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Responses of large wetland birds to human disturbances: results from experimental bird approaches in areas with different protection status in western Tanzania

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Key words: Flight distances, Large waterbirds, Malagarasi wetlands, Site protection status.

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Abstract

Flight distances are quite often used to establish wildlife responses to humans. It is generally hypothesised that animals in protected areas are more sensitive to approaching humans than in areas where animals may coexist with humans at high densities. But this hypothesis may not hold true if animals are persecuted. A field experiment was designed on three large wetland birds, two 'Vulnerable' and CITES Appendix II; Shoebill *Balaeniceps rex* and Wattled Crane *Bugeranus carunculatus* and one 'Least Concern' Saddle-billed Stork *Ephippiorhynchus senegalensis,* in areas with different protection status to test the effect of protection gradient on flight distances. Because Shoebill and Wattled Crane are restricted in western Tanzania and all the three species in this study are trapped it was also expected they should respond to the hunting pressure. The study found that birds were more wary in heavily protected area with longer flight initiation distance (83.75 ± 18.84 m) than in unprotected (57.24 ± 23.53 m), conforming to the first hypothesis. However, flight distances for Saddle-billed Stork did not differ significantly among the sites. In addition, Shoebill formed tight flocks in heavily protected area when flushed suggesting that birds were responding to persecution familiarity. Allegations of illegal bird trapping in protected areas were also rampant and insufficient on-site law enforcement was noted. Given the small population of the Wattled Crane and Shoebill in Tanzania (< 500 individuals for each species), the study recommends suspension of trapping and trade of the two species, and improving on-site law enforcement.

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Introduction

Flight initiation distance (hereafter FID), a distance at which an animal moves away from approaching perceived threat (Ikuta and Blumstein, 2003), has been used extensively to establish animals responses to human disturbances (de Boer *et al.* 2004; Blumstein *et al.,* 2005; Baines and Richardson, 2007). More studies have been carried out on avian than any other taxa (Blumstein *et al.,* 2005), with fewer studies on reptiles (Cooper *et al.,* 2008) and mammals (de Boer *et al.,* 2004). While many were carried out to establish the minimum distances required for management purposes such as creation of buffer zones and path networks in recreation sites (Rodgers and Schwikkert, 2002) or assess FIDs as indicators of birds' adaptation to urbanization (Lin *et al.,* 2012), very few studies exist to compare the response of birds along protection gradients (Fernández-Juricic *et al.,* 2004), although it is generally hypothesised that most animals especially birds respond to approaching humans differently in areas with different protection status (Magige *et al.,* 2009).

In many parts of the world, protected areas are designed to control adverse anthropogenic activities (Chape *et al.,* 2005; Banda *et al.,* 2006) and this leads to animals in protected areas to become more sensitive to human presence especially in those with little recreation activities and thus fewer human visitation (Ikuta and Blumstein, 2003). But when animals are persecuted they may show longer flight distances irrespective of site protection status (Burger and Gochfeld, 1991; de Boer *et al.,* 2004; Thiel *et al.,* 2007). In addition, other factors such as age, body size, weather condition, starting distance, flock size and vegetation structure affect the flight distances (Blumstein, 2003; de Boer *et al.,* 2004; Laursen *et al.,* 2005).

Wildlife habitats in Tanzania can be categorized as heavily or strictly protected areas (national parks and game reserves), partially protect areas (forest reserves, game controlled areas and game open areas) and areas with no protection (they include communal or public lands) (Caro, 1999; Stoner *et al.,* 2007). In addition, the Wildlife Conservation Act of 2009 (MNRT, 2009) recognises 'Wetland Reserves' and 'Wetland Areas' as one of the protected area categories but do not formally acknowledge the Ramsar sites as protected areas and unfortunately to date no wetland protected area has been established in Tanzania. Consequently, management effectiveness of Ramsar sites in Tanzania is uncertain (Mombo *et al.,* 2011). It is on the above basis that a field experiment was designed on three large wetland birds, two of conservation significance (both under AEWA, IUCN category: Vulnerable and listed in Appendix II of CITES), Shoebill *Balaeniceps rex* [Gould 1850] and Wattled Crane *Bugeranus carunculatus* [Gmelin 1789] and the 'Least Concern' Saddle-billed Stork *Ephippiorhynchus senegalensis* [Shaw 1800] (BirdLife International, 2014), in three areas with different protection status within the Malagarasi-Moyovosi Ramsar Site (hereafter MMRS) in western Tanzania. Shoebill and Wattled Crane are both legally and illegally trapped from western Tanzania where they are restricted for international export but reliable secondary data are difficult to obtain. The Saddle-billed Stork is widely distributed in all suitable wetlands throughout the country but congregations are rare. Baker (1996) estimated that 500 individuals of Saddle-billed Stork were being captured each year for the international bird trade.

