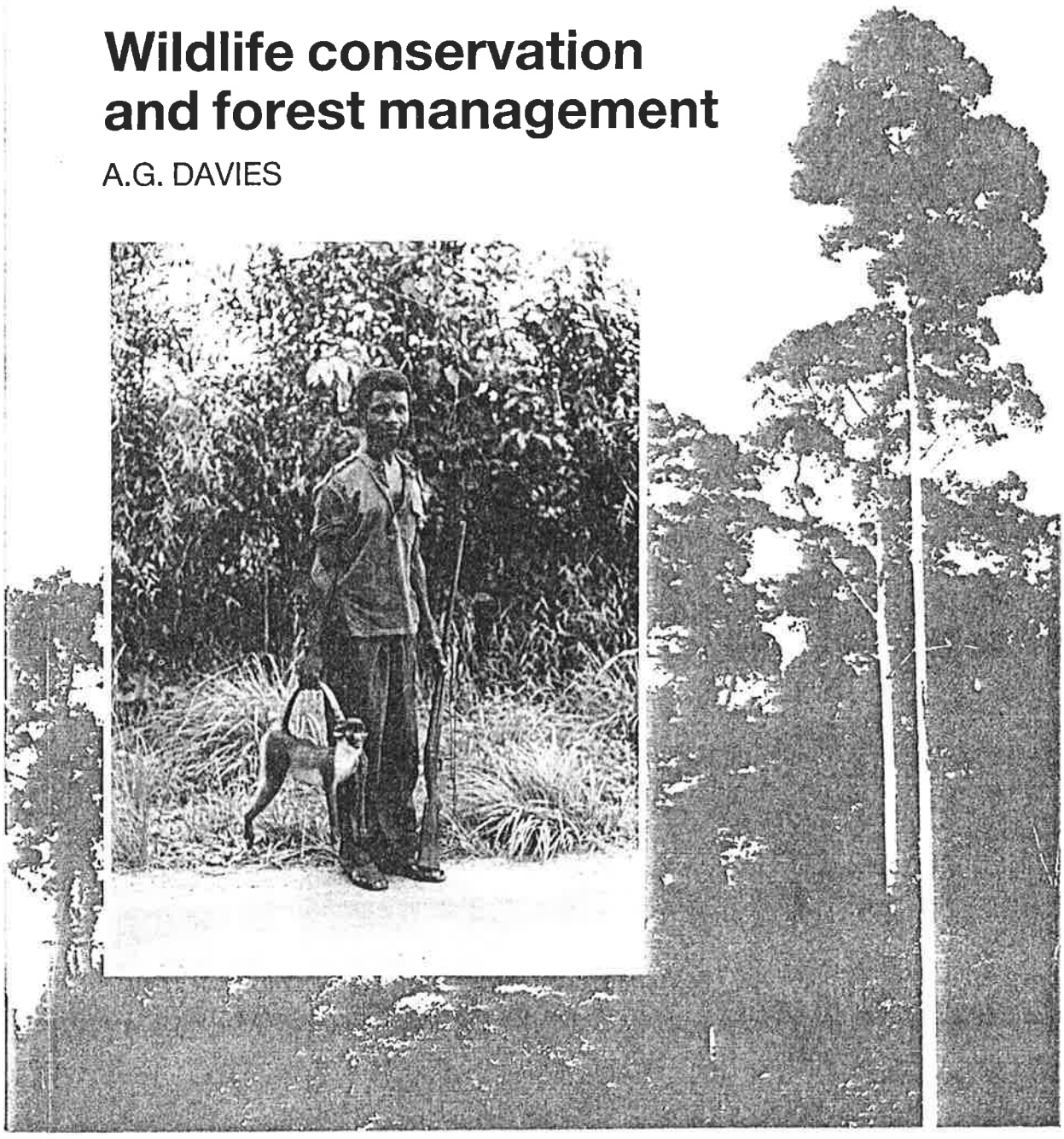
The Tropical Forest Programme

The Gola Forest Reserves, Sierra Leone

Wildlife conservation and forest management

A.G. DAVIES



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IUCN TROPICAL FOREST PROGRAMME

THE GOLA FOREST RESERVES, SIERRA LEONE

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by

A G DAVIES

International Union for Conservation of Nature
and Natural Resources

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SUMMARY AND RECOMMENDATIONS

1. **Sierra Leone** covers an area of **72,278 sq km** and has a human population of about **4 million**.

2. Over 50% of Sierra Leone has climatic conditions which favour **tropical evergreen forest**. However, agriculture and timber exploitation have greatly depleted the area under forest, by 1976 the percentage cover of the country was:

- over **55% farm bush** (trees less than 10m high)
- under **4% secondary forest** (trees 10 to 30m high)
- under **5% primary forest** (trees 30m high)

3. Most of the forest is in **Forest Reserves**:
- Forest Reserves account for 3.9% of the country
- **forested land** within Forest Reserves accounts for **2.3%**

No other areas of forest are under government control.

4. **Hunting** of wildlife occurs all over Sierra Leone. Commercial gangs are currently hunting-out forest and farm bush areas in a systematic fashion. Villagers trap animals around farmland. Much **bushmeat** is exported to Liberia and if hunting remains unchecked animal populations will be eliminated, as has already happened in parts of Liberia.

5. The proposed **Outamba-Kilimi National Park** will be Sierra Leone's first National Park once it is gazetted, and will protect fauna and flora in the arid Guinean savanna of the north. **No rain forest areas have been effectively protected,** yet rain forest harbours more species of animal and tree than does savanna.

6. Sierra Leone stands alone compared to her neighbours, Liberia, Ivory Coast and Ghana, who have all set aside rain forest areas to preserve their natural heritage.

GOLA FOREST RESERVES

1. **The reserves cover 748 sq km: Gola North (448), Gola East (228) and Gola West (62).**

2. **Exploitation of the Reserves takes several forms:**

a) **Timber extraction** has occurred in all of Gola West and about 10% of both Gola North and Gola East. Logging is currently underway in Gola North and Gola East and all three Reserves are part of a timber concession.

b) **Hunting** is carried out by Liberians and Sierra Leoneans throughout the Reserves, but it is especially intense in Gola East and Gola West where logging roads have improved access for hunters.

c) **Diamond diggers** are active, especially in the dry season, in the lower reaches of the Mogbai river.

d) Villagers collect **minor forest products**, such as palms, fruits and fuelwoods. But the Reserves' boundaries have suffered little agricultural encroachment.

3. **The Reserves need careful management if their many resources are to be exploited at sustainable levels, while avoiding the extinction of plant or animal species.**

SURVEY RESULTS

1. **Over 138 species of large tree were identified** in the five botanical plots examined. The Gola Forests still have the full complement of rain forest tree species and are comparable to primary forests in Liberia, Ivory Coast and even Nigeria.

2. **The 33 mammal species and 84 bird species** that were identified could be divided into several categories:

- **rare species**, which occur at low population densities in all habitats in Sierra Leone (e.g. elephant, pygmy hippopotamus, bongo, chimpanzee, leopard)
- **forest species**, which depend on vegetation in the moist southern zone of the country and are often

rare because little forest remains (e.g. white-breasted guineafowl, diana monkey, colobus monkeys, golden cat)

- **other species**, which can live in rain forest and other habitats (e.g bushbuck, red river hog, sooty mangabeys)

The Mogbai area in Gola North still has populations of the rarest mammals and birds in West Africa.

3. **Timber extraction**, at low to moderate levels, can be tolerated by many forest species as long as hunting does not increase concurrently. However, **some species do not adapt well to logged forest** and must be preserved in primary forests (e.g. zebra duiker, bay duiker, white-breasted guineafowl, Temminck's squirrel).

4. **Hunting is the main cause of animal extinctions in the Gola Forest Reserves.** Large mammals have been eliminated, or have migrated, from areas of logged forest where hunting is most intense. As hunting pressure declines more mammal species were encountered. Hunting pressure does tend to increase in logged forests due to improved access along logging roads.

5. **The minimum area of primary forest that can usefully be set aside is 20 - 40 sq km.** This will give populations of the commoner species that are large enough to survive catastrophes like the failure of fruiting seasons etc. Rarer species will have smaller populations preserved in primary forest and must be protected outside the main preservation areas.

RECOMMENDATIONS

The different resources in the Gola Forest Reserves have been under-rated and immediate attention must be directed towards their careful management if Sierra Leone is to avoid losing them.

1. **Forest management:**

a) Resource inventories of the Reserves must consider water balance, soil fertility, food items, and endangered species, as well as timber.

b) Management of logged forest is required to monitor and improve regeneration after timber extraction, and more research is needed to determine a sustainable felling cycle.

c) Large scale development of a tree plantation industry is the only way future timber needs will be met. It would be appropriate to domesticate indigenous trees, as well as using exotic species.

d) The Reserves need to be demarcated, with different areas set aside for different activities, including preservation of plants and animals, production of timber, tree plantations. Detailed management plans need to be drawn up.

e) The integrity of the Reserve boundaries needs to be maintained to avoid encroachments by farmers which would remove any control over land use. In particular, logging roads need to be laid out to minimise intrusions by vehicles and pedestrians who are seeking access to the public road system.

2. **Wildlife conservation** must combine the preservation of rare species and the exploitation of others.

a) **Two Strict Nature Reserves (SNR) need to be established:**

- **Mogbai (35 sq km) in the central part of Gola North,** including timberless swamps and the upper catchment of the Mogbai river.
- **Wemago (23 sq km) in the northern part of Gola East**

b) **Hunting must be prevented immediately in these two SNRs.** This must be done by the Forestry Division in conjunction with the local police and judiciary, supported by a conservation education programme.

c) **More surveys** are needed to investigate the precise distribution and abundance of animals and plants. **More research** is needed on: i) the effects of logging and ii) managing both primary and logged forests to improve the habitat for animals.

d) **The Wildlife Conservation Branch** is grossly understaffed and cannot carry out its duties properly unless more staff are recruited.

e) **A field station** needs to be established in the Gola Reserves from which to coordinate forestry and wildlife research and management.

f) **The Wildlife Conservation Act (1972)** needs to be up-dated to give more protection to species that are being lost from Sierra Leone. Sierra Leone should become a party to CITES.

3. **Rural development outside the Reserves** must be coordinated with forest management:

a) **Community forests** could usefully be encouraged in farmland areas by supplying seedlings from the Reserves. This would give forest products that are required by rural communities, but which are becoming increasingly scarce (e.g. timber for houses and canoes, preferred fuelwoods).

b) **Agro-forestry** needs considerably more development using rain forest trees for shading cash crops.

c) **Meat supplies** are currently met by hunting and trapping, without any formal management strategy. Several management strategies need to be investigated to ensure supplies are maintained:

- **complete domestication** of animals raised in captive conditions may be possible, trials with cane rats and giant rats proved initially successful in Ghana and need investigation in Sierra Leone.
- **semi-domestication** through range management of farmbush areas may be possible to encourage duiker populations that can be cropped.
- **managed hunting** of wild primate and duiker populations may be allowed, especially in logged forests, as long as stocks can be maintained by enforcing seasonal or regional controls.

IN SUMMARY, A HOLISTIC APPROACH TO MANAGEMENT OF THE GOLA FOREST RESERVES IS REQUIRED TO ALLOW SUSTAINED EXPLOITATION OF PLANT AND ANIMAL RESOURCES, WITHOUT SPECIES EXTINCTIONS. HOWEVER, IF CURRENT TRENDS ARE ALLOWED TO CONTINUE, SIERRA LEONE WILL LOSE HER LOWLAND RAIN FOREST, AND ALL THE RESOURCES THEREIN.

PREFACE

The rain forests of the world are being lost at an alarming rate, especially in West Africa where it is estimated that 5% of rain forests disappear each year. There is, therefore, an urgent need to focus attention on the plight of these areas so that the political will can be found to prevent their elimination. This report on the Gola Forest Reserves in Sierra Leone is written for this reason and to point out that, if current trends are allowed to continue, a decade is ample time for some of Sierra Leone's rarest plants and animals to become extinct.

There have been many ecological crises in Africa, none more poignant than the recent Sahelian droughts. Each time conservation strategies have been re-evaluated. Initial conservation strategies involved the preservation of sacrosanct parks, such as royal hunting areas, which were exploited very carefully by very few.

Such conservation strategies began to run into trouble as land-hungry human populations expanded. Economic justification was needed to explain why national parks should be set aside and wildlands carefully managed. From this need emerged a new realism in conservation doctrine, well-summarised in the "world conservation strategy" of IUCN, World Wildlife Fund and UNEP. The strategy clearly showed that the following make long-term economic sense: a) sustainable exploitation of natural resources, b) maintenance of ecological processes and c) preservation of genetic diversity.

In other words, biological resources can be exploited indefinitely, but only if allowed to recover. However, this dictum, and the world conservation strategy in general, underplays the problem of species extinctions.

These are occurring at a rapid rate in West African rain forests. Nonetheless, recent surveys of rural communities in Africa have shown that villagers have clear perceptions of their environment and do not favour the extinction of species. A major difficulty has always been equating species loss in monetary terms. Fortunately, however, economic theory is at last beginning to catch up with environmental reality to offer a framework for evaluating species' survival (Pearce, 1987).

In this report I consider that species' extinctions are unacceptable, since they represent the final step in bad land management. At the same time, I

accept that natural resources will be exploited, in some cases intensively, and only a few areas can be set aside, undisturbed, for the preservation of each nation's natural heritage.

From this stance of "exploitation without extinction" I have favoured the ecosystem approach to conservation, rather than pinpointing one or a few species. Time is too short for everyone to cling exclusively to their own speciality. Consequently, this report focusses on primates, my speciality, but includes details of trees, birds and other mammals to give as full a picture as possible.

Care has been taken to ensure accuracy in the presentation of the results, but any errors must remain my responsibility. Furthermore, the recommendations represent my views, based on the available evidence, and not necessarily the views of agencies which funded the work or individuals and organisations which contributed to it.

Glyn Davies,
University College London
13th June 1987.

ACKNOWLEDGEMENTS

Any survey project carried out over 18 months, involving collaboration between different organisations and Government Departments owes much to the cooperation and often unselfish help of others. I am most grateful to all of the organisations and individuals mentioned below for their support, without which this project would not have been successful.

Permission to carry out surveys in the Gola Forest Reserves was given by the Chief Conservator of Forests, initially Mr M.B.D. Feikeh and subsequently, and for most of the project, Mr A.P. Koroma. Support and advice were given freely by him, the Deputy Conservator of Forests, Mr P. Palmer and the Assistant Conservator of Forests, Mr S. Jambawai.

The project was planned with the advice and collaboration of the Game Superintendent, Mr M. Bereteh. Much time was given by the Regional Forest Officer in Bo, Mr Emmanuel Alieu, and in Kenema, Mr David Gabba, who organised everything from transport and payments of field staff to technical information and that most precious of commodities, petrol.

In the field the able and hard work of the botanical survey team deserves special commendation. The team was led by S.K. Samai and his right-hand men V.K. Kallon, P. George, Coker and Kaillie. These were assisted by several labourers, in particular Pa Ernest whose knowledge of Mende tree names is unrivaled.

The Wildlife Conservation Branch members who accompanied me all worked hard to ensure success. They included Umaro Kamara, E.A. Lavally, Dayo Metzger, John Samura and John Carey. Two trusted guides led us to suitable camping sites: Benneh Mara in Gola North and Foday Kamara in Gola East and West. Rangers Moriba, George and Yoko hospitably accommodated teams going to and from the forest.

The research work on Tiwai was done under the sponsorship of the University of Sierra Leone, through the University Research and Development Services Bureau. The Tiwai Primate Project was affiliated with the Department of Biological Sciences, Njala University College and administered there through Peter White, Ag. Head of Department, during Abu Sesay's leave of absence.

The Paramount Chief of Barri Chiefdom, V.K. Magona VI, gave permission for a research station to be established on Tiwai. He and the Honorable S.S. Magona continually supported the Tiwai project and set a

fine example of how chiefdoms can initiate their own conservation strategies.

Tiwai Project Director, John Oates and my predecessor as project manager, George Whitesides introduced me to West African rain forest and shared with me their knowledge. John Oates pointed out the need for surveys in the Gola Forest Reserves and introduced me to the Forest Division. Georgina Dasilva was my companion and colleague on Tiwai for two years with whom I collaborated in research work and who ably supervised the Project while I was away on survey.

Mr Lewally, General Manager of Forest Industries Corporation, supported the faunal surveys and encouraged the inclusion of more botanical work. Nick Woods, FIC bush manager, provided details on technical aspects of forest exploitation as well as much appreciated hospitality in the field and in Kenema. Horst Schnabbel continued with this assistance after Nick Woods had left.

The Bo-Pujehun Project supported the rain forest tree planting project. The Agronomist generously supplied potting bags, advice and space in their nursery for forest tree seedlings.

Technical advice was given by Dr John Phillipson, Dr Rob Malpas and Dr Bob Boote before I left for Sierra Leone, and I was continually kept up to date in the field by Dr Nigel Collar, Dr Simon Stuart and Ms Jane Thornback. Phil Steele of the International Centre for Conservation Education donated slides for use in Forest Division conservation education programmes.

In Sierra Leone, Ms Daphne Tobuko-Metzger, Secretary of the Sierra Leone Environment and Nature Conservation Association, supplied literature and background information on wildlife conservation, and Dr Geza Teleki and Ms Ruth Happel shared with me their notes on wildlife. Mr Osmond Gordon, Director of Lands and Surveys Division supplied vegetation maps.

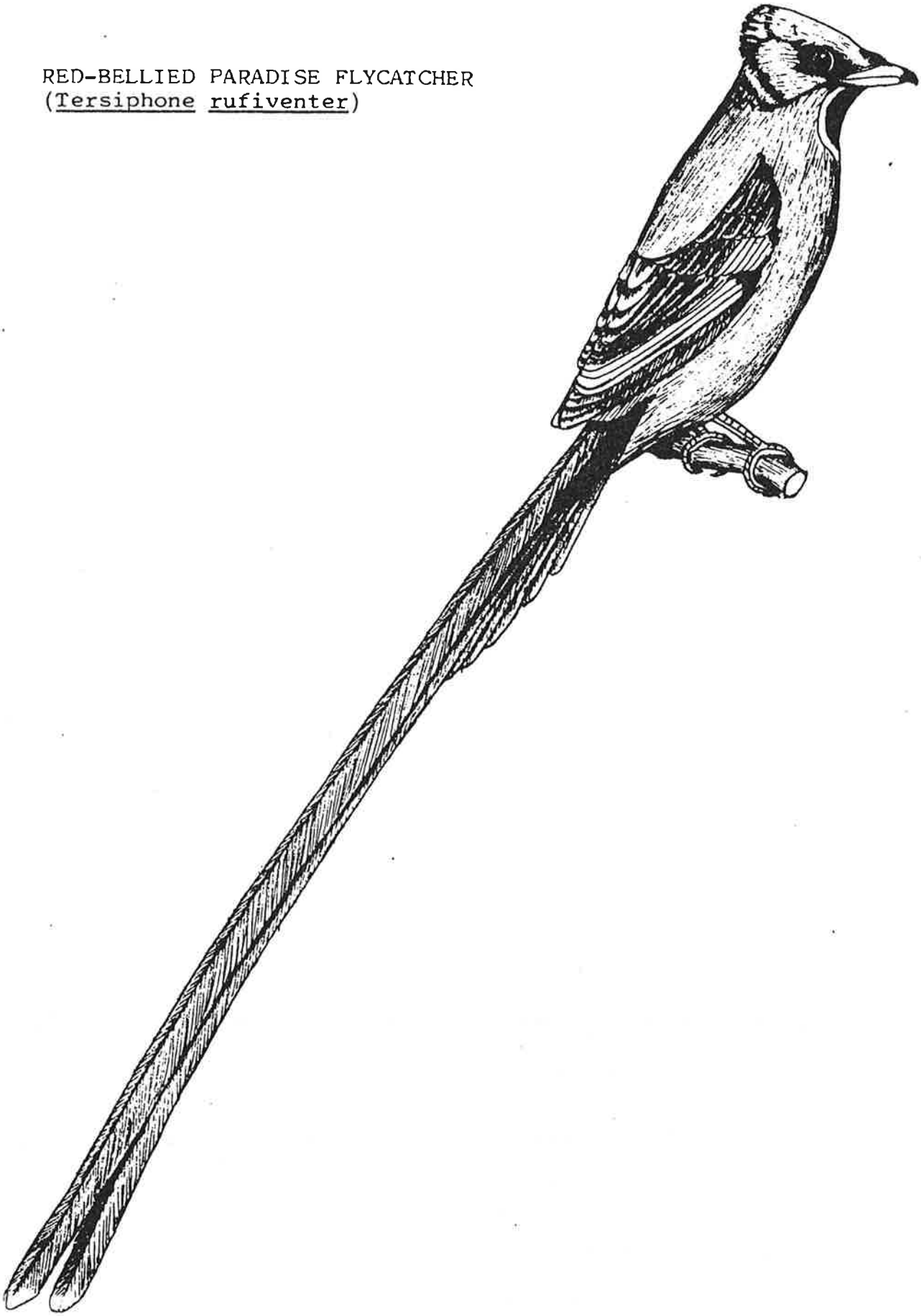
In the midst of a very hospitable country several people must be thanked for outstanding forbearance in the face of my sudden arrivals from the forest. Rachel, Nigel and later Olabisi Wakeham shared their family home in Freetown and continually helped overcome logistical problems. Similar support was given by Peter White at Njala and members of the Medical Research Council team in Bo: Judith "fix-it" Goddard, Madeleine Thompson, Paul Beech-Garwood, John MacMahon and John Davies. Valerie and Alistair Farquharson provided much-appreciated hospitality in Kenema, as did Andy King and David Harris.

Financing of the surveys came from several sources. The research work on Tiwai Island, and my salary, was funded through National Science Foundation (U.S.) grants to John Oates and Steve Green (nos. BNS 8120206 and 8505702). The New York Zoological Society granted funds to John Oates for a Mazda pick-up for use on the Tiwai Project and Gola surveys. Survey running costs were met by grants from World Wildlife Fund-U.S. to John Oates and myself and the botanical surveys were sponsored by a World Wildlife Fund-International grant to myself (project 3316).

The compilation of the report was done with the assistance of Mr Okine (Cartographer, Njala University College) who drew some maps and all of the plates and Nigel Wakeham who produced six of the maps. Most writing was done while I was in the Anthropolgy Departments of Hunter College (City University of New York) and University College London. Alex Forbes-Watson, John Oates and George Whitesides offered constructive critisism of an earlier draft of this report. Sylvia Howe proof-read the manuscript and Mark Collins gave sound editorial advice.

This report is dedicated to all those Africans who have had the foresight and courage to strive for conservation strategies in their own countries. They deserve every assistance that can be offered.

RED-BELLIED PARADISE FLYCATCHER
(Tersiphone rufiventer)



1. INTRODUCTION

This report is about a survey of the fauna and flora in the Gola Forests Reserves, eastern Sierra Leone, which was carried out from December 1984 through December 1985.

The fauna is an integral part of the rain forest ecosystem and it is the loss of this whole ecosystem - animals, plants, soil and water - which is of concern to politicians, land-use planners and ecologists alike. Most African countries are currently facing ecological problems caused by past land use practices and, although these problems are seldom as catastrophic as those recently experienced in Sahelian countries, they can have a severely negative effect on social and economic development.

A basic tenet of this report is that land development needs to be reviewed in the light of recent technical information, with particular attention paid to the long-term consequences of current actions. The relatively poor soils and heavy rainfall in coastal West Africa are ingredients for disaster when combined with short-term, maximum-gain economic policies. Moreover, the scale of human population growth may require modification of traditional land use practices to avoid exhaustion of resources.

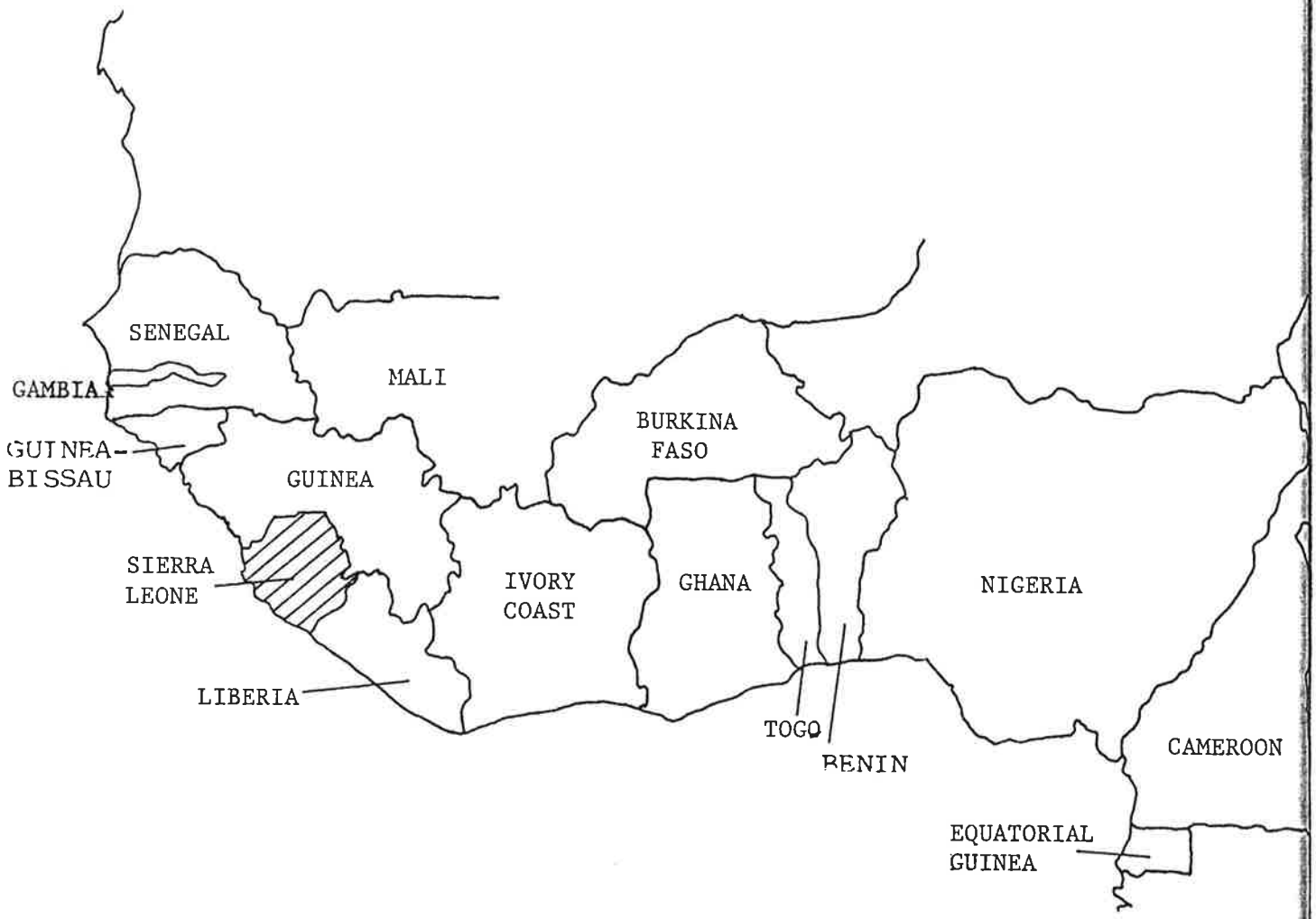
In Sierra Leone the exploitation of wildlife and "minor" forest resources has not been managed in a systematic way. As a result, these resources are being depleted very rapidly despite their central role in rural economies. For example, the trade in bushmeat with Liberia probably amounts to thousands of dollars annually.

The precarious position of wildlife conservation in Sierra Leone has been high-lighted in previous reports (Phillipson, 1978; Teleki, 1980; Oates, 1980). Phillipson drew up a set of guidelines for management and protection of wildlife, and the Government of Sierra Leone wisely ratified his report in Parliament, thereby committing itself to a policy of rational use of the wildlife resource without species' extinctions.

As a first step towards practical implementation of this policy, notice was served in the Government gazette in 1986 of the intention to establish the Outamba-Kilimi National Park in the arid Guinean savanna found in the north of the country.

This is a vital first step in the country's efforts to manage wildlife. It should be noted, however, that the diversity of plants and animals in the Guinean savanna is lower than in rain forests and

Figure 1.1 NATIONS OF COASTAL WEST AFRICA



many of Sierra Leone's rain forest plants and animals do not occur in Outamba-Kilimi. Therefore, forest regions need to be set aside and this action must be taken urgently since many rain forest species are extremely rare in the country due to pressures from hunters, timber exploitation and farmers.

With this knowledge, the Forestry Division of the Ministry of Agriculture, Natural Resources and Forestry has supported wildlife surveys that are carried out in collaboration with its Wildlife Conservation Branch to assess the situation in the Gola forest region. A detailed elephant survey has already been carried out (Roth and Merz, 1983). Following on from these surveys, the current project was primarily aimed at identifying areas within the Gola Forest Reserves that would be useful for wildlife preservation. Information was collected to this end, bearing in mind that timber has to be supplied to the Nation from the Gola Forest Reserves.

