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Shifting cultivation along the Trans-African Highway and its impact on the understorey bird community in the Ituri Forest, Zaire

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Summary

Since the 1940s, horticulturalists (the Lese) have been settled along the sides of the roads that traverse a large part of the forest in eastern Zaire. These people have maintained their lifestyle of shifting cultivation and trade with the Mbuti pygmies. This has resulted in corridors of heavily disturbed and regenerating forest. The results of a study of the understorey bird community at three sites in the Okapi Reserve in the Ituri forest in Zaire are reported here. Two primary forest sites (one monodominant *Gilbertiodendron* forest) in the Reserve were compared with an area of forest disturbed by shifting cultivation. The two primary forest sites were more similar in species composition than they were to secondary forest created by shifting cultivation. Shifting cultivation had a more severe impact on the bird community than selective logging does in forests in Uganda and Malaysia. There was a shift following disturbance from a bird community dominated by insectivores to one with more frugivore-insectivores and nectarivores. Ground thrushes *Zoothera* spp. and flycatchers were abundant in the monodominant *Gilbertiodendron* forest and appear to suffer from the change in forest structure following disturbance. The Okapi Reserve currently conserves some important bird species and at least 333 birds have been reported to occur there.

Introduction

Understanding the effects of forest disturbance on plant and animal communities is of increasing importance globally as more and more forests become altered by man. In the tropics, much of the disturbance is due to the conversion of forest to agricultural land and the subsequent fragmentation of the forest. This in turns leads to the loss of most of the forest species. Less extreme forms of disturbance are caused by selective timber extraction and shifting cultivation, both of which aim to allow a period for the recovery by the forest before an area is exploited again (IUCN 1991).

Zaire contains some of the largest areas of intact forest in Africa and consequently is of great importance for tropical forest conservation. However, the construction of roads by the Belgian Government in the 1940s to the 1960s and their resettlement policies (see below) have led to corridors of disturbed forest within this forest block (Wilkie 1989). This study investigated the effects of these corridors on the understorey bird community in the Okapi Reserve in the Ituri Forest.

Study area

The Ituri Forest is the name given to about 70,000 km^2 of tropical lowland forest in north-eastern Zaire at the watershed of the Ituri river. In 1992 over 13,000 km^2 of this region was designated as a forest reserve, the Reserve de Faune a Okapis. The Okapi Reserve lies between 1° N–2° 29'N and 28° E–29° 4'E and occurs between 700 and 1,000 m a.s.l. (See Figure 1). The Trans-African Highway traverses this reserve running from Bunia to Kisangani, passing through Mambasa and Epulu. The Ituri forest is considered to be very rich in mammals and birds because of its position as a supposed pleistocene refugium (Hamilton 1982, Kingdon 1990). Bigalke (1968) claimed that 15% of mammals in the Ituri are endemic to this region.

Large areas of the Ituri forest are dominated by *Gilbertiodendron dewevrei* which can comprise over 75% of the total trees (Connell and Lowman 1989, Hart 1985). In the Okapi Reserve most of the monodominant *Gilbertiodendron* forest occurs in the south. There is evidence that the monodominance exhibited by this species is a relatively recent phenomenon in the Ituri forest, occuring within the last 400 years (Hart *et al.* 1996). In the northern part of the Okapi Reserve no single species of tree dominates, instead there is a mixed forest of a much higher diversity per unit area. Here *Cynometra alexandri*, *Julbernardia seretii* and *Brachystegia laurentii* are the more common trees. Disturbance from wind can be high in the mixed forest and may contribute to its maintenance, stalling a progression to monodominance. Both monodominant forest and mixed forest are classed as primary forest and form about 90% of the Okapi Reserve (Wilkie 1989).

