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Habitat associations of birds at Mara Naboisho Conservancy, Kenya

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Habitat associations of birds were quantified through fixed-radius timed bird counts at Mara Naboisho Conservancy within the Greater Mara Region, Kenya. We conducted 73 timed counts in four distinct habitats (riparian, woodland, rocky outcrop and plains) in both dry and wet seasons. During this survey, we observed 188 species of birds of which 140 were recorded during the timed counts. The riparian zone had the highest species richness, more than three times that of the plains. The woodlands and rocky outcrops had similar species richness. The mean number of species seen per count was higher in the riparian zone compared with the other three habitats. Bird species composition in the riparian zone and the plains were distinct from each other and from the woodlands and rocky outcrops, although they overlapped significantly in the last two mentioned habitats. The possible conservation implication of an increasing and/or immigrant elephant population and its likely effect on the vegetation is discussed in relation to bird community composition.

Associations d'habitat des oiseaux dans le parc Mara Naboisho Conservancy, Kenya

Les associations d'habitat des oiseaux ont été quantifiées au moyen de comptages d'oiseaux chronométrés et à rayon fixe dans le parc Mara Naboisho Conservancy au sein de l'ensemble de la région de Mara (Greater Mara Region), Kenya. Nous avons effectué 73 comptages chronométrés dans quatre habitats distincts (riverain, boisé, affleurements rocheux et plaines) pendant la saison sèche et la saison des pluies. Au cours de ce relevé, nous avons observé 188 espèces d'oiseaux dont 140 ont été notées pendant les comptages chronométrés. La zone riveraine contenait la plus grande richesse en espèces, plus de trois fois celle des plaines. Les bois et les affleurements rocheux comptaient une richesse en espèces comparable. Le nombre moyen d'espèces observées par comptage était plus élevé en zone riveraine que dans les trois autres habitats. La composition des espèces aviaires de la zone riveraine et des plaines étaient distinctes et elles l'étaient également par rapport à celles des bois et des affleurements rocheux, tout en se chevauchant sensiblement dans ces derniers habitats. Au titre de la conservation, les effets éventuels d'une population d'éléphants croissante ou immigrante sur la végétation est discutée par rapport à la composition de la communauté aviaire.

Keywords: bird community, habitat associations, Masai Mara, Naboisho Conservancy

Introduction

Savannas are globally important ecosystems of great significance to human economies. In Africa, savannas cover a significant portion of the continent and are host to a diverse assemblage of bird species (Sankaran et al. 2005). The drivers of African savannas are relatively well known, the most important of which include rainfall, fire, soils and herbivory (Scholes and Walker 1993). Of these, only fire and herbivory are likely to change at a particular locality within the short term, and both are amenable to some degree of human interference and control (Scholes and Walker 1993). Savanna ecosystems in East Africa are rarely stable and can experience rapid local changes from dense woodlands to open plains (Birkett and Stevens-Wood 2005). Despites numerous studies showing associations between birds and vegetation (e.g. Lack 1987; Skowno and Bond 2003; Sirami and Monadjem 2012), the influence of vegetation structure on avian communities is not well understood (Gaston 2000). In African savannas, riparian zones typically harbour a greater species richness of birds than adjoining scrub or woodland (Lack 1987; Mondjem 2005).

The Mara-Serengeti system harbours a diverse array of vertebrate species, the best known being the large mammals, including the large migratory herds of ungulates and associated predators (Serneels and Lambin 2001). The birds of the Mara-Serengeti ecosystem have received less attention, but basic species lists are available for the region, and some ecological studies have also been conducted (e.g. Sinclair et al. 2002; Virani et al. 2011). The avifauna of the Greater Mara Region is relatively well known in the Masai Mara National Reserve but is poorly known beyond its boundaries in the conservancies to the north of the reserve.

Bird species richness is high in the Greater Mara Region, with an official checklist of 566 species (Kennedy 2012). However, many of the species on this list occur in specific habitats (such as wetlands and forests) that are restricted within this region, in space and/or time. For example, no true forest patches occur within Mara Naboisho Conservancy, where this study was conducted. As a result, only 220 species of birds have been recorded at Mara Naboisho Conservancy (MV pers. obs.). How these birds are distributed across the savanna landscape is not well known, and their habitat associations are typically based on anecdotal observations rather than quantitative surveys.