GEOGRAPHY

Sierra Leone is one of the smallest countries in coastal West Africa (Fig 1.1), covering an area of 72,278 sq km with a population of about four million. It therefore has a very dense human population which is concentrated largely in the south and east.

The south-western half of the country comprises a lowland plain, occasionally interupted by inselbergs, which lies below 75m asl (Clarke, 1969). There is then an abrupt, almost linear escarpment running from the north-west to the south-east which rises to give the eastern plateau (300-600m). The plateau is topped by Sakan Biriwa (1709m) and Bintumani (1945m), the highest mountain in Africa west of Mount Cameroon. Ten major rivers flow south-west, roughly parallel, from the northern uplands to the extensive mangrove swamps along the coast.

Annual rainfall is concentrated during a rainy season of about four months in the middle of the year. The southern areas and central part of the upland escarpment receive about 3,000mm annually, but more rain falls on the coastal zone and less than 2,000mm falls in the arid north. At the end of the rainy season the cold, dry Harmattan wind blows from the Sahara, bringing dust and reducing both temperature and air moisture levels. The mean annual temperature fluctuates little from 80'F, although mean monthly temperatures are lowest in August and highest in March.

The most luxuriant vegetation that can result from this equable climate is Tropical Rain Forest, characterised by a predominance of evergreen trees with a closed canopy at about 30m (Savill and Fox, 1967). Lianas and epiphytes (e.g. ferns and orchids) festoon the trees, but grasses are almost absent from the dark forest floor. This type of forest becomes established when fewer than three months have under 50mm of rainfall (Savill and Fox, 1967). These conditions occur in the southern region and eastern uplands.

As the length of the dry season increases, more deciduous tree species become dominant until semi-evegreen forest occurs where four months have under 50mm of rainfall and the Harmattan wind has a more stressful drying influence. If rainfall declines further woodland savanna develops.

In addition to its majestic size and the diverse structure of its different woody vegetation, the rain forest has a high tree species diversity. In one large plot in Sierra Leone's rain forest 97 tree species were recorded with girths greater than 1.8m, but far more species are known to occur (Savill and Fox, 1967). These trees provide medicines, dyes, fuelwood and edible fruits, yet the forests have been commercially exploited for little other than timber and bushmeat.

FOREST EXPLOITATION

The activity which has resulted in the greatest loss of forested areas in Sierra Leone is **agriculture**. This includes a variety of different practices, from planting cash crops under forest trees to cutting all the vegetation before planting rice.

Each year farmers fell trees in small areas (tens of hectares) during the dry season and burn the vegetation to liberate nutrients into the soil. Rice is cultivated for one or two years and root crops, like cassava, are often planted in part of the farm afterwards. The old farms are left fallow and within two years have become colonised by dense stands of small-stature trees, entwined with lianas. The small trees form a fairly uniform canopy 3-5m above ground.

This "farm bush" must be left for about eight years for the soil to recover sufficiently to give the best rice yields when refarmed. However, this period of fallow is too short for the establishment of woody vegetation other than the "farm bush" trees which are fast-growing and small in stature.

This pattern of agriculture was modified by Forestry Departments in West Africa to make use of agricultural labour for the establishment of tree plantations. Once commercial timber had been extracted from forested areas, farmers were allocated plots in which they cut and burned the remaining trees. They then planted tree seedlings beside their rice seedlings. The farmers were initially responsible for the maintanence of seedlings, but Forestry personnel assumed responsibility for trees once the farming had stopped. The trees needed some minimal maintanence until they were ready for harvesting 15 or more years later.

This **Taungya System** of forestry has some important practical implications. Farmers must be strictly controlled since they have few qualms about refarming areas, irrespective of the land-use policy being practiced. There is ample evidence of charred stumps of plantation trees in areas where new farms have been planted before the timber was extracted. As a result forested areas are permanently converted to agricultural land and lost to timber producers.

With so little forested land left in Sierra Leone, and the great difficulty of controlling villagers once they become established in forested lands, this management system needs to be stopped.

Undoubtedly tree plantations will be needed to meet local timber demands in the future, since demand is greater than can be supplied by the few Forest Reserves that remain. It may be that areas within Forest Reserves, from which farmers are excluded, should be planted as has happened in part of Gola North. However, a detailed study of plantation methods is badly needed. In particular, it would be helpful to know to what extent plantations could be developed: a) without completely clearing and burning an area and b) making more use of indigenous tree species which are locally available and valued by rural communities.

One method of forest management that does not involve the devastating use of fire is the **Tropical Shelterwood System** (TSS), developed in Nigeria (e.g. Lawton, 1978). Climbers, and middle-storey and understorey trees that are non-commercial are killed to allow light to reach the saplings of commercial trees. The commercial tree saplings are thereby encourage in the understorey, and after timber has been extracted, they rapidly develop to produce a young crop of future timber trees. These are periodically cleared of climbers and competing non-commercial tree species.

The system is reported to have worked well in Nigeria (Lawton, 1978), although an experienced staff is required and land needs to be carefully controlled for 20 years before the benefits of this forest management can be realised.

Timber extraction without management to improve the stand is the most basic form of land use in the Gola Forest Reserves and it incorporates a wide range of practices. There is generally a lower girth limit of 2-2.5m and only commercial trees with larger girths are supposed to be cut. Once a commercial tree, which may be 35m tall and contain 3-5cu m of commercial wood, is felled, the straight bole is cut into logs of about 10m length. These are towed away, along skid-paths that have been pushed through the forest by bulldozers, to a loading area where logs are put onto trucks that take them to the sawmill.

The damage to the forest varies with the intensity of timber extraction, but many trees are knocked down when the tall timber trees fall and when skid-paths, loading areas and roads are built. Up to 50% of the crown area of trees can be destroyed when 10% of the crown is extracted (Skorupa and Johns, 1987). Moreover, soil is severely compacted by the heavy machinery which is used.

There are some 25 species of Class 1 timber, which have dark wood and can be used for cabinet making, a further 23 species of Class 2 "construction and general purpose" timber, and 38 Class 3 species which can be used for plywood (White, 1972). Depending on the distribution of these species in the forest, the intensity of timber stocking and extraction will vary. The average rate of stocking of commercial species in Gola North and East has been estimated at between 46 cu m/ha and 56 cu m/ha (White, 1972), with 50cu m/ha being considered a realistic average (D. Gabba, pers comm).

Inevitably these figures will change with time and market forces. If demand increases, then previously ignored species become marketable and the amount of commercial timber in an area will increase.

Timber extraction at a rate of about 10 tree/ha allows fair-to-good regeneration of the forest following timber extraction except along logging roads and skid-paths where soil has been compacted. Management to improve regeneration often involves more modification of the forest, as climbers and non-commercial species are weeded out, but this tends to improve timber productivity without the loss of tree species.

The use of fire has a devastating effect on the tree species diversity of an area since even the smallest saplings, which may be numerous in logged forests, are lost. Some tree species are relatively resistent to fire, and may coppice from burnt stumps, but the majority of evergreen forest trees are poorly adapted to survive burning. Only if there are unburnt forest patches, to act as nuclei sources of seeds, will substantial recolonisation of burnt areas occur. In large areas of farmland, where land is frequently reburned, only small-stature farm bush will become established.

The influence of these practices on the rain forest fauna corresponds directly with the extent to which the habitat is altered; the greater the change to the vegetation, the greater the change to the fauna. However, hunting and trapping are additional pressures facing animals, which can occur independently to, or as a consequence of, changes in the vegetation.

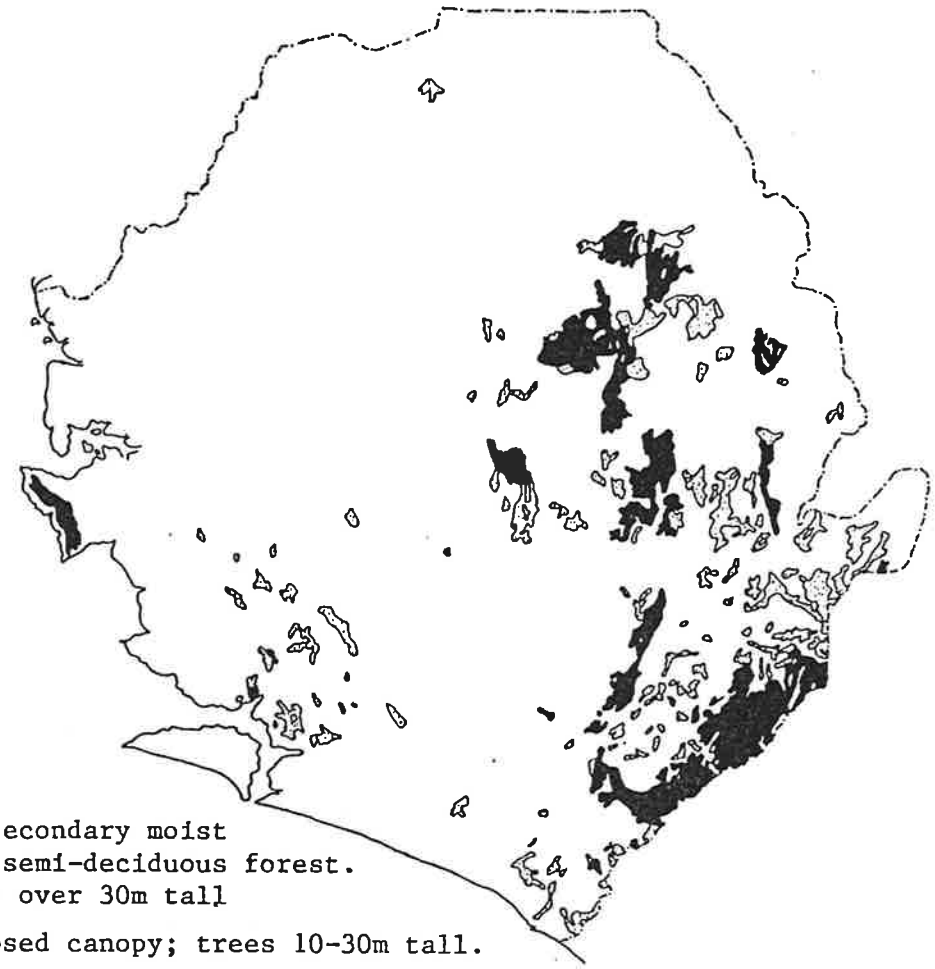
FORESTED LAND

The most thorough survey of different vegetation types within Sierra Leone was published in 1979, based on aerial photographs taken in 1976 (Gordon et al, 1979). This publication estimated that, in southern and eastern areas, 365,200ha were covered with closed-canopy high forest (equivalent to 5% of the country), 216,000 ha were covered in secondary forest (3.5% of the country) and 3,774,400ha (52.2% of the country) with forest regrowth (largely farm bush). There is some inevitable imprecision in these figures because of the map-sampling procedure used to calculate them (see Baltaxe, in Kernan, 1980), but it can be safely concluded that between 4.2% and 5% of Sierra Leone was covered in forest in 1976. A decade later, even less will be covered.

These results show the way forested land has been lost to agriculture. Only 3.6% of the country comprised secondary forest, where trees were between 10m and 30m tall, which represents the thin margin of land between farmlands and forest. Over half of the country, however, was forest regrowth where tall trees had not developed.

This conversion of forest is particularly striking when it is considered that over half of Sierra Leone has the climatic conditions to support evergreen or semi-evergreen rain forest. The history of forest loss stems from past exploitation of high quality timber

Figure 1.2 Area of primary and secondary forest in 1976 (after Gordon et al, 1979)



with little effort to replant or encourage regeneration in logged areas. Subsequently, farmers were quick to go into areas that had been opened up by timber companies. This process progressed from west to east and increased rapidly as the human population expanded. Forest now remains on the highlands of the Southern and Eastern Provinces, the axial mountain chain of the Freetown Peninsula and in the lowland Gola forests (Fig 1.2).

FOREST RESERVES

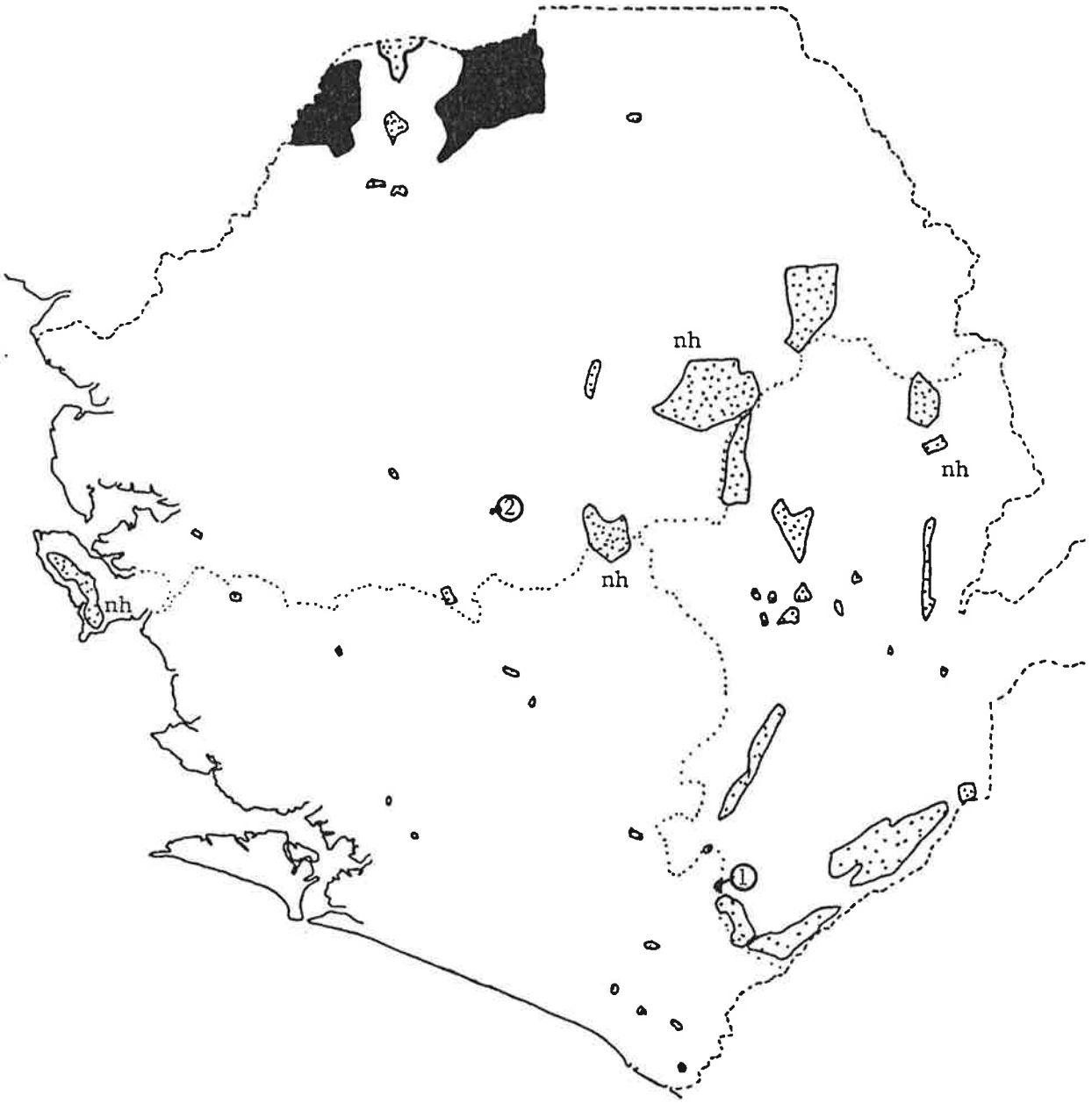
Comparison of the land still clothed by rain forest and the land in gazetted Forest Reserves (Fig 1.3) shows that most forested land is in Forest Reserves, even where these have been used for timber production. The integrity of these Reserves must be maintained if complete loss of the evergreen forest resource is to be avoided. In some cases, like the Tama and Tonkoli Reserves, there have already been considerable encroachments by farmers before timber was extracted (Kernan, 1980). Consequently valuable timber was lost and the Reserves are now redundant for all but the most carefully supervised plantation forestry, which is expensive.

There are 285,012ha within Forest Reserve boundaries (Table 1.1) of which 60% comprises closed-canopy high forest (Kernan, 1980). In other words, 3.9% of the country is in Forest Reserves and 2.3% is **rain forest** within Forest Reserves. In Eastern Province, more than 20,037ha had been exploited for commercial timber by 1980 (i.e. 13% of forested Reserves in the Province) and a further 1,710ha had been lost to farmers (Kernan, 1980). These figures will obviously increase with time.

Wildlife Reserves Until the Outamba-Kilimi National Park was formally proposed in the Government Gazette in 1986, the only protected areas for wildlife were four non-hunting Forest Reserves in which hunting without a licence is prohibited: Western Area (Freetown Peninsula), Kangari Hills, Loma Mountains and Tingi Hills. The latter Forest Reserve was not recorded in the FAO list of Reserves (Kernan, 1980), but Sakan Biriwa is the peak of the Tingi Hills and Baltaxe noted that the Sakan Biriwa Forest Reserve was ear-marked for wildlife preservation and protection forests.

Immature forest. Closed canopy; trees 10-30m tall.

Figure 1.3 Map showing National Park, Forest Reserves and proposed Game Sanctuaries approximately to scale (after Clarke, 1



National Park (Outamba - Kilimi) - proposed

Forest Reserve

1. Tiwai proposed Game Sanctuary

2. Mamunta-Mayoso Swamp proposed Game Sanctuary

nh. non-hunting Forest Reserve.

Provincial boundaries

Table 1.1 Areas within Forest Reserves (ha)

	PROVINCES			
	Northern	Eastern	Southern	Western Area
Gazetted	97523	154154	15864	17688
Proposed	4999	24876	4077	0
Number of Reserves	9	12	7	1
Number of Reserves larger than 4000ha	4	6	1	1

from Kernan,1980.

Table 1.2 Non-hunting Forest Reserves

Western Area	17688ha
Kangari Hills	8573ha
Loma Mountains	33201ha
Sakan Biriwa	12137ha

The establishment of non-hunting Forest Reserves for the purposes of wildlife protection was a far-sighted step which would have been of the greatest value if hunting within them had been effectively controlled. However it was not. For example, hunting gangs, under the charge of two Liberian women in Mongeri, have shot out large portions of the wildlife in the Kangari Hills non-hunting Reserve (E. Alieu, pers comm). Furthermore, some farms have been made in the 2,800ha of forest within this Reserve and another 5,700ha comprise steep hillsides with little forest cover (Kernan, 1980).

Similar reports come from the Loma Mountains (Phillipson, 1978). Below the 800m contour there is extensive hunting in the forested areas (Teleki, 1980; R. Happel, pers comm) and above the 800m contour there is little forest. There are even reports of mountain climbers taking shot-gun cartridges to pay for guides from local villages. There is little information from Sakan Biriwa, which is close to Loma and unlikely to have fared much better at the hands of hunters.

The Western Area forest, which is essential for protection of Freetown's water supplies and to prevent landslips onto the densely populated areas below, have been exploited by hunters for a long time.

Thus, the few areas that have been set aside for wildlife preservation are no longer of great value, especially for rain forest species, and other areas need to be considered. The Gola Forests have long been identified as of great importance, since they are the only tract of primary lowland forest left in the country (Lowes, 1970; Wilkinson, 1974; Phillipson, 1978; Merz, 1986), and urgent conservation action is needed to manage them for both timber exploitation and wildlife preservation.

CONSERVATION

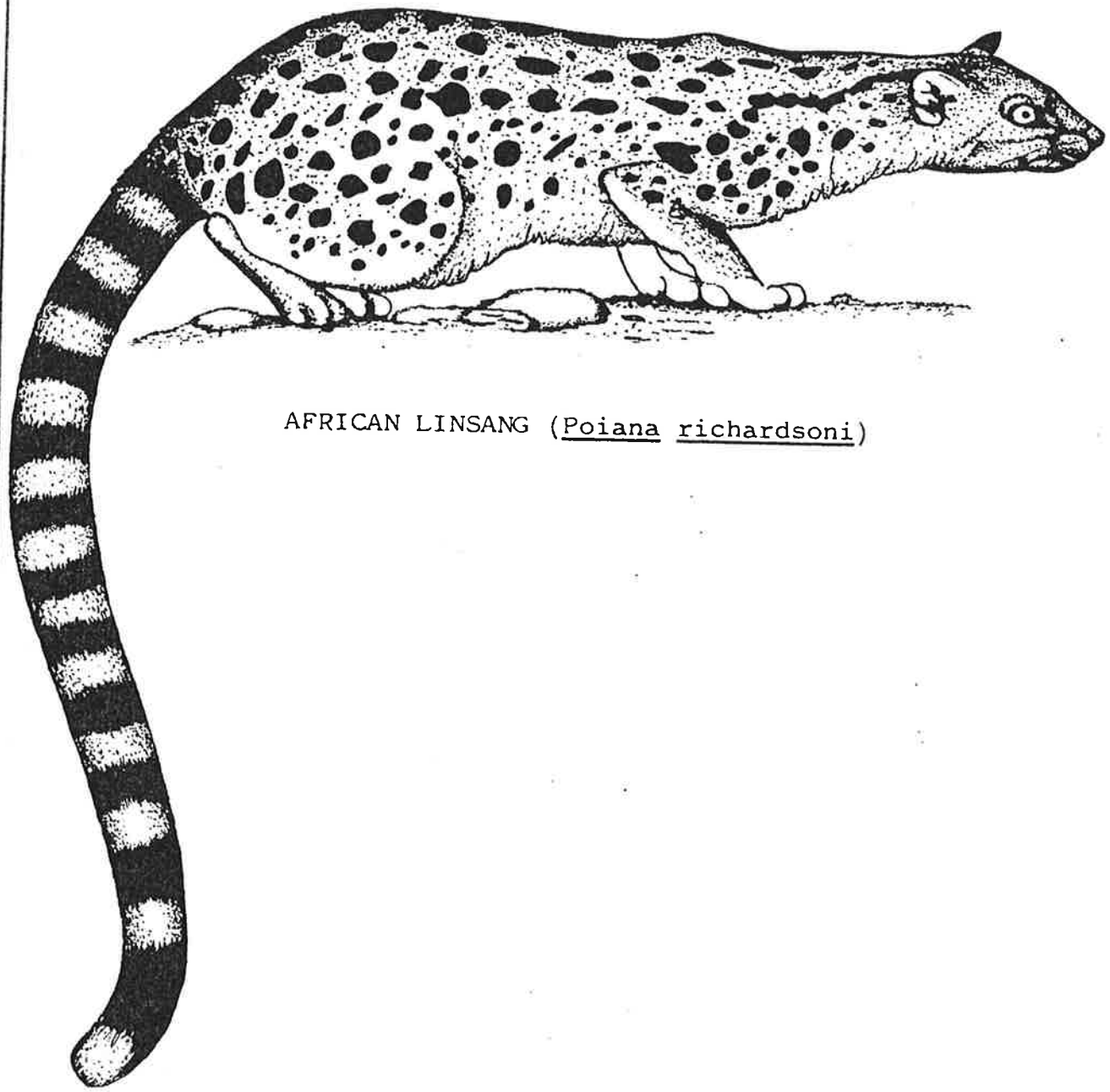
With this background it is clear that there is an urgent need to preserve some areas of rain forest and it has been recommended several times that part of the Gola Reserves be set aside as a National Park. This sound recommendation deserves serious consideration.

To put conservation into a fuller perspective, Sierra Leone stands to lose a set of resources that have been exploited to near-extinction, without any comparable replacement of raw materials being available. Yet the forest, like all biological systems, has a capacity to regenerate to supply raw materials for economic exploitation by rural communities and

industry alike. If it is lost then exploitation will cease and the biological store of plants and animals that provides the basis for future innovations in agricultural and forestry practices will also be lost. To set aside some sanctuaries is a small premium to pay now for the benefits of this important long-term investment.

Other countries in West Africa have realised the need for this long-term strategy and set aside areas to avoid losing their rain forest resources. This will also ensure that future generations are not deprived of their heritage and obliged to view animals as stuffed specimens in museums, or plants as paintings in books. In Ghana, the Bia National Park, in combination with the adjoining Game and Forest Reserves, amounts to 70,000ha of primary forest (Roth and Merz, 1983). In Ivory Coast, the Tai National Park of 340,000ha is the largest area of land protected in the Upper Guinean region, although not all of it is primary forest and it is suffering from farming and hunting. In Liberia, the Sapo National Park comprises 130,000ha of evergreen forest.

Sierra Leone still has an opportunity to follow the example of its neighbours and set aside some areas for rain forest preservation.



AFRICAN LINSANG (Poiana richardsoni)

2. GOLA FOREST RESERVES

BACKGROUND

The three Gola Forest Reserves encompass a rain forest area of 748 sq km along the south-eastern edge of Sierra Leone: Gola North (458 sq km), Gola East (228 sq km) and Gola West (62 sq km). In administrative terms, all three Reserves are in Kenema District of the Eastern Province, administered through the Provincial Secretary in Kenema. From north to south, the bulk of the Reserves lies in Malema, Nomo, Tunkia and Makpele chiefdoms, with Lalehun (Forestry Division HQ) in Guara chiefdom (Fig 2.1).

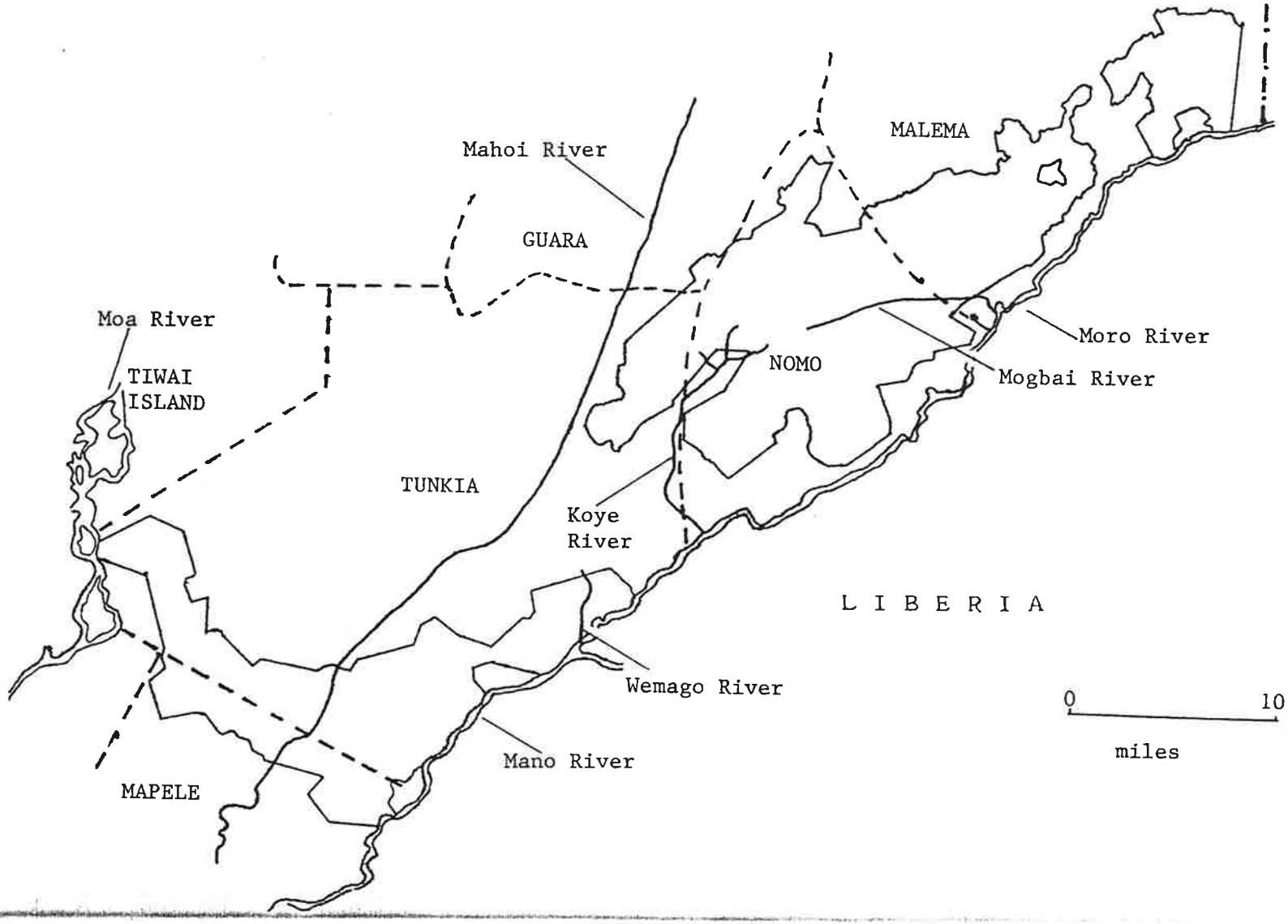
The Reserves lie between the large Moa and Mano/Moro rivers, with the intervening Mahoi river bordering Gola North and dividing Gola West from Gola East (Fig 2.1). Gola West is low-lying, as is the southern part of Gola East, with many swampy areas and a few low hills (150m high). Towards the northern part of Gola East, more substantial hills arise, such as Bagra Hill (330m), but few other places exceed 150m.

