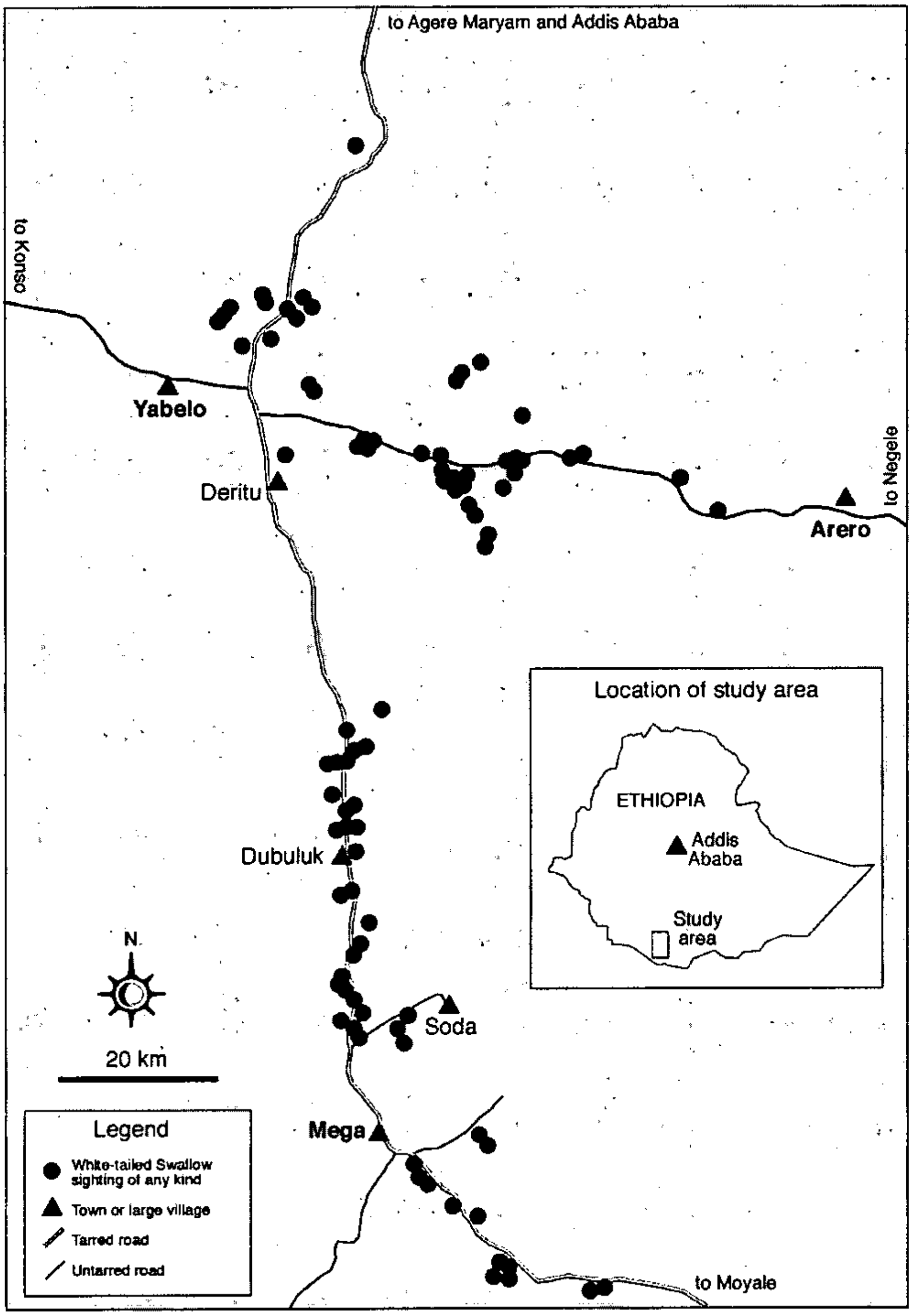

to Agere Maryam and Addis Ababa
to Konso
Yabelo
Deritu
to Negele
Arero
Location of study area
ETHIOPIA
Addis Ababa
Study area
Dubuluk
N.
Soda
20 km
Legend
White-tailed Swallow sighting of any kind
Town or large village
Tarred road
Untarred road
Mega
to Moyale

Figure 1.

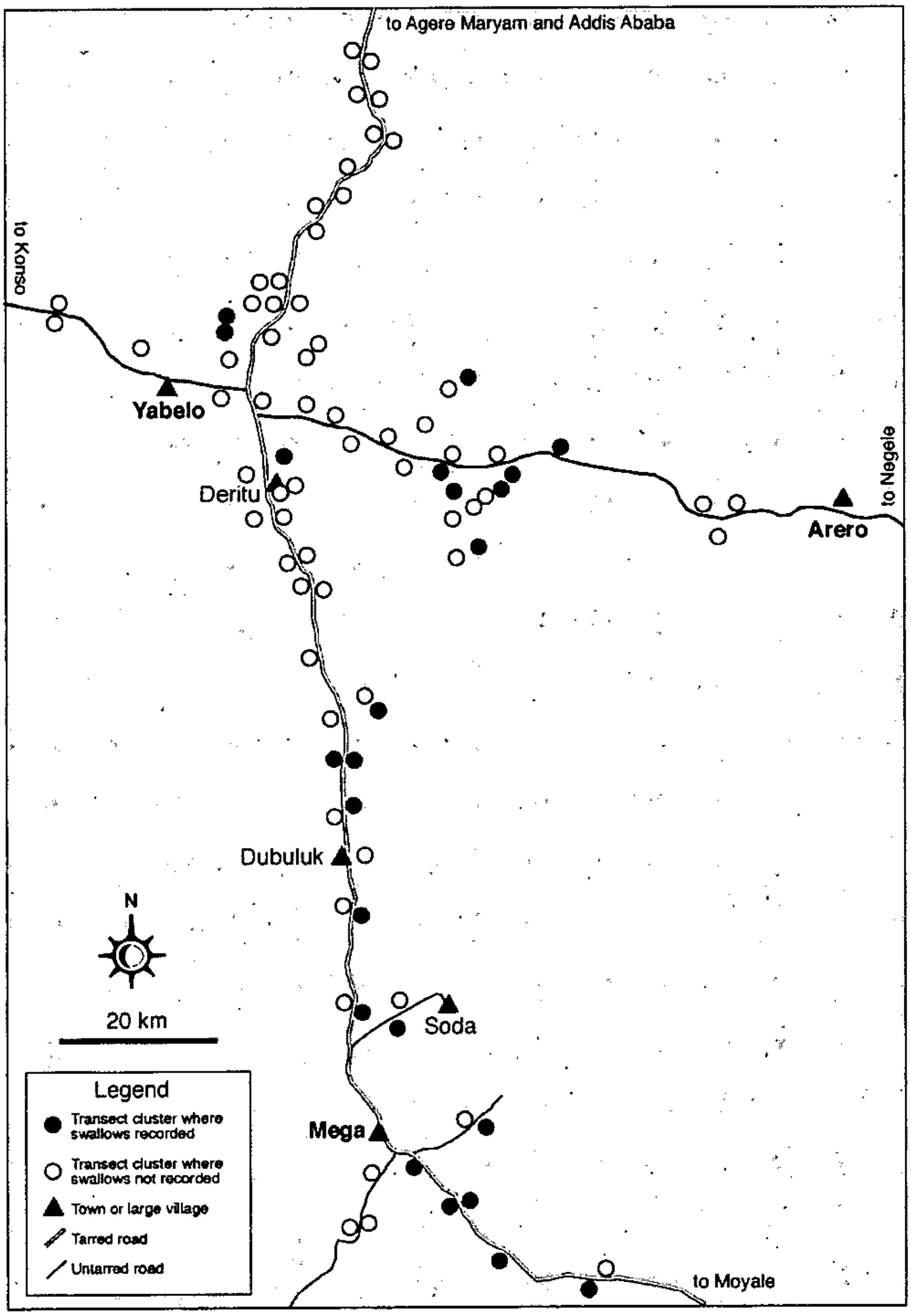

to Agere Maryam and Addis Ababa
to Konso
Yabelo
Deritu
to Negele
Arero
Dubuluk
N
20 km
Soda
Legend
Transect cluster where swallows recorded
Transect cluster where swallows not recorded
Town or large village
Tarred road
Untarred road
Mega
to Moyale

Figure 2.

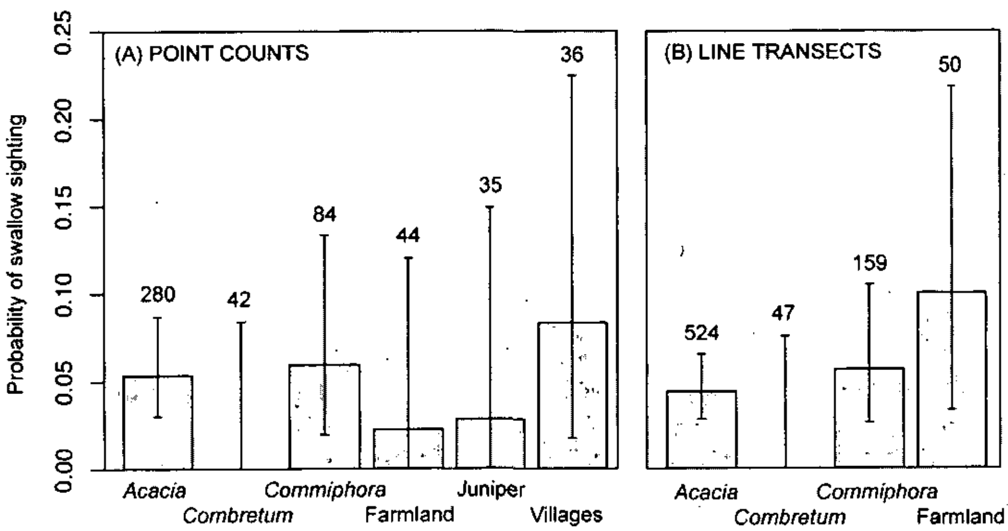


Figure 3.