The objectives of this study were to (1) compare species richness and diversity of birds inhabiting different habitats at Naboisho and (2) compare bird species composition between these habitats.

Study area

The Mara Naboisho Conservancy (hereafter Naboisho). is situated in the Greater Mara Region (GMR), south-western Kenya. The conservancy borders the Masai Mara National Reserve, as well as the Olare Orok and Ol Kinyei Conservancies. The conservancy aims to conserve biodiversity and simultaneously enhancing the livelihoods of the approximately 500 local Maasai landowners who leased the land in 2010 (Thompson et al. 2009). Naboisho is now the second largest conservancy in the region, covering just over 20 000 ha. Currently, there are eight established conservancies north of the Masai Mara National Reserve with a total area of 1 100 km^2 (C Courtney pers. comm.).

Methods

Four habitats were recognised at Naboisho (Figure 1). (1) Plains – open grasslands with at most the occasional bush or small tree extending above the grass canopy. This habitat covers much of the conservancy and comprises wide open grasslands dominated by *Themeda triandra* and *Pennisetum mezianum*. Sparse trees such as *Balanites* spp. occasionally dotted the open plains. (2) Woodland – varying amount of woody tree cover and occurring in patches throughout the conservancy, and predominantly comprising *Vachellia gerardii* (*Acacia gerardii*) and *Commiphora africana*. Other trees included *Balanites* spp. and *Dichrostachys cinerea*. Typically, this habitat consisted of short trees widely spaced within open grasslands. (3) Riparian – well-developed thickets and woodland along rivers and drainage lines comprising predominantly of tall-standing *Vachellia xanthophloea* (*Acacia xanthophloea*) and *Vachellia kirkii* (*Acacia kirkii*) with shorter stands of *Euclea*, *Albizia* and *Oleander* species. There were also large-crowned *Ficus sycomorus* trees found here. (4) Rocky outcrops – shrubs and thickets growing on rocky situations along ridges. Short shrubs and trees consisting of *V. gerrardii* and *Vachellia drepanolobium* (*Acacia drepanolobium*) were the most dominant species here.

Bird surveys were conducted over a one-week period in the dry season (October 2011), and repeated in the wet season (April 2012). A checklist for Naboisho Conservancy was prepared by recording every bird species seen during the entire survey. The bird community was surveyed by means of 50 m fixed-radius timed point counts (Hutto et