Most of Gola North is over 300m in elevation and rolling hills dominate the central part of the Reserve, with some abrupt breaks caused by steep-sided valleys. In the north, especially the northern extension, the hills become very rugged, although the highest peak is only 475m. There is no obvious altitudinal zonation of the vegetation within the Golas. Tropical evergreen rain forest predominates and different tree species associations arise as a result of edaphic and historical influences, rather than altitudinal effects.

Gazettement The Forest Reserves were established in 1926 (Gola East and West) and 1930 (Gola North), when the Colonial Administration negotiated transfer of jurisdiction over the land from the Chiefdoms to the Central Government. The Forestry Division of the Ministry of Agriculture, Natural Resources and Forestry is charged with administering them. In the 1960's and 1970's some efforts were made to get more extensions added to the Reserves, but these have not been successful.

Timber exploitation The Gola Forest Reserves, along with the Kambui Hills Reserves, form the bulk of the Kenema Sawmill Series supply area. Several small private companies in the Kenema area have made arrangements to cut timber in "savage" areas **outside** Forest Reserves, but only two companies have been

Figure 2.1 Approximate location of Chiefdom boundaries and main rivers



involved in commercial exploitation within the Reserves: Forest Industries Corporation (FIC), a Sierra Leonean Company acting under the Ministry of Trade and Industry, and Sierra Leone Timber Industries (SILETI), an Italian-Sierra Leonean company. SIlETI had a chequered history and timber operations which began in 1976 came to an abrupt end in 1983, despite the 25-year concession agreement. FIC, however, have been operating in Gola North since the 1960's and Gola East and West were included in their concession in 1984, when SILETI had left.

In Gola West, SILETI built roads through the reserve to peripheral villages whose Chiefs agreed to let SILETI cut timber from salvage areas in the vicinity of the villages (i.e. outside the Reserves). In return the village got a road which linked them with the main road system. Initially, only the most valuable timbers were cut for export both within Gola West and in the surrounding salvage areas.

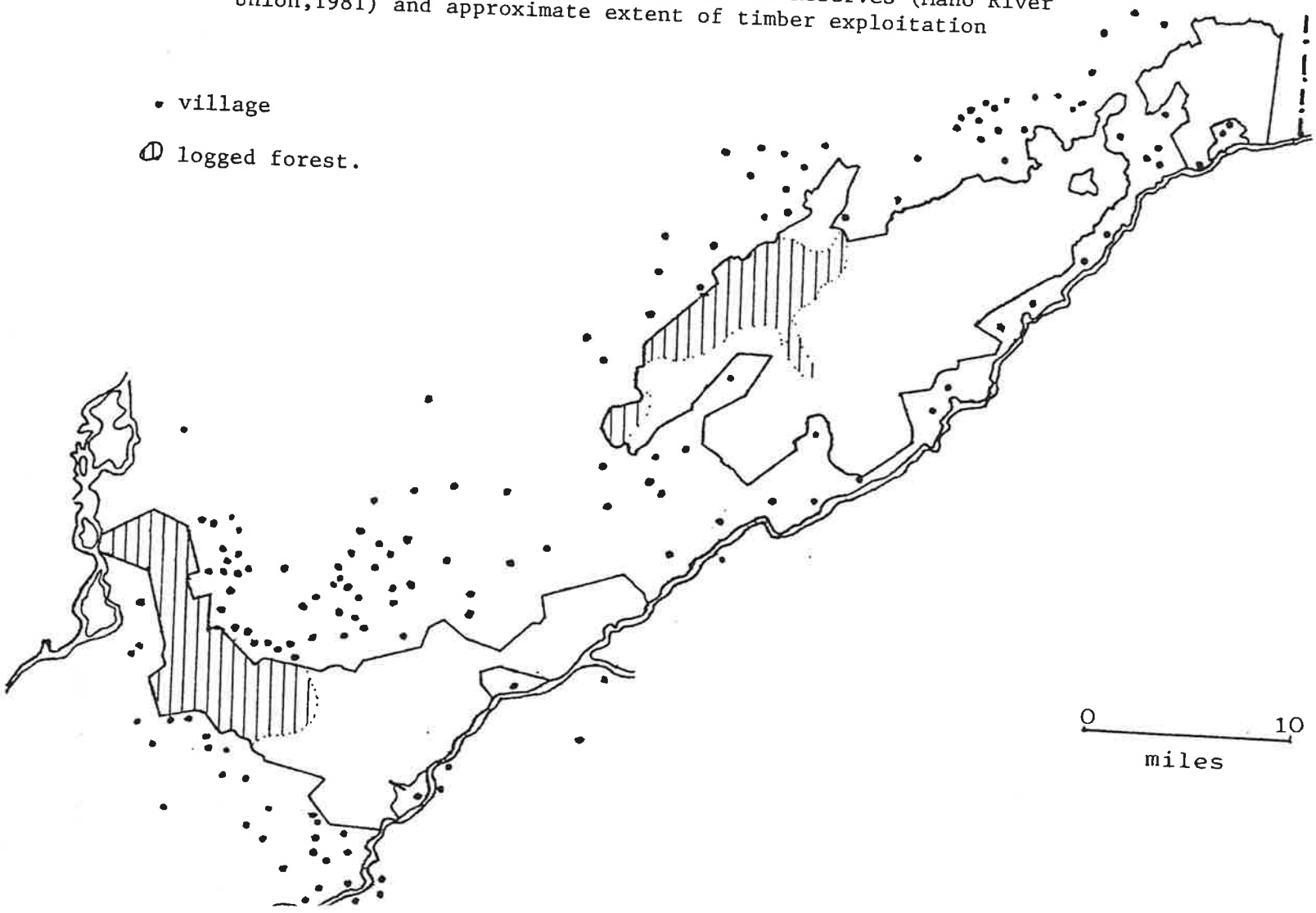
Under pressure from Government, SILETI built a sawmill in Gola East and began to process timber for the local market, as well as for export. As a result a much wider range of timber species were exploited; a higher intensity of timber extraction proceeded in Gola East and parts of Gola West were relogged.

It remains unclear how much timber has been cut in Gola East because many tree were left to rot when SILETI pulled out. A logging road has been cut right across the breadth of the Reserve to Wunde, so a large area might have been exploited. In 1985, FIC re-cut part of Block 5 in Gola East to supply the sawmill in Kenema.

In Gola North, an area of about 35 sq km around Lalehun was felled relatively lightly in 1967 and 1975 by FIC, after which the area was left to regenerate. In 1984 the FIC operation returned from Kambui Hills to Gola North. This was done as part of an aid programme, sponsored by the West German Government, which included the building of a new sawmill in Kenema and financing of timber operations. Unfortunately this programme paid little attention to conservation issues in the region.

Settlement and cultivation At present there are no permanent settlements within the Gola Reserves and this has probably been the case over the last 50 years. Villages are concentrated around the boundaries, with especially high concentrations along the northern borders of Gola East and West (Fig 2.2). This is the area in which past agricultural encroachments have

Figure 2.2 Settlement density around the Gola Forest Reserves (Mano River Union,1981) and approximate extent of timber exploitation



been noted and forewarns of future problems. Other concentrations of villages are along the southern border of Gola East and the northern border of Gola North. Overall, however, the integrity of the Forest Reserves has been well respected (Kernan, 1980).

There is evidence of hunters' camps, roughly made for short expeditions, dotted throughout the Reserves. Diamond and gold prospectors are active along many of the rivers in Eastern Province, especially when the water level is low during the dry season. People engaged in these activities also set up camps, as has been reported from the lower reaches of the Mogbai river (Roth and Merz, 1983) and are difficult to control because of the lure of quick riches. They can do extensive damage to the vegetation along water courses, but they tend not to farm and only hunt to feed themselves.

There are several enclaves intruding into the Reserves where villages and farms were established in the past. Good examples are the Tolo and Wunde enclaves on the banks of the Mano river, and the Waiawayehun enclave on the southern border of Gola North.

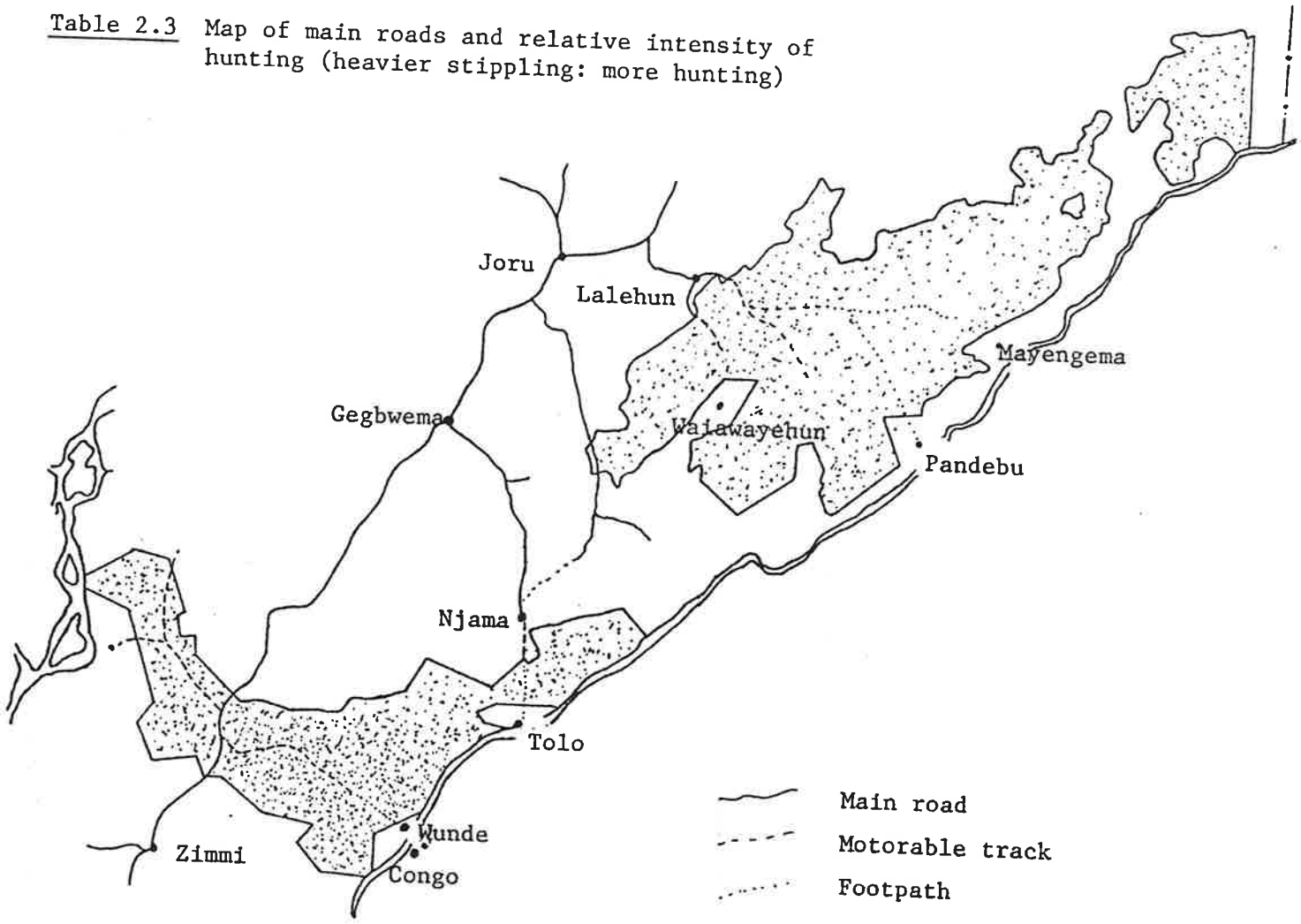
The extent of past settlement is indicated by the presence of stone monuments in Gola North (Fox, 1968) and descriptions of how parts of Gola East and West were settled during the early part of this century (Small, 1953). It appears that farms were established by fishing communities in the larger river valleys, such as the Moa and Mahoi. Occasionally small areas were also cleared in the remoter parts of the Reserves by fugitives who had fled bitter chiefdom disputes.

Thus, there are many areas of secondary vegetation arising from human activities within the Gola Reserves. However, there are also large tracts of forest dominated by climax formation tree species, such as the giant mahoganies, which show little sign of past human disturbance.

Hunting The unfavourable conditions for cattle and other livestock in the moist tropical zone of West Africa has lead to a traditional reliance on fish and bushmeat as sources of animal protein. Different communities have different preferences. For instance Moslems tend to disdain monkey meat and fishing communities obviously rely more on fish, but hunting of wildlife is a major activity anywhere.

Different hunting techniques have evolved around three basic strategies: chasing or driving with dogs, shooting with guns and setting traps. Dogs may be used to track animals or flush them from thickets, but

Table 2.3 Map of main roads and relative intensity of hunting (heavier stippling: more hunting)



they are not frequently used in forest areas.

More commonly, shot-guns are used in the daytime to hunt primates or antelopes (duikers) which are lured to the hunter by decoy calls from a whistle. Ungulates are hunted at night, when spot-lights are used to detect their eye-shine and dazzle them while the hunter takes aim. These are the commonest hunting methods in forested areas. On the edge of the forest, and around farmland near forests, fence lines are made from saplings and snares are set in gaps through which small terrestrial animals are forced to pass.

An important influence on present hunting trends was the official monkey drives organised by the Ministry of Agriculture in the 1940's and 50's. Tens of thousands of monkeys were killed annually, over a 14-year period, for a bounty paid on each head. This set a precedent for large numbers of Liberian hunters to enter Sierra Leone and make arrangements with farmers whereby the hunters kept the meat, which was smoked and exported to Liberia, and heads or tails were left with the farmers so that they could claim the bounty.

The policy ceased, but the Liberians continued to come to Sierra Leone for bushmeat, which had been largely eliminated by hunting from many parts of their own country. In Sierra Leone, the farmers wished the monkeys dead and permitted the hunting for a small charge. Needless to say, the preferred prey items were monkeys which did little crop damage (e.g. Colobus spp) and major crop pests like green monkeys, which are wary of hunters, did not get eliminated.

At present, it is estimated that during the dry season, when bushmeat can be smoked before export, more than ten 30-ton lorries carry bushmeat out of Sierra Leone each month (A.P. Koroma, pers comm).

In recent times commercial hunting has grown to such enormous proportions that a national newspaper noted that "Monkeys were saved" when the border between Sierra Leone and Liberia was closed for political reasons. This great economic pressure to hunt bushmeat for export to Liberia has resulted in commercial gangs of hunters systematically hunting in areas all over the country. The hunting is increasingly carried out by Sierra Leoneans for economic gain rather than food.

To give an indication of the political power of the hunters, Forest Division Rangers near Bo have had their lives threatened by hunters and Senior Officers were obliged to release from custody a lorry load of monkeys which were shot and exported illegally.

The proximity of the Gola Forest Reserves to Liberia equates with their vulnerability to exploitation by hunters. For example, the Paramount Chief of Nomo reported to the Provincial Secretary (Kenema) that hunters were crossing from six known Liberian villages or camps to hunt in Gola North (24th November 1984).

In Gola East, the situation is even worse because of the presence of an iron mine at Congo, on the Mano river opposite Wunde (Fig 2.3). There was a factory for making shot-gun cartridges, local demand for bush-meat and a direct road to Monrovia. Large numbers of hunters entered Sierra Leone via Wunde and hunted very intensively in the southern part of Gola East and Gola West. The mine ceased activities in March 1985, but they may recommence.

Commercial hunting by Sierra Leoneans has been infrequent in the past but is greatly increasing. Villagers around Gola West have done some hunting within the Reserve to get meat, much of which was sold at the Congo mine. This activity was stopped by the Army who moved into the area to quell political unrest and prohibited the possession of all firearms between 1982 and 1985. So fierce were the Army regulations that villagers even collected spent cartridges from the forest floor to avoid army investigations.

People from Njama clearly hunt in the northern part of Gola East and, of much more concern, a hunting gang is begining to operate out of Lalehun, concentrating on the little disturbed Gola North.

Other factors Two other factors have an indirect influence on wildlife, but need mention because they concern the movement of people through the Reserves and may pose a problem to future management.

As noted, there are diamond diggers working on the Mogbai river. Many diamond diggers travel through the Gola Reserves to smuggle diamonds into Liberia. Bulkier goods, like hill rice and palm oil, are also smuggled which means that the Reserves are a thoroughfare. This especially applies between Lalehun and Pandebu (thereafter to the Liberian market town of Kealfa), between Njama and Tolo and between Gegbwema and Wunde.

A related complication is that cattle are driven from Guinea, via Njama and Tolo, for sale in Liberia. The number of cattle passing this route is surprisingly high, and the school-teacher at Njama estimated that over 150 cattle passed each month. More accurate information is needed on these cattle movements since they may pose a risk of disease transmission to antelopes in Gola East.

SURVEY SITES

Prior to this study there was little information available on the effects of hunting and timber extraction on mammals and birds in the Gola Forest Reserves. The Forest Elephant populations had been well studied within the Reserves (Roth and Merz, 1983), surveys had been made of primates elsewhere in the Southern Province (Oates, 1980) and there was a nation-wide survey of hunting done largely through interviews with hunters (Teleki, 1980). However, no overall summary was available for the Golas and it was necessary to select survey sites therein to assess the influence of hunting and logging.

Five sites were selected during preliminary surveys carried out in December 1984 (Table 2.1). The details of the different methods used for botanical and zoological surveys are given at the beginning of the two chapters which follow. In outline, an eight hectare botanical plot was established at each site. In the area in and around this plot a survey-trail was used to search for all larger mammals and birds.

The surveys were carried out at the end of one dry season (Feb - Apr) and the beginning of the next (Oct and Nov). This was because roads in the area were often impassable during the wet season and because it was futile to do wildlife surveys in the rain. The weather during the surveys was generally fine; the worst encountered was at the end of the dry season (April), when two mornings were partly disrupted by rain.

Hunting and timber extraction intensities varied between the sites:

1) **Mogbai** This primary forest site, used during forest enumerations in the 1960's (camp 7), was in the centre of Gola North on the southern flank of the Mogbai river some 2 km upstream (west) of low-lying marshy areas which dominate the middle reaches of the river. The survey area was on the floor of a flat valley running through rolling hills. It was moderately well drained, with a small marshy area within.

The forest showed no obvious signs of recent human disturbance and the intensity of hunting was light. Two shot-gun cartridges were found on the trail leading to the camp, but none in the survey area and old paths were overgrown. There was an old hunters' drying rack on the Mogbai river, about 750m downstream of the camp, but animals in the survey area did not show the strong alarm reactions to humans that were

Figure 2.4 Settlement density around the Gola Forest Reserves (Mano River Union,1981) and approximate extent of timber exploitation

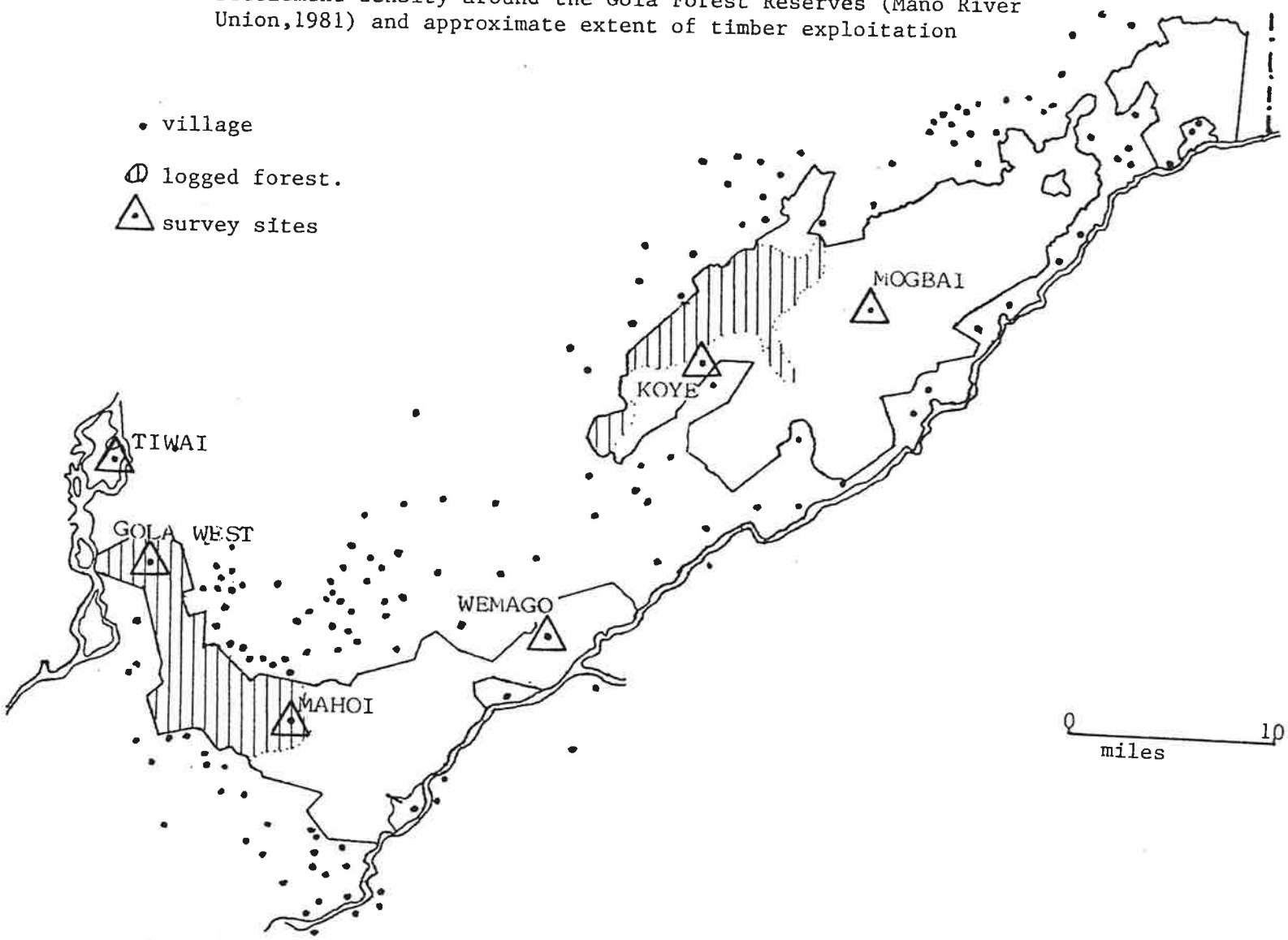


Table 2.1 INTENSIVE SURVEYS SITES IN THE GOLA FOREST RESERVES AND ON TIWAI ISLAND

Survey site	Location	Altitude (m)	Topography	Forest type	Hunting pressure	Trail (m)	Dates
1.Mogbai (G. North)	10°52'W, 7°39'N	300	Rolling hills	Unlogged	light	1650	23/2/85 - 2/3/85
2.Koye (G.North)	10°57'W, 7°38'N	120-220	Steep	Unlogged	light	1870	30/3/85 - 6/4/85
3.Wemago (G.East)	11°04'W, 7°27'N	160	Moderate	Unlogged	moderate	1750	30/4/85 - 7/5/85
4.Mahoi (G.East)	11°12'W, 7°22'N	100	Low-lying	Logged (1982)	very heavy	2010	1/11/85 - 8/11/85
5.Gola West	11°19'W, 7°28'N	130	Shallow hillock	Heavily logged (1979)	moderately heavy	1870	6/12/85 - 13/12/85
6.Tiwai (east side)	11°21'W, 7°33'N	100	Low-lying	Old secondary	light	-	-

apparent in areas where intensive hunting has occurred.

2) **Koye** This was a primary forest site sandwiched between the Waiawayehun enclave 1.5 km to the south, and forest that was logged in the late 1960's, 1 km north-west. The survey camp was made at the base of an escarpment which defined the western valley-side of one of the Koye river tributaries. The steep hillside was dominated by large boulders and sheets of bare rock were encountered at several places. Streams were narrow, with steep-sided valleys and boulder-strewn or bedrock bottoms.

The forest on this hillside was unfelled, but the canopy was broken in many places due to the irratic terrain. The vegetation at the base of the escarpment near the stream was festooned with lianas and large cotton trees (Ceiba pentandra) were present, suggesting past farming activities. There was some evidence of hunting, as might be expected considering the proximity of Waiawayehun. Two old cartridges were found within the survey area and a hunter's camp was burnt 400m away from the survey area in 1980. Furthermore, several recently cleared trails ran though the area and a shot was heard in the distance on one night.

3) **Wemago** This was the survey carried out in the primary forest of Gola East, on the side of Bagra Hill which is the highest point in Gola East. The survey trail was cut on the north-eastern flank. There were few steep slopes, except at one point where a waterfall flowed into the Wemago river.

The forest was little disturbed by human activity and many areas had a closed canopy with correspondingly open understorey. Hunting in the area was moderate, judging from the 10 cartridges found in about three miles of trail leading from Njama to the survey area. There were also cartridges and batteries (used in lights when hunting at night) on the trail between the survey camp and the Mano river. Local people confirmed that there were moderate levels of hunting.

4) **Mahoi** This survey site was 200m away from the Mahoi river, on a small tributary. The area was flat, low lying and probably partly flooded when the Mahoi was in spate during the rainy season. Some areas were marshy, with damp soil even in the dry season, and there were small Raphia-palm swamps in poorly drained areas. Half of the survey area was a better drained small knoll.

The vegetation was a mixture of swamp/marsh formations, riverine tree species and some dry forest species on the knoll. Two tractor skid paths, used to drag felled timber away in 1982 logging operations, intruded into three of the 32 botanical quadrats. Three felled trees were encountered along the survey path and a total of six stumps were counted in the eight hectare botanical plot. This is light intensity felling. There were thickets of Trema and Musanga trees colonising recently bared areas and there were thick blankets of lianas, including rattans, in some of the more heavily disturbed places.

The whole area is notorious for the intense hunting pressure it suffers. Liberian hunters offerred to sell bushmeat to survey teams that camped beside the Mahoi river in 1980 and Roth and Merz (1983) stated that a shotgun cartridge was left every 100m, on average, between Mahoi and Wunde in a three month period in 1982. Hunting in the are was intense because it was near the Mahoi bridge which funnels hunters through this small area. Even with the recent army patrols in the area, shots were heard on two nights.

5) **Gola West** This was the second survey in logged forests, located in the northern part of Gola West. The campsite was on a small hillock and the survey trail encompassed its shallow apex. No steep terrain was encountered and there were several small streams in the area draining two finger-like swamps.

Timber had been extracted from the area at an intensive rate in 1979/80. Fifty-one stumps were counted in an eight hectare plot and skid paths occurred in 26 of the 32 botanical quadrats. There was an inevitable increase in the numbers of colonising plant species in the area, but the liana load was surprisingly low considering the extent of the disturbance. A number of large trees still remained in the area.

The extent of hunting was difficult to assess because shotgun cartridges had been cleared away by villagers. Hunters from Liberia were reported to visit nearby Golawoma frequently, until the recent Army patrols, and local villagers spoke of shooting monkeys to sell in Congo. Several shots were heard on one evening and farmers shot animals raiding their crops. Villagers also set snares in this part of the Reserve and an old one was seen near the survey trail which stretched for 250m. It was concluded that hunting pressure was moderate.

6) **Tiwai** No systematic surveys were carried out on Tiwai to provide data exactly equivalent to those collected at the above sites. However, considerable research has been done on the island which allows useful comparison of the presence and relative abundance of different species on Tiwai and in the Golas. This in turn allows a fuller look at the influence of hunting and habitat disturbance on animal populations.

The east-side study area on Tiwai (60ha) is a mosaic of habitats. Most comprises closed-canopy, old secondary forest, bounded in the east by a 50m wide strip of riverine vegetation (not dominated by Raphia palms). There is a small Raphia palm swamp and a patch of young farmbush (cleared 5-10 years ago). Charcoal recorded in soil pits indicates that much of the forested area was farmed in the past, and the closed-canopy forest is probably 40-80 years old.

There is evidence of past hunting on the island, from spent cartridges still in the area, but no recent large scale hunting has been reported. The barrier formed by the river has deterred hunters, as has local dissatisfaction with Liberian hunters' behaviour. Past hunting pressure on Tiwai was light, therefore, and Barrie Chiefdom Authorities have effectively banned all hunting on the island over the past four years.

AFRICAN TULIP TREE
(Spathodea campanulata)

3. TREE FLORA

Foresters have concentrated much work in the Gola Reserves because of their great economic importance. Initial large-scale enumerations of commercial trees were made in the early 1950's by Small (1953) in Gola East and West followed, in the early 1960's, by Fox's intensive survey of parts of Gola North (Fox, 1968) which was extended in the late 1960's (White, 1972) to include most of the Reserves. The surveys concentrated on whatever species were commercially valuable at the time and little information was collected on non-commercial trees and smaller plants. Even those plants of potential economic value, such as orchids, were not studied although some omissions were filled by a nation-wide survey of the tree flora (Savill and Fox, 1967).

The botanical work carried out during the present project is limited to describing in some detail the forest areas in which intensive surveys of the fauna were carried out. The aim was to measure the diversity and density of different tree species in an effort to assess how timber extraction changed the forest and influenced animal population. Furthermore, both the Forest Division and Forest Industries Corporation were keen that botanical information be collected to make this survey report as comprehensive as possible.