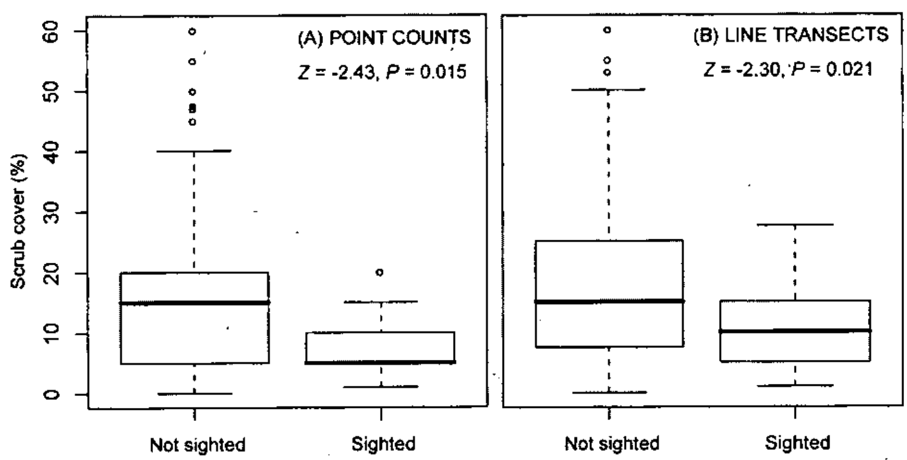
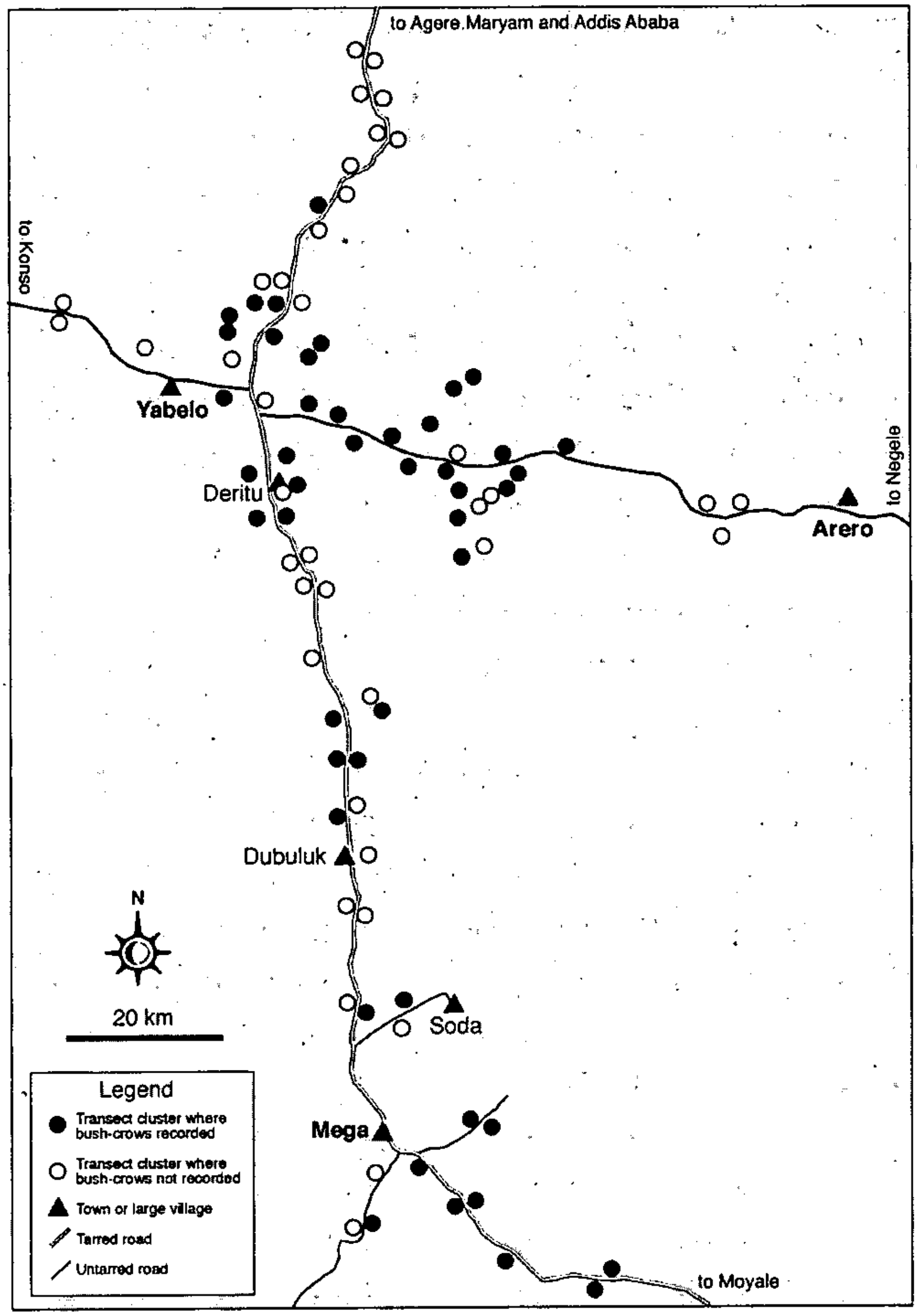


Figure 4.



to Agere Maryam and Addis Ababa
to Konso
Yabelo
Deritu
to Negele
Arero
Dubuluk
N
20 km
Soda
Legend
Transect cluster where bush-crows recorded
Transect cluster where bush-crows not recorded
Town or large village
Tarred road
Untarred road
Mega
to Moyale

Figure 5.

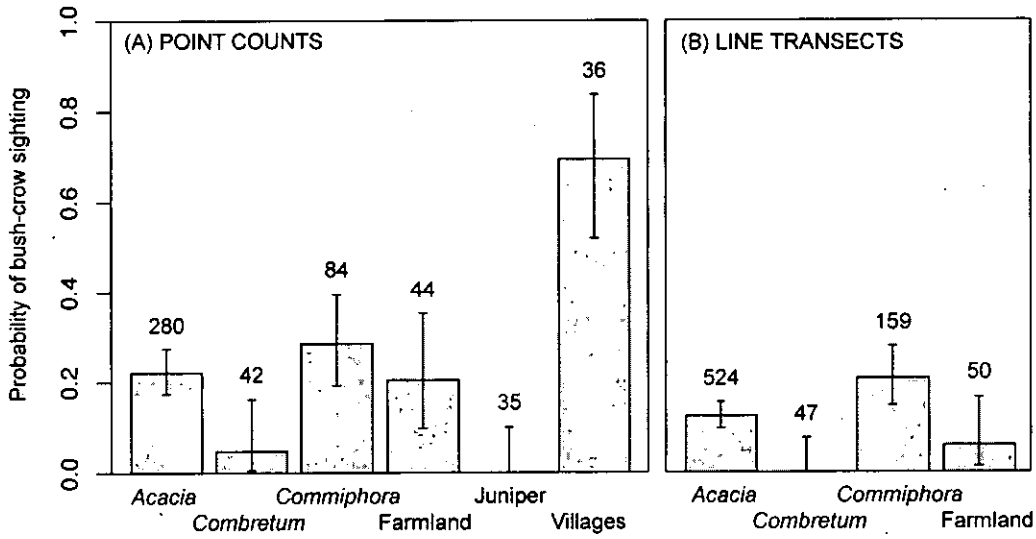


Figure 6

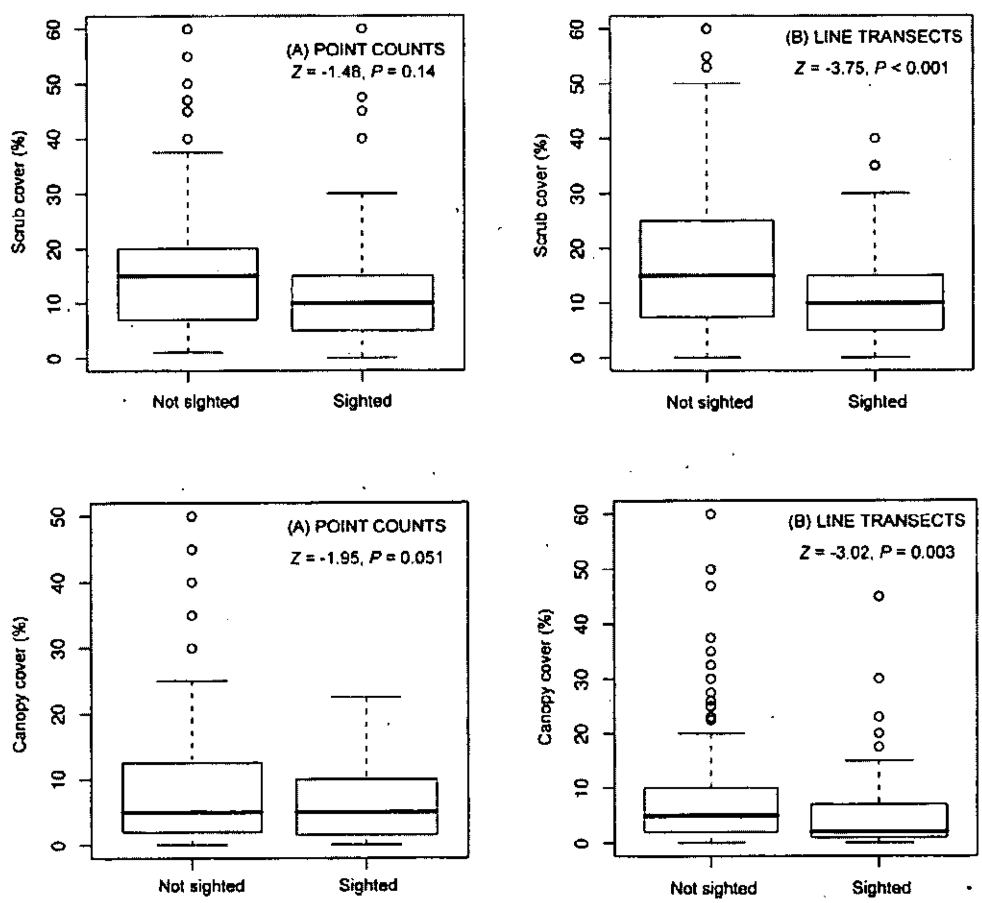


Figure 7.