Along the Trans-African Highway and other roads leading from it there is an approximately 3-km wide strip of secondary vegetation. This is due to the practice of shifting cultivation around the settlements along the roads. This vegetation varies from fields under current cultivation, through abandoned farms to secondary forest where trees such as *Musanga cecropioides*, *Trema orientalis*, *Fagara macrophylla*, *Croton macrostachys* and herbs belonging to the Marantaceae are common. In the past shifting cultivation used to occur in small settlements scattered over the reserve but in the 1940s the Belgians moved all the people to sites along the roads (see below). Figure 1 shows the extent of secondary forest and farmland in and around the Okapi Reserve. Secondary forest forms about 6% of the Okapi Reserve and agricultural land or plantations form another 2% (Wilkie 1989).

The Ituri forest is currently settled by two groups of peoples, horticulturalists and hunter gatherers. Today the Lese are the most widespread horticulturalist tribe in the Ituri. It is thought that they came from the savanna areas north-east of the forest between 400 and 1,000 years ago with the introduction of rainforest-tolerant crops from South East Asia and South America (Wilkie 1989, 1987). For most of the time they lived in the forest they were in dispersed villages, mainly along waterways or around the edge of the forest. In the 1940s the Belgian authorities forcibly resettled all villages within the forest along roads to allow better control of the population and to provide labour to help build the roads (Tondeur and Bergeroo-Campagne 1955). This led to a more long-term method of shifting cultivation.

Agriculture in the Ituri is known as swidden horticulture and involves the cultivation of about 1 ha of land per family per year. The forest is cleared to