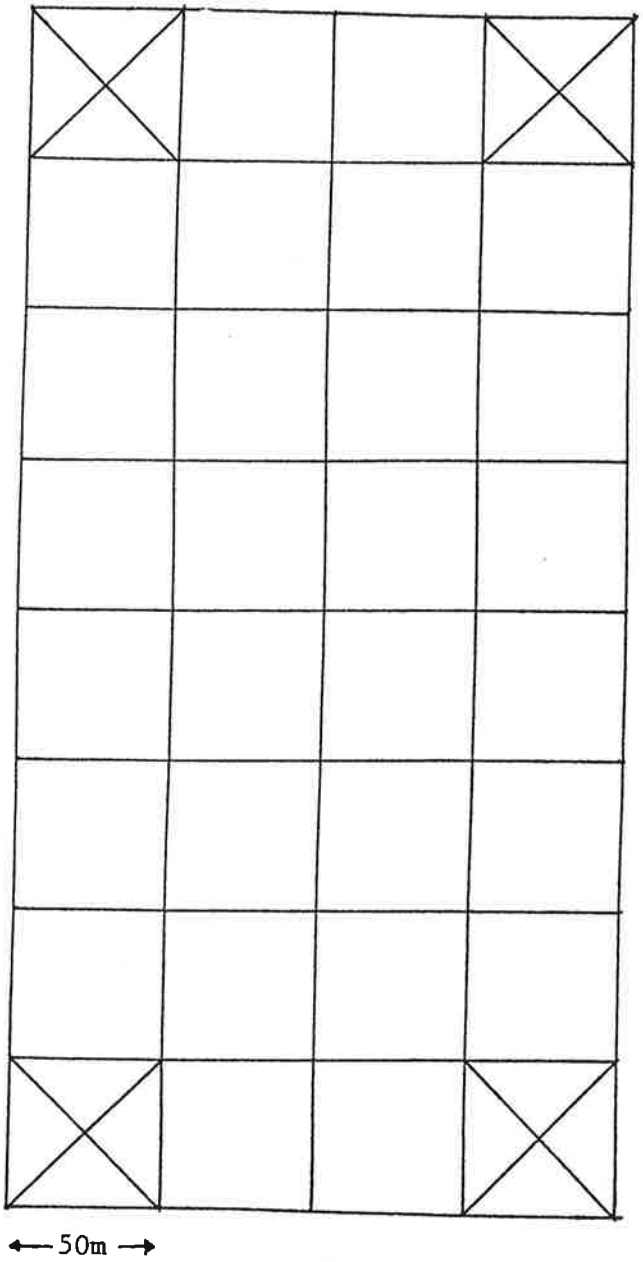
METHODS

A team of eight to ten men conducted a botanical survey over a ten-day period. One plot (8ha) was cut through the forest, sub-divided into 32 quadrats (0.25ha each).. The plot was 400m long and 200m wide and orientated along the cardinal points of the compass and overlay the area enclosed by a trail used in faunal surveys.

In each plot, all the trees over 40cm diameter at breast height (dbh) were identified to species or genus, and had their boles measured in centimeters. To sample the smaller trees, all trees with boles down to 10cm dbh were enumerated in a similar fashion in the four corner quadrats of each plot. Thus, all trees over 40cm dbh in an 8ha plot and all trees over 10cm dbh in a 1ha sub-sample of the plot were enumerated at five survey sites in the Gola Reserves (Fig. 3.1).

On Tiwai, several people contributed data towards the botanical enumerations used below. All trees over 40cm dbh were enumerated by G.H. Whitesides and

Figure 3.1 Diagram of the layout of botanical plots



All trees with girths larger than 40cm diameter were included in the enumeration. In the four corner quadrats all trees larger than 10cm diameter at breast height were enumerated.

Table 3.1

Number of trees in a) 8ha plot and b) 1ha sub-plot

	Mogbai	Koye	Wemago	Mahoi	Gola West	Tiwai
a) Large trees (over 40cm gbh)	264	339	400	354	360	402
b) All trees (over 10cm gbh)	306	431	419	367	466	301

J. F. Oates in a 40ha area on the eastern side of the island and an 8ha plot was delimited in this area. The sub-sample of four corner quadrats, in which trees over 10cm dbh were mapped and enumerated was first worked by J. Conteh, as part of an undergraduate project with Njala University College, and was re-enumerated by S.K. Samai (Forest Division Botanist) and myself.

The methods represent a compromise between what was needed to give a comparison of the forest in different areas were faunal surveys were conducted and the amount of work that could be carried out by a team in the fortnight that was available each month. The establishment of a single plot allows description of the forest, but the rain forest is very heterogeneous and care must be taken not to over-extrapolate from small plots to large tracts of forest.

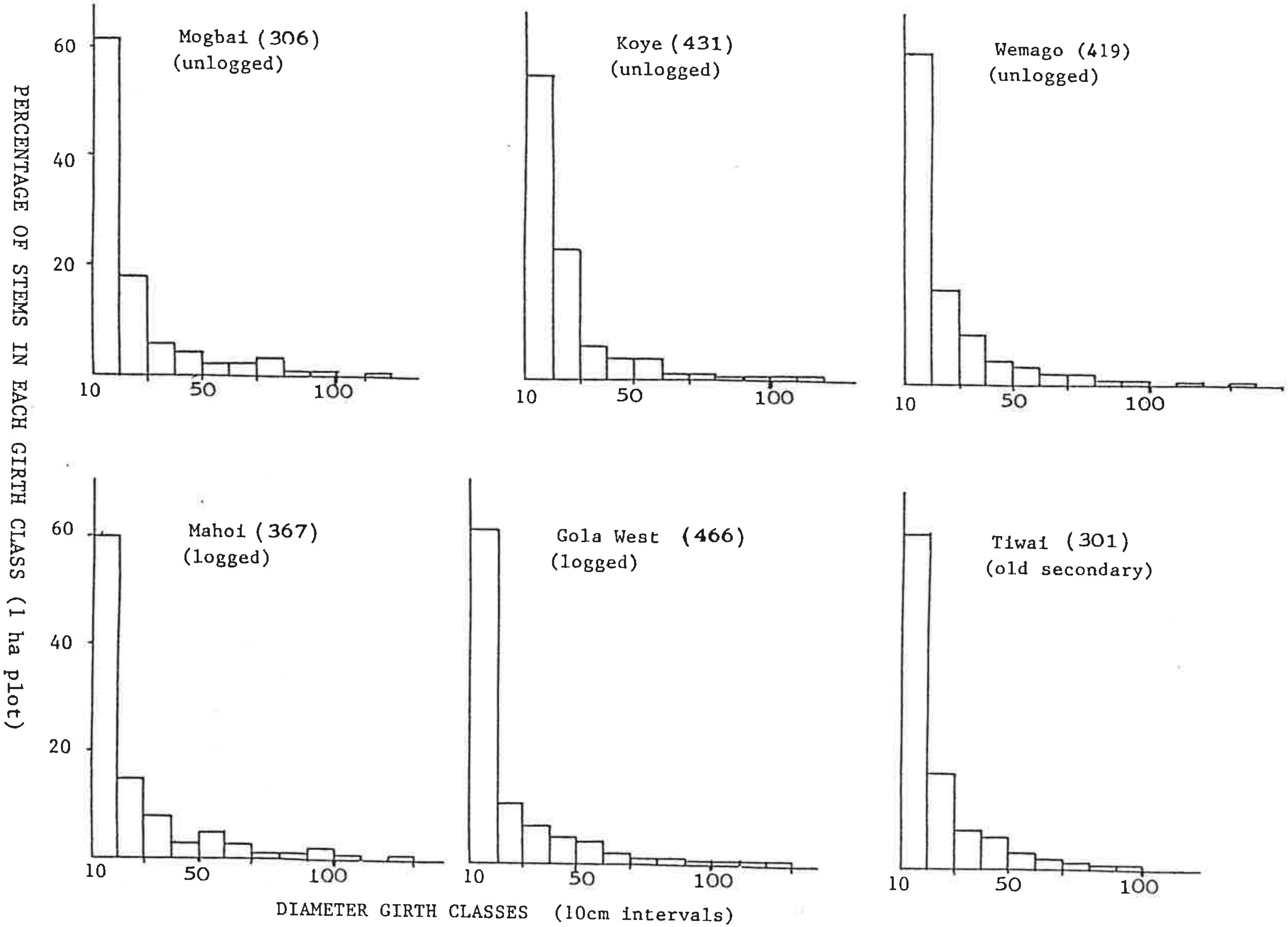
FOREST STRUCTURE

It is commonly held that the rain forest as a whole is made up of several layers of tree crowns: an understorey, middle storey, and upper canopy all of which are over-topped by emergent trees (e.g. Richards, 1952). This gives a good basis on which to consider forest structure, with different tree species tending to predominate in only one or two of the strata. It is a simplistic picture, however, and it is often difficult to discern the strata at any given point in the forest.

One important reason for this is that the growth cycle of the forest disrupts stratification (Whitmore, 1976). Big trees die and fall over, causing gaps in the canopy which are quickly colonised by fast-growing, light-demanding species. As trees grow, so the initial colonising vegetation becomes shaded out and the patch changes from "gap" phase to "building phase" vegetation. This, in turn, will give way to "mature" phase forest which is dominated by tall trees and in which canopy stratification is clearer.

Thus the forest is a mosaic of gap, building and mature phase tree patches, through which lianas weave to further confuse the picture. To a large extent, these different phases of the forest growth cycle in primary forest are analogous to the different successional stages of vegetation which arise when forest areas are cut and left to regenerate.

Figure 3.2 Frequency distribution of trees more than 10cm dbh in different girth classes within a lha sample.



There were some noticeable differences between the number of trees encountered in each of the six plots (Table 3.1), but there was no apparent correspondence between the number of large trees in a plot and the number of small trees in the sub-sample of the same plot. The scarcity of both large and small trees at Mogbai can be attributed to a treeless, pebble-strewn tributary of the Mogbai river which covered four of the 32 quadrats. The very steep terrain at Koye, with occasional outcrops of bare rock, may be the primary reason why so few large trees were recorded there. However, there was an abundance of small trees there, as was the case in the other two hillside plots: Wemago and Gola West. The abundance of large trees in the Tiwai plot indicated that the canopy was relatively closed, but the scarcity of small trees is difficult to understand.

The most surprising result of these comparisons was that there did not appear to be fewer large trees in either of the logged forest plots despite eight trees having been cut from the Mogbai plot and 51 trees from the other.

A conspicuous artefact of the sampling method was that the thickets of colonising trees which predominated on the logging roads were too small to be included in the sub-sample of small trees. A major increase in the number of colonising trees in the logged forest plots would be expected in the coming years.

A more detailed examination of the distribution of different girth classes in the 1ha sub-samples (Fig. 3.2) shows an interesting similarity between logged forests and primary forests. Over 60% of all trees measured were in the smallest girth class in all plots except one. At Koye only 56% were, and there was a corresponding increase in the size of the next girth class. The sample was too small to say very much about the abundance of the largest trees, except that they were poorly represented at Tiwai, which is a common feature of secondary forests.

TREE SPECIES

The Gola Forest Reserves are predominantly covered by a forest formation known as the Heritiera/Lophira type which is characterised by a predominance of Heritiera utilis and Cryptosepalum tetraphyllum in the main canopy, accompanied by lesser numbers of Erythrophleum ivorense and Lophira alata (Fox, 1968). Occasionally the two predominant species are

outnumbered by local concentrations of Brachystegia leonensis and Didelotia idea (Fox, 1968). Indeed, the latter species, which is unique to Gola North, is mutually exclusive of Heritiera utilis. This exemplifies the patchwork of different forest tree associations within the main Heritiera/Lophira formation in which many species are gregarious.

Different associations are typical of specific areas or edaphic conditions. For example, Parinari excelsa is widespread in a range of habitats from farmbush to evergreen forest in Sierra Leone but has a localised distribution in the Golas, favouring rolling hills (Savill and Fox, 1967). Plagiosyphon emarginatus and Cathomion altissimum are riverside trees and Cynometra leonensis is generally a tree of moist sites, often occurring in association with Heritiera utilis. It has also been recorded at drier areas (Fox, 1968). A guild of species which associates commonly in moist areas of the Golas is Pentaclethra macrophylla, Uapaca guineensis and Xylopia aethiopica (Fox and Savill, 1967) while, in the wet swamps of Gola East and West, Gilbertiodendron spp and Mitragyna stipulosa are diagnostic (Small, 1953).

An important influence on forest formations throughout West Africa is man, and this applies equally in the Golas where stone monuments indicate past settlement within the Reserves (Fox, 1968). As discussed above, cutting down trees increases the amount of light penetrating through the dark understorey of the forest which favours the establishment of colonising tree species and lianas.

The first phase colonizers of open ground and large gaps in the forest, such as Harungana madagascarensis and Musanga cecropioides, seldom persist for long since their seedlings are not tolerant of shade and species like Funtamia africana and Pycnanthus angolensis soon succeed them. Different species prefer different degrees of illumination. For example, Albizia zygia and Parinari excelsa prefer more light than do climax forest species but tolerate more shade than do first-phase colonisers.

Another human influence is that very hard-wooded trees such as Klainedoxa gabonensis, are difficult to cut and remain in farmed areas. Large Sacoglottis gabonensis trees in farmlands which lack any other tall trees have been cited as an example of this situation by Small (1953).

In the lower levels of the forest there are three main categories of trees. There are those species which are always small, even when mature, which predominate

in the dark understorey (e.g. Diospyros spp and Vitex macrantha). These tend to be widespread and locally abundant. A second category is the medium-sized, shade-tolerant trees which attain their full height in the middle and upper canopies of the forest e.g. Anthonotha fragrans and Ongokea gore. Finally, young trees of upper canopy and emergent species may remain in the lower levels of the forest until they emerge into the sunshine, often through a gap caused by a treefall.

Large tree plot The number of species of the large trees in the six plots varied between 33 and 69, with a total of 135 different tree species being encountered in all (Appendix 1a). The number of trees per species in the tree primary forest sites (5.7, 5.8, 6.1) was somewhat lower than in the either of the logged forest plots (7.7, 7.8) and about half that recorded for the closed-canopy secondary forest on Tiwai (12.2). This gives a tentative indication that timber extraction depresses the species richness of forests, and a stronger indication that the forest on Tiwai has a low species richness.

An important reason for the low tree species richness in the Tiwai plot is likely to be past farming activities. In particular, burning of areas before crops are planted kills off seedlings and saplings of most species. A further likely constraint is that the Moa river can act as a barrier to seed dispersal between forested areas and the island, especially since much farming has taken place on the riverbanks. Finally, past changes in the river course and variation in the soils could have strongly influenced the tree species composition of the island.

If the ten commonest species from each site are compared (Table 3.2) it is even clearer that the forest on Tiwai has a large secondary forest component. Funtamia africana, Holarrhena floribunda and Pycnanthus angolensis are all characteristic of secondary forests in Sierra Leone (Savill and Fox, 1967) and all are abundant on Tiwai. Other common species are Hannoa klaineana, an early colonizer of farm bush, Terminalia ivorense, a common secondary forest species uncommon in primary forests and Albizia zygia which is typical of very open-canopy forest and savanna vegetation (Savill and Fox, 1967).

The two commonest large tree species, Pentaclethra macrophylla and Uapaca guineesis, which account of over 50% for the stems on Tiwai, prefer moist sites (Savill and Fox, 1967), and are therefore favoured by the

Table 3.2 Five commonest tree species in each plot (trees larger than 40cm gbh in 8ha plot)

Mogbai — 46 species, 264 stems

Uapaca guineensis (44)
Parinari excelsa (43)
Pentaclethra macrophylla (33)
Calpocalyx aubrevillei (19)
Kaoue stapfiana (14)

Koye — 55 species, 339 stems

Kaoue stapfiana (66)
Calpocalyx aubrevillei (27)
Stephonema psuedocola (25)
Heritiera utilis (24)
Funtamia africana (17)

Wemago — 69 species, 400 stems

Cryptosepallum tetraphyllum (108)
Dacroydes klaineana (32)
Afrosersalisia afselia (21)
Drypetes sp (20)
Berlinia confusa (19)

Mahoi — 46 species, 354 stems

Cryptosepallum tetraphyllum (76)
Calpocalyx aubrevillei (32)
Parinari excelsa (28)
Gilbertiodendron ?splendidum (25)
Heritiera utilis (25)

Gola West — 50 species, 360 stems

Gilbertiodendron ?preussi (105)
Heritiera utilis (65)
Cynometra leonensis (34)
Brachystegia leonensis (18)
Diospyros sanza-minika (8)

Tiwai — 33 species, 402 stems

Uapaca guineensis (117)
Pentaclethra macrophylla (104)
Funtumia africana (52)
Parinari excelsa (27)
Piptadiniastrum africanum (24)

Figures in parentheses refer to number of stems of each species

proximity of the Moa river. Furthermore, P.macrophylla readily coppices after being cut and burned, which favours its re-establishment in areas after cultivation.

Overall, the closed-canopy secondary forest on Tiwai is very similar to the moist-deciduous forest at Tonkoli, which has been described as a relatively young phase forest (Savill and Fox, 1967).

The Mogbai plot had several similarities with the forest on Tiwai, principally the abundance of U.guineensis and P.macrophylla which, in association with Calpocalyx aubrevillei and Kaoue stapfiana, represent a forest formation typical of poorly drained sites (Savill and Fox, 1967). The abundance of P.excelsa probably reflects the undulating terrain as much as any human disturbance to the canopy, but the abundance of H.floribunda gives stronger evidence of past human disturbance.

At Koye, Didelotia idea was predictably common, along with several damp site species (e.g. K.stapfiana, C.aubrevillei and Xylopia staudtii) and one secondary forest species F.africana. The latter may have arisen as a result of past cultivation, given the proximity of Waiawayehun and indications of past farming in the nearby stream valley. Alternatively it could have been encouraged by tree falls on the steep terrain which in turn could favour the establishment of colonising tree species.

The third primary forest plot, on a hillside at Wemago, also had a typical moist forest formation : Afrosersalisia afzelii, X.evansii and Parkia bicolor, along with valley-dwelling Berlinia confusa (Savill and Fox, 1967) in a forest predominated by C.tetraphyllum. The only secondary forest tree was P.angolensis, which is unlikely to have colonised as a result of past cultivation in the area since it was not accompanied by other secondary forest species.

C.tetraphyllum predominated in the logged forest plot at Mahoi, in the south of Gola East, as it did in the northern part of the same Reserve (Wemago). However, the Mahoi plot was in a low-lying and flat area very close to the large Mahoi river and two of the quadrats were in a swamp. As a result, a classic swamp formation of Gilbertiodendron ?splendidum and Mitragyna stipulosa was recorded. These trees were accompanied by C.aubrevillei which is common around swamp edges (Savill and Fox, 1967).

Dry forest species such as H.utilis and L.alata were found in the better drained parts of the plot. Trees of Nauclea diderrichii were common. Although

they are indicative of secondary forest, they were much too large to have become established as a result of the recent timber extraction process. These elements of secondary forest were evidently in the area prior to logging.

In the second logged forest plot, from which 51 trees had been removed, there was a predominance of Gilbertiodendron ?preussi in a Cynometra/Heritiera forest formation. These three common trees made up such a large proportion of the stems that other species contributed little.

In summary, all of the botanical plots contained species of large trees which were characteristic of damp, poorly drained areas and little information was collected from the rugged terrain of Gola North, although hillsides in both Gola North and Gola East were examined. There was little evidence of recent cultivation at Koye, Wemago and the logged forest of Gola West, but there were clear indications of it at Mogbai and Tiwai and possibly Mahoi.

Small tree plot The results of the enumerations of both small and large trees in the 1 ha sub-samples showed a range in species between 53 at Mogbai and 76 at Koye. The overall results of these comparisons bear out the general pattern seen for the large trees (Appendix 1b).

Of the three primary forest sites, Mogbai again showed the clearest signs of past disturbance with Blighia spp, P.excelsa and H.floribunda all abundant. At Koye, the probability that secondary forest species were favoured by openings in the canopy on the steep slopes, rather than human activities, was supported by the abundance of Mareya micrantha and the blankets of P.emarginatus seedlings growing on some of the rockiest areas. Small stands of Diospyros sanza-minika were also clustered in the rockiest areas.

There was no information from the primary forest plot at Wemago to change the impression that little past cultivation had occurred.

In both the logged forest plots, thickets of colonising tree species such as Musanga cecropoides and F.africana were springing up along the old tractor paths, although these were too small to be included in the enumeration. There was no evidence that the small tree species' richness had declined as a result of timber extraction; the abundance of Diospyros spp and Acioa spp, along with specimens of middle and upper

Table 3.3 Five commonest species in 1ha sub-plot (trees larger than 10cm gbh)

Mogbai — 53 species, 306 trees

Protomegabaria stapfiana (34)
Kaoue stapfiana (34)
Pentaclethra macrophylla (15)
Acioa whytei (14)
Acioa sp (15)

Koye — 76 species, 431 trees

Kaoue stapfiana (82)
Heritiera utilis (59)
Diospyros sp (25)
Calpocalyx brevibracteatus (18)
Didelotia idea (19)

Wemago — 66 species, 419 trees

Protomegabaria stapfiana (65)
Drypetes sp (57)
Diospyros sp (42)
Afrosersalisia afzelii (41)
Cryptosepallum tetraphyllum (20)

Mahoi — 61 species, 367 trees

Diospyros sp (43)
Ochthocomus africanus (31)
Gilbertiodendron ?splendidum (31)
Cryptosepallum tetraphyllum (27)
Heritiera utilis (19)

Gola West — 64 species, 466 trees

Gilbertidendron ?pruessi (50)
Diospyros sp (48)
Heritiera utilis (40)
Diospyros sanza-minika (39)
Anthonotha fragrans (20)

Tiwai — 56 species, 301 trees

Funtumia africana (48)
Anthonotha macrophylla (29)
Myrianthus libericus (24)
Pentaclethra macrophylla (19)
Uapaca guineensis (17)

figures in parentheses refer to both small and large trees found in the plot.

canopy species, was typical of what occurred in the primary forest plots.

On Tiwai there was an abundance of saplings of big trees (U.guineensis, P.macrophylla and Antiaris africana) but the understorey was dominated by just two species: Myrianthus libericus and Anthonotha macrophylla, neither of which were common in any of the other plots.

WEST AFRICAN FORESTS

The species composition of the Gola Forests is typical of that of the Upper Guinean Forest zone, which stretches from south-eastern Sierra Leone, through Liberia and Ivory Coast, to Ghana. A comparison of the data from the Golas with those from Banco and Yapo forests in the Ivory Coast (data presented in Bernard-Reversat et al, 1978) shows that the Golas are truely representative of this scarce habitat. The five commonest species of large trees (over 40cm dbh) at Banco and Yapo were: Dacroydes klaineana, Strombosia glaucescens, Allanblackia floribunda, Coula edulis, Diospyros sanza-minika and, on the sandy soils at Banco, Blighia welwitschii and Turraeanthus africana. These seven species were recorded in Gola (Appendix 1) and all of the trees enumerated in the Yapo plots have been recorded in the Golas (Appendix 1; Savill and Fox, 1967). These similarities are further supported by comparison of the Golas and Tai National Park in Ivory Coast (Galat-Luong 1983), where 14 of the 20 commonest species have been recorded in the Golas.

There is even a marked similarity between the Gola forests and the moist forests in Nigeria, in the Cameroon Forest zone (data from Lawton, 1978). Both sets of forests are dominated by leguminous trees, and the four tree families which dominate the emergent layer and main canopy in Nigeria: Meliaceae (Entandrophragma spp), Leguminosae (Afzelia spp, Pachypodanthium spp), Combretaceae (Terminalia spp) and Sterculiaceae, predominate in the Gola Forest Reserves (Savill and Fox, 1967).

This similarity is worthy of note since the two forest blocks are separated by the arid Dahomey Gap, which lacks rain forest.

From a global perspective the tree species diversity of these forests is low (Table 4.3). It is not clear why this should be, but the forests of South-east Asia, where the Dipterocarpaceae predominate, and those of South America have roughly twice as many tree species per unit area, within plots

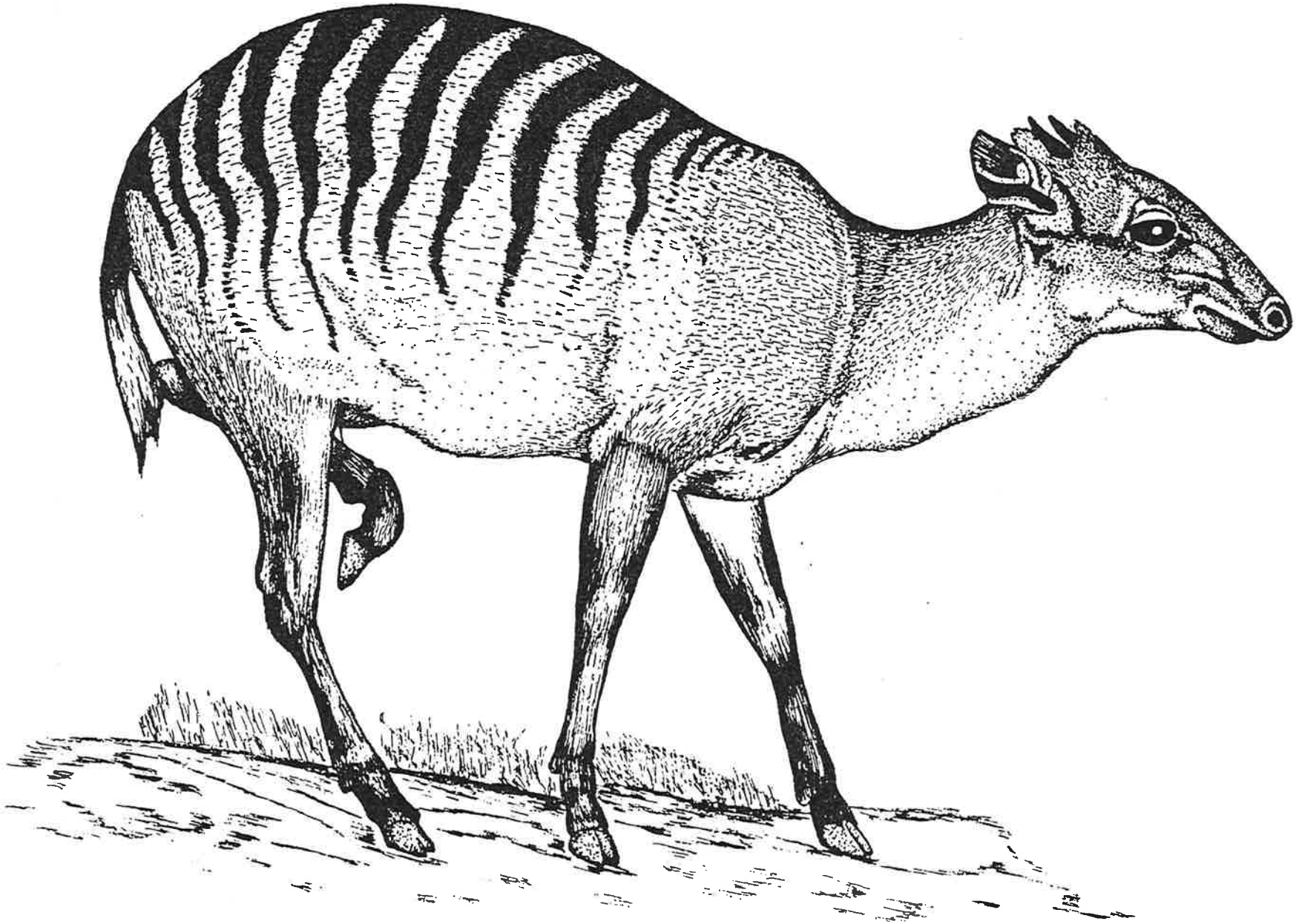
found

of 2ha - 4ha (reviewed in Bernard-Reversat et al, 1978). This may imply that many trees in the legume-dominated forests of Africa have broader ecological niches than trees in South-east Asian and South American rain forests. If this is the case, then the African trees may be more adaptable to changes in the rain forest environment, such as those brought about by timber extraction.

Table 3.4 Simple measures of tree species richness in some forests

Country	species/ha	girth limit	Source
Malaya	130	10cm dbh	Ashton
Sabah	130	30cm gbh	Davies,1984
Surinam	110	10cm dbh	Schultz
Ivory Coast (Tai and Yapo)	50	40cm dbh	Bernhard-Reversat et al , 1978
Sierra Leone (Golas)	60+	10cm dbh	this study

plots less than 5ha in area.



ZEBRA DUIKER (Cephalophus zebra)

4. FOREST FAUNA

Until the recent increase in the destruction of Africa's forests by man, tropical evergreen and semi-evergreen forests stretched from coastal West Africa through the Congo Basin as far as the uplands of East Africa, interrupted only by the savanna vegetation of the Dahomey Gap. However, during the Pleistocene Ice Ages, which ended some 10 to 20 thousand years ago, the climate of Africa was much drier than it is today and rain forests retreated to a number of discontinuous refuges in which moister conditions prevailed. Within each refuge there was an assemblage of animals which were related to those in other refuges, since they had originated from the same stock, but which evolved distinct characters during the period of isolation.