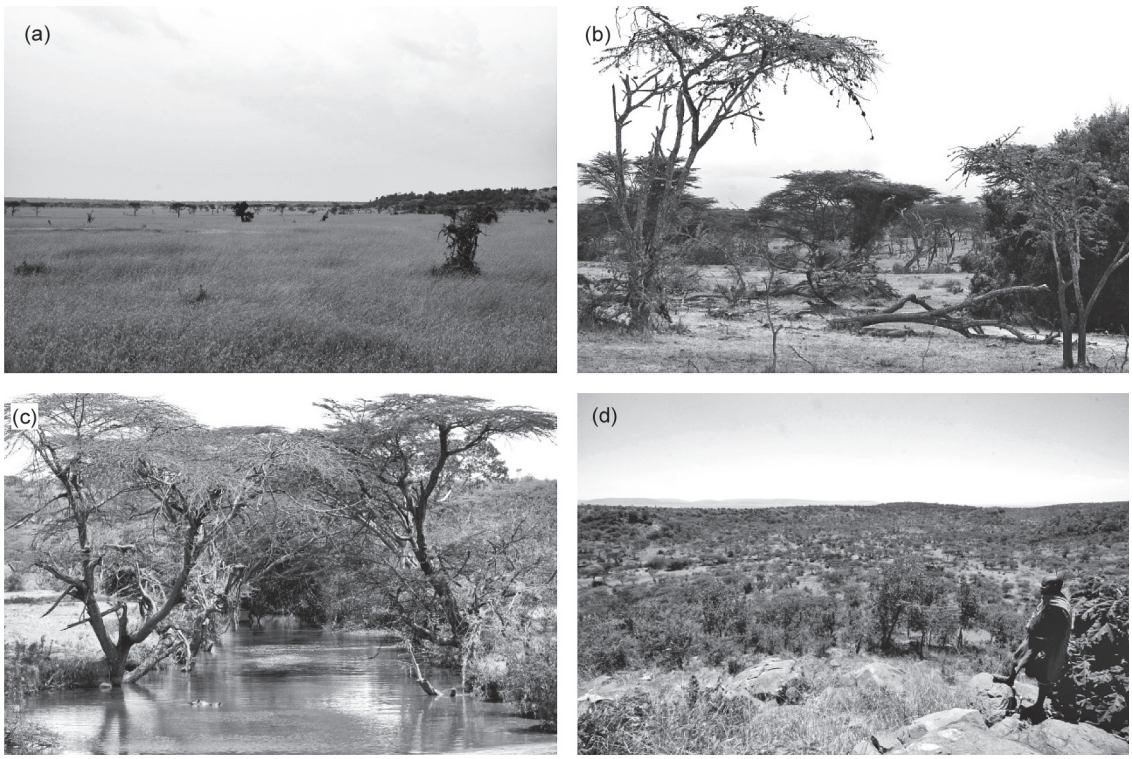

Figure 1: The four habitats recognised at Mara Naboisho Conservancy. (a) Plains, (b) woodland, (c) riparian and (d) rocky outcrops

al. 1986). We used a fixed width because we deemed this the best approach for maximising our limited time spent locating birds at Naboisho. We took a GPS reading (using a Garmin eTrex) at the centre of each point, and we used the GPS to measure out 50 m from the centre allowing us to demarcate the boundary of the point. Timed counts were conducted over four mornings between 07:00 and 11:00 to maximise the chances of observing birds. A total of 73 timed counts were conducted in the four habitats. Each habitat was sampled at least three times and rotated in the order in which sampling began. So, for example, if the wooded savanna habitat was sampled at 07:00 on the first day, then on the second day it was sampled at 08:30 and on the following day at 10:00 and so on. Each timed count was commenced once the two observers had arrived at the centre of a point. We counted all birds seen or heard, within a 50 m radius, during a 5 min period. When the time was up, we walked to the next point. We sampled eight points per habitat per day, and we visited three different habitats each day. where all birds observed over a 5 min period were recorded over eight transect points per habitat spaced at least 200 m apart. To the best of our ability, the double counting of birds was avoided. This was only really an issue with the larger birds (such as raptors, hornbills, storks and francolins) that were capable of rapid long-distance movements.

An analysis of variance (ANOVA) was used to compare mean species richness in the four habitats. A Tukey test was used to determine where the difference between the habitats laid. All statistical analyses were conducted in R (R Development Core Team 2010). All multivariate statistics were performed using the software package PRIMER (Clarke and Gorley 2001). Non-metric multi-dimensional scaling (MDS) was used to plot the 73 locations of the timed counts. Bray–Curtis similarities were computed on the square-root of the number of bird species recorded at each location, so as to down-weight the contributions of a few superabundant species in relation to rarer species (Clarke and Warwick 1994). ANOSIM (based on the Bray–Curtis similarities) was used to detect significant differences between the four habitats. Finally, SIMPER was used to determine which species contributed most to each of these four habitats.

Results

A total of 188 species of birds were recording during the two surveys, of which 104 were seen during the dry season visit and 102 in the wet season. Species accumulation curves for all the habitats combined and for each individual habitat showed upward trends without reaching an asymptote, although all the curves had started to taper off somewhat (Figure 2). Of these species, 140 (based on 743 individual sightings) were seen during the timed counts and all subsequent analyses are based on these data.

The riparian habitat had the highest species richness, followed by woodland, rocky outcrop and plains (Table 1). Mean number of species recorded per timed count was 10.2 across all four habitats. There were significant differences in the mean number of species recorded per timed count in these habitats ($F_{3,69} = 16.74$, $p < 0.05$; Figure 3). However, only the mean species richness of the riparian habitat was significantly different from any other habitat (Tukey test; $p < 0.05$); the remaining three habitats were not significantly different from each other (Tukey test; $p > 0.05$).