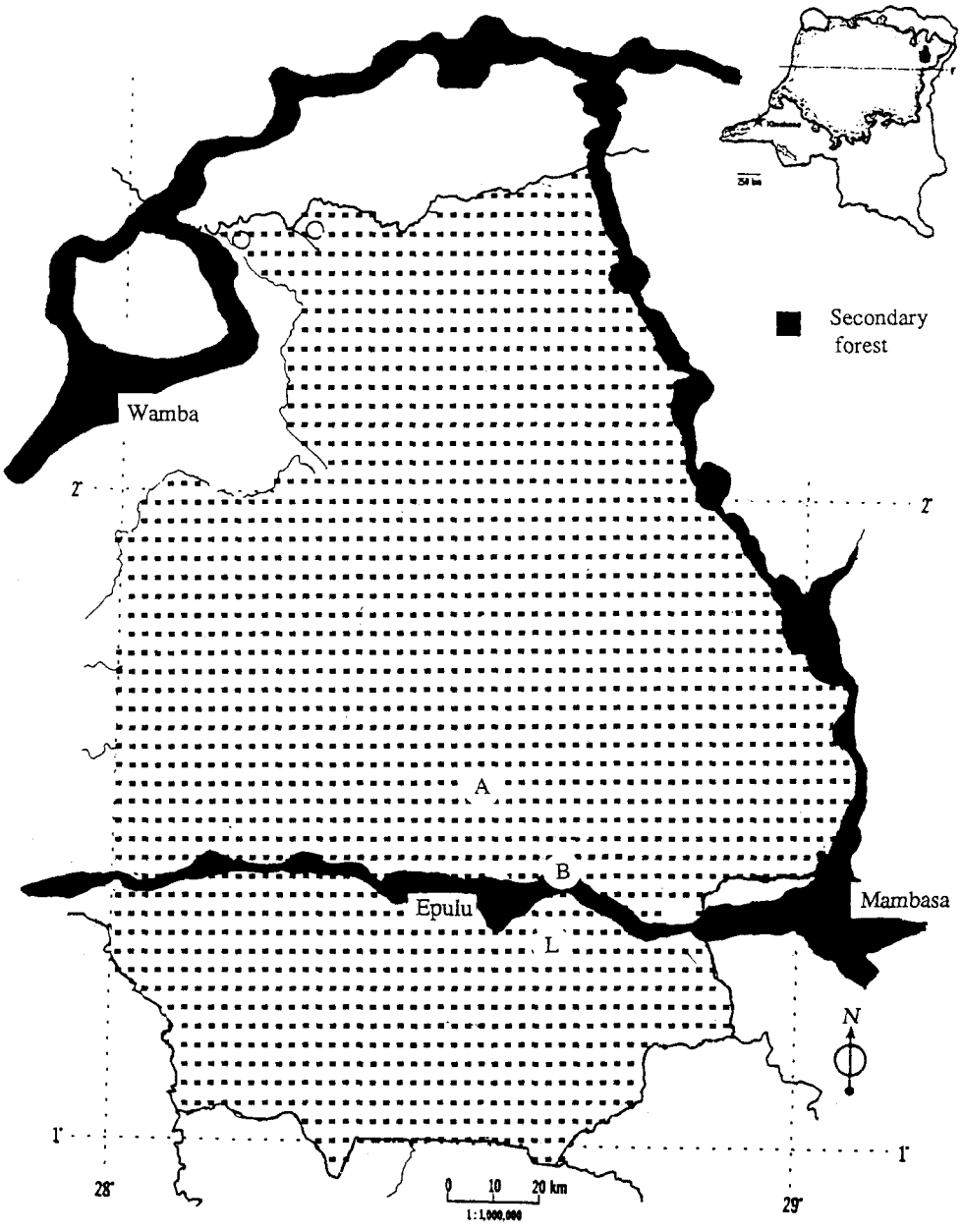

Figure 1. A map of the Okapi Reserve and its location within Zaire. The three research sites at Lenda (L), Apharama (A) and Babukeli (B) are marked. Secondary vegetation is shown in black along the Mambasa-Epulu road and side roads (redrawn from Wilkie 1987).

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plant peanuts, cassava, sweet potatoes, oil palms and bananas; following the first crop, rice is grown. The field is abandoned after 15 months and visited periodically for the next 1–5 years to harvest any remaining bananas or oil palm nuts. The land is then left for 15–20 years as fallow (Wilkie 1987).

About 20,000–40,000 Mbuti pygmies are thought to live in the Ituri (Hart 1978). They live in small family groups which are usually associated with a Lese family or village whom they provide with meat and honey from the forest. The Lese in turn provide produce from their fields. Hart and Hart (1986) have shown that the Mbuti could not obtain a balanced diet if they had to rely solely on the forest and consequently have probably always lived in association with other peoples. Secondary forest also contains more human foods than the primary forest. Consequently they also remain within about 2 km of the roads for most of the year and hunt for duikers *Cephalophus* spp. within 20 km of the roads.

Previous bird surveys

Very little bird work has been carried out in the Ituri despite its supposed richness. In the 1940s and 1950s Schouteden (1963) collected specimens for museums throughout much of eastern Zaire. Dejaifve (1989) spent from February to July 1989 in the region of Epulu compiling a bird list. His list, which includes specimens found by Schouteden, has a total of 326 species for the Ituri forest, with 226 forest species. He also states that only three ornithologists have spent more than a month in the Ituri forest and that none has looked at the northern part of the Okapi Reserve where the vegetation can differ greatly due to the presence of inselbergs. Diamond and Hamilton (1980) showed that the Ituri forest was one of the richest areas for forest passerines in the whole of Africa and is a key site for biodiversity protection (Diamond and Lovejoy 1985). Collar and Stuart (1988) also identified this forest as the third most important for bird conservation in Africa.

Methods

Study sites

Three study sites (Figure 1) were selected to allow the comparison of the understorey bird communities in the three major vegetation types.

Lenda The Lenda study site (1° 19′N, 28° 38′E) is about 10 km south of the Trans-African Highway at an elevation of 770 m. It is in *Gilbertiodendron* forest and the vegetation is typical with a lower density of trees than the mixed forest, a dense canopy and a sparse understorey of herbs. The canopy trees are dominated by *Gilbertiodendron dewevrei* (about 80% of basal area of trees > 30 cm diameter at breast height (DBH)) with *Cynometra alexandri*, *Alstonia boonei* and *Julbernardia seretii* being the other most common species (Makana and Hart in press). The understorey trees are dominated by *Scaphopetalum dewevrei* (79% of stems), with *Drypetes bipendensis* and *Pancovia harmsiana* as the next most common species.