Habitat selection by birds in the Yabelo Sanctuary, southern Ethiopia

Mellanby, R.J.[1,2], Ross, B.[2], Watt, A.[2], Wondafrash, M.[2,3], Ewnetu, M.[2,4], Spottiswoode, C. [2], Broadhurst, C.[2], Critchlow, R.[2], Dadesa, A.[2,5], Deas, T.[2], Enawgaw, C.[2,4], Gebremedihin, B.[2,6], Graham, E.[2], Maclean, S.[2], McKean, M.[2]

[1] Immunology Division, Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge, CB2 1QP, U.K.

[2] Project Yabelo, Institute of Biomedical Sciences, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, U.K.

[3] Ethiopian Wildlife and Natural History Society, PO Box 13303, Addis Ababa, Ethiopia.

[4] Ministry of Agriculture and Rural Development, Wildlife Conservation Department, PO Box 10-22-98, Addis Ababa, Ethiopia.

[5] Yabelo Wildlife Sanctuary, PO Box 34, Yabelo, Ethiopia.

[6] Institute of Biodiversity and Conservation, Addis Ababa, Ethiopia.

Please address correspondence to R.J. Mellanby at Immunology Division, Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge, CB2 1QP, U.K.

Summary

The Yabelo Sanctuary in southern Ethiopia is the only protected area within the remarkably restricted ranges of Ethiopian Bush Crow and the White-tailed Swallow. Despite the global importance of the Sanctuary, it faces considerably environmental challenges from over grazing and cultivation and a recent study, based on the analysis of satellite images, has highlighted dramatic changes in the habitat of this region over the past two decades. In the light of the ongoing habitat changes in the Yabelo Sanctuary and the surrounding areas and the total absence of quantitative data on how this habitat alteration affects the regions' avifauna, we undertook a study to assess how bird species richness varied between habitats. Although the initial analysis of the cumulative number of species observed in successive point counts in each of the six main habitat types found in the Yabelo region suggested that village and farmland habitats were species rich in contrast to the predominant *Acacia* habitat, species richness is likely to be artefactually low in the *Acacia* habitat due to the reduced detectability of birds in this habitat. When the effects of varying detectabilities in different habitat was minimised by calculating the cumulative number of species observed in successive point counts in the six habitat types within a 25m radius from the centre of the point count, the *Acacia* habitat was the most species rich environment. In addition, within the *Acacia* habitat considerably more species were observed inside the Sanctuary compared to outside. Our study suggests that the *Acacia* habitat is species rich relatively to the degraded habitats in the Yabelo region and that the *Acaica* habitat within the Yabelo Sanctuary supports more species than outside. Interviews with local villagers clearly revealed a consensus view that the amount of grazing land had decreased, the amount of cultivation had increased and that further habitat degradation is likely. In the face of these ongoing environmental pressures, our data highlights the importance of the Yabelo Sanctuary in protecting the diverse avifauna of this region.

Introduction

East Africa contains a large number of bird species that occur nowhere else in the world (Birdlife International 2000). Many of these endemic species are threatened by loss and alteration of habitat, and are vulnerable because of their restricted ranges (Stattersfield et al 1998). Several key areas of bird endemism, known as endemic bird areas (EBAs), have been identified in East Africa (Stattersfield et al.1998). The South Ethiopian Highlands is considered to be an EBA of critical priority which supports five restricted range species of which two, the Ethiopian Bush-crow (*Zavattariornis stresemanni*) and the White tailed Swallow (*Hirundo megaensis*), are found within a small area around the Yabelo and Mega regions in southern Ethiopia (Stattersfield et al 1998, Birdlife 2005a,b). The most recent study on the status of the Ethiopian Bush Crow based on roadside counts concluded that the population may have decreased by as much as 80 per cent in the past two decades and, consequently, its status has been upgraded from vulnerable to endangered (Birdlife International 2005a, Borghesio and Giannetti 2005). Very little data is available on the status and distribution of the White tailed Swallow and is currently considered to be vulnerable (Birdlife International 2005b).

The only designated area for wildlife within the range of the Ethiopian Bush Crow and White-tailed Swallow is the Yabelo Sanctuary (Fishpool and Evans 2001). As defined by regional Ethiopian governments, activities prohibited in a wildlife sanctuary include 'grazing cattle, settlement and hunting of animals unless granted a permit or written permission' (Fishpool and Evans 2001). The only assessment of the avifauna of the sanctuary was a brief survey in June 1996 which recorded 210 species in the area (Birdlife International 2000, Fishpool and Evans 2001). The most common habitat within the Yabelo Sanctuary is woodland savannah dominated by species of *Acacia* (*A. tortilis, A. brevispica, A. horrida, A. drepanolobium*), *Terminalia* and *Commiphora* (Borghesio and Giannetti 2005). Small patches of *Juniperus* forest can be found in upland areas just outside the boundary of the Sanctuary although grazing and logging threaten the persistence of this woodland (Borghesio et al. 2004). The dominant land use is pastoralism by the Borena tribe although agriculture has increased in recent years (EWNHS 1996, Borghesio and Giannetti 2005). Significantly, recent objective data has shown that the land cover within Yabelo sanctuary has dramatically changed over the past two decades; analysis of Landsat satellite images of the Yabelo sanctuary from 1986 and 2002 revealed that vegetation density has increased within the Sanctuary and decreased outside the Sanctuary over the past two decades. It was speculated that the increase in bush density within the reserve was due to an increase in grazing pressure by domestic animals, fire suppression and the disappearance of wild herbivores and that the decrease in bush density outside the Sanctuary may be related to the felling of trees by locals (Borghesio and Gianetti 2005).

The aims of the study were twofold; firstly, since there is no quantitative data on the avifauna of the Yabelo sanctuary, we wished to assess the relative abundance of bird species in the various habitat types found in the Yabelo region. Given the rapid loss of natural habitat in this area, we were particularly interested to evaluate the degree to which the avifauna had adapted to new, man made habitats. We employed a simple, robust methodology which could be repeated in the near future so that, for the first time, meaningful changes in the relative abundances of the birds within the various habitat types of the Yabelo region could be detected. Secondly, we wished to evaluate the attitudes of local villagers towards their local natural environment and to assess their knowledge and attitudes towards the Yabelo sanctuary.

Methods

Point counts

Fieldwork in southern Ethiopia was carried out between 15th July and 29th August 2005. The first few days were spent learning the vocalisation of the birds under the tutelage of local members of the project after which we attempted to determine the relative abundances of the birds of the region by carrying out point counts in representative habitats with two distant bands, with the cut of point set at 25m (Bibby et al 2000). On arrival at each point count a settling period of two minutes was observed before beginning each 15 minute census period. There were at least three and a maximum of six observers during each point count and all observers remained at the centre of the point count for the duration of the census. All bird species and numbers of individuals identified visually or by call were recorded during the point count and whether they were within or outside (to a maximum of 250m from the observer) a 25m radius of the centre of each point count at first detectión. In order to minimise the effect of time and weather conditions on bird detectabilty, point counts were undertaken between 06.15 and 09.15 hrs and not under unfavourable weather (strong wind or rain).

The location of the point counts were randomised by selecting a position on a map and then getting as close as possible to this location on an access road which varied from tarmac main roads to almost impassable dirt tracks. The first three point counts of each morning were taken at 500m intervals on a bearing perpendicular to the access road beginning 250m away from the access track. The next two point counts were then taken at 500m intervals on a bearing 90 degrees to the first three point counts followed by two further point counts, if time allowed, on a bearing 90 degrees from the middle two point counts.

Habitat data was measured at the end of each point count; all observers within the group independently made their own assessments which were then pooled and a median value obtained.

Habitat classification and variables

A number of habitat variables were recorded at the end of each 15 minute point count. The variables measured were

1) Habitat type

The broad habitat types within a 25m radius from the centre of each point count were categorised by the following definitions :

a) Farmland : Intensive agriculture, commonly maize, wheat and tef.
b) *Commiphora* forest/ scrub : *Commiphora* species form more than 50 per cent
c) *Juniper* forest : *Juniper* species form more than 50 per cent of tree species
d) *Combretem – terminalae* forest/ srub : species form more than 50 per cent of tree species
e) *Acacia* scrub : *Acacia* trees form more than 50 per cent of tree species
f) Villages : three of more houses were within 50m from the centre of each point count

2) Altitude
3) Bare earth defined as the percentage of bare earth visible within a 25m radius from the centre of each point count
4) Scrub cover defined as the percentage of the ground cover by woody vegetation without a single trunk at a minimum height of 50cm within a 25m radius from the centre of each point count
5) Sward height defined as the average height of grasses within a 25m radius from the centre of each point count
6) Canopy cover defined as the percentage covered by tree canopy within a 25m radius from the centre of each point count
7) Number of tress (defined as vegetation with a single or double woody trunk at breast height) less than and greater than 6m high within a 25 radius from the centre of each point count
8) Number of termite mounds within a 25m radius from the centre of each point count

In addition, the time and whether the centre of the point count was inside or outside the Yabelo sanctuary was noted at each point count. This was decided by A.D., who was the warden of the Yabelo Sanctuary. As the exact boundaries of the sanctuary are ill-defined, this was recorded when A.D. was confident of the exact relationship between the point count location and the boundaries of the reserve. The habitat variables 2 to 8 were not collected in farmland habitats.

