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Abundance, movements and habitat use by African Grey Parrots (*Psittacus erithacus*) in Budongo and Mabira forest reserves, Uganda

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Populations of African Grey Parrots are threatened by increased forest loss and the pet trade. Budongo forest reserve has, for over 60 years, been subjected to selective logging. Mabira forest reserve faces human pressures characterised by extractive disturbances, and agricultural activities with increased boundary settlements. We estimated parrot populations using the 'forest limiting circumference' method, and 'encounter rate approach' for general abundance and forest type associations, respectively. Counts were conducted on flyways in the morning and evening of one day, and observations on food tree location and preference were made by forest type and time of day. Total parrot populations were estimated at 714 in Budongo and 342 in Mabira. Mean numbers of flocks observed per flyway were 4.18 ± 4.33 and 4.70 ± 2.71 for Budongo and Mabira, respectively. Similarly, flock sizes varied from 2.59 ± 2.95 in Budongo to 2.87 ± 3.06 in Mabira forest. High encounter rates were recorded in disturbed/secondary forests during foraging activities and these coincided with areas of abundant fruiting trees. Movements into and out of main forests followed regular flyways and inter-forest movements increased with forest fragmentation. However, the presence of forest strips seemed to enhance the stability of flyways. While African Grey Parrots in Budongo may benefit from its large size, the Mabira population is likely to face a greater threat of further decline. More protected areas are needed to maintain viable populations, and future research should focus on breeding ecology, population monitoring and the impact of trade activities on this species.

Introduction

Bennun *et al*. (1996) classified African Grey Parrots as 'forest specialists' (FF) typical of the forest interior and most likely to disappear when the forest is modified to any great extent. Forest cover continues to be lost as a result of human population pressure. Shifts in bird species adaptations to such changes in land use, though not easy to measure in the short term, can be rapidly assessed from simple data on species-habitat associations (Marsden and Fielding 1999).

Because the abundance of birds and the community diversity are difficult to measure (Pomeroy and Dranzoa 1997), a variety of techniques have been used to estimate population variables that can be translated into management and conservation decisions, since these cannot be postponed simply because of uncertainties as to the exact population size and trends (Snyder *et al.* 2000, Anon. 1995 as quoted in Marsden and Fielding 1999).

The population biology of all parrots is still poorly known (Bessinger and Bucher 1992), but the choice of census methods is strongly influenced by field conditions and the biology and ecology of individual species, making none of these methods applicable to all parrot species (Snyder *et al*. 2000, McGowan 2001). This has made accurate census of wild parrot populations one of the more difficult tasks confronting researchers and conservationists (Snyder *et al.* 2000).

Although considerable work has been done on several bird species in Uganda, no study of the African Grey Parrot has been attempted. Therefore, we focused on the acquisition of basic data in preparation for later comprehensive studies. In this study, we present abundance data for African Grey Parrots in two widely separated forest reserves in Uganda, which differ in size and degree of human impact.

Methods

Study areas

African Grey Parrots were studied in two central forest reserves, Budongo and Mabira (Figure 1). Budongo forest reserve is a tropical moist semi-deciduous forest located in western Uganda between latitude 1°37'–2°03'N and longitude 31°22'–31°40'E, and covers an area of 793km^2. Mabira forest reserve is located to the west of Victoria Nile 20km north of the Lake Victoria shoreline. It lies between 32°52'–33°07'E and 0°24'–0°35'N. Both forest reserves experience similar climatic conditions, characterised by two rainfall peaks from March–May and September–November. The annual rainfall ranges from 1 150–1 500mm for Budongo and from 1 200–1 500mm for Mabira (Howard 1991). Minimum annual temperature ranges are 17–20°C and 16–17°C for Budongo and Mabira, respectively. Both forests experience a maximum annual temperature range of 28–29°C.