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Apharama This study site (1° 33'N, 28° 32'E) is about 25 km north of the Trans-African Highway at an elevation of 800 m and is typical of mature mixed forest. The forest here has been disturbed by strong winds, causing many treefalls. Areas where relatively intact forest was present were chosen for study. Due to the disturbance from wind the understorey here is not so open and the canopy is more broken. *Cynometra alexandri* dominates the canopy trees (about 40% of the basal area of trees > 30 cm DBH) with *Fagara macrophylla, Julbernardia seretii, Cleistanthus michelsonii* and *Canarium schweinfurthii* forming the next most abundant species (Makana and Hart in press). *Scaphopetalum dewevrei* once again is the most abundant understorey tree (63% of stems) with *Pancovia harmsiana* and *Diospyros bipendensis* as the next most common species (Makana and Hart in press).

Babukeli This site (1° 23'N, 28° 35'E) is 6 km east of Epulu on the Trans-African Highway and encompasses cultivated fields, abandoned farms and areas of secondary forest. The trees that are commonly found in the secondary forest are *Musanga cecropioides, Croton macrostachys* and *Trema orientalis*, with oil palms that have remained from abandoned fields. Babukeli was probably mixed forest before it was cultivated, judging from the composition of surrounding mature forest.

Trapping

At each site mist-netting was used to compare the different forest bird species. Trapping was done during the main dry season between February 11 and March 22 1996. Identification of birds was made with reference to Mackworth-Praed and Grant (1960, 1973), Van Perlo (1995) and Keith *et al.* (1992) for greenbuls.

At each study site 15 nets of 14 m length were sited at 50 m intervals along grid trails or transects. The nets were opened at dawn (about 06h00) and checked at 30–45 minute intervals up to 12h15. At this time the nets were closed and moved to the next transect position. Netting was not continued for a full day because rain would have forced the closing of the nets in the afternoons on some days and this could affect the comparability of the results.

Results

Species numbers

Table 1 summarizes the effort and capture success. Overall capture rates were fairly similar between sites but could vary widely between days (range: 14–60 birds). Table 2 lists the species and numbers caught at each site. A total of 59 species and 1,123 individuals were caught. Species accumulation curves, plotted as the increase in number of species with number of captures, are given in Figure 2. These show that the curves have nearly levelled off after 400 captures.

Seven species are new records for the Okapi Reserve (not occurring on the list compiled by Dejaifve (1989)): Chestnut-flanked Sparrowhawk *Accipiter castanilius*, Black-eared Ground Thrush *Zoothera camaronensis*, Crossley's Ground Thrush *Zoothera crossleyi*, Forest Ground Thrush *Zoothera oberlaenderi*,

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Table 1. The mist-netting effort made at each study site and the capture success

	Monodominant (Lenda)	Mixed (Apharama)	Secondary (Babukeli)
Days trapping	11	11	10
Metre-net-hours (mnh)	14,438	14,438	13,125
Number of birds caught	400	346	377
Number of species	36	38	34
Capture success (birds/mnh)	0.028	0.024	0.029

Chestnut-breasted Negrofinch *Nigrita bicolor*, Northern-bearded Scrub Robin *Cercotrichas leucosticta* and Red-fronted Antpecker *Parmoptila rubifrons*. They have, however, been recorded in eastern Zaire before.