The MDS ordination of the 73 locations resulted in relatively good separation between the four habitats, namely riparian, woodland, rocky outcrops and plains (Figure 4). These four habitats differed significantly from each other with respect to their bird species communities (ANOSIM; $R = 0.531$, $p < 0.01$). Between 13 and 19 bird species contributed 50% of the dissimilarity between the four habitats (Table 2). The plains were typically characterised

Table 1: Number of species recorded in the four different habitats at Naboisho

	Riparian	Woodland	Rocky outcrop	Plains
Number of species	88	66	59	29
Number of Red List species	1	1	1	1

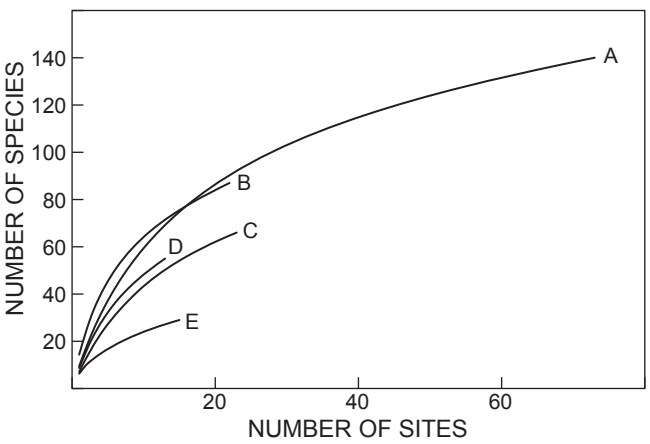

Figure 2: Species accumulation curves for birds at Naboisho. A = all records, B = riparian records, C = woodland records, D = rocky outcrop records, E = plains records

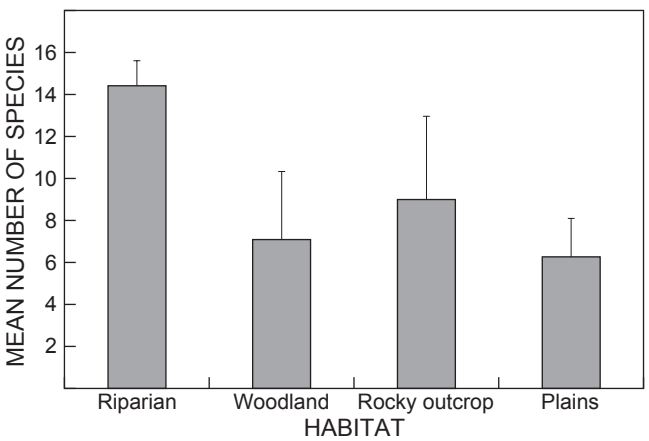

Figure 3: Mean number of bird species recorded per timed count in each of the four habitats at Naboisho

by pipits, larks and cisticolas, whereas the riparian habitat was distinguished by a taxonomically diverse group of birds typically associated with thicket and gallery woodland, such as *Cossypha heuglini*, *Laniarius funebris* and *Apalis flavida*. The distinction between the bird community associated with woodland and rocky outcrops was not as clear as that between other habitats.

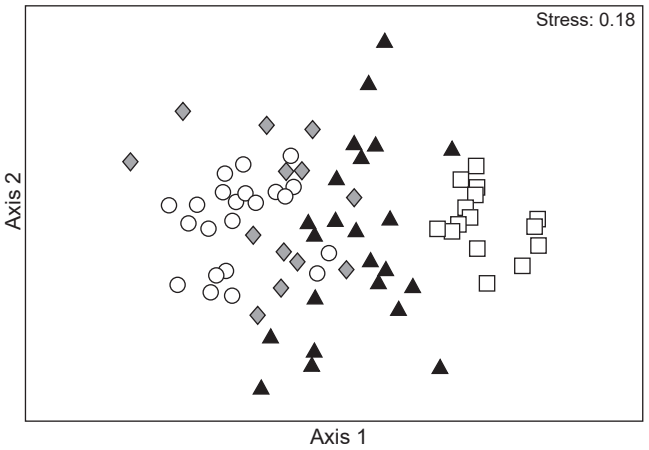

Figure 4: Non-metric multidimensional scaling of the 73 locations using timed counts of birds. Open squares = woodland, grey diamonds = rocky outcrops; open circles = riparian; and filled triangles = plains

Discussion

We emphasise that this study was by no means an exhaustive survey of the birds of Naboisho, something that is not possible in the short timeframe of this study. In fact, the 188 species recorded during the study period represent just 64% of the 220 species on the official, but unpublished, Naboisho checklist (MV pers. obs.). This is further corroborated by the fact that the species accumulation curve (Figure 2) had not yet reached an asymptote. However, this study aimed to elucidate the habitat associations of the birds at Naboisho, and for this purpose the data are adequate.