In this study it was hypothesised that: (1) birds to show longer flight distances in heavily protected areas than in least or no protection. (2) birds to show longer flight distances in areas where they are persecuted irrespective of the site protection status. It is also important to note that the effectiveness of protected areas as defined by Chape *et al.* (2005) in the study area was largely unknown at the time of our experimental design.

Materials and methods

Study sites

Fieldwork took place in the core wetland area of MMRS (3–6°S 30–32°E). The area is comprised of major rivers (confluence), two major lakes, permanent swamps and floodplains. At one time especially at low flood it hosts c.50% of the estimated total Tanzanian population of Shoebill and Wattled Crane (Kaaya *et al.,* 2007). Because 95% of the MMRS is within protected areas and the balance is in district or communal lands, we therefore selected three sites to represent a protection gradient. They are; Kigosi-Moyovosi Game Reserves (henceforth Chagu, the closest village), Luganzo Game Controlled Area/Mpanda Line Forest Reserve (henceforth Lumbe, the swamp) and the communal wetland (henceforth Kasisi, the closest village) (Fig. 1).

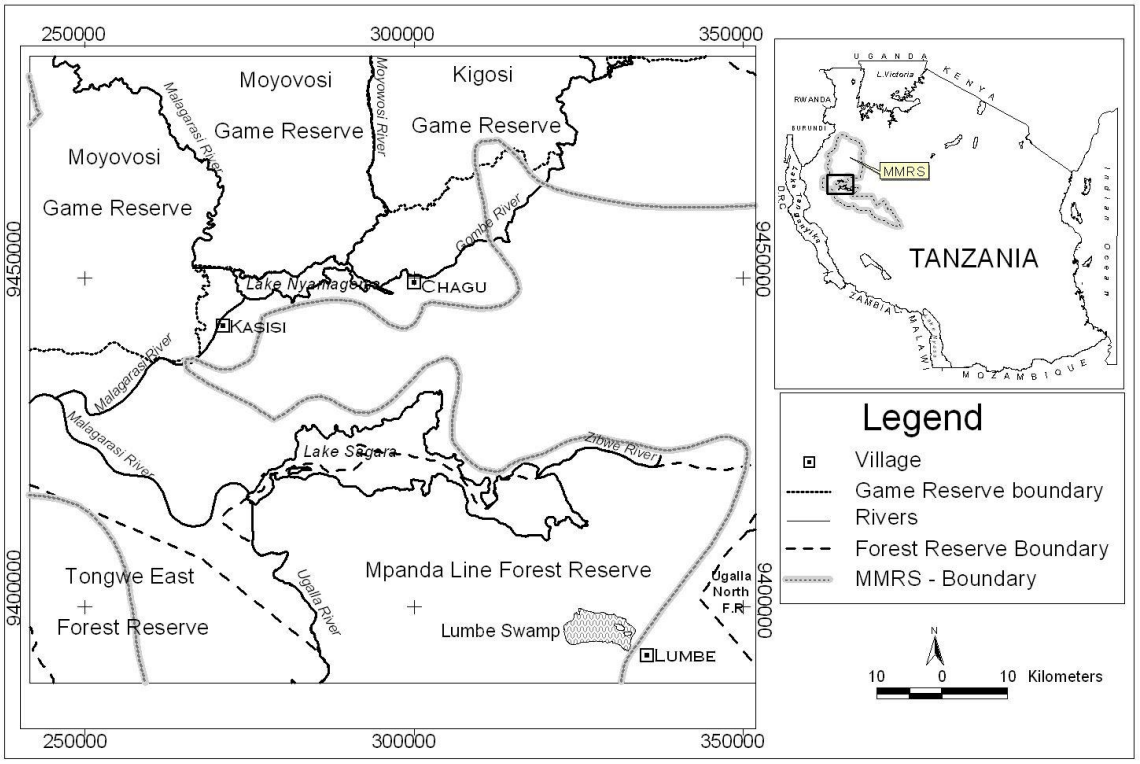


Fig. 1. Map of the study sites within the core wetland area of MMRS, the three villages Lumbe, Kasisi and Chagu are used throughout this manuscript to refer to LumbeSwamp (Mpanda Line Forest Reserve/Luganzo Game Controlled Area), communal wetland and the Kigosi-Moyovosi Game Reserves, respectively.

According to the Tanzania wildlife legislations, no temporary or permanent settlements or grazing are allowed in game reserves and game controlled areas/forest reserves prohibit human settlements but grazing permits can be obtained from relevant authorities. Hunting and fishing are also supposed to be regulated by licensing (MNRT, 2009). Because human activities affect flight distances, and because people were scared of the research team to be counted in the field, human presence was accounted by counting traditional fishing boats, permanent and seasonal fish camps, and pastoralist houses in the three study sites (Table 1).

In most areas, the vegetation was open, short-laying and or floating. Tall vegetation dominated by *Cyperus papyrus* [L.] and *Typha capensis* [Rohrb. N.E.Br.]. *Miscantus violaceus* [K.Schum. Pilg.] was also common but not used by the study species. Dense-short floating vegetation was characterized by *Eleocharis dulcis* [Burm.f., Trin.ex Hensch.] and *Nymphae* spp [Thunb & L.] while *Vossia cuspidate*