The vegetation of Budongo forest reserve comprises a large proportion of grassland (47%) and the rest (53%) is

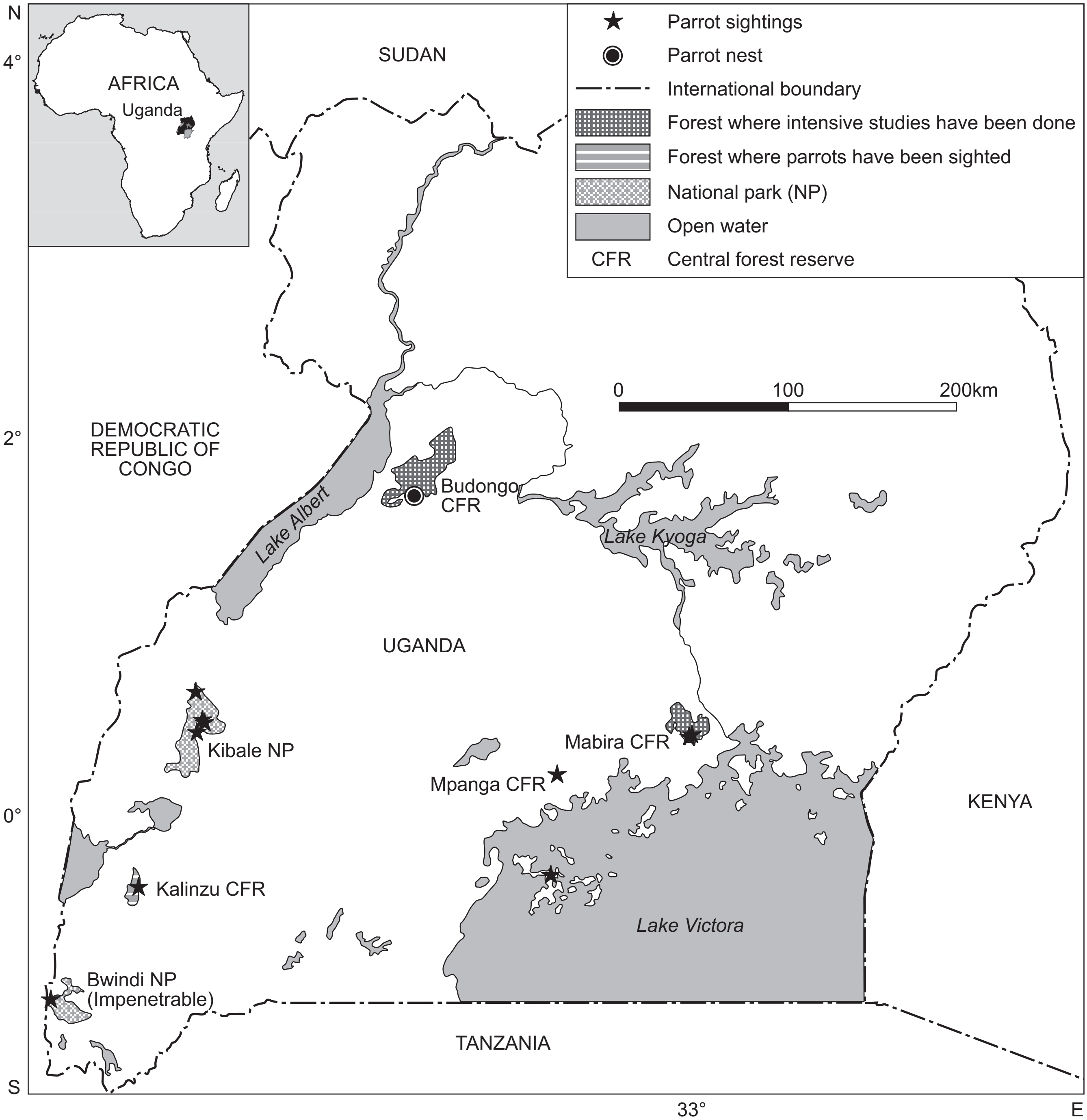

Figure 1: Map of Uganda showing the location of the study sites

comprised of various forest types. Eggeling (1947) classified the forest into four types, namely cynometra forest, mixed forest, colonising forest (woodland) and swamp forest. The vegetation has also been described according to dominant tree species as Celtis-dominated, Khaya-dominated, and Cynometra-dominated types (Howard 1991). With an area of 306km^2 of which only 290km^2 is forest, Mabira forest reserve is considered to be a secondary forest with distinctive vegetation types representing sub-climax communities (Howard 1991). The vegetation has colonising forest that has segregated into communities dominated by different species, representing four major forest types. In association with *Albizia* spp., *Markhamia platicalyx*, *Celtis* spp. and others, the *Maesopsis emini*-dominated community represents the youngest colonising forest (secondary forest) (over 25%). Broken canopied structures represent communities classified as young mixed forest (disturbed forest) and *Celtis holoptelea* forest, originally covering 59% of the reserve's area, represents 'primary' forest. Some poor mixed forest, covering 15%, exists in the wet valley bottoms (Howard 1991).

Study methods

Field visits were conducted on a monthly basis between October 2002 and May 2003. Apart from reports from informants within the surrounding communities, daily flight routes of African Grey Parrots (flyways) were systematically searched for along the forest edges and, once discovered, the flight regularity was monitored for two to three days to confirm their recurrent use. A flyway was defined as a route along which parrots flew in both morning and evening hours for more than two consecutive days (four sample observations), and which two or more flocks used regularly. Confirmed flyways/parrot flights were categorised as 'a short inter-forest flight' or a 'long distance habitat flight'. The second category was used in estimating parrot abundance at flyways.

Counts of parrot groups at flyways were conducted for six hours a day, divided into four hours in the morning (06:00–10:00) and two hours in the evening (17:00–19:00), timed to coincide with the time when parrots moved from roosting areas to feeding sites, and when they returned (Mackworth-Praed and Grant 1962, Fry *et al.* 1988, Wirminghaus *et al.* 2001). All counts were treated as independent observation periods. During counts, each flock of African Grey Parrots that passed was recorded and the number of individuals counted. No counts were conducted during bad weather. Equal effort was put into monitoring every flyway throughout the study period except where the flyways were discovered after commencement of the study.