The four habitats at Naboisho support different bird communities, with those of the plains being the most distinct. The plains typically supported a species-poor assemblage of mostly ground-dwelling birds, such as pipits, larks and cisticolas (Table 2, Appendix 1). This association is not surprising as these are typical grassland birds, foraging on the ground and nesting either on the ground or low down within the grass layer. The plains are structurally the simplest of the habitats at Naboisho, resulting in fewer niches being available, and

Table 2: Species contributing a cumulative 66% of the dissimilarity between the four habitats at Naboisho. Species are listed in order of importance

Riparian/Woodland	Riparian/Rocks	Riparian/Plains	Woodland/Rocks	Woodland/Plains	Rocks/Plains
Psalidoprocne fuliginosa[a]	*Psalidoprocne fuliginosa*[a]	*Psalidoprocne fuliginosa*[a]	*Cinnyris mariquensis*[c]	*Cisticola brunnescens*[d]	*Mirafra africana*[d]
Cinnyris mariquensis[a]	*Cinnyris mariquensis*[a]	*Mirafra africana*[d]	*Cisticola chiniana*[c]	*Hirundo rustica*[d]	*Cisticola brunnescens*[d]
Cisticola chiniana[b]	*Cisticola chiniana*[a]	*Cisticola brunnescens*[d]	*Streptopelia capicola*[b]	*Mirafra africana*[d]	*Hirundo rustica*[d]
Cossypha heuglini[a]	*Laniarius funebris*[a]	*Hirundo rustica*[d]	*Dicrurus adsimilis*[c]	*Vanellus coronatus*[d]	*Vanellus coronatus*[d]
Laniarius funebris[a]	*Cossypha heuglini*[a]	*Cinnyris mariquensis*[a]	*Laniarius funebris*[c]	*Anthus cinnamomeus*[d]	*Cinnyris mariquensis*[c]
Camaroptera brachyura[a]	*Dicrurus adsimilis*[c]	*Vanellus coronatus*[d]	*Batis molitor*[b]	*Cisticola chiniana*[b]	*Anthus cinnamomeus*[d]
Pycnonotus barbatus[a]	*Pycnonotus barbatus*[a]	*Laniarius funebris*[a]	*Francolinus coqui*[c]	*Batis molitor*[b]	*Cisticola chiniana*[c]
Batis molitor[b]	*Francolinus coqui*[a]	*Cisticola chiniana*[b]	*Mirafra africana*[b]	*Streptopelia capicola*[b]	*Dicrurus adsimilis*[c]
Streptopelia capicola[b]	*Streptopelia capicola*[c]	*Anthus cinnamomeus*[d]	*Turtur chalcospilos*[c]	*Anthus similis*[d]	*Laniarius funebris*[c]
Francolinus coqui[a]	*Chalcomitra senegalensis*[a]	*Cossypha heuglini*[a]	*Hirundo rustica*[c]	*Coracias caudatus*[d]	*Anthus similis*[d]
Gyps africanus[a]	*Apalis flavida*[a]	*Camaroptera brachyura*[a]	*Lamprotornis superbus*[c]	*Cisticola juncidis*[d]	*Turtur chalcospilos*[c]
Cercotrichas leucophrys[a]	*Gyps africanus*[a]	*Pycnonotus barbatus*[a]	*Serinus dorsostriatus*[c]	*Terathopius ecaudatus*[d]	*Cisticola juncidis*[d]
Chalcomitra senegalensis[a]	*Cercotrichas leucophrys*[a]	*Francolinus coqui*[a]	*Bradornis microrhynchus*[c]	*Lamprotornis hildebrandti*[b]	*Terathopius ecaudatus*[d]
Mirafra africana[b]	*Pogoniulus pusillus*[a]	*Gyps africanus*[a]	*Lamprotornis purpuroptera*[c]		*Francolinus coqui*[c]
Apalis flavida[a]	*Batis molitor*[a]	*Chalcomitra senegalensis*[a]	*Crombec whytii*[c]		
Corythaixoides personatus[a]	*Hirundo rustica*[c]	*Cercotrichas leucophrys*[a]	*Pycnonotus barbatus*[c]		
Pogoniulus pusillus[a]	*Turtur chalcospilos*[c]	*Anthus similis*[d]	*Tockus deckeni*[b]		
Hirundo rustica[a]	*Dendropicos goertae*[a]	*Pogoniulus pusillus*[a]	*Apalis flavida*[c]		
Dicrurus adsimilis[a]	*Rhinopomastus minor*[c]				
Halcyon chelicuti[a]	*Crombec whytii*[c]				
Terpsiphone viridis[a]					
Halcyon leucocephala[a]					