[Roxb. Griff], *Oryza longistaminata* [A. Chev.], *Leersia hexandra* [Sw.], and *Cyperus articulatus* [L.] dominated the floodplains and inundated grasslands. Detailed account on vegetation of this area is given by Ndangalasi *et al.* (2005).

Table 1. Indices of human presence in the study sites. Pastoralist houses were counted within respective sites but traditional fishing boats were counted at fish landing points or fishing camps not necessarily within the respective study sites and fishing was not confined in any one locality and it took place in open waters, swamps and floodplains. No pastoralist houses were located at Lumbe Swamp because it is easily accessible and pastoralists stay in the village or surrounding woodland.

Sites	Protection status	Fish camps		Total number of boats	Pastoralist houses
		Permanent	Seasonal		
Kasisi	No protection (Communal land)	11	3	370	10 (from 3 locations)
Lumbe	Partially protected (Game controlled area)	4	10	40	-
Chagu	Heavily protected (Game reserves)	6	9	255	191 (from 4 locations)

Study species

The three species were selected because; (1) Shoebill and Wattled Crane are restricted in western Tanzania and their population is in low hundreds (Beilfuss *et al.,* 2005; BirdLife International, 2014) while Saddle-billed Stork is found in all suitable wetlands in Tanzania (Baker, 1996) and locally common in MMRS which made it worth being included; (2) they are legally and illegally trapped; (3) they are among the tallest and largest wetland birds (Wattled Crane is c.175 cm, c.9 kg; Shoebill c.150 cm, c.7 kg; Saddle-billed Stork c.150 cm, c.7.5 kg), their set-back distances – the minimum distance that a man may approach before the bird is disturbed (Rodgers and Smith, 1995) would embody that of many other species because large birds are more sensitive to humans; (4) their ecological information is limited and finally, (5) the three species are wetland dependent with different degrees; Shoebill forage solitarily by stand-and-wait for fish to surface, Saddle-billed Stork forage on small fishes, reptiles, amphibians and invertebrates (Kasoma and Pomeroy, 1987) whereas Wattled cranes predominantly fed on sedge roots in shallow and soft ground. Saddle-billed storks forage in loose pairs or singly (Kall, 1973) whereas wattled cranes live in either pairs or groups.