The western-most Pleistocene refuge was probably centered in present-day Liberia (Diamond and Hamilton, 1980) and many of the rain forest animals in Sierra Leone, Liberia, Ivory Coast and Ghana are derived from this Upper Guinean refuge population. The past isolation was not a simple process of contraction without fragmentation, and it probably occurred several times.

As a result some animal species have restricted distributions in part of the forest block, while others extend to varying degrees eastwards. Moreover, there is an important sub-division of the Upper Guinean forest fauna in the region of the Cavally and Bandama rivers in Ivory Coast, either side of which several different sub-species occur.

Thus, the animals now dwelling in the last remnants of Sierra Leone's rain forest are the western-most representatives of rain forest communities, not only within the Upper Guinean region, but within Africa as a whole. Furthermore, some are the western-most races of rain forest animals from the Upper Guinean block, which are also found in Liberia and the western part of Ivory Coast. If full genetic diversity is to be maintained, areas of forest at either end of the Upper Guinean region must be preserved.

Because Sierra Leone is on the edge of the forest belt, the country contains savanna as well as rain forest vegetation. Rain forest animals extend through gallery forests beside rivers into the arid north and savanna species intrude into the moister south as forest is cultivated and converted to farm bush.

For example, Harding (1983) reported forest mammals living beside savanna counterparts in the

Guinea savanna of Kilimi: Forest Pig and Warthog, mangabey and baboon. Conversely, savanna animals, such as Green Monkeys have been recorded in the farmbush of the south-east where rain forest is the climax vegetation.

There is no clear barrier between forest and savanna species, therefore, but the former are the main concern of this report since they predominate in the Gola Reserves and are generally more endangered than savanna species. In this report mammals have been divided into three main categories:
a) **rare** species, whether they are dependent on rain forest or not, b) **forest** species, which may extend beyond the bounds of the forest zone but whose populations decline markedly outside and c) **other** species which live at relatively high population densities, in both forest and savanna (Appendix 2a).

METHODS

Two basic approaches were used when surveying the fauna of the Gola Forests: extensive and intensive surveys.

Extensive surveys were made along roads, footpaths and riverbanks to gain an impression of the situation over a wide area and to get to intensive survey areas. Each extensive survey route was travelled along rapidly and the presence of different animal species was noted, along with evidence of different human activities such as hunting. This made it possible to check different areas for large animals if they or their signs were conspicuous (e.g. elephant tracks). The distribution of different species was plotted on 5km grided maps of the area.

It was not possible to make a realistic assessment of the population densities of animals from the opportunistic records obtained during brief extensive surveys, so **intensive surveys** were made to estimate population densities of the commoner mammals. At each site a survey trail was cut in the shape of a rectangle, joined by a short path to the survey camp (Table 2.1). Well-used paths were not surveyed in case they were hunters' trails which the animals might avoid.

The survey trails were walked between 06.45 hrs and 12.00 hrs on eight consecutive mornings, when all sightings of animals and their signs were recorded (Appendix 2a). The bearings were taken on primate calls heard during morning surveys, along with the number of the 50m trail marker from which the bearing was taken.

Nocturnal animals were sought along the survey trail on three nights when one hour was spent walking through the forest between 19.00 hrs and 21.30 hrs.

Sightings of birds made during morning surveys and afternoon strolls was supplemented with information on understorey species caught in three mist nets which were operated for seven days. No other trapping was done, so the very diverse rodent and bat faunas were poorly studied and should be the subject of future work.

The only group of animals which were seen sufficiently often to allow estimation of their population densities were the primates. The brevity of each survey, combined with the poor visibility in the rain forest, militated against the use of transect methods to assess the population densities (see Anon, 1981; Burnham et al, 1980). Few sightings were recorded for each species at a given site, making it impractical to calculate an effective transect width through the forest or even assess the accuracy of population estimates statistically.

Instead, a combination of information on sightings of groups and triangulation of calls was used. The most useful situation was when several groups called within a short space of time, often replying to one another, so that it was possible to define the minimum number of groups in an area and their approximate location. At the end of each survey, clusters of calls and sightings were mapped out to gain an indication of the minimum number of groups in an area. Care was taken to ensure that two groups were recorded only if there was good evidence to distinguish them, so that a single, wide-ranging group was not recorded twice.

The relative abundance of primate groups was assessed at each survey site, by giving each group a score of one if it was found in the immediate vicinity of the survey trail (about 1 sq km). Calls of primates heard outside the immediate survey area were recorded, mapped and given an arbitrary value of 0.3 (i.e. 30% of the home range overlay the survey area). This method allowed a comparison of the **relative** density of primate populations in different areas, to make a preliminary assessment of the effects of logging and hunting.

Much more detailed surveys, over a long period, would be needed before accurate population densities could be calculated.

On Tiwai, where research work on primates has been underway for four years, the number of primate groups in the east-side study area (approx. 60 ha) was

estimated by mapping sightings and calls. Data were collected by myself and G.L. Dasilva over a four-month period, in conjunction with data on the home range size of different species (J.F. Oates and G.H. Whitesides, pers comm). Since these data were collected by a different method, only cautious comparison can be made between them and the Gola data.

LARGE MAMMALS

The largest mammal in Sierra Leone is the Elephant, represented by the diminutive forest race (Loxodonta africana cyclotis) as well as the larger savanna race. The **Forest Elephant** is restricted to three forest areas in Sierra Leone: Tonkoli, Kangari and Gola. The species has been the subject of an ecological survey in 1982, coordinated and reported by Roth and Merz (1983). The relatively small amount of information on elephants collected during the present survey concurs with Roth and Merz past findings and it is appropriate to re-iterate their more detailed results, supplemented with the more recent data.

Roth and Merz concluded that there are two isolated populations of elephants in the Gola Forests. One, comprising about 60 animals in Gola East, has a dry season refuge of some 13,000 ha centered on the Mahoi river basin. In the wet season there is an increase in the availability of surface water and the animals are free to range over a wider area. They travel into the farmlands to the south of the Reserve, and to a lesser extent the north, but they do not appear to enter Gola North Reserve.

In Gola North, there is a smaller population of some 50 individuals. Their dry season range of about 8,500 ha is centered on the Mogbai river valley, part of which is swampy. In the wet season the animals range over a 21,000ha area, occasionally entering the farmlands of the Waiawayehun enclave but not going east across the Moro river into Liberia. Few sightings have been made of elephants in the northern extension of Gola North, but those that have been seen probably represent the western edge of a population from the neighbouring Lofa-Mano area of Liberia.

There have been no recent reports of Elephants in the logged forests of Gola West.

Of the two Gola populations, the one in Gola North is under less pressure at present. Agricultural settlements are concentrated around Gola East and West, and the Gola East elephants come into considerable conflict with these communities because they damage

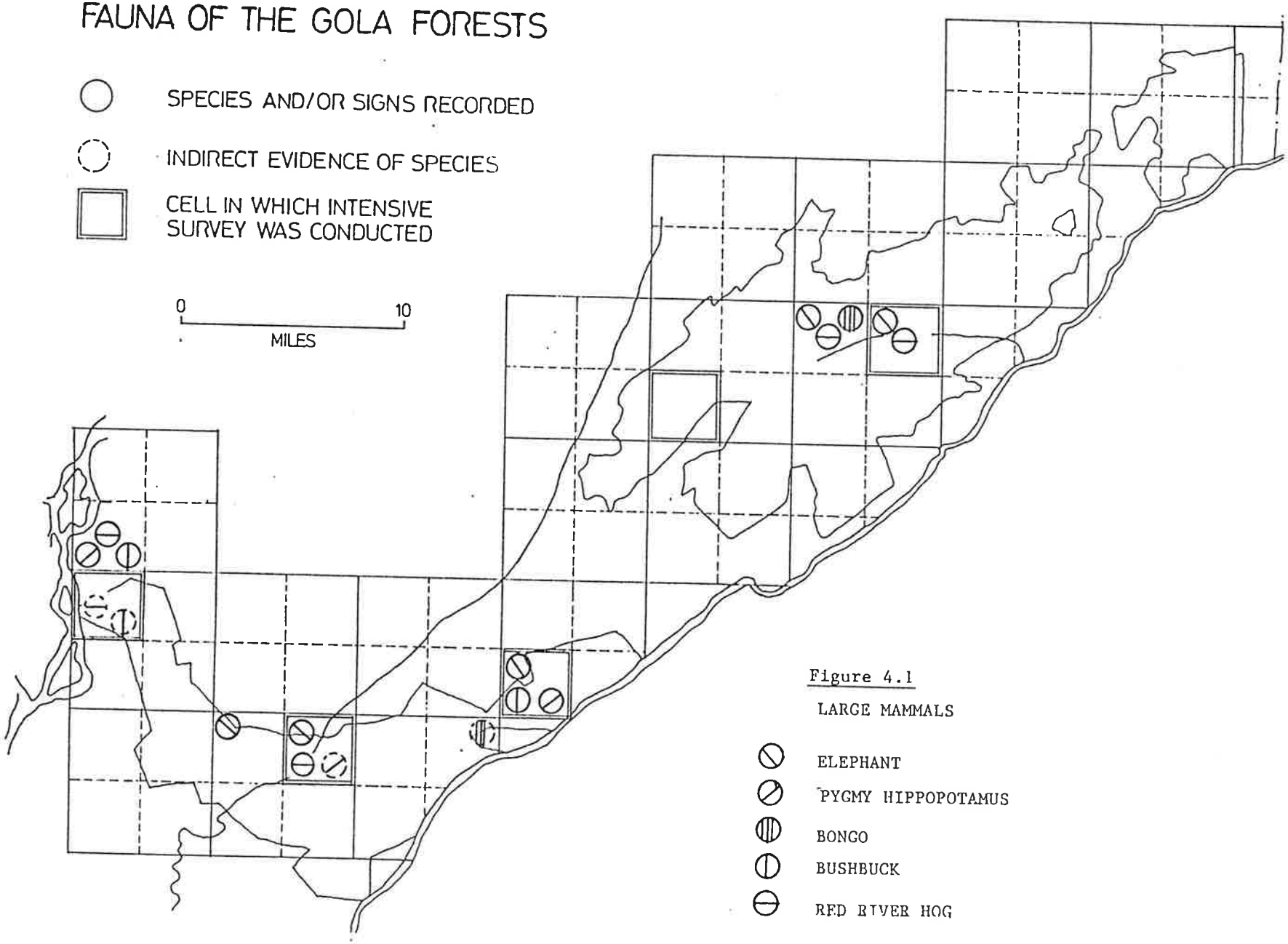

FAUNA OF THE GOLA FORESTS
SPECIES AND/OR SIGNS RECORDED
INDIRECT EVIDENCE OF SPECIES
CELL IN WHICH INTENSIVE SURVEY WAS CONDUCTED
0
10
MILES
LARGE MAMMALS
ELEPHANT
PYGMY HIPPOPOTAMUS
BONGO
BUSHBUCK
RED RIVER HOG

Figure 4.1

crops when they range outside the Reserve in the wet season.

As a result they have been shot; six killings were reported in 1981 and three in 1982, representing a 5% annual loss. No official records or casual reports of elephant killings have been collected since then, but no detailed questionaires surveys have been carried out either. The strict control of arms use by the army over the past two years may have reduced the killings in this area.

By contrast, there have not been any reports of elephant killings for Gola North since 1980, largely because there is much less conflict between this population and agriculturalists.

Timber extraction from forests may not have a deleterious effect on forest-dwelling elephants. The animals tend to shy away from disturbances initially but commonly travel along logging roads. The opening up of the forest canopy encourages the growth of grasses and palms, which are favoured foods of elephants. Studies in the Tai National Park (Ivory Coast) indicate that rotational logging benefits Forest Elephants (Merz, 1982). An important corollary to this is that logging greatly improves the access for hunters, so logged forest will only be suitable for elephants if hunting is controlled.

The two small elephant populations in the Golas represent the last chance to save the Forest Elephant in Sierra Leone (Roth and Merz, 1983). Populations in the Kangari Hills (less than 20 animals) and Tama Forest Reserve (less than 50 animals) which are small and under much greater pressure from hunters, are probably not viable in the long-term. Forms intermediate between the Forest and Savanna Elephants probably occur in the Loma Mountains, where hunting is very intensive (Teleki, 1980), and the Outamba area where elephants are uncommon. Unless firm measures are taken to protect one of the Gola populations, then the species will continue to decline in fragmented pockets until this majestic mammal is lost.

The Gola populations are important from an international perspective as well as a national one. Throughout West Africa, the populations of Forest Elephants are in decline due to hunting and agricultural activities (Douglas-Hamilton, 1987). The Gola East population density (0.27 animals/sq km) is above average for West Africa (Merz, 1986) and the Gola North density (0.1 animal/sq km) is lower, although this latter population probably has better chances of surviving in the long-term.

The **Pygmy hippopotamus** (Choeropsis liberiensis) is a small, smooth-skinned and rather appealing animal which has been the subject of a brief survey in Sierra Leone (Robinson, 1971), but has not been intensively studied yet. The species has a very restricted distribution, occurring in parts of only four West African countries where it has a preference for swampy and riverine vegetation along the main river courses in forested areas. These animals can extend along gallery forests into the savanna zone, but they are undoubtedly concentrated in the forest zone.

Reports from the Gola region are scattered and there is little information on this very shy, nocturnal animal, except that it is rare throughout its range in West Africa, so animals in the Gola population represent a significant part of the world population. Concentrations of the species have been reported from the Mahoi river (Teleki, 1980) and along the Moa river, especially on Tiwai and the adjoining islands (J.F. Oates, pers comm; L.J.T. White unpubl report). There are old reports of animals on the Moro river (Forest Division Surveyors), to the east of Gola North, and faeces were seen near the Wemago survey site (Fig 4.1).

There is considerable threat to these animals from hunters. Not only can they be sought at night using powerful lamps which dazzle them, but they tend to use regular pathways along riverbanks into which hunters can build lethal pitfall traps. At least two animals are reported to have been killed on the Mahoi river in early 1985 by hunters from the Congo iron mine in Liberia, and populations are thought to have declined along the Moro river for the similar reasons (Forestry Division reports).

The Mahoi and Wemago rivers are the only sites where Pygmy hippotamuses have been recorded **within** the Gola Forest Reserve boundaries and they deserve special attention. It is probable that there is a population in the Mogbai swamplands, which were not sur veyed in detail and need fuller examination. It is also possible that there are viable populations in the remoter parts of the Mano and Moro rivers, but it would be difficult to afford these realistic protection.

For these reasons, it is important to emphasise the importance of Tiwai Island for the preservation of the Pygmy Hippopotamus in Sierra Leone. Effective control of hunting has been imposed by chiefdom authorities and this offers the best hope for the species at present.

Bongo (Tragelaphus euryceros). This rare, thin-striped, rufous forest antelope is widely distributed in suitable habitats through west, central and east Africa, but nowhere is it common. The only definite signs of Bongo recorded during these surveys were tracks seen on a trail in the central part of Gola North. This record can be supplemented with reports of the species in the vicinity of Tolo (Gola East) and at least one was reported shot in Gola West in 1983/84 (Fig 4.1).

With so few records on a species which is rare and poorly studied, little can be said other than that Gola North has a population of unknown size and some may occur in Gola East and Gola West. Hunting, again, is the main cause for concern and it must be controlled if a population is to survive. The ability of the species to adapt to timber extraction and the possibility of improving forest for Bongos by providing salt licks etc. are still unknown quantities.

A commoner cogener, the **Bushbuck** (T.scripta), occurs throughout the woodland savanna of sub-Saharan Africa and the species is well known in the savanna and farm bush areas of Sierra Leone, where carcasses are often for sale at roadsides. Bushbuck can also live in rain forest, where they exploit vegetation in forest clearings, and sightings were obtained at Wemago and on Tiwai. An unclear sighting was made in Gola West and the species is probably widely distributed through the Reserves.

The species is very adaptable, and cannot be considered an endangered species in Sierra Leone at present, although hunters are making serious inroads into the populations.

The **Red River Hog** (Potamochoerus porcus) is widely distributed throughout the forested areas of sub-Saharan Africa. In rain forest populations, individuals have a pale red/brown coat with conspicuous white and brown facial markings, and piglets are striped. In Sierra Leone, the species is found in farmland, where it is trapped as a pest, in primary and secondary forest and in woodland savanna (Harding, 1983). Red River Hogs tend to be nocturnal, at least in part, and were seldom seen, but can be detected from their footprints and wallows (Fig. 4.1).

During the survey period six animals, including a boar, two sows and an immature animal were seen on Tiwai, and a sow with four piglets was seen on a trail near the Mogbai river (Gola North). Diggings and tracks

were seen in Gola West and at Mahoi, and it is probable that the poorly defined tracks and small-scale digging seen at the other primary forest sites were attributable to hogs.

The species is thinly distributed over a wide range of habitats, in most of which it is hunted, and its capacity to produce large litters is likely to be important in off-setting losses to hunters. The species is probably not in need of preservation measures at the present time but, like the Bushbuck, management of its population could prove important in ensuring meat supplies for rural areas in the future.

PRIMATES

There are 11 species of non-human primates in the forest region of Sierra Leone. Two of these are small, nocturnal prosimians, one is an ape (the Chimpanzee) and the rest are monkeys which vary in size from under 4.5 to over 11kg.

The Chimpanzee is **rare** throughout Africa and the monkeys can be subdivided into three categories: the **forest** species (three colobine monkeys and the Diana monkey) which are dependent on forest, **forest, farmbush and savanna** species (Sooty Mangabey, Spot-nosed and Campbell's Monkeys) which are very adaptable to changes in habitat and the one **savanna** species (Green Monkey) which does not live in primary forest.

At this stage it is important to note that the forest species, which are often favoured human foods, have long been known **not** to be agricultural pests (Jones, 1951).

The populations of diurnal monkeys can be examined relatively easily because they are conspicuous and still comparatively common. Thus, changes in populations can often be perceived and used to measure the health of a rain forest. If there is a full complement of species, each at high population density, then the forest is providing the required resources and hunting has not exceeded capacities to recover. However, if species are missing, or population densities are depressed, then adverse conditions are affecting the primates, and probably other forest mammals.

Prosimians. The smallest primate encountered, **Demidoff's Galago** (Galago demidovii) is a diminutive animal, about the size of a small squirrel. It was seen or heard at all sites visited; most commonly in scrubby

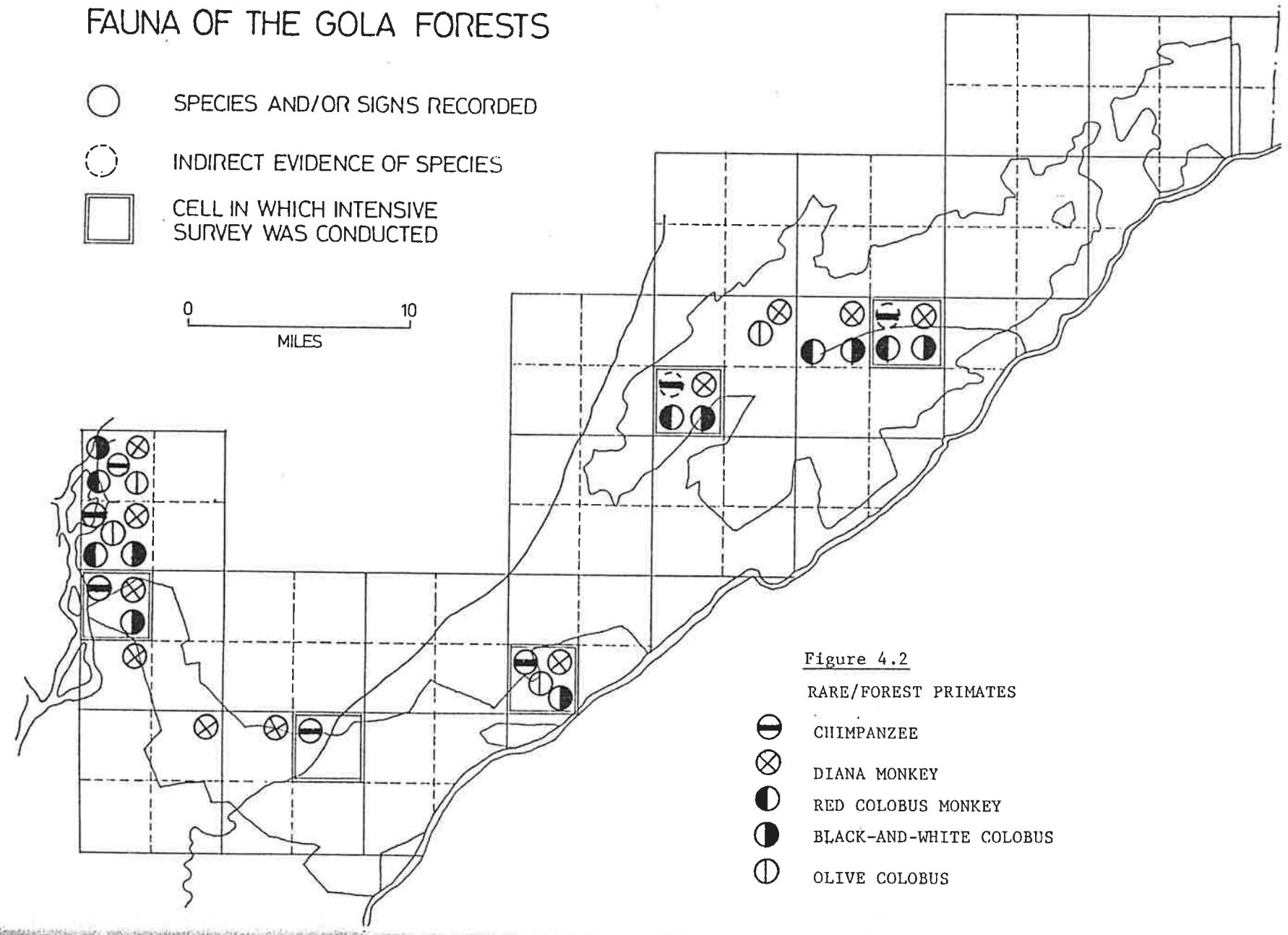

FAUNA OF THE GOLA FORESTS
SPECIES AND/OR SIGNS RECORDED
INDIRECT EVIDENCE OF SPECIES
CELL IN WHICH INTENSIVE SURVEY WAS CONDUCTED
0
10
MILES
RARE/FOREST PRIMATES
CHIMPANZEE
DIANA MONKEY
RED COLOBUS MONKEY
BLACK-AND-WHITE COLOBUS
OLIVE COLOBUS

Figure 4.2

understorey vegetation. Animals appear able to adapt easily to logged forest and were heard in young farmbush both on Tiwai and on the outskirts of Kenema town. They appear well distributed throughout the rain forest zone. The other prosimian is the slow-moving Potto (Perodicticus potto) which tends to live in the upper levels of the forest (Oates, 1983) where it is quite difficult to detect. They have been seen on Tiwai, but none were seen during surveys, and their tolerance to habitat alteration was not assessed.

Chimpanzee (Pan troglodytes verus). The western race of the Chimpanzee, which is the rarest, is restricted to West Africa and occurs in Sierra Leone. It has been the subject of a nation-wide survey and an international conservation campaign to prevent export (Teleki, 1980). However, detailed studies of the species' ecology and population densities in different habitats in Sierra Leone have yet to be carried out. The species is widely distributed in the country where it occurs in primary and secondary forests, farm bush, woodland savanna, montane forest, gallery forests and in forest around swamps. In the woodland savanna at Kilimi, where there was a sparce human population and relatively little hunting of Chimpanzees, about 75 animals were recorded in 240 sq km, approx. 0.3 animals/sq km (Harding, 1983).

In the Golas there was evidence of Chimpanzees from all parts of the Reserves surveyed (Fig 4.2). In the primary forest of Mogbai and Wemago indirect evidence indicated their presence; reports at the former and nests at the latter. At Wemago, a group of at least two animals was heard calling and drumming on two evenings and one morning. Better evidence of Chimpanzees was obtained in the two logged forests, despite the intense hunting pressure. A party of at least four animals was seen and heard on three occasions in Gola West, and a nest and distant call was heard at Mahoi from animals which were seen on the same day by timber company workers. On Tiwai, Chimpanzees have been seen or heard at least twice each week during 1986, although less frequent records were made prior to this time (Whitesides, 1985).

A major drain on the population has been the capture of live Chimpanzees for export to provide specimens for biomedical research. Over 1,000 were recorded as exported to USA and Japan over a five-year period begining in 1973, but many more will have been lost in the course of capture, transport and storage if careless methods are used by trappers (e.g. Teleki,

1980). This wasteful carnage needs to be stopped.

The effect of hunting on populations is difficult to assess. Field workers have suggested that Chimpanzee populations have been depressed by hunting, since there were few signs of them and little calling (A. Kortland, pers comm). Despite the wariness of chimps and their skill at evading hunters, experienced men can still track them down and shoot them. They are also vulnerable to hunters when they enter farms to raid crops.

Apart from the negative influence of hunting, Chimpanzees seem to be able to adapt to live in logged forest, and their sparse populations showed no obvious decline following timber extraction. This has also been recorded in logged forest in Gabon (Tutin et al, 1982). It would certainly be appropriate, therefore, to set aside both primary and logged forests when preserving Chimpanzee populations in Sierra Leone.

Diana monkeys (Cercopithecus diana) are the most colourful and engaging of the arboreal monkeys, with their clear, whistling calls and quick, agile movements in the upper strata of the forest. In Sierra Leone, the species is only found in the high forest zone of the south and east, extending as far north as the foothills of the Loma Mountains. There is also an outlying population in the Freetown Peninsula (R. Happel, pers comm). The species can exploit a variety of vegetation types, including tree plantations (J.F. Oates, pers comm), farmbush, logged forest and primary forest, but the animals have not been recorded in areas which totally lack tall trees.

Within the Gola Reserves and on Tiwai, the Diana Monkeys were recorded over the wider area than any other species; in ten of the 5km grid cells visited (Fig 4.2). In the primary forest of Gola North, where there was little hunting, the species was abundant (3 groups at Mogbai and Koye). In the primary forest at Wemago, where hunting was moderate, two groups were recorded.

The apparent negative effect of hunting was shown clearly at Mahoi, where there was no evidence of this conspicuous species in the logged forest. This absence could not be attributed to timber extraction since the species was seen in other logged forests were hunting was lighter: a) Gola East, near the SILETI camp, b) two parts of Gola North and c) Gola West where timber extraction was intensive but three diana groups were recorded in the vicinity of the survey trail.

Table 4.1

RELATIVE NUMBERS OF PRIMATE GROUPS AT EACH OF THE FIVE INTENSIVE SURVEY SITES AND TIWAI (EAST)

SPECIES.	MOGBAI a	b	c	KOYE a	b	c	WEMAGO a	b	c	MAHOI a	b	c	GOLA WEST a	b	c	TIWAI d
Colobines: P.badius	2	16	3+2	2	8	1+2	0	0		0	0		0	0		1(+2)
C.polykomos	2	5	3+1	3	14	4+1	2	2	2+	0	0		0	1		2(+2)
P.verus	0	0		0	0		0	2	1	0	0		0	0		2(+1)
Cercopithecines: C.diana	3(1)	10	3+1	3(1)	14(6)	3+2	1	6	2+1	0	0		3(1)	17(1)	3+1	2(+2)
C.petaurista	2	0	2?	0	1	1	2	3	2+	0	0		1	2(1)	2+	3+
C.campbelli	7	10	6	2(1)	2(2)	2+1	7	1	5	2	6(2)	2+1	2(1)	3(1)	3	4+
Cercocebus atys	0	1	1+	0	1	1+	0	2	1	1	2	1+	0	3	2	1+
Pan trogolodytes	0	0	+	0	0	+	0	1(2)		Nest (1)			1	2(1)	4+	(3+)
Forest type	Primary			Primary			Primary			Lightly logged			Heavily logged			old secondary
Altitude (a.s.l.)	300m			120-220m			160m			100m			130m			100m
Hunting	light			light			moderate			very heavy			moderately heavy			very light

+ evidence of presence nearby.
a. Total number of sightings of groups (solitary individuals)
b. Total number of calls recorded between 06.30 and 12.00 (calls at other times)
c. Minimum number of groups in the immediate vicinity of the survey trail (groups heard in the distance)
d. Minimum number of groups occuring in the 60ha East side study site at Tiwai. (groups with less than 40% of the home range inside the study area).

Thus, Diana Monkeys appear to adapt readily to habitat alteration brought about through timber extraction, even when it is quite a marked alteration. Furthermore, they can tolerate moderate hunting pressure since they are very alert and live in widely-dispersed groups which flee rapidly from humans.

They can be eliminated by intensive hunting and appear to need some high forest in at least part of their home range if they are to survive.

Red Colobus (Procolobus badius) species are found throughout the equatorial forest zone of west and central Africa, with small outlying populations in the galleys forests of Zanzibar and Tana River to the east, and Senegambia to the west. The species has been recorded from all parts of Sierra Leone, but populations are very sparse in the gallery forests of savanna areas. A few small groups were recorded in Kilimi in places where there was a year-round supply of water and tall trees (Harding, 1983).

Data from the Golas indicate that Red Colobus are the least adaptable of all forest primates to both hunting pressure and timber extraction. In primary forests the populations declined with increasing hunting pressure: three groups at Mogbai, two groups at Koye and none recorded at Wemago. The apparent size of groups also declined from 60+ animals at Mogbai, to 20 counted at Koye. Accepting that this is a very small sample, this species appears exceptionally susceptible to hunting pressure.