Diversity and overlap: a comparison between communities

Table 3 gives the values of two diversity indices, standard errors and the evenness calculated for each of the three communities. Evaluation of the rank abundance curves shows that the log-series does not fit these curves well and hence alpha is probably not a good measure of diversity here (normally it is considered one of the better measures, Krebs 1989). Both indices give higher diversity values for the two primary forest sites. This is partly because the secondary forest site is so heavily dominated by Olive Sunbirds *Nectarinia olivacea*. Significant differences were found between the Shannon–Wiener values for monodominant and secondary forest ($t = 7.53$, $df = 723$, $P < 0.001$) and mixed and secondary forest ($t = 5.97$, $df = 723$, $P < 0.001$) but not between mixed and monodominant forest ($t = 1.08$, $df = 696$, $P > 0.05$).

Horn's overlap index was calculated on presence/absence data for each species. The secondary forest is least similar to the monodominant forest (49% overlap) and mixed forest is more similar to monodominant forest (76% overlap) than secondary forest (53% overlap). This is probably a function of changes in forest structure.

Guild changes with disturbance

Each species caught was assigned one of seven guild classifications as follows: (a) frugivore, (b) frugivore-insectivore, (c) insectivore, (d) graminivore, (e) omnivore, (f) nectarivore, (g) raptor. Although these are fairly crude classifications it would be difficult to assign guilds more accurately to several of these species of which very little is known. Using this classification, most birds fall into the category of insectivore; to improve the analysis flycatchers were separated as a subgroup.

Table 4 gives the percentage of birds and number of species caught in each guild category for the three sites. Flycatchers (including wattleyes) and insectivores in general were rarer in the disturbed secondary forest while frugivores appear to benefit from the disturbance.

One-way analysis of variance was used to test the differences between the mean daily capture percentages of each guild category between the three sites.

Table 2. The species caught, number of captures and guild for each of the three study sites

Species	Monodominant (Lenda)	Mixed (Apharama)	Secondary (Babukeli)	Guild
African Goshawk *Accipiter tachiro*	1	—	—	RAP
Chestnut-flanked Sparrowhawk *Accipiter castanilius*	—	—	1	RAP
Blue-headed Dove *Turtur brehmeri*	4	1	1	FR
Malachite Kingfisher *Alcedo cristata*	1	4	3	IN
Dwarf Kingfisher *Ispidinia lecontei*	1	4	—	IN
Pygmy Kingfisher *Ispidinia picta*	—	—	1	IN
Red-rumped Tinkerbird *Pogonilius atroflavus*	—	—	1	FRIN
Speckled Tinkerbird *Pogonilius scolopaceus*	—	—	1	IN
Brown-eared Woodpecker *Campethera caroli*	2	—	3	IN
Buff-spotted Woodpecker *Campethera nivosa*	2	1	—	IN
Square-tailed Roughwing Swallow *Psalidoprocne nitens*	1	—	—	IN
Cameroon Sombre Greenbul *Andropadus curvirostris*	1	1	4	FRIN
Little Greenbul *Andropadus virens*	—	2	59	FRIN
Yellow-whiskered Greenbul *Andropadus latirostris*	12	13	17	OM
Eastern Bearded Greenbul *Criniger chloronotus*	—	3	—	FRIN
White-bearded Greenbul *Criniger ndussumensis*	—	—	1	FRIN
Red-tailed Greenbul *Criniger calurus*	—	1	7	IN
Icterine Greenbul *Phyllastrephus icterinus*	—	8	—	IN
Sassi's Olive Greenbul *Phyllastrephus lorenzi*	—	3	—	IN
White-throated Greenbul *Phyllastrephus albigularis*	—	—	3	IN
Xavier's Greenbul *Phyllastrephus xavieri*	4	3	—	IN
Yellow-throated Nicator *Nicator vireo*	—	—	1	FRIN
Green-tailed Bristlebill *Bleda eximia*	13	15	7	OM
Red-tailed Bristlebill *Bleda syndactyla*	30	24	21	OM
Northern Bearded Scrub Robin *Cercotrichas leucosticta*	2	2	—	IN
Brown-chested Alethe *Alethe poliocephala*	69	14	—	IN
Fire-crested Alethe *Alethe diadematа*	19	57	35	IN
Lowland Akalat *Sheppardia cyornithopsis*	19	4	—	IN
Forest Robin *Stiphrornis erythrothorax*	15	33	10	IN
Rufous Thrush *Stizorhina fraseri*	—	1	—	IN
Red-tailed Antthrush *Neocossyphus rufus*	7	—	—	IN
White-tailed Antthrush *Neocossyphus poensis*	7	5	1	IN
Black-eared Ground Thrush *Zoothera cameronensis*	1	—	1	IN
Crossley's Ground Thrush *Zoothera crossleyi*	1	—	—	IN
Forest Ground Thrush *Zoothera oberlaenderi*	2	—	—	IN
Grey Ground Thrush *Zoothera princei*	—	1	—	IN
Black-faced Warbler *Bathmocercus rufus*	1	—	—	IN
Olive-green Camaroptera *Camaroptera chloronota*	1	2	5	IN
Green Hylia *Hylia prasina*	2	8	17	IN
Dusky-crested Flycatcher *Trochocercus nigromitratus*	12	7	—	INsa