Data collection

The fieldwork was conducted from June 2010 to mid-January 2011 and June to September 2011 thereby avoiding high floods and heavy rain season (January–May). A subject bird once located were approached by walking towards it at a constant pace of about 0.5m/s while maintaining eye contact as suggested by Cooke (1980) and Blumstein (2003). Two people usually approached resting or hunting birds, foraging bird were not approached because feeding may effectively blind them. Birds that flew >1 km or took to cover were ignored. When a pair was located, except for wattled cranes which took wing together and landed together, only one individual became a focus of our study. Observers avoided approaching young, groups and nesting birds. Pseudo-replication was avoided by rotating visits at least one week later.

Starting distance (hereafter SD), the distance from where the observer started walking up to the original position of the bird, FID and distance of flushing (hereafter DF), a distance between original location to the next landing point when flushed were measured by converting footsteps/pace into metres and by use of rangefinder (7*26, 5-1600 yds, Bushnell). Although very little is known about DF for birds most probably because of complexity of birds' habitats, our

preliminary observations on the study species had indicated that they landed within sight when flushed and habitats were less complex to affect visibility.

In addition to distances, two environmental parameters were recorded; vegetation height and water depth. Water depth was measured by cm-marked rod at bird original point while vegetation height was taken at three different points (at where the observers started walking, at the point where FID was established and at the original bird position) and the average was used in the analyses. To avoid losing the focal bird, coloured flag tapes were placed on points for vegetation measurements which were taken later after the flight distances were established; this also helped to reconfirm the FID and SD. All data were gathered concurrently by three different teams, the author constantly switched between sites throughout the study period.

Statistical analyses

Both partial (variables controlled for the effect of species and sites) and bivariate (Pearson) correlations were used to assess the effects of environmental parameters and SD on FID. Parametric analyses especially independent *t*-test and one way analysis of variance (ANOVA) were used to determine whether FID/DF varied with location and between species. But when normality was not assumed non-parametric Kruskal-Wallis *H*-test was used and all adjustment were made using Bonferroni Post Hoc Test of multiple comparisons (Beal and Khamis, 1991). Homogeneity of variances was tested by Levene's tests. All tests were two tailed, $P = 0.05$ was used as a cut point to determine significance. All statistical analyses were conducted using SPSS for Windows (SPSS ver. 16.0, Chicago, IL, USA) and data are presented as mean ± SD throughout the text except where stated otherwise.

Results

FID, SD and environmental correlates

A total of 273 approaches were conducted towards three study species; 82, 87 and 104 for Shoebill, pairs of Wattled Crane and Saddle-billed Stork, respectively. Pooled data showed that Wattled Crane had the highest FID (97.83 ± 23.24 m) followed by Saddle-billed Stork (77.72 ± 22.56 m), while Shoebill had the least FID (71.62 ± 24.48 m). Flight initiation distances differed significantly among species ($F_{(2,270)} = 29.99$; $P < 0.001$). Bonferroni Post Hoc Test of multiple comparison showed statistically significant differences in FID between Wattled Crane and Shoebill ($P < 0.001$), Wattled Crane and Saddle-billed Stork ($P < 0.001$), but not between Saddle-billed Stork and Shoebill ($P = 0.235$).

Of the three variables, starting distances, water depth and vegetation heights measured in this study, only water depth was significantly correlated with FIDs (Table 2). Birds controlled for species delayed responses when in deeper water ($r = -0.436$; $P < 0.001$), but this did not hold true for Wattled Crane and Saddle-billed Stork when each species were treated separately instead it improved the correlation for Shoebill ($r = -0.524$; $P < 0.001$). Wattled Crane and Saddle-billed Stork were located in both dry and shallow waters than Shoebill (Fig. 2). Additionally, shoebills were found in taller vegetation (55.82 ± 12.29 cm) than wattled cranes (36.56 ± 16.01 cm) and saddle-billed storks (36.61 ± 15.59). However, in addition to vegetation height and starting distance, water depths did not differ significantly among sites for all the three species [Shoebill; $F_{(2,81)} = 0.712$; $P = 0.494$, Wattled Crane; $F_{(2,86)} = 0.697$; $P = 0.501$, Saddle-billed Stork; $F_{(2,103)} = 0.932$; $P = 0.051$]. The lack of significant difference among sites not only indicates that the variables pose no significant effects to flight distances when species flight distances are compared among sites but also it shows that the three species selected micro-habitats (vegetation height and water depth) consistently in all sites.