Habitat association studies were based on encounter rates (Bibby *et al*. 1998) in order to estimate parrot abundance indices in the respective forest types. Based on a scale of abundance, the method has proved useful in estimating abundance of some rare and wide-ranging species of birds such as parrots and hornbills (Marsden 1999, Bibby *et al.* 1998). Three forest types were selected: nature reserve (primary forest), logged/disturbed forest (records of selective logging or current extractive disturbances), and secondary forest patches. In Budongo forest reserve N15 (nature reserve forest), N3 (logged forest), and Kisagura forest patch (south of Budongo main block) were surveyed. In Mabira forest reserve, a nature reserve zone, disturbed forest zones, and marginal secondary forests were surveyed. Approximately three to four kilometres of established transects were walked in each forest type during each survey. Count periods were divided into one-hour units and spread through different times of the day with durations lasting between two hours and whole day counts. Records were based on the number of individuals/groups detected per hour of observation (encounter rate). The methods of detection included 'seen only', 'calling only' or 'seen and calling' (Marsden 1999). It was assumed that any African Grey Parrots within a reasonable radius from the observer relative to the forest area would be detected. Scanning nearby canopies helped to locate hidden birds. Vegetation characteristics along flyways were assessed by recording presence or absence of continuous forest strips, forest patches and large trees at three points, separated by at least 0.5km, along the main axis of a flyway.

Data analysis

Parrot abundance at each flyway was calculated as a product of the mean number of flocks and flock sizes. From abundances estimated at forest sections, we projected parrot abundance for the entire reserve by estimating the possible number of flyways along the forest sections not surveyed using mean distance between flyways as a function of edge use intensity. Measurements between flyways were derived from scale maps of the study areas. Distances of forest sections were treated as fractions of entire forest circumferences, themselves estimated from the known areas of particular forests.