[a] Predominantly in riparian
[b] Predominantly in woodland
[c] Predominantly in rocky outcrops
[d] Predominantly in plains

hence fewer bird species occupying this habitat. The riparian zone supports a structurally complex habitat, with a diverse bird community associated with it. Similar observations were made at Tsavo National Park in eastern Kenya (Pearson and Lack 1992).

The mean number of species recorded during the timed counts was higher only for the riparian zone; the other three habitats did not differ significantly in this regard. This is at first glance rather surprising, considering the far higher species richness in the woodlands and rocky outcrops than in the plains (Table 1). This suggests that at the scale of a timed count (less than 1 ha), the number of bird species supported by these three habitats is similar. The higher diversity in woodland and rocky outcrop therefore can be explained by a greater turnover in these habitats as one moves across the landscape at a higher scale (for example, over 10 ha or more). Within the plains, however, the same species occur throughout with little, or no, turnover at the same scale. The higher mean number of species recorded in the riparian zone may be related to the greater structural diversity of this habitat (Monadjem 2005).

There are possible conservation implications of this study, the most obvious one being the potential effect of increasing elephant numbers in the region. Although the Greater Mara Region has experienced a decline in its non-migratory herbivore populations (Ogutu et al. 2011), the number of elephants in the region have remained stable and the creation of new wildlife conservancies with tracts of undisturbed woodland has resulted in a large number of elephants using this relatively 'newer' habitat (Ottichilo et al. 2000). The negative relationship between elephant numbers and woody biomass has been well established across Africa (Dublin et al. 1990). As a result, the Serengeti has experienced a gradual opening up of its wooded habitats as trees get pushed over by elephants at a faster rate than they can regenerate. In Laikipia County of Kenya, *Vachellia drepanlobium* trees were monitored from 1998 to 2001, a period that included 12 months when rainfall was 60% below average and elephants were responsible for the loss of 40% of the trees (Birkett and Stevens-Wood 2005). These findings have implications for research into the causes of instability in savanna ecosystems and the management of enclosed reserves. Pellew (1983) showed that elephants were largely responsible for the damage of *Vachellia tortilis* (*Acacia tortilis*) trees in the Seronera grasslands of the Serengeti at an annual rate of 6%.

What happens to the bird community during such a transition has not yet been documented and this study is an exploratory approach towards getting a better understanding of how vegetation dynamics of the Mara-Serengeti ecosystem affects avifaunal communities. Sirami and Monadjem (2012) showed that as woody vegetation in the form of bush encroachment increased, grassland birds disappeared and were replaced by birds associated with thickets. We suspect that the reverse of this pattern will be shown in Naboisho in the next decade or two, with grassland birds replacing woodland and thicket birds. This is particularly worrying since the birds associated with plains in Naboisho constitute only a small number of widely distributed and abundant species, none of which are currently threatened with extinction. In contrast, the nine Near Threatened and Threatened species of birds recorded during this survey were all raptor species that breed in large trees, predominantly in the riparian zone. Hence, we recommend that the bird community at Naboisho be closely monitored over the next decade to determine whether such expected changes are observed or not. Birds have been widely regarded as a key element in monitoring biodiversity to assess ecosystem health. We believe that while birds are unlikely to be an umbrella or indicator taxon for other biota (other vertebrates, invertebrates, plants and micro-organisms), they do represent a taxon that can be efficiently and inexpensively monitored. At Naboisho, there is the capacity to mobilise local Maasai guides to undertake bird surveying. While there are many limitations to acquiring high-quality information (scale, dynamism, mobility and paucity of observers over much of the rangelands), we consider that these can be dealt with sufficiently well to justify the use of birds as a key component of biodiversity monitoring for conservancies.

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