Wattled cranes and saddle-billed storks remained at Lumbe swamp throughout the survey period while shoebills vacated when water started to recede and returned at high floods. Only eight (8) shoebills were recorded at Lumbe swamp during the entire period of

our study. As water recedes a large portion of this swamp is burnt and grazed making it difficult for shoebills to stay.

Table 2. Partial correlation between birds' flight initiation distance (FID) and water depth, vegetation height and starting distance controlled by sites, species, and sites and species.

Control variables		Water depth	Vegetation height	Starting distance
Sites	Correlation	-0.384	-0.026	-0.013
	Significance (2-tailed)	**0.000**	0.674	0.836
	Df	270	270	270
Species	Correlation	-0.436	-0.009	0.026
	Significance (2-tailed)	**0.000**	0.889	0.666
	Df	270	270	270
Sites & Species	Correlation	-0.421	0.006	-0.007
	Significance (2-tailed)	**0.000**	0.919	0.903
	Df	269	269	269

Significant correlations ($P<0.05$) are bolded.

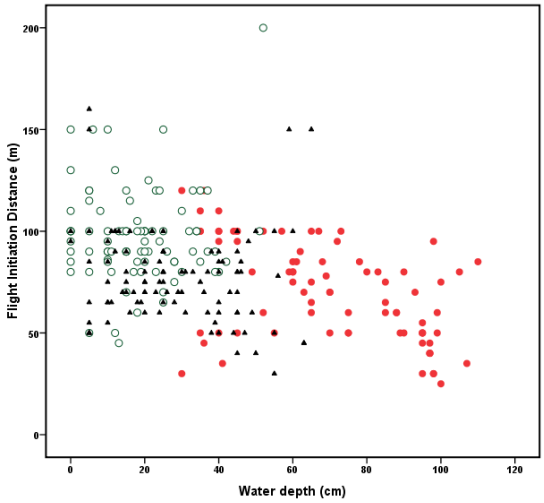


Fig. 2. Water depths negatively correlated with FID but the effect was stronger for Shoebill (solid circles). All shoebills were located at water depth > 25 cm. Both Wattled Crane (open circles) and Saddle-billed Stork (solid triangles) were found in dry to shallow waters.

Flight distances along protection gradient

Variation was found for both FIDs and DFs for all species between sites (Fig. 3). An independent samples *t*-test revealed a statistically significant difference between Chagu and Kasisi for FID (t = 5.33; df = 72; P < 0.001) and DF (t = 8.518; df = 72; P < 0.001). Birds in Chagu were more wary (FID; 83.75 ± 18.84 m; DF; 391.67 ± 86.60 m) than those approached at Kasisi (FID; 57.24 ± 23.53 m; DF; 181.58 ± 121.60 m). Although shoebills usually forage solitarily and at good foraging sites they hardly forage within 50 m from each other, but at Chagu (Heavily protected) they repeatedly formed compact assemblages (3–20 individuals) when flushed, a behaviour that was not observed elsewhere.