Assessment of changes in the environment and in farming practices by local villagers

Interviews with representatives from villages inside and outside the Yabelo Sanctuary were undertaken throughout the eight week study period. In an effort to gather information from a broad geographical spread of villages and to reduce bias by repeat sampling in the same location, only one interview was undertaken in each village. Representatives from each village were randomly selected and ranged from young females who were at home looking after their family to male village elders. After introducing ourselves and describing the background to project, we asked for permission to conduct a brief, verbal, semi structured interview. The standardised interview consisted of 16 questions and an opportunity was given at the end of the interview for the respondent to offer their own additional comments. The interview was conducted in the local language by the warden of the Yabelo Sanctuary who then translated the answers to Amharic to an interpreter who subsequently translated the responses into English.

Statistics

Habitat variables (Bare earth, Scrub cover, Canopy cover, Number of trees less than and greater than 6m, Number of termite mounds) within *Acacia* scrub, *Combretum-terminale* forest/scrub and *Commiphora* forest/scrub habitats were compared in point counts outside and inside the Sanctuary by a Mann Whitney U test. Comparison of habitat variables between habitat types was by Kruskal-Wallis analysis. In addition, the number of species observed in the point counts within the six habitat types were compared by a Kruskal-Wallis test. When Kruskal-Wallis analysis showed significant difference, a post test Dunn's Multiple Comparison Test was performed to assess differences between each broad habitat types. In all cases significance was taken to be $p<0.05$.

Results

Habitat assessment of the Yabelo Sanctuary and the surrounding area

A total of 521 point counts were undertaken during the study period. Two hundred and eighty point counts were done in *Acacia* forest/scrub (185 inside, 95 outside), 84 in *Commiphora* forest (39 inside, 45 outside), 44 in farmland (38 inside, 6 outside), 42 in *Combretum terminalia* (23 inside, 19 outside), 36 in villages (33 inside, 3 outside) and 35 in *Juniper* forest (35 outside). Habitat assessments made at the end of each point count revealed that there were considerably differences in the micro-habitat between the broad habitat groups (table 1). Notably, there were very few trees less than 6m in the Village habitat and a large number of trees less than 6m in the *Juniper* habitat.

There were also differences in the habitat variables within the broad habitat groups inside the Sanctuary compared to outside (table 2). The main differences were an increase in bare earth outside the Sanctuary in the *Acacia* habitat and an increase in canopy cover and in the number of trees in both the *Acacia* and *Commiphora* habitat inside the Sanctuary compared to outside.

Species richness between habitats

Species richness, as defined by the cumulative number of species observed in each habitat, is shown in figure 1 and summarised in table 3. After 35 points counts, the Village habitat contained the highest number of species and the Acacia habitat contained fewer bird species than all other habitat types apart from *Juniper* forest. Although this suggests that the farmland and Village habitats supported more bird species than the *Acacia* habitat, there is the clear risk of bias in presenting results in this manner since observation of birds is likely to be greater in more open habitat. As there are fewer small trees and scrub in the Village habitat compared to the *Acacia* habitat (table 1), there maybe a greater tendency to observe species in this more open habitat. To more objectively assess species richness in habitats with varying vegetation densities, the cumulative number of species observed in a 25m radius from the centre of each sequential point count were compared in the six habitat types. When the analysis was confined to a small radius around the centre of the point count where visibility is more likely to be similar between habitats, the *Acacia* habitat was found to support the greatest number of bird species (figure 2, table 3). Analysis of the cumulative number of species observed in each of the habitat types outside a 25m radius from the centre of the point count yields very similar results to the assessment of the combined data (figure 1,3). There were no significant differences between the mean number of species observed per point count between the six habitat groups (p=0.089) (table 4).

Species richness inside and outside the Yabelo Sanctuary

Given the significant habitat differences inside the Sanctuary compared to the surrounding area, particularly in the *Acacia* and *Commiphora* habitats, the cumulative number of species identified inside the reserve where compared to outside the reserve in the *Acacia* and *Commiphora* habitats. As shown in figure 4, there is little difference in the cumulative number of species observed inside the Sanctuary in the *Commiphora* habitat compared to outside the Sanctuary. This is in contrast to the *Acacia* habitat where the cumulative number of species inside the Sanctuary compared to outside the Sanctuary was similar after 40 point counts (25 species and 21 species, respectively) but were considerably different after 80 point counts (47 species and 27 species, respectively).

Assessment of changes in the environment and in farming practices by local villagers

Sixty villages were visited and interviews were undertaken with a representative from each village. Permission to undertake an interview was granted by everyone who was approached. Forty nine of the respondents were male and the median age of the sixty interviewees was 40 years (range 20 to 89 years). The occupation of the respondents was farming (6 respondents), herding (8 respondents) and farming and herding (46 respondents). The respondents had lived in their village for a median time of 22 years (range 1 to 75 years) and all respondents lived permanently in their villages.

When asked whether the amount of grazing had increased, decreased or stayed the same, 59 respondents replied that it had decreased whereas only one person thought that the amount of grazing had stayed the same. There was no consensus between the respondents on whether the number of domesticated animals had increased, decreased or stayed the same (table 5). The majority of respondents replied that the number of wild animals had decreased; 58 interviewees stated that the number of wild animals had decreased and one person stated that the numbers stayed the same and no interviewees replied that the numbers had increased. When asked about specific animals, there was a clear consensus between respondents that the number of gazelle, kudu and giraffe had decreased in the last two decades (table 6).

There was a strong consensus amongst interviewees that the environment had changed in recent years.in two major ways; firstly, the amount of land available for grazing had decreased and secondly, the amount of land used for cultivation had increased. When asked 'How has the environment had changed?', 26 respondents stated that the amount of grazing had decreased and the amount of cultivation had increased, 16 respondents stated that the amount of grazing had decreased, 13 respondents replied that the amount of cultivation had increased. Two people said that the amount of grazing had decreased and there was an increase in settlements, one respondent stated that there was a decrease in grazing and an increase in the human population and one respondent stated there had been no change in the environment. Forty five of the 60 respondents stated that they did not plan to change their farming practices. Of the 15 who stated that they plan to alter their agricultural practice, five planned to increase cultivation, four wished to increase trade, three hoped to harvest water, one respondent planned to increase trade and water harvest, one interviewee planned to change to herding only and one respondent planned to increase herding and decrease farming.

When asked if they were aware of the existence of the conservation sanctuary in the Yabelo region, 24 interviewees had heard of the conservation area and were aware of the general boundaries, 19 respondents had heard of the existence but were not aware of the boundaries and 17 interviewees did not know of the existence of the conservation area. When asked if there were any birds that they no longer saw, 51 of the respondents replied that they had observed a decline in 'chirie' which was the local name for Red-billed Oxpecker. The respondents frequently commented that they considered that the Red-billed Oxpecker had declined due to changes in farming practices, notably the use of ectoparasitic drugs on cattle, and most respondents considered this decline to be highly regrettable.

Discussion

One of the biggest difficulties facing conservation biologists is the assessment of wildlife populations in a variety of habitats in which the species of interest have a differing degree of detectability (Bibby and others 2000). Numerous census methodologies have been proposed to address this problem although many of the assumptions on which they are based, such as maximum detection probability at zero distance and the accurate measurement of the distance between the observer and animal, are often not met (Bibby and others 2000, Catry and others 2000). Our response to these challenges was to utilise a simplified point count technique which had been used successfully in other tropical avifauna census studies (Catry and others 2000). We simply recorded all birds heard or seen during a 15 minute point count and noted whether the bird was inside or outside a 25m radius from the centre of the point count and at the end of the point count a number of habitat variables were recorded. We hope that this simplified methodology, which does not require complex modelling, will encourage other biologists to repeat the census so that trends in species richness between habitats can be tracked over time.

The cumulative number of species observed during sequential point counts in the different habitats of the Yabelo region further highlights the importance of considering detectability in census surveys. For example, when the cumulative number of species are plotted against sequential point counts, the village habitat is the most species rich. However, this conclusion is not supported by further analysis when only species observed within a 25m radius are considered. This assessment, which attempts to minimise the impact of differing detectabilities in various habitats, indicates that the *Acacia* habitat is the most species rich habitat. We speculate that the lower number of species detected in the *Acacia* habitat overall is artefactually low compared to the village and farmland habitats where the more open habitat allows birds to be more readily detected. Consequently, we feel that our study indicates that the importance of the *Acacia* habitat in supporting avian diversity in the Yabelo region.

Our data also indicates that there are considerable differences in habitat structure inside compared to outside. In broad agreement with the observations of Borghesio and Giannetti (2005), which was based on the analysis of satellite images of the Yabelo region over the last two decades, we found that within the *Acacia* and *Commiphora* habitats, the number of trees and canopy cover were significantly higher inside the reserve compared to outside. It is difficult to establish the cause for the differences in habitat structure inside the Sanctuary compared to outside. The Sanctuary receives no formal management, its boundaries are ill defined and over a quarter of local people interviewed had no knowledge of the existence of the reserve. Consequently, the difference in habitat structure is unlikely to reflect any active, conservation based management and is more likely to result from variations in land use strategies together with natural variations in the habitat structure. In light of the different habitat structures inside the Sanctuary compared to outside, it is particularly noteworthy that the cumulative number of species within a 25m radius in the *Acacia* habitat inside the Sanctuary was almost twice the number of species observed outside the Sanctuary. Whilst the *Acacia* habitat within the Sanctuary is unlikely to be species rich due to active conservation management strategies, it nonetheless highlights the importance of the Yabelo Sanctuary in protecting the diversity of the avifauna of this region.