There are several reasons for this: a) they are preferred prey because they are large; providing much meat per cartridge, b) they are conspicuous because they are brightly coloured, noisy and live in large groups and c) they are often slow to flee from humans.

Red Colobus were not seen in either of the logged forest sites, and it is difficult to separate the effects of habitat alteration from hunting. However, there is good evidence of the deleterious effects of timber extraction on populations of Red Colobus in Ghana (Martin and Asibey, 1979) and Uganda (Skorupa, 1986) and it is probable that the Gola populations are sensitive to habitat alteration as well as hunting pressure.

Some animals can survive in the patchwork of forest types which remain after logging, as evidenced by their presence in the old, lightly-logged forest near Lalehun. They have also been reported in parts of Gola West (L. White, pers comm), but the study group on Tiwai seldom used any of the abundant farmbush and

showed a strong preference for the closed-canopy forest.

Black-and-white Colobus (Colobus polykomos) This species has somewhat larger than the Red Colobus, lives in smaller groups (about 12 animals) and, as the name implies, has a black body, white tail and white mane. Both of these larger colobines have a similar geographical range within Sierra Leone, but the Black-and-white seems better able to cope with more arid habitats and is much commoner at Kilimi (Harding, 1983). They also appear better able to exploit secondary forests and farm bush in the high forest zone (e.g. Martin and Asibey, 1979).

Population densities were similar at Mogbai, Koye and Tiwai (3-4 groups), somewhat lower at Wemago. In logged forest, the species was not noted at Mahoi and was only represented by a single, distant group at Gola West. They are a preferred prey of hunters because of its large size and "sweet" taste, although they are probably shot less often than Red Colobus because they are more cryptic: living in smaller groups, calling less often and hiding in tangles of vegetation when alarmed. The species had been eliminated by hunting from Mahoi and all but lost from Gola West but had survived moderate hunting at Wemago.

Animals which have been studied on Tiwai frequently forage in young farm bush and liana tangles which were found in secondary vegetation (G.L. Dasilva, pers comm). It is probable, therefore, that this species can adapt to live in logged forests, as has been recorded in Ghana (Martin and Asibey, 1979). Their absence from logged forests in the Golas, therefore, is more likely to be a consequence of hunting than alteration of the habitat.

Olive Colobus (Procolobus verus) is the smallest Colobus species, with adults weighing about 4.5kg. It has a limited geographical distribution in West Africa and is only found in the southern part of Sierra Leone (Oates, 1978). The animals commonly occur in small groups (4-10 animals) which live in the scrubby understorey and thick liana tangles, especially in the vicinity of tree falls and rivers (Oates, 1980). Swamps and old farmland are also inhabited. Although the species can live outside closed-canopy forests, and indeed shows a preference for secondary or riverine vegetation, there have been no records of it north of 8 05' North (J.F. Oates, pers comm); and they are somehow dependent on moist habitats in the rain forest

zone.

Two records of Olive Colobus were obtained during the Gola surveys, in addition to records of their presence on Tiwai. An adult male was heard to call on two occa sions, separated by six days, at Wemago and three animals were seen by J.F. Oates and G.H. Whitesides in the logged forest of Gola North, east of Lalehun.

Nowhere is there evidence that this species occurs at high population densities in Sierra Leone, although it can clearly live in secondary forests and can survive moderate hunting pressure.

Campbell's Monkey (Cercopithecus campbelli) This small cercopithecine was the only species to be seen at all sites. The greatest population densities were 5-6 groups at Wemago and Mogbai, but only 2+ groups were encountered at Koye. In disturbed forest, 2-3 groups occurred at Mahoi and Gola West and at least 4 groups entered the east side study area on Tiwai.

The unexpectedly low number of groups at Koye confounds interpretation of the results, although there is a clear trend towards a reduction in population density in logged forest where hunting was greatest. This species readily adapts to secondary vegetation, both in savanna and forest zones, and is a major pest of crops. It is unlikely to suffer losses as a result of habitat alteration, and low population densities are far more likely to be a consequence of hunting pressure.

Indirect evidence to support this is that groups were only seen in swamps and marshes in logged forest, which were difficult for hunters to penetrate.

Spot-nosed Monkey (Cercopithecus petaurista) This small cercopithecine is widely distributed throughout Sierra Leone, but does not adapt well to savanna (Harding, 1983). They are widely distributed in the farm bush of the southern and eastern provinces, where dead animals are commonly for sale on roadsides.

In the Golas they were encountered at all sites except Mahoi, where they may have been hunted out. At the other sites 1-2 groups were noted in the logged and primary forests, although this species is particularly cryptic and difficult to survey. Their abundance on Tiwai, therefore, could reflect the longer period spent surveying them or a preference for the mosaic of habitats on the island. The species can clearly adapt to live in logged forests and withstand moderate levels of hunting pressure.

Sooty Mangabey (Cercocebus atys) This largely terrestrial species occurs in large groups (up to 100 animals) and is extremely adaptable, living in a variety of habitats in Sierra Leone. In Kilimi, it occurs at low population densities (0.5 indiv/sq km) (Harding, 1983) and clearly fares better in the wetter south where it has long been considered the worst of crop raiders (Jones, 1951). A single group occupies a large home range, probably greater than 1 sq km, with a result that they were seldom seen during surveys. Their loud "whoop-gobble" calls, however, indicated that they occurred throughout the Reserves.

There is no reason to assume that timber extraction has a deleterious effect on them since they are largely terrestrial and often enter farm bush. They have a reputation for avoiding traps and hunters, so they are in no need of urgent conservation management.

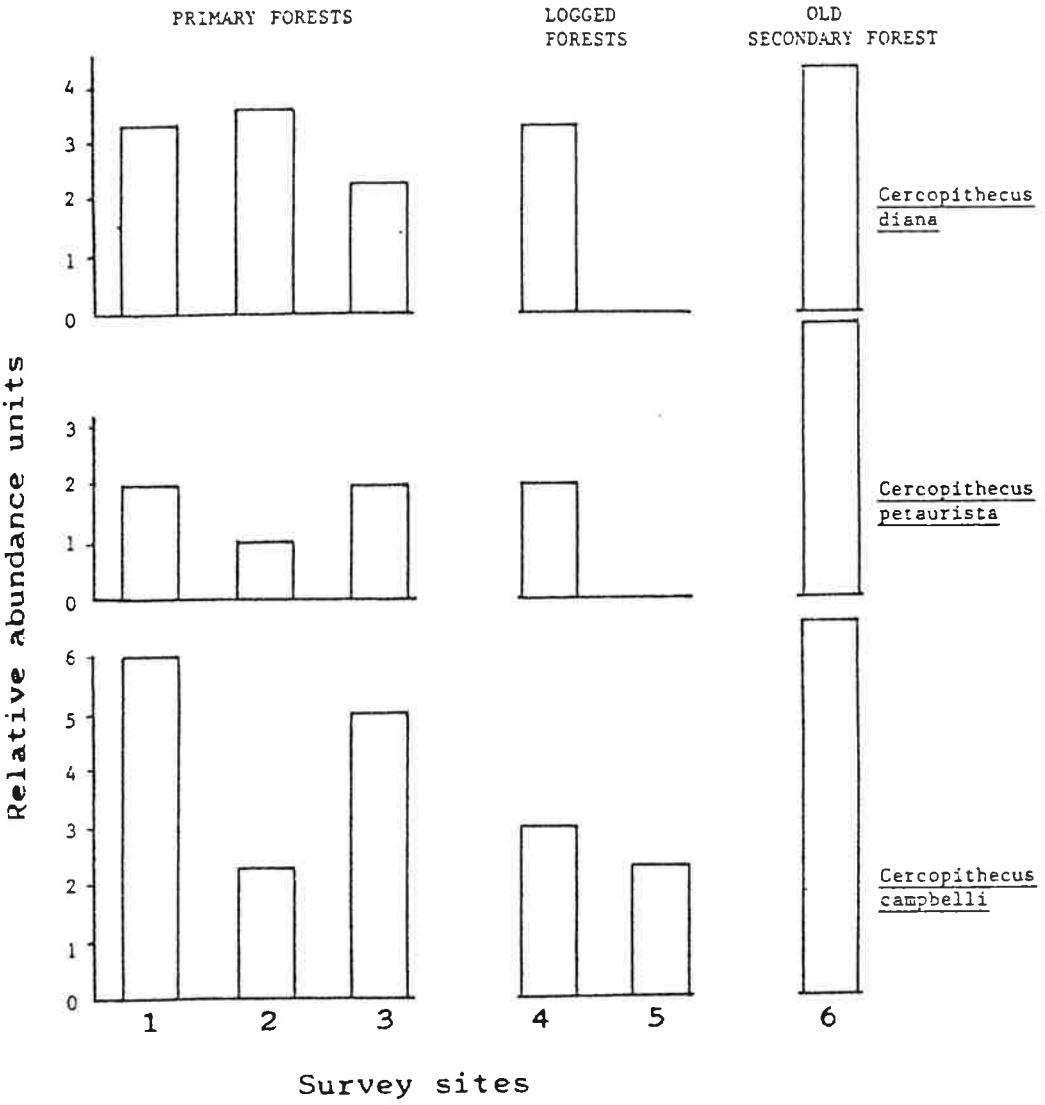
Primate conservation Enough records of Diana, Campbell's and Spot-nosed monkeys, as well as the Red and Black-and-white Colobus were collected to estimate population size and allow comparisons between sites.

The cercopithecines showed no obvious decline in abundance from levels in primary forests to those in logged forests with moderate hunting pressure (Fig 4.3a). However, both the Diana and Spot-nosed Monkeys were not seen or heard in the intensively hunted Mahoi area, and Campbell's Monkey only appeared to survive the hunting by taking refuge in swamps. Hunting, therefore, is the main cause of population declines among cercopithecine monkeys. All three species can adapt relatively well to timber extraction and both Campbell's and Spot-nosed Monkeys adapt to live in farmlands.

The colobines are much less adaptable to human influence (Fig 4.3b). Red Colobus populations declined with increasing hunting pressure, even in primary forest. The Black-and-white Colobus appears better able to adapt to moderate hunting pressure in primary forest, but fared less well in logged forests where access was easier for hunters. The Olive Colobus has a specialised habitat preference and was seen too infrequently to be included in this analysis.

The prosimians, Chimpanzee and mangabeys were seen too infrequently to make detailed comparisons between sites, but it was quite possible that the Chimpanzee populations were depressed by hunting.

Figure 4.3a
Changes in the abundance of Cercopithecus monkeys in the Gola Forest Reserves and on Tiwai island

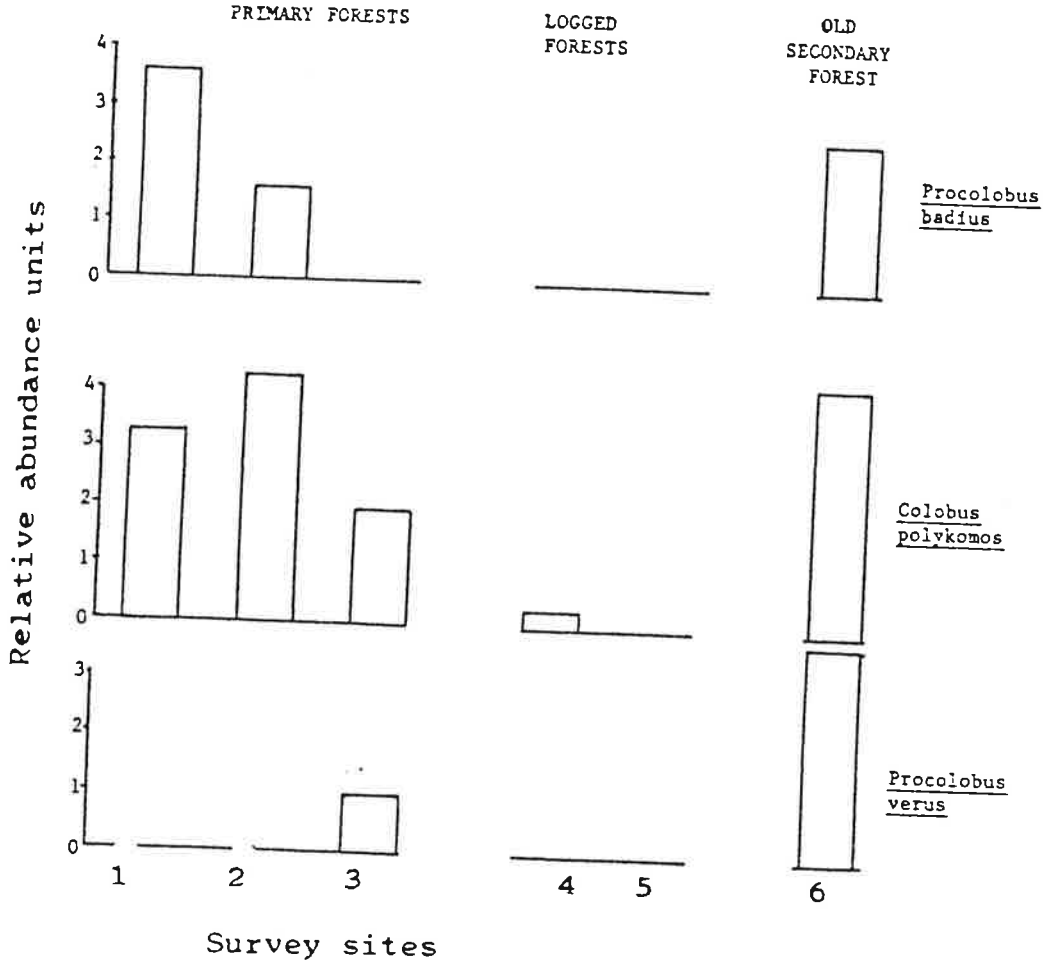


Survey sites ranked from least hunting pressure to the greatest hunting pressure within the Reserves, with Tiwai shown afterwards for comparison
(1 Mogbai; 2 Koye; 3 Wemago; 4 Mahoi; 5 Gola West; 6 Tiwai)

Increasing hunting in logged forests causes declines in Cercopithecus populations

Figure 4.3b

Changes in the abundance of colobine monkeys in the Gola Forest Reserves and on Tiwai island



Survey sites ranked from the least hunting pressure to the greatest hunting pressure within the Reserves, with Tiwai shown at the end for comparison.
(1, Mogbai; 2 Koye; 3 Wemago; 4 Mahoi; 5 Gola West; 6 Tiwai)

With increasing hunting the abundance of colobines declines.

It is still not clear what changes occur in primate populations following logging, but the 50 year-old closed-canopy forest on Tiwai clearly supported dense populations and it is probable that species, with the exception of the Red Colobus, can maintain reasonable populations in logged forest.

It is realistic, therefore, to use a patchwork of primary and logged forest areas when preserving rain forest primates, as long as hunting can be controlled.

The minimum area required for the preservation of viable populations is discussed at the end of this chapter, but it should be noted that Tiwai is an especially important area for primate conservation because it has sizeable populations of all four forest primates (C.diana, P.badius, C.polykomos and P.verus). Furthermore, there are now more than 10 Chimpanzees on Tiwai Island, possibly as a result of the strict enforcing of hunting controls.

DUIKERS

The duikers (Cephalophinae) are a group of small antelopes which have radiated to fill a variety of niches on the forest floor of West African rain forests. Five species of forest duiker occur in Sierra Leone. A sixth, Jentink's Duiker, has been reported in the Golas by experienced hunters and has been collected from several parts of neighbouring Liberia (Kuhn, 1965). However, there are no past records of it in Sierra Leone (Jones, 1960) and the possibility of its occurance needs thorough investigation since it may be the rarest duiker in the world. Ogilby's Duiker, with its distinctive white feet, was not reported in Sierra Leone by Jones (1960) and it was not seen during these surveys, although it has been recorded in western Liberia (Kuhn, 1965) and Teleki (1980) reports it as present in the Gola Reserves.

Despite their abundance in the forest, duikers are seldom seen because they are small, stealthy, often nocturnal or crepuscular animals which spend much of the day resting beneath fallen logs, in thickets and between tree trunk buttresses. Unfortunately efforts to see them at night with spotlights proved largely ineffective, so no population estimates could be made.

The **Zebra Duiker** (Cephalophus zebra) is a striking forest antelope, restricted to the western parts of the Upper Guinean forest belt and it has been reported as relatively common in the upland areas of Liberia (Kuhn, 1966). It is rare in Sierra Leone and was seen on only two occasions at Mogbai. A pair was seen foraging along

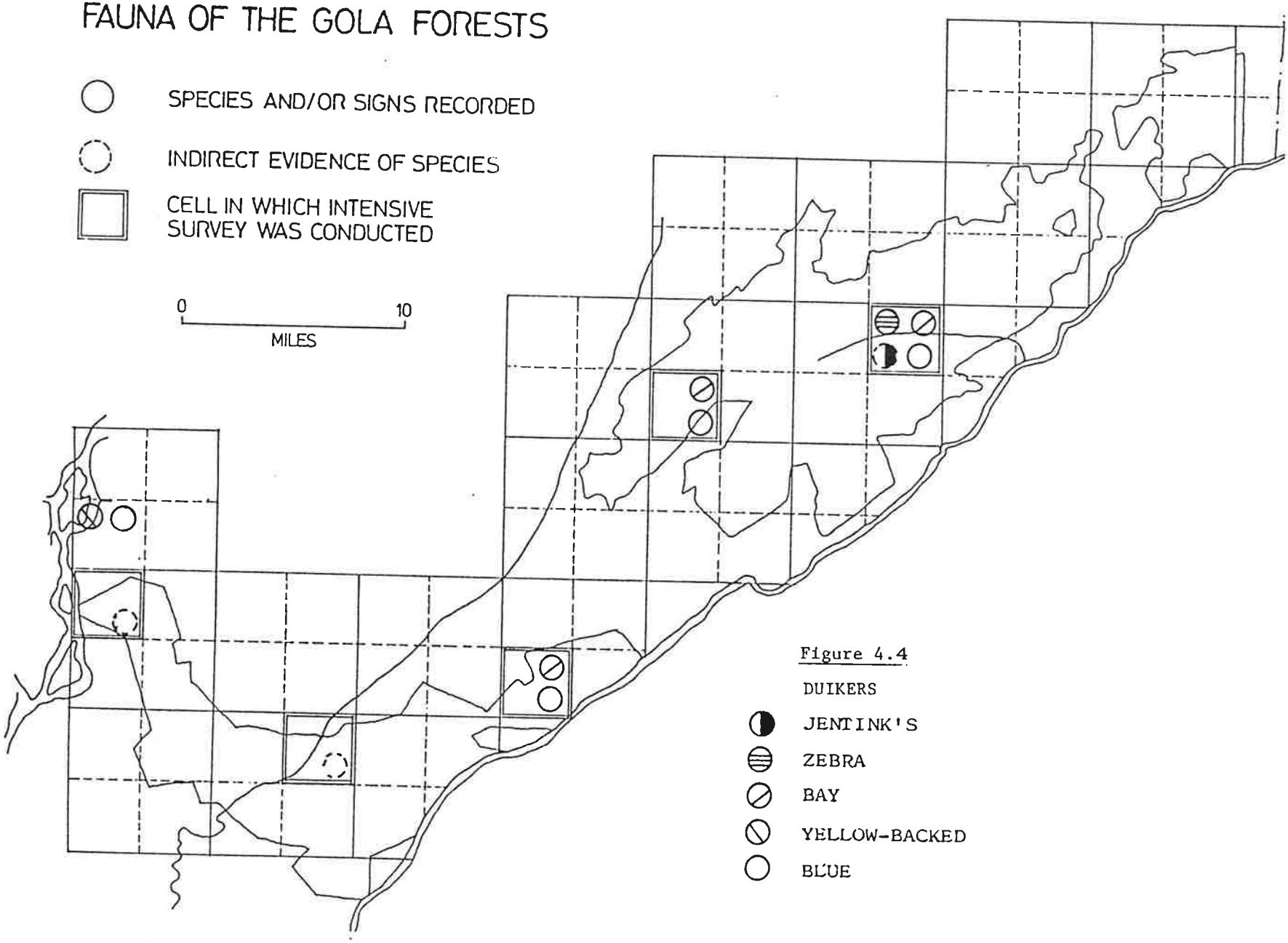

FAUNA OF THE GOLA FORESTS
SPECIES AND/OR SIGNS RECORDED
INDIRECT EVIDENCE OF SPECIES
CELL IN WHICH INTENSIVE SURVEY WAS CONDUCTED
0
10
MILES
DUIKERS
JENTINK'S
ZEBRA
BAY
YELLOW-BACKED
BLUE

Figure 4.4

a stream bed at midday and a different animal was disturbed from its resting place during a morning survey. No other evidence of this species was found. It is undoubtedly rare, but more details are needed on the extent of its distribution since there are old records of it in the Freetown Peninsula.

The other forest-preferring species was the **Bay Duiker** (C.dorsalis). It was apparently more widely distributed in the Golas where it was seen at all three primary forest sites, including Wemago where hunting was moderate. It has been recorded in rubber plantations in Liberia (Kuhn, 1965; pers comm), but was not seen in the logged Gola forests.

The two other species encountered were both adaptable, occurring in farm bush and secondary forest: **Yellow-backed** (C.sylvicultor) and **Maxwell's** (C.maxwelli). The former, the largest of the duikers, was seen on three occasions on Tiwai where, judging from its tracks it was relatively common. Maxwell's Duiker is ubiquitous to habitats in the forested region of Sierra Leone where it is easily the commonest species, it even adapts to make a household pet. It is very common on Tiwai.

The fifth species, the **Black Duiker** (C.niger), has been reported by hunters in the Gola region, but none were seen during the surveys and the species is more commonly encountered in semi-deciduous forests in more arid areas (Haltenorth and Diller, 1980), so its presence in the Golas needs fuller study.

Duikers, like primates, differ in their ability to adapt to habitat alteration and hunting. In addition to Jentink's Duiker, if it occurs, the Zebra and Bay Duikers appear wholly dependent on primary forest, but others are more adaptable.

Duikers are highly favoured food and are hunted intensively as a result. Hunters use shot-guns, either at night with spot-lights to find the animals by their eye-shine and then dazzle them, or by day when whistles are used as lures to attract them. Large numbers of duikers can be eliminated from areas in a short time by these methods. Villagers, however, use firearms less often and tend to set up fenced snare lines to catch small antelopes in the vicinity of villages and farms.

More detailed information is needed on species' ecology before comprehensive conservation plans can be drawn up, but areas of primary forest are clearly needed if the rarer species are to be preserved. Hunting within these areas must be prevented.

Two diminutive antelopes are expected to occur in the Gola forests, the **Royal Antelope** (Neotragus pygmaeus) and the **Water Chevrotain** (Hyemoschus aquaticus). A single Royal Antelope was killed in a snare in the logged forest of Gola West where hunters reported they were common. Tracks have been reported from Tiwai (J.F. Oates, pers comm) and several have been killed in the farm bush around Tiwai. Local farmers say that they are common near coffee and cacao plantations, but none were seen in primary forest. No records were taken of the Water Chevrotain.

SQUIRRELS

Forest squirrels vary in size from the Giant Forest Squirrel (Protoxerus stangeri), weighing 750g, to the Small Green Squirrel (Paraxerus poensis), weighing about 100g. Five species were observed during the surveys, but none of the large, nocturnal flying squirrels were noted.

The most interesting records were those of the rare, forest-dwelling **Temminck's Squirrel** (Epixerus ebii) which was seen in the primary forests of Gola North and East. No records were collected on Tiwai where much time was spent observing arboreal mammals, indicating that the species may be restricted to primary forest.

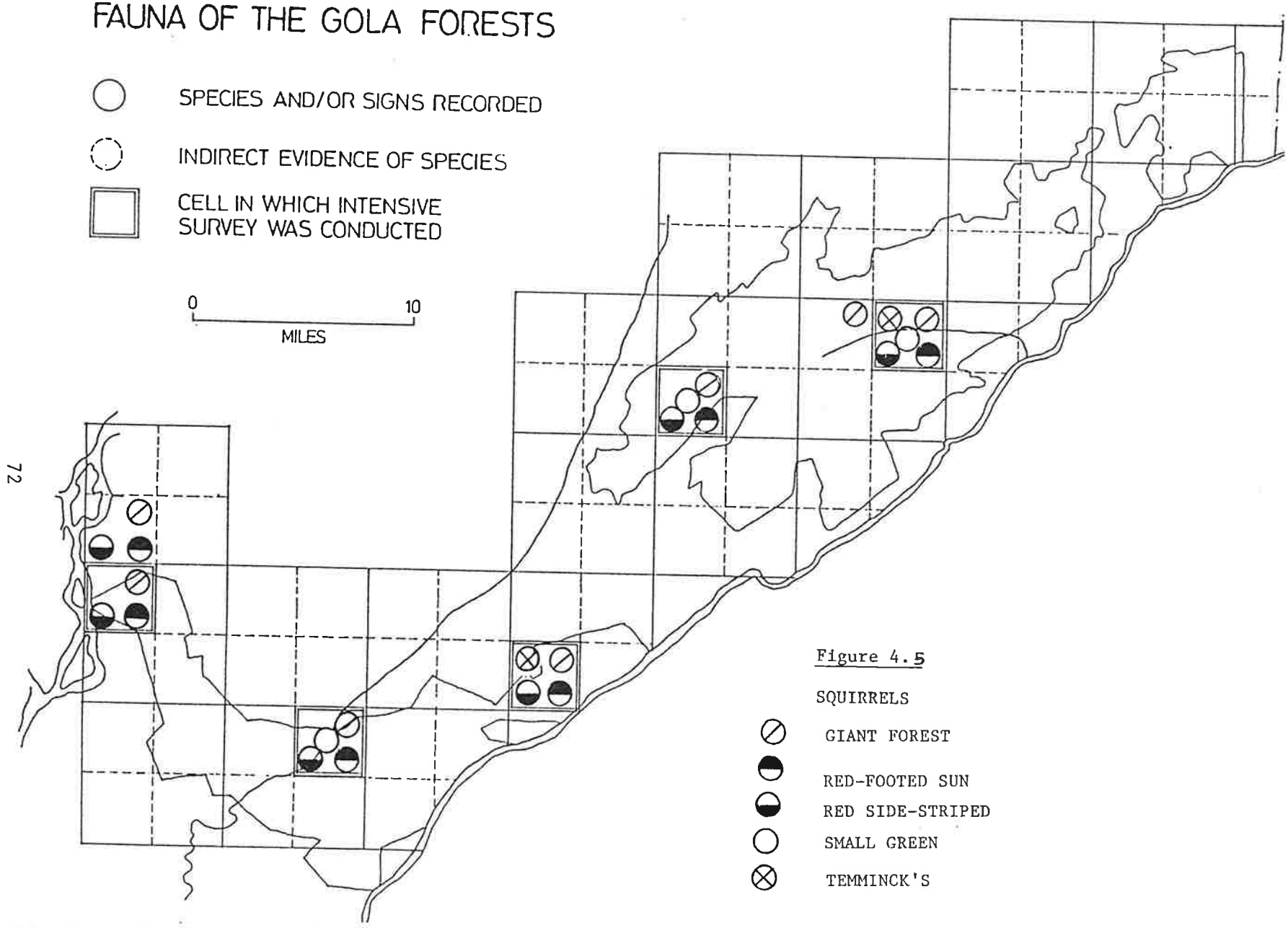
Three species which adapt to live in logged forest as well as primary forest are the **Giant Forest Squirrel**, **Red Side-striped Squirrel** (Funisciurus pyrrhopus) and **Sun Squirrel** (Heliosciurus rufobrachium). All of which have also been recorded on Tiwai. Considering their small size, it is not surprising that they did not appear to be adversely affected by hunting, and the Sun Squirrel was very common at Mahoi.

The **Small Green Squirrel**, which is easily over-looked, was seen at three sites but not in the primary forest at Wemago nor the secondary forest at Tiwai. This species is reputedly common in farmlands and able to live in secondary forests (Booth, 1977).

Only Temminck's Squirrel appears to be in need of priority conservation action, but some of the flying squirrels may be rare and in need of attention too.

CARNIVORES

Because carnivores are ofen at the apex of a pyramid of biomass they are generally rare; the larger and more specialised they are, the rarer they become.


FAUNA OF THE GOLA FORESTS
SPECIES AND/OR SIGNS RECORDED
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0
10
MILES
SQUIRRELS
GIANT FOREST
RED-FOOTED SUN
RED SIDE-STRIPED
SMALL GREEN
TEMMINCK'S

Figure 4.5

The two rarest carnivores in the rain forest of Sierra Leone are probably cats: the **Leopard** (Panthera pardus) and **Golden Cat** (Felix auratus) which occurs in two colour phases (Jones, 1960). There have been unconfirmed reports of both in the Golas, and reports of a Leopard on Tiwai (G.H. Whitesides, pers comm), but no evidence of either was collected during these surveys.