The mean distance between known flyways along a forest section were calculated as follows:

$$\text{Mean Distance } (d_f) = \frac{\text{Total distance between the flyways}}{\text{Number of distances measured between flyways}}$$

The minimum number of flyways possible along such a forest section of specified length is calculated as follows:

$$NF_x = D_S / d_f + C$$

where NF_x = the number of flyways present in forest section X

D_S = the distance between two extreme flyways bordering a forest section

d_f = the mean distance between the flyways (determined by survey)

C = a correction factor with value 1 for one forest section, and 2 when two sections of a forest are considered, etc.

The possible number of flyways present throughout the forest stretch was calculated from the known circumference of the forest, here treated as a line encircling a forest block with equal and minimum forest and non-forest surfaces left to the outside and inside of the line respectively (Forest Limiting Circumference = FLC). The minimum distance approach allows for the calculation of a possible flyway between any two flyways separated by a long distance.

Parrot encounter rates per forest type were derived from the number of groups detected per hour of observation, assigned abundance scores, and ranked in an ordinal scale of abundance (Bibby *et al*. 1998) (Table 1). Means were compared using one-way ANOVA at 95% level of significance, and statistical values are presented as ± SD.

Results

Number of flocks and flock sizes

Table 2 shows variations in the number of flocks and flocks sizes of African Grey Parrots in Budongo and Mabira forest reserves. In Budongo, the number of flocks observed during morning counts (5.88 ± 5.38, n = 85) was significantly higher than for evening counts (2.45 ± 1.57, n = 82). The number of flocks observed in Mabira forest reserve was lowest in February (3.30 ± 1.86, n = 33) compared to April (6.56 ± 3.14, n = 39). Of the flocks recorded, the sizes of 6.5% (n = 1 037) and 2.7% (n = 700) were not determined for Mabira and Budongo forest reserves, respectively. In both study areas, parrots moved either singly, or in flocks of up to 28 individuals (Budongo) (Figure 2).

Generally, for both forest reserves, the mean number of flocks has remained higher than mean flock sizes, suggesting that both populations are rather fragmented, being composed mainly of numerous small 'units'.

Parrot abundance at flyways

Forest survey results, for Budongo and Mabira respectively, are as follows: distances surveyed — 10.2 and 16.7km; number of flyways — eight and seven; and mean distance of separation of flyways — 1.7 and 2.4km. There were more flyways per unit length in Budongo than in Mabira forest reserve. Parrot abundances at flyways are shown in Table 3. From the FLC method, about 60 and 26 flyways were estimated for Budongo and Mabira forest reserves respectively. These estimates are based on the assumption that parrot flights are equally likely anywhere along forest edges. Therefore, estimates of parrot abundance for the reserves are based on these estimated numbers of flyways, and the number of parrot flocks and flock sizes projected for such flyways.

For Mabira forest reserve, using mean number of flocks and flock sizes as 4.5 (SD 2.6) and 2.9 (SD 3.1) respectively, the total number of flocks along the Effective Forest Edge (EFE; 16.7km) was estimated at 36 giving an average of 2.2 flocks or 6.4 birds per kilometre. From the above, the entire reserve is estimated to have about 117.9 flocks (or 341.9 parrots). Thus, in Mabira forest reserve, for every kilometre walked, either in the morning or evening, along any part of the forest edge, there is a likelihood of sighting up to two (2) flocks or 5.7 parrots. Estimates for Budongo yielded an average of 12.1 parrots for each flyway along the EFE. With mean flock size as 2.6 ± 3.0 and mean number of flocks as 4.6 ± 4.4, up to 32.2 flocks were estimated to pass through the EFE; hence 3.2 flocks, or 8.2 parrots, were likely to be seen for every kilometre of survey. The entire reserve is estimated to have about 274.6 (275) flocks giving a population of approximately 714 parrots.