It is clear from our questionnaires with local villagers that the environment of the Yabelo region has changed considerably over recent years. Almost all interviewees replied that the amount of grazing had decreased and many replied that the amount of cultivation had increased. Furthermore, 75 per cent of respondents stated that they had no plans to change their farming practices suggesting that the conversion of woodland into cultivated land is likely to continue. In addition to the habitat changes, the questionnaires revealed there was a widespread consensus amongst local people that the populations of wild animals had also changed in recent years, in particularly that the numbers of giraffe, gazelle and kudu had declined. Less than half of all respondents were aware of the Yabelo Sanctuary and the position of its boundaries and over one quarter of all respondents were unaware of the existence of the Sanctaury.

An interesting and unexpected finding from the questionnaires with local people was the almost universal and unprompted observation that Red-billed Oxpeckers had markedly decreased in recent years; our field observations agree with this assessment from local villagers as the bird was not recorded during 418 observer days. Many villagers considered that the bird was no longer found in their environment due to changes in the management of ectoparasites on domesticated animals; they suggested that insecticides used to treat domestic animals lead to either a decrease in the food or had a toxic effect on the Red-billed Oxpeckers. No clear evidence in support of either of these theories was found during the project. A decline in Oxpeckers has been observed in other parts of Africa which has also been linked to the use of insecticides on domestic animals (Robertson and Jarvis 2000).

In summary, the Yabelo Sanctuary and the surrounding areas are facing a considerable environmental challenge as the amount of grazing land decreases and the amount of cultivation increases. Although the initial analysis of the cumulative number of species observed in successive point counts in each of the six main habitat types found in the Yabelo region suggested that village and farmland habitats were species rich in contrast to the predominant *Acacia* habitat, species richness is likely to be artefactually low in the *Acacia* habitat due to the reduced detectability of birds in this habitat. When the effects of varying detectabilities in different habitat was minimised by calculating the cumulative number of species observed in successive point counts in the six habitat types within a 25m radius from the centre of the point count, the *Acacia* habitat was the most species rich environment. In addition, within the *Acacia* habitat considerably more species were observed inside the Sanctuary compared to outside. Our study suggests that the Acacia habitat is species rich relative to the degraded habitats in the Yabelo region and that the *Acaica* habitat within the Yabelo Sanctuary supports more species than outside. Our data highlights the importance of the Yabelo Sanctuary in protecting the diverse avifauna of the Yabelo region.

Acknowledgements

The authors of the study are very grateful to the BP Conservation Awards Programme, Carnegie Trust, University of Glasgow, Peoples Trust for Endangered Species, Royal Geographical Society, African Bird Club, Glasgow Natural History Society and Edinburgh Trust 1 for their generous financial support of this project. We would also like to thank the local guides and drivers. We are also very grateful to Luca Borghesio for his excellent advice throughout the development of the project. The project would not have been possible without the initial assistance from Yilma Dellelegn and Nigel Collar to whom the authors are very grateful. We are also grateful to John Ash and Per Ole Syvertsen for their advice and guidance.

References

Bibby, C.J., Burgess, N.D., Hill, D.A. (2000) and Mustoe, S.H. Bird Census Techniques. Eds Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S.H. 2nd edition. Academic Press, London.

Birdlife International (2000) Threatened birds of the World. Barcelona and Cambridge, UK: Lynx Edicions and Birdlife International.

Birdlife International (2005a) Species factsheet: *Zavattariornis stresemanni.* Downloaded from http://www.birdlife.org on 23/12/2005

Birdlife International (2005b) Species factsheet: *Hirundo aethiopica.* Downloaded from http://www.birdlife.org on 23/12/2005

Borghesio, L., Giannetti, F., Ndang'ang'a K. And Shimelis, A. (2004) The present conservation status of *Juniperus* forest in the South Ethiopian Endemic Bird Areas. *African Journal of Ecology*. **42**, 137-143

Borghesio, L. and Giannetti, F. (2005) Habitat degradation threatens the survival of the Ethiopian bush crow *Zavattariornis stresemanni*. *Oryx*. **39**, 44-49

Catry, P., Mellanby, R.J., Sulieman, Salim, Anderson, N., Armitage, M., Constant, G., Heaney, V., Hughes, M., McKean, M. Habitat Selection by Terrestrial Birds on Pemba Island (Tanzania) with particular reference to six endemic taxa. (2000) *Biological Conservation*. **95**, 259-267

EWNHS (1996) Important bird areas of Ethiopia. Ethiopian Wildlife and Natural History Society, Addis Ababa, Ethiopia. pp185-187

Fishpool, L.D.C. and Evans, M.I. (2001) Important bird areas in Africa and associated islands: priority sites for conservation. Eds Fishpool, L.D.C. and Evans, M.I. 1st edition. Newbury and Cambridge, UK: Pisces Publications and Birdlife International.

Robertson, A. and Jarvis, A.M. (2000) Oxpeckers in north-eastern Namibia: recent population trends and the possible negative impacts of drought and fire. *Biological Conservation*. **92**, 241-247

Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. (1998) Endemic Bird Areas of the World. Eds. Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. 1st edition. Burlington Press, Cambridge. pp382-383

Tables

Habitat variable	*Acacia* forest/scrub Mean ± SD (n=280)	*Commiphora* forest/scrub Mean ± SD (n=84)	*Combretum terminalia* forest/scrub Mean ± SD (n=42)	*Juniper* forest Mean ± SD (n=35)	Village Mean ± SD (n=36)	p value
% Bare earth	27.6 ± 19.0	32.1 ± 15.6	24.5 ± 17.0	18.9 ± 13.1	18.2 ± 15.2	<0.0001 * [1]
% Scrub cover	15.1 ± 11.9	17.6 ± 12.4	17.9 ± 12.4	24.1 ± 17.8	8.4 ± 4.5	<0.0001* [2]
Sward height/ cm	16.0 ± 15.2	10.9 ± 9.0	16.6 ± 14.0	11.3 ± 16.6	8.5 ± 5.8	0.006 * [3]
% Canopy cover	8.5 ± 9.0	3.5 ± 4.5	12.1 ± 13.3	35.9 ± 23.2	3.0 ± 3.3	<0.0001 * [4]
Number of trees less than 6m high	21.9 ± 23.9	12.9 ± 11.4	18.7 ± 15.3	24.7 ± 15.7	3.5 ± 7.3	<0.0001 * [5]
Number of trees greater than 6m high	1.5 ± 2.3	1.1 ± 4.2	1.9 ± 2.6	13.2 ± 22.2	1.0 ± 2.0	<0.0001 * [6]
Number of termite mounds	0.3 ± 0.6	0.6 ± 0.7	0.6 ± 0.7	0.09 ± 0.3	0.5 ± 0.7	0.0001 * [7]

Table 1 : Comparison of habitat variables in various broad habitat types. p value is from Kruskal-Wallis analysis of the four groups. When Kruskal-Wallis analysis showed significant difference, post test Dunn's Multiple Comparison Test was performed to assess differences between each broad habitat types.

[1] Commiphora forest vs Juniper % Bare earth p<0.001, Commiphora forest vs Village p<0.001, Acacia vs Village p<0.05, all other pair comparisons p>0.05

[2] Acacia scrub vs Juniper % scrub cover p<0.001, Acacia vs Village p<0.01, Commiphora vs Village p<0.001, C+T vs Village p<0.001, Juniper vs Village p<0.001, all other pair comparisons p>0.05

[3] Combretum terminalia vs Village % sward height p<0.05, Acacia vs Village p<0.05, all other pair comparisons p>0.05

[4] All pair comparisons p<0.01 apart from Acacia versus Combretum terminalia forest canopy cover and Commiphora vs Village, p>0.05

[5] Acacia vs Village p<0.001, Commiphora vs Juniper p<0.001, Commiphora vs Village p<0.001, Combretum terminalia vs Village p<0.001, Juniper vs Village p<0.001, all other pair comparisons >0.05

[6] Acacia vs Commiphora p<0.01, Acacia vs Juniper p<0.001, Commiphora vs Combretum terminalia p<0.05, Commiphora vs Juniper p<0.001, Combretum terminalia vs Juniper p<0.001, Juniper vs Village p<0.001, all other comparisons p>0.05

[7] Acacia vs Commiphora p<0.05, Combretum terminalia vs Juniper p<0.05, Juniper vs Village p<0.05, Commiphora vs Juniper p<0.001, all other comparisons p>0.05

* notifies significant difference

Habitat variable	Acacia scrubland/ forest			Combretem – terminalae scrubland/ forest			Commiphora scrubland/ forest		
	In Mean ± SD (n=185)	Out Mean ± SD (n=95)	p value	In Mean ± SD (n=23)	Out Mean ± SD (n=19)	p value	In Mean ± SD (n=39)	Out Mean ± SD (n=45)	p value
% Bare earth	25.5 ± 19.7	31.6 ± 17.0	0.00017 *	23.0 ± 15.6	28.5 ± 18.7	0.36	33.8 ± 15.9	30.7 ± 15.3	0.26
% Scrub cover	15.5 ± 11.5	14.4 ± 12.6	0.19	16.8 ± 10.4	19.1 ± 14.7	0.82	13.9 ± 7.3	20.9 ± 14.8	0.026 *
Sward height/ cm	16.3 ± 15.4	15.3 ± 14.8	0.24	18.9 ± 11.6	13.8 ± 16.3	0.047 *	11.4 ± 11.4	10.6 ± 6.3	0.42
% Canopy cover	9.8 ± 9.7 [1]	6.1 ± 7.1 [2]	<0.0001 *	9.9 ± 7.9 [3]	14.7 ± 17.9 [4]	0.44	4.2 ± 4.1	2.9 ± 4.7	0.0009 *
Number of trees less than 6m high	28.2 ± 26.3	9.7 ± 10.5	<0.0001 *	18.3 ± 13.7	19.2 ± 17.5	0.98	17.3 ± 10.7	9.0 ± 10.7	<0.0001 *
Number of trees greater than 6m high	1.7 ± 2.5	1.0 ± 1.7	0.0083 *	1.8 ± 2.6	1.9 ± 2.6	0.70	2.0 ± 6.0	0.3 ± 1.1	0.0006 *