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Table 2. *cont.*

Species	Monodominant (Lenda)	Mixed (Apharama)	Secondary (Babukeli)	Guild
Grey-throated Flycatcher *Myioparus griseigularis*	—	—	1	INsa
Red-bellied Paradise Flycatcher *Terpsiphone rufiventer*	4	4	—	INsa
Rufous-vented Paradise Flycatcher *Terpsiphone rufocinerea*	1	2	—	INsa
Sooty Flycatcher *Miscicapa fuliginosa*	—	—	1	INsa
Yellow-footed Flycatcher *Muscicapa sethsmithi*	—	1	—	INsa
Chestnut Wattleye *Dyaphorophyia castanea*	—	—	3	INsa
Yellow-bellied Wattleye *Dyaphorophyia concreta*	16	2	—	INsa
Brown Illadopsis *Illadopsis fulvescens*	21	8	4	IN
Pale-breasted Illadopsis *Illadopsis rufipennis*	3	2	3	IN
Scaly-breasted Illadopsis *Illadopsis albipectus*	7	7	1	IN
Capuchin Babbler *Phyllanthus atripennis*	7	2	—	IN
Grey-headed Sunbird *Anthreptes fraseri*	1	1	—	NEC
Blue-throated Brown Sunbird *Nectarinia cyanolaema*	—	—	2	NEC
Olive Sunbird *Nectarinia olivacea*	92	95	152	NEC
Blue-billed Malimbe *Malimbus nitens*	—	2	2	FRIN
Red-fronted Antpecker *Parmoptila woodhousei*	—	2	5	IN
Chestnut-breasted Negrofinch *Nigrita bicolor*	—	—	1	IN
Green-backed Twinspot *Maningoa nitidula*	—	—	2	GR
Grant's Bluebill *Spermophaga poliogenys*	18	1	—	GR
Total:	400	346	377	

Guild codes: RAP, raptor; FR, frugivore; FRIN, frugivore-insectivore; IN, insectivore; INsa, sallying insectivore; GR, Graminivore; OM, omnivore; NEC, nectarivore.

Tukey's test was used to find where the differences lie. The secondary forest is significantly different from the two primary sites for three guild categories: frugivore-insectivores ($F = 15.76$, $df = 2,30$, $P < 0.001$); insectivores ($F = 21.34$, $df = 2,30$, $P << 0.001$); nectarivores ($F = 13.91$, $df = 2,30$, $P < 0.001$). In addition, if frugivores and frugivore-insectivores are combined into one frugivory category there is a significantly higher percentage in the secondary forest ($F = 14.94$, $df = 2,30$, $P < 0.001$).