Table 1: Categories of abundance of African Grey Parrots based on number of groups sighted per hour

Abundance categories (flocks h^{-1})	Abundance score	Ordinal scale
< 0.71	1	Rare
0.71–1.40	2	Uncommon
1.41–2.10	3	Frequent
2.11–2.80	4	Common
2.81+	5	Abundant

Parrot abundance by forest type in Mabira forest reserve

A total of 235 flocks was encountered during observations in three forest types: nature reserve (43.4%), disturbed (28.5%), and secondary forest (28.1%). We spent 68, 80.5 and 59 hours observing in nature reserve, disturbed and secondary forests respectively. Mean numbers of flocks detected per hour in each forest type were 1.22 ± 0.79 (n = 10) for nature reserve zone, 1.42 ± 0.60 (n = 21) for disturbed forest, and 1.46 ± 0.85 (n = 14) for secondary forest, and these did not differ significantly (ANOVA, F = 0.36; df = 2, 42; p > 0.05). Most parrots were encountered in the first (44.7%) and last (43.0%) quarters of the day (Figure 3). Monthly variation in mean number of groups detected per hour was highest in January (mean = 1.75 ± 0.89, n = 8), and lowest in November (mean = 0.88 ± 0.53, n = 5).

Categories of parrot abundance were calculated from the mean number of groups detected per hour in the different forest types. The hourly abundance estimates combined for the three types of forest show parrot abundance in Mabira forest reserve at the levels of rare (17.8%); uncommon (28.9%), frequent (42.2%), common (6.7%) and abundant (4.4%) (n = 45). Overall abundance by forest types is shown in Table 4.

Parrot movements

The directions of parrot flights were defined as north-to-south (out of forest in the morning), south-to-north (into forest in the evening), and any other direction (AOD). Generally, more parrots were observed flying into the forest in the evenings (88.6% and 73.6%) than flew out in the mornings (74.7% and 67.5%) for Budongo and Mabira forest reserves respectively. Some parrots did, however, fly back into the forest during the morning hours but at a lower frequency for both Budongo (22.2%) and Mabira (13.3%) forests, and movements away from the forest in the evening were less frequent for both Budongo (3.5%) and Mabira (11.6%). Random movements were more common in the mornings (19.2%) than evenings (14.8%) in Mabira forest. Daily movements were, therefore, in predictable directions. The presence of continuous strips and remnant patches of forest along some flyways increased their average stop over values (ASOV) as variety index (VI),

Table 2: Variations in mean number of flocks and flock sizes of African Grey Parrots in Budongo and Mabira forest reserves. Levels of significance are denoted as * = p < 0.001, ** = p < 0.01, * = p < 0.05, and ns = not significant. M–E: M = Morning counts; E = Evening counts

				Flyways		Time of day (M–E)		Months	
Study area	Parrot flocks	n	Mean	F	p	F	p	F	p
Budongo	No. of flocks	167	4.18 ± 4.33	8.84	***	30.16	***	1.21	ns
	Flock size	681	2.59 ± 2.95	2.26	*	7.58	**	1.63	ns
Mabira	No. of flocks	220	4.70 ± 2.71	7.42	***	0.05	ns	5.51	***
	Flock size	970	2.87 ± 3.06	4.82	***	6.09	*	0.95	ns

and the proportions of parrots flying in the any other direction (AOD) were higher on such flyways than on others (Figure 4). This suggests that movements in AOD, generally constituting inter-forest movements, are related to foraging, and for Mabira forest reserve this percentage is higher (17%) than for Budongo (4%) forest reserve.

Discussion

Why the FLC method?