Table 2 : Habitat characteristics in three main woodland habitats inside and outside Yabelo Sanctuary based on data collected during point counts. * notifies significant difference

[1] Based on 171 point counts, [2] Based on 93 point counts, [3] Based on 21 point counts, [4] Based on 17 point counts

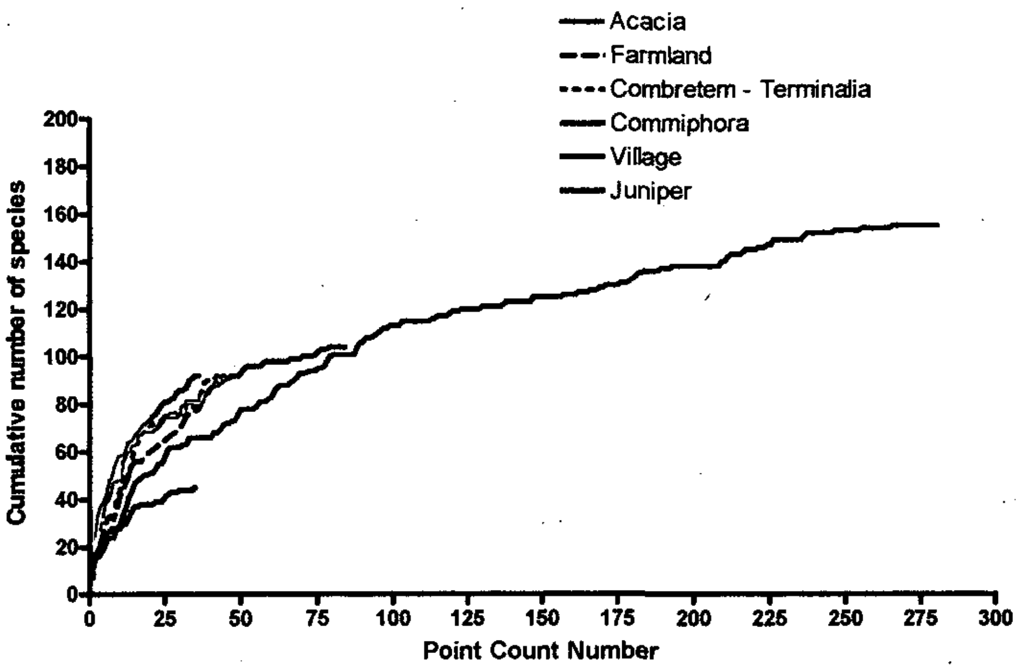


Figure 1 : Cumulative number of species observed in each habitat type

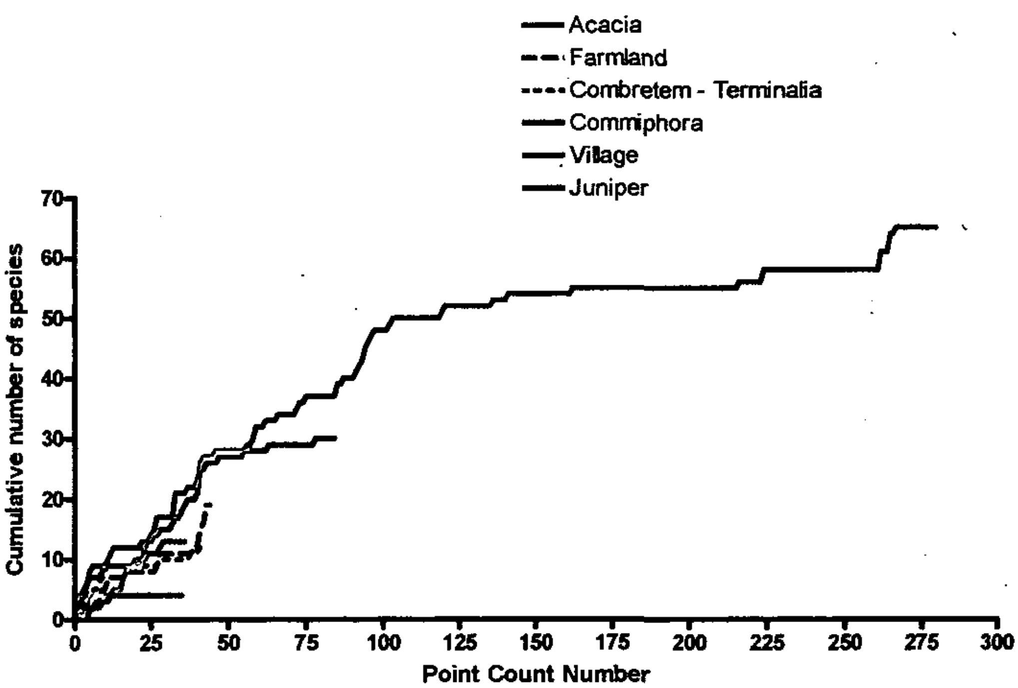


Figure 2 : Cumulative number of species observed in each habitat type within a 25m radius from the centre of the point count

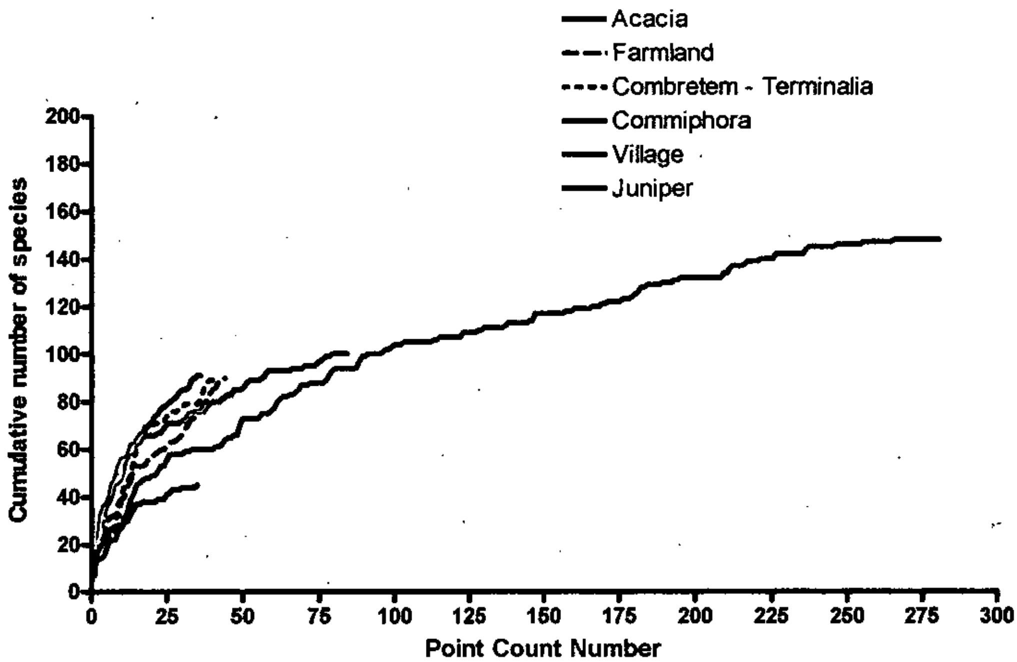
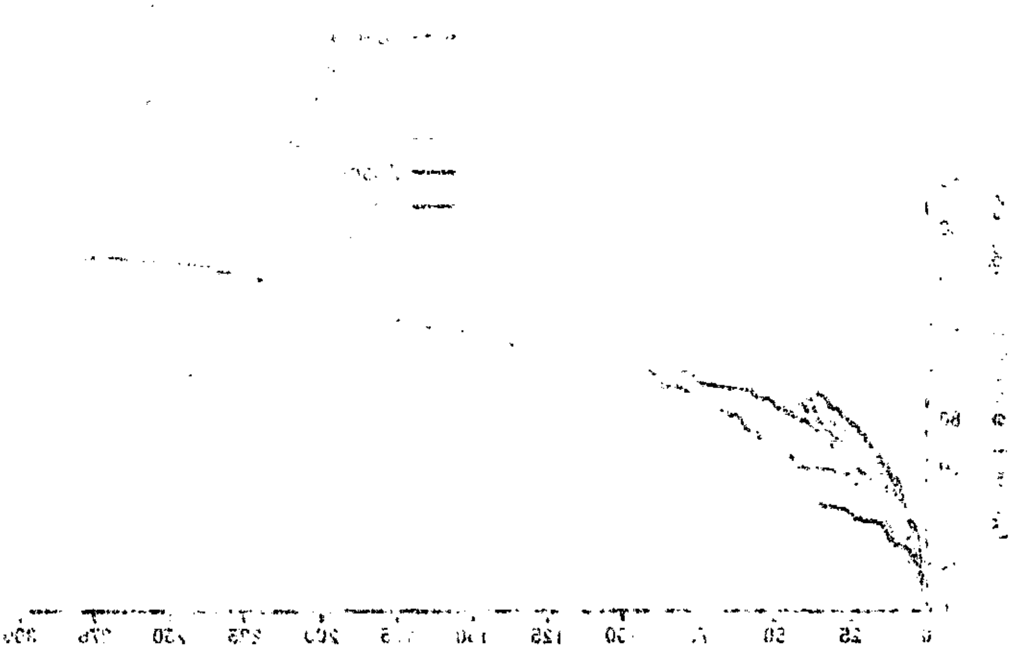


Figure 3 : Cumulative number of species observed in each habitat type outside a 25m radius from the centre of the point count

	Number of species observed after 35 point counts		
	Inside	Outside	Combined
Acacia	21	60	66
Farmland	11	75	77
Combretem-terminalia	10	79	79
Commiphora	18	76	81
Village	13	91	92
Juniper	4	45	45

Table 3 : Number of species observed after 35 point counts in all habitats within 25m and outside 25m from the centre of the point count together with the combined number of species.