There are three mongooses expected to occur in the Golas, of which only the **Cusimanse** (Crossarchus obscurus) is a forest species. Small parties of this animal were encountered at all sites except Gola West, and their population densities appeared to be high in primary forests and in closed-canopy, secondary forest on Tiwai, but effects of timber extraction could not be assessed. The **Dwarf Mongoose** (Herpestes sanguineus) was seen on Tiwai and on a road through farm bush to the west of Gola East. It is a notoriuos raider of chicken coops (Booth, 1977) and clearly adapts to farmland habitats.

Two species which are generally associated with savanna were seen; the **Egyptian Mongoose** (H.ichneumon) at Mogbai and the **Marsh Mongoose** (Atilax paludinosus) at Mogbai.

The **Cape Clawless Otter** (Aonyx capensis) was seen at Mogbai and 400m inland on Tiwai. No records of the **Spot-necked Otter** (Lutra maculicollis) were collected. Similarly, no civets were seen, although the **Common Civet** (Vivera civetta) is known to occur on Tiwai and the smaller **Palm Civet** (Nandinia binotata) has been reported from the Golas. The **Forest Genet** (Genetta maculata) has been seen on Tiwai, but eluded detection during the Gola surveys.

At this stage more information is needed on the distribution and abundance of carnivores before conservation plans can be considered. Such plans need to be drawn up with a national perspective, since carnivores are rare throughout Sierra Leone. As a result, any conservation measures in the Gola region will be a substantial contribution to their conservation throughout the country.

MAMMAL CONSERVATION

Of the ten **RARE** species of mammal that were expected to occur in the Gola Forest Reserves, direct sightings or reliable reports were obtained to confirm the presence of six. Forest Elephant populations were well surveyed by Roth and Merz (1983), but the Pygmy Hippopotamus, Bongo and Zebra Duiker all need more investigation. The other rare species recorded was Temminck's Squirrel which is certainly rare in Sierra Leone.

In all there is an encouragingly rich complement of rare mammals in the Golas, some of which will be lost if action is not taken to preserve them immediately. These are of international conservation concern.

A further 17 **FOREST** mammals are in a less precarious position, but are still vulnerable because of their dependence on the shrinking areas of rain forest. Eleven of these species were identified during the surveys. All four forest primates were seen, often at high densities: Diana Monkey, Red Colobus, Black-and-white Colobus, Olive Colobus, along with Demidoff's Galago which is restricted to the wetter southern part of Sierra Leone.

The Giant Forest Squirrel, Sun Squirrel and Cusimanse all occurred at high densities in forested areas and the call of Tree Hyraxes were heard in a wide variety of forest and farm bush habitats. The Bay Duiker was the only forest species which appeared largely dependent on primary forest.

A further 16 mammals were observed, excluding bats and small rodents, which probably did not rely on forest for their survival. However, they still contribute to the wealth of mammal species occurring in the forest.

The main cause of mammal extinctions in the Gola Forest Reserves is the systematic hunting carried out by commercial gangs. Primates and duikers are most highly sought, but all larger mammals that are encountered will also be shot. If this hunting continues unchecked, Sierra Leone will loose her wildlife heritage.

Timber extraction without hunting does not have a deleterious effect on most species, although it may reduce populations of Zebra Duikers, Bay Duikers, Temminck's Squirrel and possibly Bongos. However, hunting generally increases after logging, and the need for primary forest where hunting is low to preserve wildlife populations should not be underestimated.

There is, therefore, an urgent need for some areas of primary forest to be set aside and logged forest around them should be used both to buffer the primary forest areas against hunting and support supplementary populations of forest animals.

In addition to setting aside areas for species preservation, more surveys are needed to check for the presence of Leopard, Jentink's Duiker and Golden Cat. The effects of logging and hunting also need to be investigated more thoroughly.

AVIFAUNA

The avifauna of Sierra Leone, like the mammal fauna, incorporates elements of both savanna and forest which intermingle. For example, the "savanna" Senegal Coucal (Centropus senegalensis) and the "forest" Black-throated Coucal (C.leucogaster) occur together at Kilimi (Harding, 1983). Similarly, both the Blue-throated (Eurystomas glaucurus) and Broad-billed Rollers (E.gularis) were seen on Tiwai at the end of the dry season when the latter, savanna species, had probably migrated from the dry north. Thus, the boundary between forest and savanna birds is often obscure, with some species occupying both forest and savanna habitats.

Despite this intermingling, it is possible to identify a guild of about 80 species which are strongly forest-preferring, some of which are severely threatened by forest losses throughout West Africa (Thiollay, 1985). They range in size from the diminutive, ever-energetic wattle-eye flycatchers to the large, lumbering hornbills. In all, 76 species were recorded in the Golas (between 34 and 41 at each survey site) which reflects the great diversity of bird species in the area since it was clearly an incomplete enumeration (Appendix 2a). A larger, but still incomplete sample of 80 species was identified on Tiwai in the course of two years (Appendix 2b) with still more species recorded by other researchers (Appendix 2c).

RARE BIRDS

The **White-breasted Guineafowl** (Agelastes meleagrides) is "one of the most threatened birds in continental Africa" (Collar and Stuart, 1985) and the six sightings made during the survey period are an unexpected confirmation of the species' occurrence

Table 4.2 SIGHTINGS OF WHITE-BREASTED GUINEAFOWLS IN THE GOLA FORESTS AND ON TIWAI.

DATE	LOCALITY	COMMENTS
14th Dec '84	Tiwai (11°21'W, 7°33'N)	Two birds seen at 10.02 hours walking along the ground beneath a group of red colobus monkeys. The birds ran and flew a short distance on seeing the observer, but soon returned, passing within 10m of the observer while he sat still.
29th Dec. '85	Tiwai	A single bird seen at 16.45 hours travelling along the ground. Bird fled rapidly along the ground on seeing the observer. This sighting was made less than 150m from the earlier one.
8th Jan. '86	Path leading to Mogbai (10°51'W,7°39'N)	Two birds disturbed by observer walking along path and a larger group of birds (at least six in all) moved away noisily foraging through the dry leaf litter.
23rd Feb. '85	Mogbai Camp (10°52'W,7°39'N)	At least four birds flew away from the survey team, in different directions, and landed 30m away before being disturbed and fleeing once again.
31st Mar. '85	Koye Survey (10°57'W,7°38'N)	A group containing at least three birds flew away from the survey team at 08.25 hours, but a party of more than six birds was seen within 30 mins, and was assumed to be the same party of birds. They were moving noisily through the leaf litter in a broad front making chicken-like "clucks". They eventually ran away.
2nd Apr. '85	Koye Survey	Nine birds, at least one of which was small and had a dark head, crossed the path 20m in front of the surveyor.

in Sierra Leone (Fig 4.6). Apart from reports that a family party was caught in the Gola Forest in the 1960s (G. Field in Collar and Stuart, 1985), the birds have not been seen in Sierra Leone despite the efforts of experienced ornithologists.

The sightings on Tiwai were interesting because there is no primary forest on the 12 sq km island. About half is covered by secondary forest and the rest is a mosaic of swamps and farm bush thickets at different stages of regeneration. The two sightings were made within 150m of each other, in a narrow corridor of forest between a swamp and an area of relatively young farm bush. This forest had a closed-canopy, with trees that were over 30m tall, and the sightings were made almost exactly one year apart.

On the basis of these records, and on the assumption that this species does not migrate in December, it is taken that there is a small population resident on Tiwai.

The Gola sightings were all made in primary forest where hunting was light. The birds were travelling in parties of four to nine individuals (minimum counts) and one group was seen in an area of about 6ha in the course of six days. The findings accord with other reports of group size for this species, but there is no precise information on the size of the annual home range. It was especially encouraging to note successful breeding at Koye, where a dull-coloured, immature bird was seen.

Hunting is a major cause of population decline throughout the species' limited geographical range in West Africa (Collar and Stuart, 1985). The birds fled only short distances when flushed and foraged noisily through the leaf litter at the end of the dry season, making them easy prey for hunters with shotguns.

The Tiwai records indicate that the species may not be as wholly dependent on primary forest as has been described. However, there are areas of closed-canopy forest on Tiwai and there are no grounds to assume that the birds can use open-canopy forests. This is an important consideration since the birds feed extensively on leaf litter insects which may be killed off by desiccation, especially at the end of the dry season.

Timber extraction opens up the canopy, and leaf litter is pushed aside by machinery or washed away by rains. As a result forest-dwelling pheasant and partridge populations decline after logging because the "forage substrate" is damaged (Johns, 1985). The same may apply to White-breasted Guineafowl.

Wattle-eye, netted and seen in Gola North and the **Little Green Woodpecker**.

In the understorey of **logged** forests in both Gola North and Gola West the attractive **Blue-headed Bee-eater** was seen in vegetation comprising pole-sized trees next to logging paths. Logging has increased the number of forest clearing to which this species is adapted. Two other species were seen in the upper canopy of logged forests: the **Blue Cuckoo-shrike** and the **Copper-tailed Glossy Starling**. The latter is reported by Field as fairly common in the eastern forests of Sierra Leone (Collar and Stuart, 1985).

Hornbills deserve special mention partly because they are conspicuous and arouse interest, but mainly because several species are rare and forest-dependent. The uncommon **Black Dwarf Hornbill** was often seen in the vicinity of monkey troops and probably adopts a similar strategy as the **Red-billed Dwarf Hornbill** and the **White-crested Hornbill** catching insects dislodged by movements of monkeys. The three large hornbills: Yellow-casqued, Black-casqued and Brown-cheeked were often detected in areas because of their loud calls, but they did not appear to have dense populations.

OTHER BIRDS

Commoner species were generally observed in the understorey of the forest travelling in noisy flocks of several species. These included a complement of forest bulbuls, many of which were difficult to identify and were excluded from the records, flycatchers, Blue-billed Malimbe and the ubiquitous, chattering Drongos, of which the two species were not distinguished.

Other birds of the understorey, less commonly seen in mixed-species flocks included the **Fire-crested Alethe**, **White-tailed Ant-Thrush** and kingfishers. Only one dove, the Blue-headed, was commonly seen in the understorey, while the **Green Pigeon** was only seen in the upper canopies of the forest. Also in the upper canopy were two species of Malimbe and the raucous Touracos and Plantain-eaters. Finally, on the forest floor, **Latham's Francolin** was common, but only one sighting was made of the Crested Guineafowl, on Tiwai, where it appears sympatric with the White-breasted Guineafowl.

BIRD CONSERVATION

Species were categorised according to their habitat preference (after Field, 1971; Serle et al, 1981) and separated into those that occurred in primary and logged forests (Table 4.2). Forest preferring birds were recorded frequently in both primary and logged forests, indicating that logged forest still provided resources for the majority of forest-preferring birds. However, rare species were seen more often in primary forest sites than logged forests.

There were similar numbers of forest/gallery forest birds at all sites, but there were many more savanna species on Tiwai indicating that it is now on the edge of the forest-savanna border as a result of forest clearance by farmers to the north. Most forest birds probably cannot adapt to live in farm bush.

Despite the incompleteness of the Gola surveys, it is clear that the avifauna fully represents the bird species diversity recorded in other Upper Guinean forests. For example, of the 105 species identified in this study, 97 of them have been identified from Mount Nimba (A. Forbes-Watson, pers comm). Furthermore, 83 of them have been reported from Tai National Park, Ivory Coast, of which 57 were "restricted or regularly seen well inside primary forests" (Thiollay, 1985).

Fuller surveys are undoubtedly needed for a more complete list of birds, which will show an even greater overlap in the species composition of this lowland forest with others. However, it is already clear that both primary and logged forests can be important for the conservation of even forest-dependent birds. There is indirect evidence that hunting will reduce the numbers of larger birds, such as guineafowls and hornbills, but the effects of trapping on smaller species are unknown.

SIZE OF CONSERVATION AREAS

Having established that some species of mammals and birds are dependent on primary forest for their survival while the majority can adapt to live in logged forests, it is necessary to consider what minimum size of population must be protected to ensure against species' extinction. This, in turn, will dictate what minimum areas of land need to be set aside.

Inbreeding has long been known to have deleterious effects on domestic animals and weak animals have been born in zoos to related parents (Ralls and Ballou1985). These ill-effects can only be avoided if a wild population of at least 50 breeding adults is maintained (Franklin,1980). However, since most individuals in a population do not usually breed at the same time, the minimum population that must be set aside is between 150 and 200 (Soule, 1980).

The chances of weakly, inbred infants surviving in the wild are low. On top of this there are often environmental catastrophes, such as the failure of a fruiting season, epidemics of disease or the arrival of a gang of hunters, which bring about sudden declines in a population. Populations can only recover from these "crashes" if sufficient breeding adults remain (Southwood et al, 1974). Something in the order of 500 adults would ensure against such catastrophes.

Translating population density estimates to a minimum area of land needed to harbour populations of 50-500 animals is not easy because few data are available. However, even when these data are available (Table 4.8) very large areas may be needed; a population of 500 Forest Elephants would occupy an area five times larger than all three Gola Reserves! In some cases, therefore, it may be necessary to preserve fewer than 500 individuals in the main protected areas, but numbers should be supplemented by managing populations in surrounding areas.

Therefore, a compromise has to be reached when identifying the smallest useful patch of primary forest that can preserve the majority of species. Thiollay (1985) has recommended a network of 10 to 20 sq km Reserves to preserve West African forest birds. Such an area would also harbour 500 individuals of each forest primate species in the Golas. Sanctuaries of similar size have been recommended for the preservation of trees (Ashton, 1976) and rain forest birds and mammals in Borneo (Davies and Payne, 1982).

It should be stressed that these figures do not take account of the adverse effects of hunting. Where

Table 4.3 Number of bird species seen in different habitats.

	SURVEYED HABITATS		
Bird species habitat preference	Primary forest (unlogged)	Logged forest	Tiwai (mosaic)
Closed forest	37 (9 rare)	33 (5 rare)	33 (5 rare)
Forest, forest clearings, gallery forests, secondary forest.	12 (1 rare)	11 (2 rare)	14
Forest and savanna	12	10 (1 rare)	20
Savanna	1	0	7
Riverine	0	1	6
TOTAL	62	55	80
No. of days of survey	34	22	100+

Table 4.4 Minimum areas needed for a population of 500 individuals

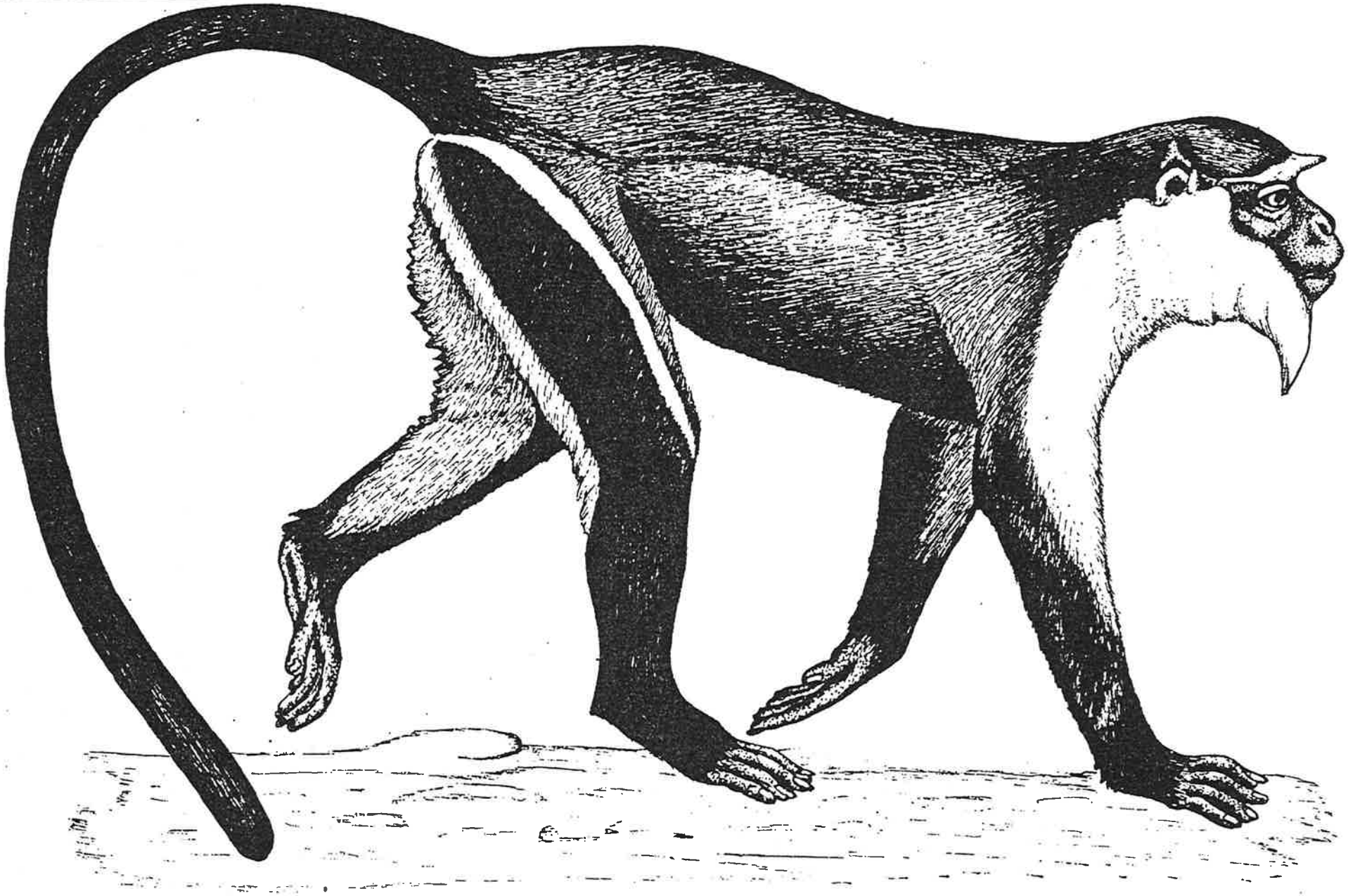
SPECIES	Population density (/km^2)	Area (km^2)	Source
Forest elephant[2]	0.1 - 0.27	2,000-5,000	Merz,1986
Chimpanzee[3]	0.3	2,000	Harding,1983;
Red colobus[1]	approx. 50	approx. 10	this study.
Diana monkey[2]	approx. 50	approx. 10	G.H.Whitesides. pers comm.

N.B. These figures include young animals with adults and hunting pressure is taken to have little effect.

1. species able to live well in primary forest only.
2. species able to live well in primary and logged forest.
3. species adapts to live in primary, logged and old secondary forest.

hunting pressure is potentially high, the minimum reserve size can justifiably be doubled.

The shape and layout of sanctuaries must also be considered (Soule, 1980). If a patch of forest is long and thin it is easy for hunters to penetrate, especially if it is surrounded by paths or logging roads. Circular reserves are preferred to long thin reserves. Since the edge of a forest patch may be prone to desiccation or windfalls, it is preferable to have forest sanctuaries surrounded by logged forest or tree plantations, rather than bare ground or farmland.



DIANA MONKEY (Cercopithecus diana)

5. RECOMMENDATIONS

There is an immediate need for careful management of forest and wildlife resources within all three Gola Forest Reserves. Timber surveys are planned in the next five years and these need to be holistic, taking into account all aspects of the ecosystem: wildlife, trees, other plants, water balance and soil fertility.

Ideally, the plans for different types of land-use would be put into effect together, once all the necessary information has been collected and integrated. However, animal species are already being eliminated at an alarming rate and immediate action is needed to set aside some areas for wildlife preservation. These areas can be incorporated into a more extensive land-management policy at a later date, supported by appropriate legislation.

In addition to drawing up a thorough and balanced management plan for exploitation of the Golas, it is essential that management of the Reserves be coordinated with agricultural policies and rural development in the surrounding areas. Farmers are increasingly short of forest products, such as preferred firewood and building materials. If forest management within the Golas can be seen to benefit surrounding villages, people will continue to respect the boundaries.

Recommendations are made here to point out immediate steps which must be taken to ensure against extinction of the rain forest fauna within the Gola Forest Reserves. Thereafter, suggestions are made on how to combine exploitation and preservation of wildlife and timber resources, through multiple use strategies. Finally, projects that integrate forest management with rural development are discussed.

PAST RECOMMENDATIONS

Three wildlife reports have emphasised the great need to preserve Sierra Leone's rain forest fauna and flora. Phillipson (1978), Oates,(1980) and Roth and Merz (1983) have been unanimous in their concern about the lack of any area of protected rainforest in the lowlands and have recommended that some areas of primary forest be set aside. This report fully supports their concern since Sierra Leone has little opportunity left to preserve some of her rarest plants and animals.

Phillipson (1978) advised that the southern part of Gola East be established as a Strict Nature Reserve and that SILETI's short-term concession licence to fell the area be renegotiated. Roth and Merz recommended that the whole of Gola East be set aside as a National Park (Merz, 1986). However, Gola East is no longer of highest priority for wildlife conservation and it is appropriate to reconsider the rationale for these past recommendations.

Phillipson (1978) considered that it was appropriate to renegotiate the SILETI concession in Gola East, rather than the FIC concession in Gola North, because SILETI was a foreign company with a short-term agreement and FIC was a Sierra Leonean company with a long-term concession. Phillipson did note, however, that some important areas of Gola North should be set aside if no area was preserved in Gola East.

Roth and Merz considered it better to protect Gola East than Gola North because, at the time of their survey, SILETI had just ceased operations in Gola East while FIC was just recommencing operations in Gola North. This recommendation was a compromise in the face of evidence that the Gola North elephants were hunted less and had better chances of survival than the Gola East population which was to be protected.

The results collected during the present survey show that hunting has a markedly adverse effect on wildlife populations in Gola East and many of the larger mammals have been eliminated from the southern part of the Reserve. This factor alone means that Gola East should not be given highest priority for conservation.

In addition, FIC now has all three Reserves in its concession and has already extracted timber from that part of Gola East which Phillipson (1978) considered appropriate to protect. Therefore, protecting Gola East instead of Gola North to reduce conflicts of interest no longer carries much weight either.

The highest conservation priority should be given to Gola North since this is the only area from which there is recent evidence of the rarest animals, such as the Bongo, Zebra duiker and White-breasted Guineafowl. These records all coming from the central areas of the Reserve, away from hunting centres.

This does not mean that Gola East should be ignored. For example, there are different forest formations there and some animals were recorded in Gola East that were not seen at Mogbai, such as the Pygmy

Hippopotamus. Thus, an open-minded approach is needed which considers each area on its merits.

TIMBER INTERESTS

Considerable effort needs to be put into developing timber extraction and plantation forestry so that sustainable yields of timber are available to Sierra Leone. The Gola Forest Reserves are an important area for timber production and wildlife conservation must be coordinated with timber management to minimise conflicts.

It is in the interests of both wildlife conservationists and timber producers to ensure that the existing boundaries of the Gola Forest Reserves remain intact. Any agricultural encroachment reduces future supplies of timber and eliminates many plant and animal species. In addition to losing trees, control of land will also be lost since it is very difficult to evict villagers once they settle in Forest Reserves (Kernan, 1980).

A corollary to this problem is that the pattern of logging road construction must be planned with caution. Particular care must be taken to avoid building roads via the Reserves to villages around the periphery. This practice, which was used by SILETI, forces vehicles to pass through the Reserves to gain access to villages and encourages pedestrians to use the same routes. This in turn increases access for hunters and allows farmers to enter and establish roadside farms.

Ideally, areas of little use for timber production could be used for wildlife preservation. White (1972) did a thorough survey of over half of Gola North and all of Gola East, identifying unproductive forest, steep and swampy ground. This information has been used as much as possible when selecting conservation areas.

In addition to incorporating land unproductive for timber exploitation, immediate conflicts between forestry and wildlife conservation can be reduced by establishing Sanctuaries in areas which are not due for immediate exploitation.

Unfortunately, however, it is difficult to predict what areas are due for exploitation in the next decade. Recent rates of timber extraction from Gola North (Table 5.1) do not tally with recommended rates (Atlanta,1978). The Atlanta report (1978) recommended an annual cut of 31,900 cu m and the Kenema sawmill has a maximum annual capacity of 24,300 cu m, but far less than this has been cut in recent years.

Table 5.1 Rates of timber extraction by Forest Industries Corporation, Kenema, based on Forestry Division felling records.

Reserve	Gola North	Gola North	Gola East
Year	1984	1985	1985
Duration	12 months	6 months	3 months
Volume cut	14,000 m^3	7,000 m^3	2,000 m^3
Area exploited[a]	2.7 km^2	1.4 km^2	0.4 km^2

a - Timber stand volume estimated at 50.3 m^3 per hectare (Mr D. Gabba, pers comm). White (1978) gives : 46 m^3/ha for Gola North plus East
56 m^3/ha for Gola East.

There are no detailed working plans for Gola East and West. In the circumstances, the best that can be done is to focus wildlife preservation outside FIC's immediate planned working area (up to 1990) and away from current timber operations in the southern part of Gola East. This will allow timber operations to continue while wildlife and forestry policies are put into effect.

Most parts of the Forest Reserves will be altered by lumbering activities and wildlife preservation will have to be centred in sanctuary areas, where timber extraction is prohibited, surrounded by large areas of logged forest.

GOLA NORTH

1. Mogbai The Mogbai area needs to be set aside as a Strict Nature Reserve (SNR) in which hunting, timber extraction and farming are prohibited. The SNR should incorporate several areas:

a) The swampland in the central part of the Mogbai river valley is unproductive for timber and is an important dry season refuge for Forest Elephants and probably other animals. The swamps also form something of a barrier to movement of hunters and diamond diggers from the east.

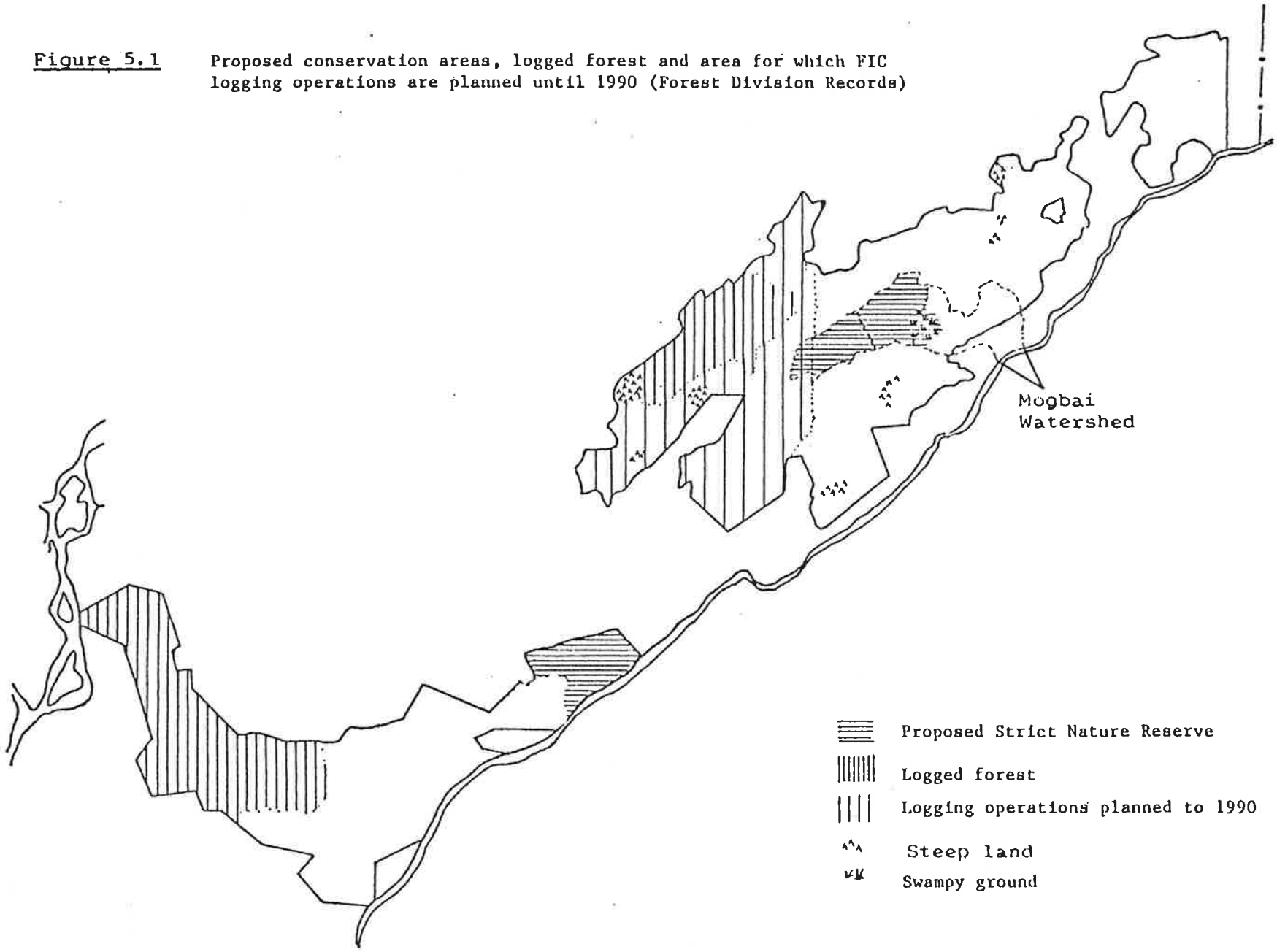
b) The area to the west of the swamps (Mogbai survey area) is the only place for which there are recent reports of some of Sierra Leone's rarest mammals and birds.

c) The swamp and western area constitute the upper catchment of the Mogbai river, which forms an ecological unit of about 35 sq km. This is small enough for Forestry Division staff to patrol effectively but still large enough to support reasonable populations of rain forest animals and plants.

d) Timber should not be extracted from any part of the watershed upstream of the swamps, to ensure that the dynamics of the river are not altered. Timber could be exploited from the area east of the swamplands.