When parrot populations are very low and patchily distributed, their total numbers or densities become difficult to measure. Most of the bird census methods used require adequate records of the birds to convert into density estimates, and for parrots this may mean several long field seasons. Marsden (1999) stresses that in cases of extreme rarity, methods such as the variable circular plot method may never be appropriate. FLC method, using data generated at parrot flyways, was applied in gaining some idea of African Grey Parrot abundance in the two forest reserves of Budongo and Mabira. Counts at roosts would have been a good alternative, but we were aware of the difficulties associated with assessing bird movements and counting individuals as they arrive at roosts. The FLC method not only assesses patterns of daily movements but also avoids the problem of having to locate all possible roosts, and simultaneously conduct counts there. We could safely assume that all parrots flying into these forests went to roosts. The relevance of other methods, including those based on distance estimates, to African Grey Parrot population studies has been considered by McGowan (2001) and for parrot species generally by Snyder *et al*. (2000).

Grey parrot abundance

Results from this study show that African Grey Parrot populations in Ugandan forests are small and rather fragmented. Flock sizes remained small throughout the study period and numbers of flocks sighted each time were highly variable. Because of this, roosts have been difficult to locate. With the significant changes in forest structures that have occurred in the past decades, populations probably failed to expand into potentially suitable habitats. Birds flock more in the evenings than in the mornings (that is, flock sizes were relatively higher in the evenings). This is probably because there is a concentration at roosts in the evenings as opposed to scattered feeding in the mornings. If parrot numbers are estimated based on roost-directed flyways, then counts in the evenings are more appropriate when using the FLC method. This could be affected by the short interval, as well as a possibility of missing breeding pairs that may not make

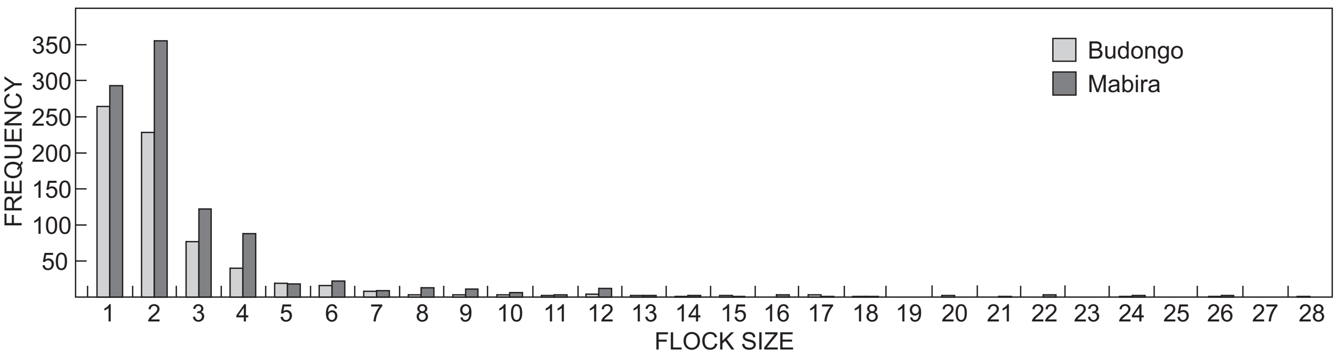

Figure 2: Flock sizes of African Grey Parrots in Budongo and Mabira forest reserves between October 2002 and May 2003 (n = 700 and 1 037 for Budongo and Mabira respectively)

Table 3: African Grey Parrot abundance at different flyways in Budongo and Mabira forest reserves