[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Table 3 : [illegible] species [illegible] after 35 point counts in all habitats within 25m [illegible]

Habitat	Mean number of species per point count within 25m ± SD
Acacia (n=280)	0.56 ± 1.18
Farmland (n=44)	0.70 ± 1.27
Combretem-Terminalia (n=42)	0.31 ± 0.60
Villages (n=35)	0.71 ± 1.30
Commiphora (n=84)	0.46 ± 0.88
Juniper (n=35)	0.17 ± 0.51

Table 4 : Mean number of species observed per point count in the six habitat types

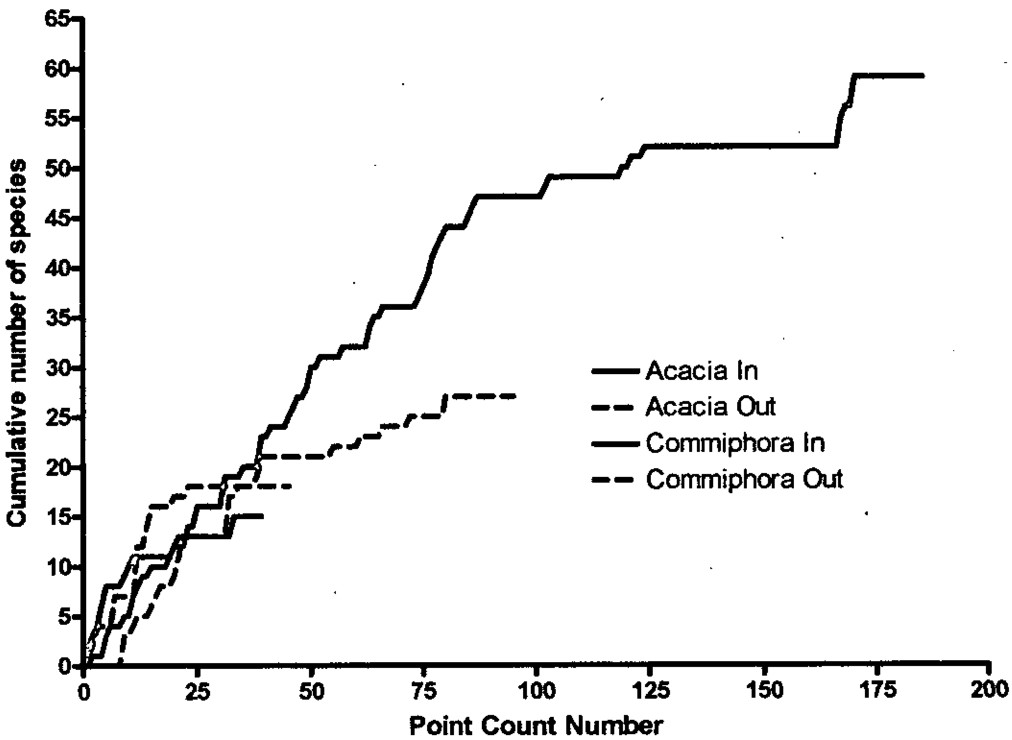


Figure 4 : Cumulative number of species observed in the Acacia and Commiphora habitats both inside and outside the Yabelo Sanctuary.

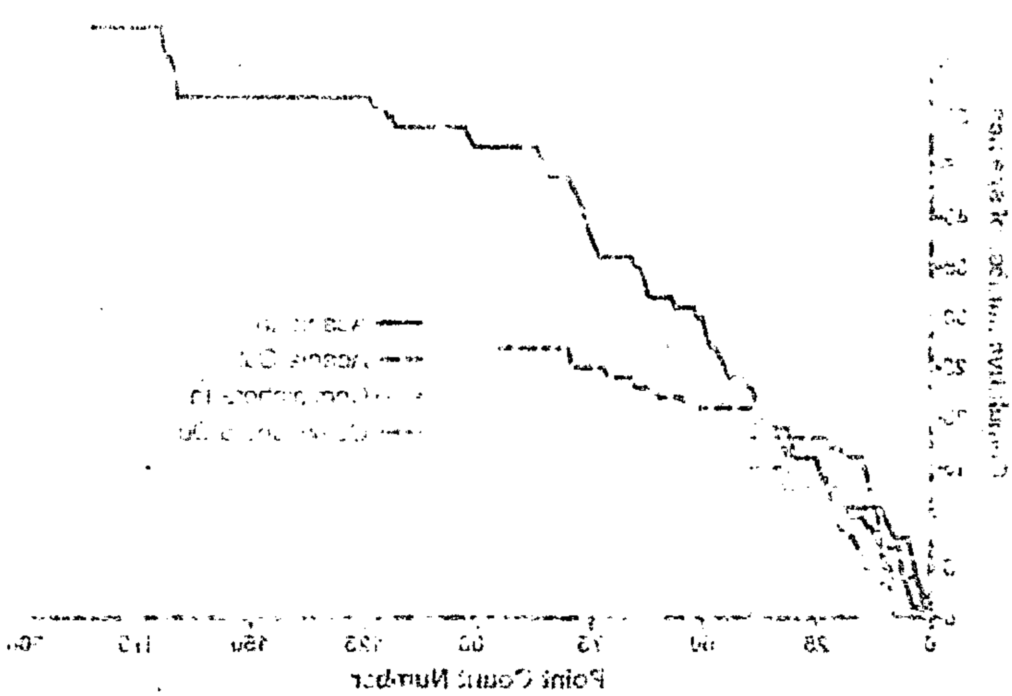


Figure 4.: Cumulative number of species observed in the Acacia and Commiphora habitats both inside and outside the Yabelo Sanctuary

Have the numbers increased, decreased or stayed the same? (n=60)	Decreased	Same	Increased
Goats	27	2	31
Camels	22	2	36
Cattle	25	1	34

Table 5 : Responses to the questions 'Have the numbers of these specific domesticated animals increased, decreased or stayed the same?' (n=60)

Have the numbers increased, decreased or stayed the same? (n=59)	Decreased	Same	Increased
Zebra	29	2	28
Gazelle	57	1	1
Hyena	11	1	47
Kudu	58	1	0
Giraffe	58	1	0

Table 6 : Responses to the questions 'Have the numbers of these specific wild animals increased, decreased or stayed the same?' (n=59)

Notes on the ecology of Ethiopian Bush Crow, *Zavattariornis stresemanni*

Ross, B.[1,2], Mellanby R.J.[2], Watt, A.[2], Wondafrash, M.[2,3], Ewnetu, M.[2,4], Spottiswoode, C.[2], Broadhurst, C.[2], Critchlow, R.[2], Dadesa, A.[2,5], Deas, T.[2], Enawgaw, C.[2,4], Gebremedihin, B.[2,6], Graham, E.[2], Maclean, S.[2], McKean, M.[2]

[1] Scottish Natural Heritage, Great Glen House, Leachkin Road, Inverness, IV3 8NW.

[2] Project Yabelo, Institute of Biomedical Sciences, Graham Kerr Building, University of Glasgow, Glasgow, G12 8QQ, U.K.

[3] Ethiopian Wildlife and Natural History Society, PO Box 13303, Addis Ababa, Ethiopia.

[4] Ministry of Agriculture and Rural Development, Wildlife Conservation Department, PO Box 10-22-98, Addis Ababa, Ethiopia.

[5] Yabelo Wildlife Sanctuary, PO Box 34, Yabelo, Ethiopia.

[6] Institute of Biodiversity and Conservation, Addis Ababa, Ethiopia.

Please address correspondence to Ben Ross, Scottish Natural Heritage, Great Glen House, Leachkin Road, Inverness, IV3 8NW.

Introduction

The Ethiopian Bush Crow (figure 1) is an endemic bird found in the Yabelo and Mega region of southern Ethiopia (Birdlife International 2005). Little is known about this species ecology and the factors contributing to the species remarkably restricted range are unknown. There have been few reports on the species status other than descriptive reports of brief field observations (Ash and Gullick 1989, Syvertsen and Dellelegn 1991, Gedeon 2006). Notably, the most comprehensive and most recent survey on the population of the Ethiopian Bush Crow, based on roadside counts carried out between 1989 and 2003, reported a dramatic decline in the number of Bush Crow sightings over the study period (Borghesio and Giannetti 2005).

The only protected area within the range of the Ethiopian Bush Crow is the Yabelo Sanctuary (EWNHS 1996, Fishpool and Evans 2001). The Yabelo sanctuary receives little to no active management, its boundaries are ill defined and the only assessment of the avifauna of the sanctuary was made in a brief survey in June 1996 which recorded 210 species in the area (Birdlife International 2000, Fishpool and Evans 2001). The most common habitat within the Yabelo Sanctuary is woodland savannah dominated by species of *Acacia* (*A. tortilis, A. brevispica, A. horrida, A. drepanolobium*), *Terminalia* and *Commiphora* (Borghesio and Giannetti 2005). In addition, small patches of *Juniperus* forest can be found in upland areas just outside the boundaries of the Sanctuary although grazing and logging threaten the persistence of this woodland (Borghesio et al. 2004). The dominant land use is pastoralism by the Borena tribe although agriculture has increased in recent years (EWNHS 1996, Borghesio and Giannetti 2005). Significantly, recent objective data has shown that the land cover within Yabelo sanctuary has dramatically changed over the past two decades; analysis of Landsat satellite images of the Yabelo sanctuary from 1986 and 2002 revealed that vegetation density has increased within the Sanctuary and decreased outside the Sanctuary over the past two decades. It was speculated that the increase in bush density within the reserve was due to an increase in grazing pressure by domestic animals, fire suppression and the disappearance of wild herbivores and that the decrease in bush density outside the Sanctuary may be related to the felling of trees by locals (Borghesio and Gianetti 2005). The evidence of a rapidly declining population together with the deteriorating habitat quality caused the Bush Crow's status to be uplifted from vulnerable to endangered.