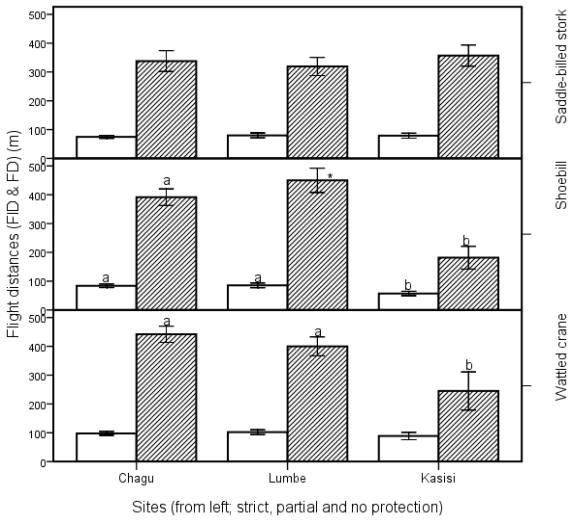


Fig. 3. Flight initiation distance, FID (open bars) and fleeing or flushing distance, FD (hatched bars) ($\bar{X} \pm 2SE$) between sites for the three study species. Different letters within panels denote statistical significance at P < 0.05 and comparison is made for FID and FD separately for each species among sites, * not included in inferential statistical analysis due to small sample size ($n = 8$).

Analysis of variance showed significant difference for DF among species ($F_{(2,270)}$ = 10.85; P < 0.001) and

among sites ($F_{(2,270)}$ = 32.26; P < 0.001). Bonferroni Post Hoc Test revealed a statistically significance difference between Shoebill and Wattled Crane (P < 0.001) and Wattled Crane and Saddle-billed Stork (P = 0.017). Wattled Crane had the highest DF (389.31 ± 121.57 m), followed by Saddle-billed Stork (338.0 ± 103.89 m) and Shoebill (300.0 ± 151.13 m). Wattled Crane did not show any significance difference between sites for FID ($F_{(2,84)}$ = 1.86; P = 0.162) but did show significant difference for DF ($F_{(2,84)}$ = 22.19; P < 0.001) between sites, DF being significant between Kasisi and Chagu/Lumbe (P < 0.001) but not Lumbe and Chagu (P = 0.240). Overall Wattled Crane showed longer DF at both Lumbe (400 ± 95.35 m; n = 34) and Chagu (441.89 ± 86.21 m; n = 37) than did at Kasisi (245.0 132.67 m; n = 16). Saddle-billed Stork did not show any significant differences between sites for both FID ($F_{(2,101)}$ = 0.540; P = 0.584) and DF (H = 0.656; df = 2; P = 0.720) and post hoc test for multiple comparisons did not show any other significant differences for either FID or DF between sites for this species.

Discussion

Wattled Crane had longer flight distances than others most probably because it is slightly taller and heavier. The subject on how body mass/length relate to bird's escape distances is well documented (Laursen *et al.,* 2005). On the other hand in addition to being less heavy the Shoebill food availability is restricted in hypoxic swamps especially in dry season which are not always easy to locate (John, 2013). Shoebill may have valued much of its foraging sites for food availability which increased the benefits to stay. Although there is very little information on flight distances for the study species but Abebe (1998) reports that in Boyo, Ethiopia, Wattled Crane can be approached to between 40–50 m while at Kafue flats, Zambia, Bokatch (2002) found a mean of 197.3 m in ten approaches for this species. Nesting shoebill can allow approaching human to within 30 m (Buxton, 1978). Therefore, our general flight distances although may be within range but cannot be compared with those estimates. For example, the Zambia study was conducted when the area was completely grazed and wattled cranes were nesting, making them more wary. Unlike in Boyo, where they forage in maize stubbles, Wattled Crane in western Tanzania has never been reported in croplands.

Vegetation structure and starting distance do not appear to play a major role to the tallest wetland birds as they can spot approaching human at distant. The study species preferred short-vegetated swamps where vegetation height was less than half way up their body throughout the study sites and they could see over it. Data presented in this study mirrors that of Fernandez-Juricic *et al.* (2005) who found that vegetation structure not to affect high latitude grassland species because of low variability in visibility. Saddle-billed Stork and Wattled Crane used both dry and shallow waters and this could explain the lack of correlation between FID and water level for these species. The association between FID and water depths for Shoebill could be explained in terms of its life history. In additional to wading Shoebill has adapted to walking on floating swamp vegetation due to possession of long toes allowing it to use deeper water than any other large wading birds which are limited by their morphology (Baker, 1979; Ntiamoa-Baidu *et al.,* 1998). Second, shoebills nests are surrounded by open water as it is for wattled cranes, a strategy to deter terrestrial predators, but shoebills chicks stay longer on nest (>100 days) (Buxton *et al.,* 1978) while wattled cranes chicks can swim and walk to follow their parents within days of hatching. The longer stay of shoebills chicks at nest may have allowed them to learn that being in deeper water is safer for approaching threat.