Discussion

The effects of shifting cultivation

The results presented here show that shifting cultivation as it is currently practised in the Ituri Forest causes marked changes to the bird communities that live in this forest region. The overlap in species composition between the secondary forest and the two primary forest sites is much lower than the overlap

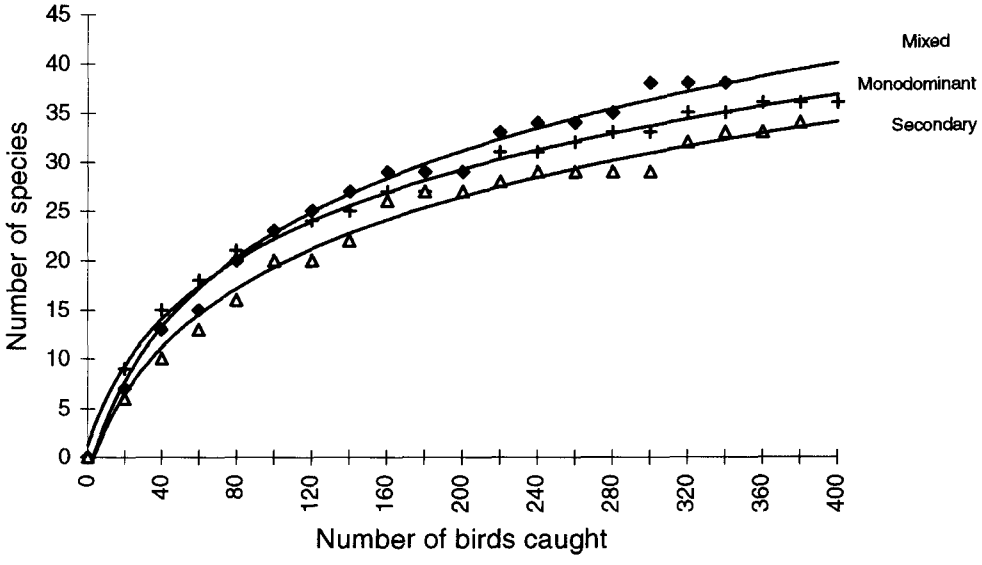

Figure 2. Species accumulation curves for the three sites in the Ituri. The number of species is plotted against the number of captures.

Table 3. Diversity and evenness for each study site. The results of Shannon–Wiener index and the log-series alpha are given as measures of diversity. Evenness for the former index is also given. Standard errors are given in parentheses

	Monodominant (Lenda)	Mixed (Apharama)	Secondary (Babukeli)
Shannon–Wiener	3.97 (0.0029)	3.87 (0.0038)	3.25 (0.0039)
Evenness	0.77	0.74	0.64
Log-series alpha	9.58 (0.080)	10.89 (0.095)	9.07 (0.080)

Table 4. The percentage number of captures and number of species in each of the seven guild categories for the three forest types. In addition the percentage of flycatcher species (sallying insectivores) is given as a subcategory of insectivores

	Monodominant (Lenda)		Mixed (Apharama)		Secondary (Babukeli)	
	%	No.	%	No.	%	No.
Frugivore	1.0	1	0.9	1	0.8	1
Frugivore-insectivores	8.2	1	10.7	4	26.8	6
Insectivores	55.3	27	53.2	27	24.9	20
Flycatchers	8.3	4	4.6	5	1.3	3
Graminivores	4.5	1	0.3	1	0.8	1
Nectarivores	23.3	2	27.7	2	40.8	2
Omnivores	7.5	3	7.2	3	5.6	3
Raptors	0.2	1	—	—	0.3	1

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between the two primary forest sites themselves. It is also much lower than the overlap of bird communities between selectively logged and unlogged areas of the Budongo Forest in Uganda (Owiunji 1996). This is notwithstanding the fact that the mixed forest site in the Ituri has a fair amount of disturbance from wind and contains a fairly broken canopy. This site is probably more similar to the situation which used to obtain in the past when the shifting cultivation was much more localized in small patches near the rivers in the forest. It is probable that this type of farming had less of an impact on the forest birds than the current situation with the farming concentrated along the roads.