Flyways	Budongo forest reserve			Mabira forest reserve		
	MNF	MFS	Abundance	MNF	MFS	Abundance
1	3.26 ± 2.3	3.17 ± 3.5	10.3	6.02 ± 2.6	3.19 ± 3.5	19.20
2	2.74 ± 1.8	1.92 ± 2.0	5.3	5.62 ± 3.5	2.77 ± 2.6	15.6
3	2.67 ± 1.3	2.43 ± 1.9	6.5	3.03 ± 1.4	2.13 ± 1.4	6.5
4	8.55 ± 6.7	2.90 ± 3.7	24.8	4.34 ± 1.7	2.27 ± 1.4	9.9
5	4.35 ± 2.5	2.11 ± 2.2	9.2	3.16 ± 1.5	2.46 ± 2.4	7.8
6	4.07 ± 4.0	1.96 ± 1.5	8.0	6.15 ± 3.1	2.80 ± 2.2	17.2
7	7.00 ± 6.1	2.91 ± 3.2	20.3	3.31± 1.0	2.16 ± 1.2	7.2*
8	2.00 ± 0.9	2.00 ± 0.0	4.0*	3.86 ± 2.0	4.89 ± 6.6	18.9*
9				3.25 ± 1.7	3.73 ± 4.0	12.1
10				4.86 ± 2.0	3.00 ± 1.7	14.6
Total Grey Parrot abundance		88.5				128.82

MNF = Mean number of flocks; MFS = Mean flock size

* Not included in overall abundance estimation for the forest

late evening flights. In Mabira, the further flyways are apart, the greater the consistency in the number of flocks that use these flyways in both morning and evening forays. This could be related to the nature of the forest edge. Where the forest edge is severely degraded, as around Mabira forest reserve, there is little flexibility in the use of flyways.

Parrot movements

African Grey Parrots followed regular routes out of (morning) and into forests (evening). We found that fewer flocks flew north-to-south (out of forest) than south-to-north (into forest) at both reserves. Consequently, random flights (flights in AOD) were more common in the mornings than in the evenings. This is probably because, during morning flights, the parrots continuously stop off to feed as they fly towards other foraging areas. When vegetation characteristics along these flyways were assessed and translated into variability indexes as ASOV, interesting relationships with parrot numbers emerged (Figure 4). Variations in ASOV with the different flyways correspond fairly well with both mean number of flocks and flights in the AOD, and this is more apparent in Budongo than in Mabira forest reserve. The presence of forest patches along flyways seemed to have had greater influence in Budongo than in Mabira forest reserve, where other aspects of variability (forest strips and large trees) might have been more important. We now consider three aspects of random flights (AOD): (1) if AOD flights are related to food search and foraging, then functional flights are more important (maximised) in the morning than in the evening; (2) if AOD flights are a consequence of forest fragmentation, then Mabira forest reserve is more fragmented than Budongo; (3) if AOD flights are indicative of the degree of habitat variability (variety index-VI) and location of resources, then these are more variable within Mabira forest reserve but rather far from the forest edge in the case of Budongo forest reserve. Overall, we suggest that flight directions are both functional and indicative of habitat utilisation by African Grey Parrots. Thus, a rich flight corridor (high VI) would provide a number of stopover opportunities to feed, rest or socialise as parrots move to other feeding areas.

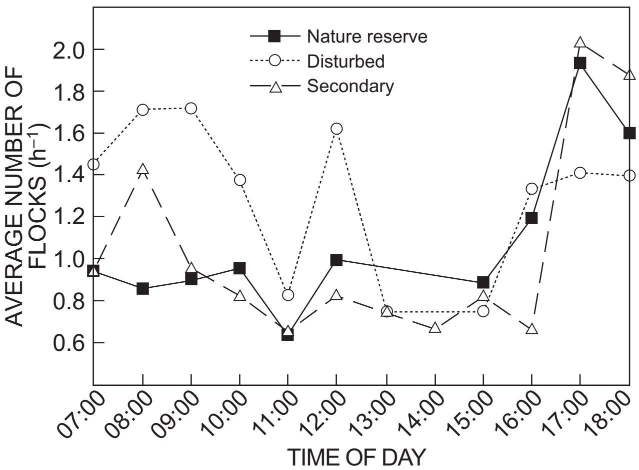

Figure 3: Variation in average number of African Grey Parrot flocks encountered in different forest types in Mabira

Table 4: Indices of abundance of African Grey Parrots by forest type in Mabira forest reserve