Although the longer flight distances in heavily protected areas may have conformed to our first hypothesis, but other aspects such as formation of compact groups by shoebills and the lack of significant differences in flight distances for Saddle-billed Stork along the protection gradient suggest that other factors may be playing a significant role. The fact that daily human activities except trapping were

common across the study sites (Table 1) in contrast with our earlier expectation that human activities are not common in strictly protected area is another explanation that birds were not only responding to site protection status. Furthermore, the formation of compact groups might indicate increased wariness in any given situation (Caraco *et al.,* 1980; Metcalfe, 1984). The more likely explanation therefore is that shoebills and wattled cranes were responding to persecution familiarity. Lack of variation in flight distances for Saddle-billed Stork is another evidence to exclude the effect of protection status. It is possible that trapping is not as frequent for this bird in western Tanzania because it is a wide spread species unlike the other two.

According to CITES trade database (CITES, 2012), between 1990 and 2010, 94 live shoebills were exported from Tanzania. In addition, 22 wattled cranes were also exported between 1999 and 2006. These does not include re-exportation data citing Tanzania to be the original source. There is no doubt therefore that live trade is significantly affecting the behaviour and survival of these birds in the wild (all CITES data above were labelled as from wild). In a worse situation, countless individuals may have died in the process of being trapped or shipped to holding centres information that is never reported. Given their small population in Tanzania (< 500 individuals for each species) (BirdLife International, 2014), it is obvious therefore that they have been harassed as it is never easy to capture live birds of such body mass.

Lumbe Swamp and the Kigosi-Moyovosi Game Reserves are good candidate sites for trappers because the birds are locally common and the sites are also accessible by train which seems to be a convenient transport for large live birds. Trappers pledge between US$300 and US$ 600 for each live bird and at one time one of the field assistants at Chagu was allegedly being involved into the business before was dropped from the research. Some trappers also visited Lumbe in 2010 but left immediately when they were asked to report to the village government (John pers. obs.).

Major limitations of our field experiment is that because of possible local movements between suitable wetlands within MMRS, having been previously exposed to persecution birds might find it difficult to adapt to lack of harassment even in areas where they are not trapped and thus show longer flight distances. In India where animals are never persecuted for cultural reasons, Burger and Gochfeld (1991) found longer FIDs in migrants (from areas where they are hunted) than resident birds. In connection with the above, this study could not be prolonged to avoid stressing birds. Second, because the study species are rare, it is likely that a certain degree of pseudo-replication accompanied this experiment but according to Runyan and Blumstein (2004) a modest degree of pseudo-replication does not affect FID results. Nevertheless, the present study provides a valuable insight on the effect of humans on large wetland birds, and it reveals that site protection status does not always correlate with management effectiveness. It provides anecdotal evidence of actual trapping events during the period of this study inside these protected areas to lend support to the results we gathered on these threatened wetland birds.

Conclusion

There was virtually no on-site law enforcement in protected areas (see Table 1) probably for the same reasons given by Caro (1999) of insufficient funds from central offices for field operations. Based on this and the findings on Saddle-billed Stork's flight distances and Shoebill's behaviours, it can be concluded that the flight distances in this study were more biased towards bird persecution than site protection status. Nonetheless, the communal wetlands are good potential candidates for 'Wetland Reserves' as a form of new category of protected areas addressed in the Tanzanian Wildlife Act of 2009 but has yet to be set, when time comes, local residents should be involved. Finally, given the small population of Wattled Crane and Shoebill in

Tanzania, the wildlife authority is advised to suspend trapping of the two species and support the annexing of Shoebill to CITES Appendix I.

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