Species that seem to be particularly affected by disturbance include the sallying insectivores (flycatchers and wattleyes) which probably require the open understorey of mature forest, and the insectivorous ground thrushes *Zoothera*. Four ground thrushes were caught at Lenda and one at both the other sites, although the one at Babukeli was caught in a strip of mature riverine forest between secondary forest. During a major study of the birds in the forests of Uganda by the Uganda Forest Department with 1,210,978 metre-net-hours (mnh) and 14,216 birds caught, only three ground thrushes were captured, one Black-eared Ground Thrush *Zoothera camaronensis* and two Grey Ground Thrushes *Zoothera princei* (R. Mathews pers. comm. 1996). In 158,508 mnh and after capturing 3,993 birds in Budongo Forest, Uganda, I have only caught one Black-eared Ground Thrush which was in undisturbed forest. By comparison the Ituri forest seems to be particularly good habitat for these species. At all the sites where they were captured the understorey was very open with a short herb layer of Marantaceae and Zingiberaceae up to a height of about 40 cm. These bird species are likely therefore to suffer from forest disturbance and this may be why they are so uncommon in the forests of Uganda. Brown-chested Alethes *Alethe poliocephala* and Brown Illadopsis *Trichastoma fulvescens* also seem to require undisturbed forest (Table 2) and this is also true in Budongo Forest (Owiunji and Plumptre unpublished, Owiunji 1996). Many greenbuls on the other hand seem to do well in disturbed forest and some species in the Ituri seem only to occur in the disturbed secondary forest.

Community changes and ecosystem function

The increase in frugivory and the decrease in insectivory, particularly sallying, species following disturbance in this forest is likely to have an effect on the functioning of the forest. Grieser-Johns (1996) and Owiunji (1996) also found an increase in frugivore-insectivores and frugivore-nectarivores following logging in rainforest in Malaysia and Uganda respectively. The increase in frugivory will increase seed dispersal and should benefit those plants that rely on animal-mediated seed dispersal (although this will depend on the number of frugivores in relation to fruit available). Thomas (1991) also showed that frugivorous primates were more numerous in secondary forest when compared with monodominant forest in the Ituri.

The increases in frugivory and nectarivory leading to increased seed dispersal and pollination,will probably favour certain plant types over others thus leading to long-term changes in the forest. For example, several climbers have small fleshy fruits that are dispersed by birds (pers. obs.) and if these plants increase

in density they may have a negative effect on the regeneration of tree species and slow the recovery of primary forest structure. Climber tangles in Budongo are one of the major problems for the forester and in the past all climbers used to be cut to improve the regeneration of the trees (Eggeling 1947, Plumptre 1996).

Conservation importance of the Okapi Reserve

Seven new species were added to the bird list for this forest bringing the total bird list to 333 birds and 233 forest species. The findings of this mist-netting study suggest that the Ituri is an important area for certain species. Ground thrushes in particular (four species caught in only 32 days netting) appear to be reasonably abundant. Of the birds caught, the Forest Ground Thrush *Z. oberlaenderi* and Sassi's Olive Greenbul *Phyllastrephus lorenzi* are classed as threatened or in danger (Collar *et al.* 1994). Consequently the recently gazetted Okapi Reserve does appear to be conserving some important species.

Given that the Okapi Reserve has people living along the roads that traverse it efforts must be made to limit the increase of the population. Stephenson and Newby (1997) identified immigration as one of the greatest threats to this Reserve. The secondary forest created by the shifting cultivation contained fewer bird species and those that did occur there were reasonably common species. If the human population and cultivation increases then the conservation importance of the Okapi Reserve will be lessened. The recent political turmoil in Zaire has lead to a breakdown of what little law and order existed in this area of Zaire. Most of the Reserve staff have fled the area (some to Uganda) and refugees have been travelling along the roads shown in Figure 1 to escape the fighting. Now that the major towns and cities in the east of Zaire have been taken and the fighting has stopped in the area of the Reserve, it is hoped that the staff will be able to resume their positions soon to prevent settlement of refugees here.

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