Forest type	Average flocks h^{-1}	Abundance score	Ordinal scale
Nature	1.22	2	Uncommon
Disturbed	1.42	3	Frequent
Secondary	1.46	3	Frequent
Overall abundance	1.39	2	Uncommon

Habitat use

Our study has shown that African Grey Parrots were relatively more abundant in open forests compared to primary forests. This finding is in agreement with previous studies (Dranzoa 1995, Owiunji 1996, Cresswell *et al*. 1999, Marsden and Fielding 1999). This may be as a result of fruit abundance in open forests (Dranzoa 1995, Kalina 1988) compared to closed canopy forests. Other possible explanations advanced for this kind of observation include variation in detectability of birds with forest cover (Cresswell

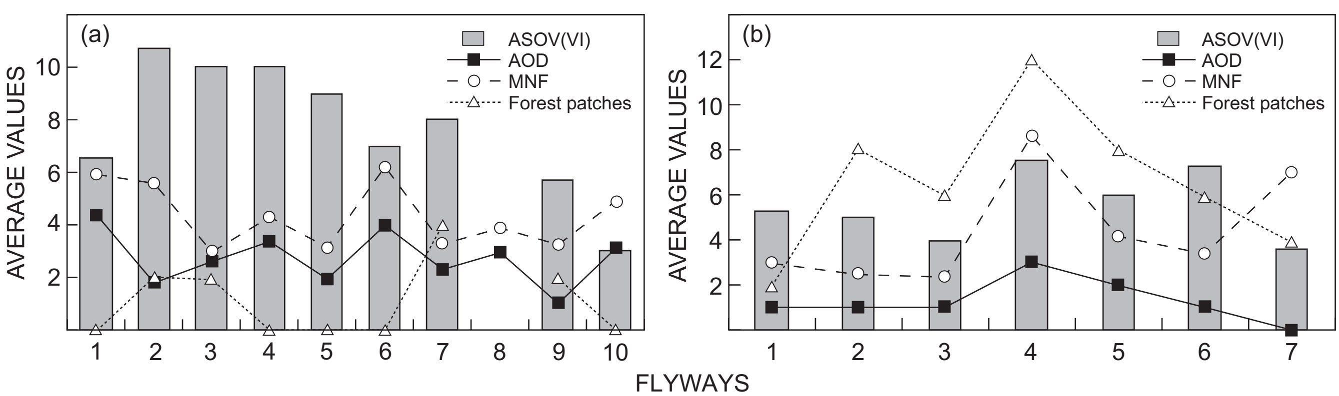

Figure 4: Relationship between number of parrots flying in the AOD with mean number of flocks and average stop over values (ASOV) as variety indices (VI) of forest features along flyways in (a) Mabira, and (b) Budongo forest reserves

et al. 1999, Marsden 1999, Poulsen and Lambert 2000), but this is likely to be less significant in the case of African Grey Parrots since we used detection cues that accommodated species-specific behaviour with forest type. Food resources for the parrots are generally found in lowlands and forest fringes, secondary forests and savannah woodlands (Ngenyi 2002, Tamungang and Ajayi 2003, Amuno 2005). Most open-canopied forest patches tend to survive in these areas (Marsden and Fielding 1999), and are the focus of foraging flights. This food-related nomadism suggests that suitable habitats with adequate food resources are either sparse or highly fragmented. Consequently, resource bases for food, nesting, and roosting may not be available in the same area (McGowan 2001).

Conclusions

The populations of African Grey Parrots in both reserves are small, with groups being rather fragmented. The Budongo population may benefit from the large size of that forest, but those in Mabira are likely to fragment even further as the forest there is threatened with further degradation. Effective protection of the forest habitat may in the long run lead to expansion of African Grey Parrot populations. But there is an urgent need for research focusing on population size and the biology of the species in Ugandan forests, as well as eliminating persecution and illegal trapping of parrots.

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