Due to the dramatic alterations in the habitat of the Ethiopian Bush Crow, its already remarkably restricted range and the recent data that indicated that the population had significantly decreased in recent years, a project was established to further assess the ecological requirements of the Ethiopian Bush Crow.

Methods

Behavioural observations were made using the focal sampling method. Individual Ethiopian Bush Crows were observed through binoculars and position and behaviour was recorded every 15 seconds. Position and behaviour categories used are given below. Individual birds were observed for up to ten minutes at any time. Observations were made on an opportunistic basis whenever Bush Crows were encountered during a wider survey of the Yabelo region. In flocks of greater than one individual, data was collected by single or pairs of observers relaying position and behaviour to a recorder keeping time and prompting observers for behavioural information every 15 seconds. Observations made by pairs of observers followed different birds within a flock. At the end of any one observation period, if flock size and time permitted, new birds were followed.

Position was recorded in accordance with the following categories:

1. Ground	4. On wall or fence
2. Tree	5. In nest
3. In flight	6. Obscured

Behaviour type was recorded in accordance with the following categories:

1. Feeding on vegetation	5. Hawking for insects	9. Being fed by another bush crow	13. Interacting with other species
2. Feeding on bare earth	6. Walking	10. Preening another bush crow	14. Nest repair
3. Feeding on dung	7. inactive	11. Being preened by another bush crow	15. Collecting nest material
4. Feeding on wasp nest	8. Preening	12. Calling	16. Obscured

The number of Bush Crows in each flock was recorded at the start of each observation period and changes to the flock size were recorded as they occurred throughout the observation period. A bird was defined as being in a flock if it was within ten metres of another bush crow. The number and species of other birds within the flock was also recorded at the start of each observation period.

At the end of each observation period, where time permitted, habitat variables (2 to 7 above) were recorded from the spot where the last bird was seen.

In the behaviour study, all observation periods less than two and a half minutes in length or with less than ten behaviour recordings were discounted. The behaviour category observed most often in any one observation period was defined as the dominant behaviour type. In analyses looking at observation periods where feeding was the dominant behaviour type, records for behaviour categories 1 to 5 were pooled. Social activities were taken as records under categories 9 to 12. To examine the effect of time of day the day was split into four equal periods; early morning (0600 to 0900h), late morning (0900 to 1200h), early afternoon (1200h to 1500h) and late afternoon (1500h to 1800h).

Kruskal-Wallis test was used to compare position and activity for different times of the day. A Mann Whitney U test was used to compare habitat variables for observations where dominant behaviour was feeding to those where feeding was not the dominant behaviour. A Chi-square test was used to test for relationships between presence and absence of termite mounds and villages and observations where feeding was the dominant behaviour. Changes in flock size according to time of day were tested using a one-way ANOVA, with *post-hoc* testing using Tukey's pairwise comparisons.

Results and Discussion

A total of 16,685 individual behaviour records of bush crows were recorded in 840 different observation periods. The overall percentage of time observed in each of the different positions and activities and during different times of day are shown in table 1. The percentage of time spent in all positions and activities other than flying varied significantly at different times of the day.

		% of three-hour period					
Position	No. individual observations	0600-0900h	0900-1200h	1200-1500h	1500-1800h	Overall %	P Value
Ground	10534	83%	61%	55%	65%	68%	P < 0.001*
Tree	3991	12%	33%	40%	29%	26%	P < 0.001*
Nest	98	0%	2%	0%	0%	1%	P < 0.001*
Fly	527	4%	3%	3%	3%	3%	P = 0.240
Activity							
Feed (all)	6319	47%	40%	33%	40%	41%	P < 0.001*
Walk	4029	32%	24%	22%	23%	26%	P < 0.001*
Preen	1547	4%	12%	29%	11%	10%	P < 0.001*
Social	551	2%	5%	5%	4%	4%	P < 0.001*
Inactive	2343	11%	15%	18%	19%	15%	P < 0.001*

Table 1: Relative amounts of time in each three-hour daytime period spent by Ethiopian Bush Crow in different positions and activities. * notes significant difference.

Feeding was the most common behaviour type observed, accounting for 41% of observations. The most common feeding method observed was feeding on the ground amongst vegetation which accounted for 79% of all feeding behaviours. Feeding on bare earth and on dung accounted for 7% each, feeding in trees for 3%, on termite mounds for 2%, on rubbish and on wasp nests for 1% each and hawking accounted for less than 1 % of all feeding observations.

When habitat characteristics were compared between observation where feeding was the dominant behaviour and when feeding was not dominant, the percentage canopy cover was significantly different (W = 24609, p = 0.004) (Table 2). The frequency of observations where termite mounds were present was also significantly different between observations where feeding was dominant and when it was not ($\chi 2 = 4.70$, df = 1, $p<0.05$).

Habitat variables	Feeding dominant (n=154) Mean ± SD	Feeding not dominant (n=138) Mean ± SD	P value
% Bare earth	18.8 ± 16.8	20.2 ± 19.2	0.974
% Scrub cover	12.9 ± 8.5	11.5 ± 7.7	0.172
Sward height (cm)	6.4 ± 3.5	7.4 ± 5.6	0.630
% Canopy cover	15.0 ± 20.7	8.1 ± 12.9	0.004*
No. trees <6m high	2.9 ± 4.7	4.4 ± 10.6	0.766
No. trees >6m high	2.4 ± 2.5	2.8 ± 5.2	0.190
No. observations with termite mounds	74 (48%)	49 (36%)	$\chi 2 = 4.70$ $p<0.05$*
No. observations near villages	83 (54%)	78 (57%)	$\chi 2 = 0.20$ $p>0.05$

Table 2: Habitat characteristics for behavioural observations for Ethiopian bush crow when feeding was and was not the dominant behaviour observed. * notes significant difference.

The average number of bush crows in observed flocks was 4 (range 1-12). Flock size changed significantly throughout the day ($F=6.90$, $df=3$, $p=0.000$), with flock size in late morning significantly lower than in early morning or early afternoon. Other species were seen with bush crows in 51% of observations. The average total flock size was 6 (range 1-29). 27 different species were seen with bush crows. The most common species found in flocks with Ethiopian bush crow were superb starling, *Lamprotornis superbus*, in 27% of observations, followed by white-browed sparrow-weaver, *Plocepasser mahali* (8%), red-billed buffalo weaver, *Bubalornis niger* (6%), red-billed hornbill, *Tockus erythrorhynchus* (5%), white-headed buffalo weaver, *Dinemellia dinemelli* (5%), and ring-necked dove, *Streptopelia capicola* (2%).

Acknowledgements

The authors of the study are very grateful to the BP Conservation Awards Programme, Carnegie Trust, University of Glasgow, Peoples Trust for Endangered Species, Royal Geographical Society, African Bird Club, Glasgow Natural History Society and Edinburgh Trust 1 for their generous financial support of this project. We would also like to thank the local guides and drivers. We are also very grateful to Luca Borghesio for his excellent advice throughout the development of the project. The project would not have been possible without the initial assistance from Yilma Dellelegn and Nigel Collar to whom the authors are very grateful. We are also grateful to John Ash and Per Ole Syvertsen for their advice and guidance.

References

Ash, J.S. and Gullick, T.M. (1989) The present situation regarding the endemic breeding birds of Ethiopia. *Scopus.* **13,** 90-96

Bibby, C.J., Burgess, N.D., Hill, D.A. (2000) and Mustoe, S.H. Bird Census Techniques. Eds Bibby, C.J., Burgess, N.D., Hill, D.A. and Mustoe, S.H. 2nd edition. Academic Press, London.

Birdlife International (2000) Threatened birds of the World. Barcelona and Cambridge, UK: Lynx Edicions and Birdlife International.

Birdlife International (2005) Species factsheet: *Zavattariornis stresemanni.* Downloaded from http://www.birdlife.org on 23/12/2005

Borghesio, L., Giannetti, F., Ndang'ang'a K. And Shimelis, A. (2004) The present conservation status of *Juniperus* forest in the South Ethiopian Endemic Bird Areas. *African Journal of Ecology.* **42,** 137-143

Borghesio, L. and Giannetti, F. (2005) Habitat degradation threatens the survival of the Ethiopian bush crow *Zavattariornis stresemanni. Oryx.* **39,** 44-49

EWNHS (1996) Important bird areas of Ethiopia. Ethiopian Wildlife and Natural History Society, Addis Ababa, Ethiopia. pp185-187

Fishpool, L.D.C. and Evans, M.I. (2001) Important bird areas in Africa and associated islands: priority sites for conservation. Eds Fishpool, L.D.C. and Evans, M.I. 1st edition. Newbury and Cambridge, UK: Pisces Publications and Birdlife International.

Gedeon, K. (2006) Observations on the biology of the Ethiopian Bush Crow, *Zavattariornis stresemanni.* Bulletin of African Bird Club. **13,** 178-188

Robertson, A. and Jarvis, A.M. (2000) Oxpeckers in north-eastern Namibia: recent population trends and the possible negative impacts of drought and fire. *Biological Conservation.* **92,** 241-247

Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. (1998) Endemic Bird Areas of the World. Eds. Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. 1st edition. Burlington Press, Cambridge. pp382-383

Syvertsen, P.O. and Dellelegn, Y. (1991) The status of some bird species endemic to south Ethiopia. *Scopus*. **15**, 30-34