2. Steep land The areas of steep land in the western and southern parts of Gola North and the northern extension of Gola North have small potential for timber production (White, 1972) and may be useful for wildlife preservation. However, these areas are prone to hunting pressure because they are on the outside of the Reserve

Figure 5.1 Proposed conservation areas, logged forest and area for which FIC logging operations are planned until 1990 (Forest Division Records)



Action needed

1. The Mogbai Strict Nature Reserve (SNR) should be surveyed and marked on the ground.

2. Hunting must be prevented within the Mogbai SNR immediately. The paths leading through the area must be patrolled to deter hunters and, if possible, smugglers.

3. Gun licences and hunting licences should be inspected and law enforcement carried out in conjunction with the police. From this perspective, it will be important to liaise with Police Chiefs and the Judiciary to make them aware of the chronic situation in the Golas, thereby ensuring that laws are enforced and offenders fined.

4. It is especially important that the hunting gang which is beginning to establish itself in Lalehun should be prevented from hunting in the Reserve generally, and the Mogbai area specifically.

5. Patrols need to be started along the boundary of the Reserve so that encroachments can be prevented and local villagers made aware of conservation issues through an education programme.

6. A secondary priority would be to investigate ways of improving the habitat at Mogbai for the existing wildlife, especially those which are endangered. For example, it may be possible to provide small salt licks for antelopes to encourage them into the best-protected areas. This would provide opportunities for future wildlife viewing by tourists.

7. In addition to basic investigations into habitat improvement, more research and surveys are still needed.
a) The usefulness of the steep land near the edges of the Reserve needs to be fully assessed.
b) General studies of little-studied animals, e.g. bats and rodents, need to be carried out.
c) Specific searches to locate Jentink's duiker or Pygmy Hippopotamus and to define the extent of Bongo and Zebra Duiker distributions are needed.
d) Research into the long-term effects of logging on wildlife is a prerequisite for drawing up future wildlife management plans.

GOLA EAST

Wemago Many mammals have already been eliminated from the southern part of Gola East and some are beginning to go extinct in the north. However, there is still a fine stand of trees in the Wemago watershed, and there is scope to protect some rare animal species. Given the uncertainty of future events it would be prudent to make efforts to preserve wildlife in the northern part of Gola East, to supplement populations in Gola North.

a) Results from Wemago indicate that the White-breasted Guineafowl, Forest Elephant, Chimpanzee and most forest primates are present, but the Red Colobus was not seen and nor were rare duiker species.
b) Bagra Hill is reported to have deposits of iron ore. Open-cast mining on Mount Nimba in Liberia resulted in complete destruction of one of West Africa's most important wildlife and forest areas. Similar destruction could occur on Bagra Hill which should not be set aside for wildlife preservation.
c) To the east and north of Bagra Hill (Block VIII) there is primary forest which could conveniently be gazetted as a Strict Nature Reserve, assuming that it contains no iron ore. The Wemago river should be incorporated into this area.

Actions needed

The management priorities for Gola East are the same as those in Gola North.

1. The area needs to be surveyed and marked out on the ground as a Strict Nature Reserve.

2. Regular patrols must be made to stop hunting in the vicinity of the northern part of the Reserve.

3. Surveys are needed to locate populations of Pygmy Hippopotamus and other rare animals.

4. Damage to crops by wildlife must be assessed, since farmers at Njama complained of crop-raiding elephants.

5. The movements of cattle through Njama to Tolo and Liberia should also be monitored.

GOLA WEST

This reserve is of the lowest immediate conservation priority. No substantial areas of primary forest remain, so it is not possible to develop a wildlife management strategy where rare species are preserved in patches of primary forest surrounded by logged areas. However, many animals do still occur in the logged forests and may persist if hunting is controlled.

Actions needed

1. If sufficient staff can be found to control hunting, it may be possible to organise culls on a sustained yield basis rather than leave hunters uncontrolled to eliminate species as has happened in nearby Gola East. To work, such a policy would require continuous monitoring of population levels.

2. The possibilities of combining wildlife management with timber extraction and tree plantations could be examined.

3. It may be possible to resuscitate patches of logged forest for forest-dependent species that have been lost, either through hunting or habitat alteration. Some species may be bred in captivity and re-introduced (e.g. Zebra Duikers), but captive breeding or translocation programmes will have to be carried out with care.

TIWAI ISLAND

Tiwai is not within the Gola Forest Reserves, but it is only 6km upstream of Gola West and is part of the Gola ecosystem. In addition to being important for the preservation of all the forest primates and the rare Pygmy Hippopotamus, a policy of multiple land use has already been put into effect through the Tiwai Primate Project directed by J.F. Oates.

Chiefdom Authorities have prohibited all hunting on the island and about half the area has been set aside for research, while other areas are being used for small-scale farming and tree plantations. This provides a good model of conservation for rural development which has a strong bearing on wildlife policies throughout the region.

Furthermore, it is an important training centre for University of Sierra Leone students and could be used for the training of Forestry Division staff.

Ultimately, Tiwai and the adjacent islands downstream should be surveyed and managed to preserve some of the increasingly rare riverine forest of southern Sierra Leone.

RURAL DEVELOPMENT

Recent research has shown that villagers in Sierra Leone have a sound knowledge of the natural resources which they want to exploit and this expertise can be used profitably when planning rural development (Richards,1985). For example, certain trees are preferred as fuelwood, but these have been selectively cut and are now very rare in the Gola Forest Reserves. Less preferred species have to be used (D.Gabba, pers comm). Similar problems are being experienced by villagers seeking timber for canoes and houses.

As young people migrate from rural areas to urban centres, knowledge about forest resources is lost and forests cease to be seen as valuable store-houses. Concepts of forest management must be redeveloped and integrated with rural development if villagers are to extract forest products and realise the full value of this renewable resource, without destroying the few remaining forested areas.

The integrity of the Gola Forest Reserves offers an unusual opportunity to coordinate rural development outside the Reserves with forest management within them. Little formal work has been done in Sierra Leone to link rain forest management with rural development, so progress needs to be made in collating information from villagers, identifying potential projects and establishing pilot schemes.

On the basis of information collected during the Gola surveys and while working on Tiwai, several topics have been identified for further investigation (Davies and Oates, 1985).

a) **Community forests**

These are needed in the vicinity of villages to supply timber, fuelwood, medicines, dyes etc (see Savill and Fox, 1967, for review of uses of different timbers). Trees that have been identified as useful can be collected from within the Forest Reserves and distributed, either as seeds or seedlings, to villages through agricultural extension channels.

It has already proved relatively easy to collect tree seeds (Appendix 3), although methods for planting and maintaining multi-species community forests need to be developed from Taungya and Tropical Shelterwood

Systems of forest management (section 1.1). As forested land is converted to farm bush the need for action by villagers to establish and manage their own timber resources will increase.

b) **Agro-forestry**

The Taungya system results in conversion of forest to farm bush and is untenable inside the few forested Forest Reserves that remain. However, there is every reason to continue the existing system of roadside plantations, and include more species of rainforest trees, as long as the plantations are not destroyed before harvesting.

Shade is often needed for tree crops (e.g. coffee and cacao), and it is possible to use a wide range of rain forest trees for shade, either planting them with crops or leaving them uncut and planting crops beneath them. When the crops have aged, the plantation area can be converted to a community forest and the trees felled.

Finally, systems of planting crops between alleys of trees have been developed to some effect at IITA in Nigeria, and there is ample scope to employ this system in eastern Sierra Leone.

c) **Game management**

A major forest resource is bushmeat. Mainly monkeys and antelopes are shot, although almost anything encountered is butchered. If the pressure on wild populations within Forest Reserves is to be reduced, then other sources of animal protein must be made available to supplement the fish and domestic stock villagers consume. Three obvious approaches should be considered:

i) Culling pest species is the traditional method of supplementing the diet and reducing crop losses.

ii) Ranching could be used in farm bush areas. There is good evidence that smaller antelopes (e.g. Maxwell's Duiker) can adapt to live in this vegetation, at high populations if conditions are favourable. Provision of salt licks, water and grazing areas might be used to improve fallow land for these species. Thereafter hunting could be controlled by season or zones.

iii) It may be possible to domesticate some animals within villages. For example, both the Giant Rat (Cricetomys gambianus) and Cane Rat (T. swinderianus) are highly-favoured foods and preliminary trials in Ghana indicate that both species can be domesticated (Ajayi and Tewe, 1980). Maxwell's Duiker adapts to become a household pet, indicating it too might be domesticated.

Community forests, agro-forestry and game management must be organised together. Given the potential for rural development through these activities, it is appropriate that some villages in the vicinity of the Gola Reserves be selected and feasibility studies carried out.

WILDLIFE CONSERVATION BRANCH

Staff

1. To protect the Mogbai and Wemago Strict Nature Reserves, staff from the Wildlife Conservation Branch (WCB) of the Forestry Division need to be deployed to the Gola Reserves full time. This will be difficult, since the WCB is under-staffed for the major responsibilities it is expected to fulfil in different parts of the country.

2. This lack of staff can only be overcome through recruitment of more and both Phillipson (1978) and Roth and Merz (1983) have outlined the need for staff increases and how the Wildlife Conservation Branch might be structured.

3. As pointed out by Phillipson (1978), there are major problems in having WCB staff widely scattered around the country and it would be better to divide them into **units** to help "...give a sense of purpose, aid morale, and gain respect for wildlife conservation from the local populace."

4. A unit, comprising two **field teams**, is made up of two Game Rangers, two Game Guards, six Wildlife Workers and sundry casual labourers, with all men supervised by a Superintendent.

5. It is very important that WCB staff be stationed at Lalehun immediately to patrol the Mogbai area. A field team of five men would be sufficient since there are already Forestry Division staff at Lalehun with whom the WCB staff would collaborate.

6. It is also important that a second field team be deployed at Njama to begin work in Wemago, but the field team from Lalehun could make regular visits to Njama if shortages did not permit full-time staffing at Njama.

Accommodation

1. At present accommodation for Forestry Division Staff at Lalehun consists of one brick house, four prefabricated metal huts and sundry mud-walled houses.

2. All are in a bad state of repair and all are already occupied by FD personnel. WCB staff cannot be housed there in the long term. Similarly, at Njama there is only one dilapidated prefabricated metal hut.

3. At Lalehun and Njama simple cement structures comprising four two-roomed apartments, side by side, in a single long building would be adequate, with latrine facilities nearby.

4. If extended patrols are to be made in the Mogbai and Wemago areas, a semi-permanent camp should be established in which basic camping equipment can be stored. Prefabricated metal huts would suffice as semi-permanent bases.

5. With the planned timber surveys of the Gola Reserves and a programme of research and management on different land use policies, it will be necessary to construct rest houses at Lalehun for technical staff.

6. One rest house should have an office attached for long term projects and the second should be for short term visitors.

7. Given the isolation of this area from headquarters in Kenema or Freetown, a reasonable degree of self-sufficiency would be needed. Water and electricity supplies should be organised on site, fuel stores built and radio communication arranged.

8. It would be appropriate to solicit funds from an aid agency to build these structures, thereby establishing a base from which to put into effect research and management policies.

9. Four-wheel-drive vehicles and motorcycles will be needed so that Senior Officers can move about within the complex of Reserves and Rangers can report to Kenema. There are no serviceable vehicles for this purpose and the recent fuel shortages make public transport impossible.

Legislation

Government Departments must exercise their policies through the law, and the provisions of the Wildlife Conservation Act, 1972, are adequate to put the above recommendations into effect.

1. There are four categories of legally-protected land: Strict Nature Reserves (and Game Reserves), National Parks and Game Sanctuaries.

2. The first three all have the same thorough restrictions on land use, but there are no restrictions on land use in Game Sanctuaries, where only hunting is prohibited.

3. The main difference between a Strict Nature Reserve and a National Park is the intention with which they are gazetted. The purpose of a Strict Nature Reserve is "...protecting land, fauna and flora therein from any kind of injury or destruction" (Sec.4), while the purpose of a National Park is "...propagating, conserving and managing wildlife and wild vegetation and protecting sites, landscapes or geological formations of scientific or aesthetic value for the benefit and enjoyment of the public" (Sec.5).

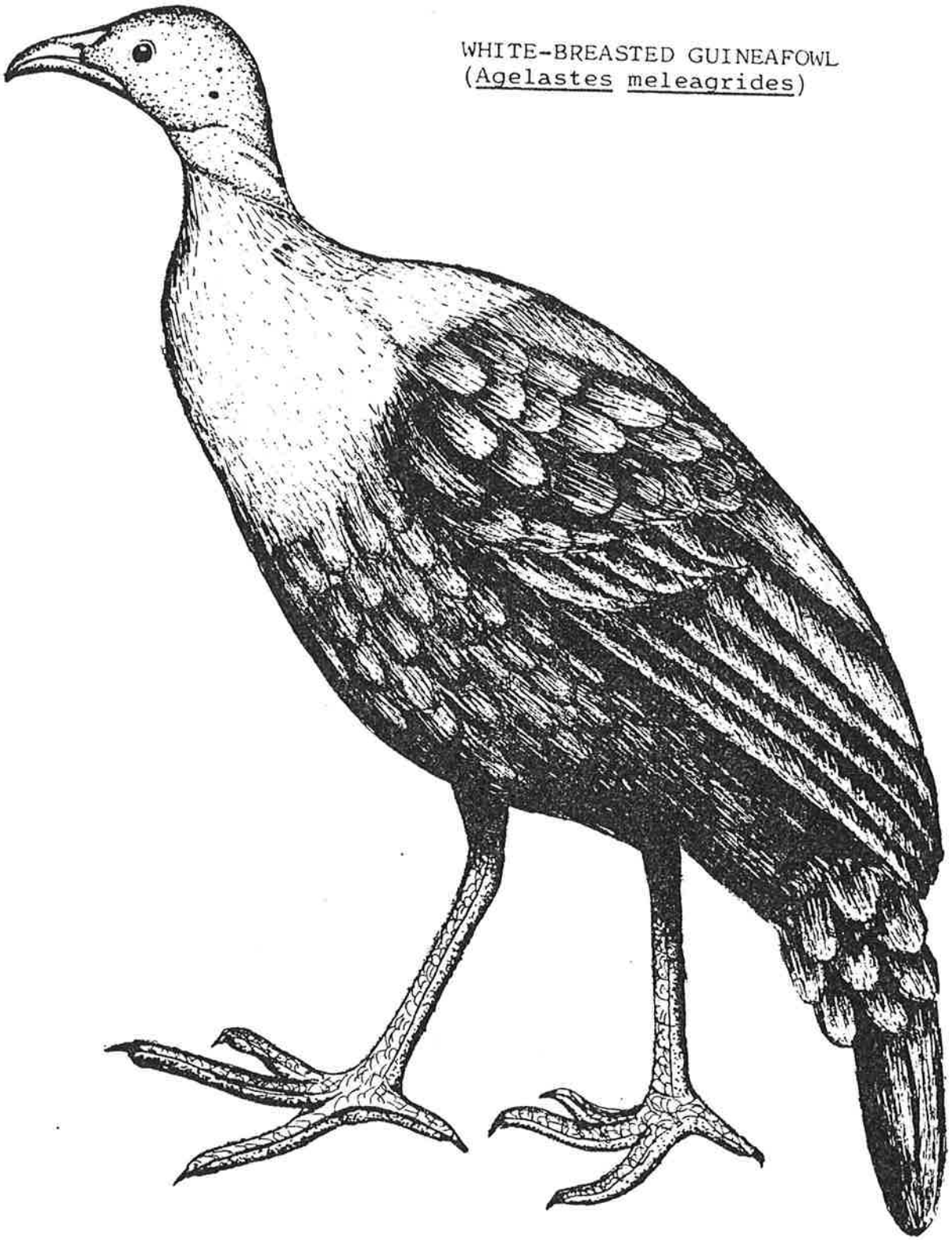
4. When legal protection is given to primary forest areas within the Golas, they should initially be gazetted as Strict Nature Reserves, since their primary function is to save species from extinction. Tourism is a low priority at present.

5. Until these areas are gazetted, the animals within them still have legal protection, albeit less rigorous, since no hunting or capture of wildlife is allowed without a permit (Secs. 31,32,33).

6. It would be appropriate, however, to improve the legal protection of several species because of their rarity. All the mammals included as Rare or Forest species in Appendix 2a of this report should be included in the Second schedule of the Act as Prohibited species, as should the birds marked as endangered, rare or uncommon in Appendix 2b.

7. Special consideration must be given to the Forest Elephant, and possibly the Leopard, because of the damage they do to crops and livestock, but the Chimpanzee is not dangerous and is so rare throughout Africa that it should be included without reservation.

8. At present there are no provisions in the Wildlife Conservation Act for controlling the export of species and legislation is badly needed. It would be most appropriate for Sierra Leone to become a party to the Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES), which could offer advice in drawing up this legislation. CITES has over 90 party nations and represents a considerable body of international scientific and ethical thought.



WHITE-BREASTED GUINEAFOWL
(Agelastes meleagrides)

Appendix 1a All trees greater than 40cm dbh in 8ha botanical plots at six sites.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Acioa pallescens	1		4	3		
Acioa scabrifolia					1	
Acioa sp	2			3	4	
Acioa whytei			4			
Afrosersalisia afzelii			21			
Afrosersalisia sp		1	3	1		2
Afzelia africana			1			
Albizia ferruginea	1	1				2
Albizia zygia		1		1		5
Allanblackia floribunda			1			
Amphimas pterocarpoides		1	3		3	
Amphimas sp			1		1	
Anisophyllea laurina			3			
Anthonotha fragrans		6		7		
Anthonotha macrophylla					5	
Antiaris africana			4			2
Anopyxis klaineana		2			7	
Aubrevillea kersingii			1			
Beilschmiedia mannii				3		
Berlinia confusa	3	2	19	2	7	
Berlinia grandiflora					4	
Berlinia occidentalis					1	
Berlinia sp	1				5	
Blighia sp	1					
Blighia welwitschii			1			
Bombax brevicuspa			3			
Brachystegia leonensis	2	16	1	6	18	
Bridelia micrantha		2	1		1	
Bussea occidentalis	3	2	5	1		
Caloncoba sp					1	
Calpocalyx aubrevillei	19	27		32	3	
Calpocalyx brevibracteata	10	9	4	4	2	2
Canarium schweinfurthii	1	1				1
Cassia sieberiana	1					
Chlorophora regia	1	4				
Chrysophyllum perpulchrum					1	
Chrysophyllum pruniforme		1	3		3	
Cola ?accuminata				1		
Combretodendron africanum			2		2	
Combretodendron macrocarpum					1	
Copaifera salikounda		1				
Cordia platythyrsa		1				
Coryanthe pachyseras			1			
Cryptosepallum tetraphyllum			108	76		
Cynometra leonensis	3		1	1	34	
Dacroydes klaineana			32		4	
Daniellia dinklagei					4	
Daniellia ogea				1	1	4
Daniellia thurifera					2	

Appendix 1a cont.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Detarium senegalense						1
Dialium aubrevillei			7			
Dialium dinklagei			1	2		
Dialium guineense				2		1
Dialium pobequini		1	1			
Dialium sp			1			
Didelotia idae	2	10				
Diospyros sanza-minika		3	4		8	
Drypetes afzelia			6	?1	2	
Drypetes sp	1	1	20		2	
Entandrophragma sp			7			
Entandrophragma utile		1				
Erythrina mildbraedii	1			1		
Erythrophleum ivorense	12	6	5	4		4
Fagara macrophylla		2	1			
Fakai-wuli (Mende)				2		
Funtamia africana		17	1			52
Gilbertiodendron ?splendidum				25		
Gilbertiodendron ?preussii					105	
Gogoi (Mende)						1
Hannoa klaineana			1			4
Heritiera utilis	12	24		25	65	
Hexalobus crispiformes			2			
Holarrhena floribunda	7					7
Homalium latesui			4	1		
Homalium smythei			9	2	6	
Homalium sp		1			1	
Homalium pobequinii			1			
Hymenocardia lyrata	1					1
Irvingia gabonensis			2		1	
Kaoue stapfiana	14	66		5	2	
Khaya sp			1			
Klainedoxa gabonensis			6	2	6	
Klainedoxa sp	1					
Lophira alata	1	3	1	10	1	
Lovoa trichiliodes	2					
Male-guli (Mende)	2					
Mammea africana			2			1
Milletia rhodantha						1
Mitragyna stipulosa				8		
Musanga cercoides		1				
Nauclea diderrichii	3	1		14		
Neolemoniera ditandrofolia			1			
Newtonia aubrevillei	1	2		1	2	1
Newtonia duparquitiana			3		1	
Nyengalei (Mende)	2					
Ochthoscosmos africanus		1	8	24		
Octoknema borealis		1	1		4	
Ongokea gore			9			
Oldfieldia africana		2	1	2		
Pachypodanthium staudtii	2	3	4	2	1	2
Parinari excelsa	43	3	4	28		27
Parinari glabra	2	2		5	7	
Parkia bicolor	7	3	8	13	7	3

Appendix 1a cont.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Pentaclethra macrophylla	33	10			6	104
Pentadesma butryaceae	1		3		2	
Phyllanthus sp	1					
Piptadiniastrum africanum	7	6	3		7	24
Plagiosiphon emarginatus		1	1			
Protomegabaria stapfiana	2		10	4		
Pycnanthus angolensis	1		14	1		6
Sacoglottis gabonensis	3	15		15	2	
Sakpei (Mende)	1					
Samakui (Mende)					1	
Samanea dinklagei	1	1	2		2	11
Sapium aubrevillei						1
Senjei (Mende)		3				
Sersalisia sersalisia			1			
Sterculia tragacantha			1			
Strephonema pseudocola		25		1	1	
Symphonia globulifera				1		
Terminalia ivorense		3	1			4
Teighmellia hecklii			3			
Timber "o"		1				
Treculia africana			1			1
Trichilia heudelotti		2				
Tyo-hini (Mende)	1					
Uapaca guineensis	44	9		8		117
Vitex micrantha		2				
Vitex sp		1				
Xylia evansii		8	8	1		2
Xylopia aethiopica						4
Xylopia elliotii			2			
Xylopia quintasii	3				2	
Xylopia staudtii	1	16	6	1		
Zanthoxylum sp						2
unidentified		4	5	1	1	2
No of species	46	55	69	46	50	33
No of trees	264	339	400	354	360	402

Appendix 1b All trees greater than 10cm dbh in the 1ha sub-sample at six sites.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Acioa scabrifolia	8				9	
Acioa sp	14(1)		1	9	11	4
Acioa whytei	14		5	5		
Afrolicania eleosperma				8	1	
Afrosmosia laxiflora				1		
Afrosersalisia afzelii			36(5)		1	12
Afrosersalisia sp		1		1		
Afzellia sp	1					
Albizia adianthifolia						1
Albizia zygia		1				(1)
Albizia ferruginea		(1)				
Allanblackia floribunda	2		1(1)			
Allophylus africanus			1			
Amphimas pterocarpoides		1		1	2(1)	
Anisophyllea laurina	1		4(2)			
Anopyxis klaineana		2				
Anthonotha fragrans		1(1)	3		20	
Anthonotha macrophylla	6	1		9	3	29
Antiaris africana			(1)			9
Aporrhiza urophylla					1	
Aubrevillea kerstingii		1			2	
Baphia nitida			2			
Beilschmiedia mannii	2	9		10	3	
Berlinia confusa			(3)		2(1)	
Berlinia grandiflora					(3)	
Bartiera spicata		1				
Blighia sapida				2	4	
Blighia sp	12		3		3	2
Blighia unijugata	11		5			
Bombax brevicuspe			1	2		
Brachystegia leonensis		2		4(2)	1(4)	
Bridelia micrantha		2(1)				1
Bussea occidentalis	23	4(1)	5	1		
Caloncoba brevipes		11				1
Caloncoba echinata			3	2		
Calpocalyx aubrevillei	6(3)	(11)			2(1)	
Calpocalyx brevibracteatus	3(2)	17(1)	2(1)	16	4	1
Cassipourea barteri				1		
Chidlowia sanguinea		1				
Chlorophora regia	(1)					
Chrysophyllum albidum						1
Chrysophyllum pruneforme		4	1	1	13	
Chrysophyllum sp		1				
Cleistopholis patens				1	1	
Cola acuminata				(1)		
Cola chlamidantha			2	2	6	
Cola lateritia			1		1	
Cola nitida			1	1		
Copaifera salikounda		(1)				
Cordia platythyrsa		2				
Coryantha pachyceras			3			
Crudia senegalensis				2		

Appendix 1b cont.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Cryptosepalum tetraphyllum			7(13)	15(12)		
Cynometra leonensis				(1)	10(7)	
Dacroydes klaineana	1		5(3)	5	11	
Daniellia ogea						I
Daniellia thurifera					3	
Dialium dinklagei			(1)	(1)	1	2
Dialium guineense		2		(1)	7	15
Dialium pobegumii		1(1)				
Didelotia idae		16(3)				
Diospyros elliotii	9	7	8	8	16	8
Diospyros sanza-minika			16	7	39	
Diospyros sp	11	25	42	43	45(3)	4
Diospyros thomasii						15
Drypetes afzelii			3(1)	5	10	
Drypetes sp	1		54(3)			I
Enantia polycarpa	3	I	2	6	3	
Erythrophleum ivorense	(1)		(1)	(1)		I
Fagara macrophylla		1	1			
Fagara sp						1
Fakai-wuli (Mende)			3	15(1)		
Funtumia africana		3(1)	2			46(2)
Garcinia afzelii	1	1	1			
Garcinia cola						I
Gilbertiodendron ?splendidum				13(19)		
Gilbertiodendron ?pruessi					38(22)	
Hannoa klaineana	1	3			5	4
Hele-lahun (Mende)		1				
Heritiera utilis	7(3)	57(2)	2	18(1)	36(8)	
Hexalobus crispiflorus		3				
Hexalobus sp					1	
Holarrhena floribunda						2(2)
Homalium letestui					2	
Homalium smythei			4(4)		4(2)	
Homalium sp		(1)			(1)	2
Hunteria elliotii	2	I	6			
Hymenocardia acidia		6		I		
Hymenocardia lyrata			3		2	4
Eugenia sp						I
Irvingia gabonensis					(1)	
Isolona campanulata	1		1			
Isolona sp			1			
Kaoue stapfiana	32(2)	74(8)	2	5	19	
Klainedoxa gabonensis	2	1		3(1)	I	
Kotu-wuli (Mende)	1					
kpindi (Mende)			6			
Lophira alata	2(1)	10	(1)		(1)	
Maesobotrya barteri	1	2		1		I
Mareya micrantha		7		4	3	
Mareya sp						3
Memecylon sp	1					
Milletia lane-poolei			1			

Appendix 1b cont.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Milletia sp		2		1		1
Mitragyna stipulosa				11(2)		
Myrianthus arboreus		1				
Myrianthus libericus						24
Nauclea diderrichii	2(1)			(1)		
Neolemonniera clitandrifolia			(1)			
Newbouldia laevis		2	1			1
Newtonia aubrevillei		2(2)			1	(1)
nyina-nyina (Mende)		1				
Ochthocosmus africanus	2	2	11(2)	31		2
Octoknema borealis	3	1		3	1(1)	
Oldfieldia africana		4		1	2	
Ongokea gore		1	6(1)	9	4	
Pachypodanthium staudtii	1	2	(1)		(1)	
Pachystela brevips					1	
Paramacrolobium sp?						1
Parinari excelsa	1(4)			(3)		1
Parinari glabra		1	1(1)		1(3)	
Parinari sp						3
Parkia bicolor	(1)	2	(1)	1(3)	1	1
Pentaclethra macrophylla	5(10)	1			1(1)	8(11)
Pentadesma butryracae		1	(1)		6(1)	
Piptadiniastrum africanum		1(2)	(1)			(5)
Plagiosiphon emarginatus		4(1)				
Polyalthia oliveri	11	3		3	6	1
Protomegabaria stapfiana	34	6	64(1)	1	11	
Pterogota macrocarpa						1
Pycnanthus angolensis	2		(1)			4
Rubiaceae sp A						6
Sacoglottis gabonensis	(1)	5(1)		1(6)	2(1)	
samakui (Mende)		1	1	2		
Samanea dinklagei		1	(1)			7(2)
Santirea trimera						4
Smeathmannia sp						5
solei (Mende)	1					
sokimani (Mende)	(1)					
Soyauxia floribunda		1				3
Strephonema psuedocola	8	9(7)			5	
Symphonia globulifera					2	
teli (Mende)		1				
Terminalia ivorense			1			1(2)
Tetrorchidium didymostemon			1			
teyei (Mende)					1	
Treculia africana			(1)			(1)
Trichilia heudelotii		(1)				
Trichilia lanata				2	1	
Trichilia prieureana			18			
Trichilia sp		1		2	1	
Trichosypha arborea	1			2		
twa-wo-bo-yei (Mende)		1				
Uapaca guineensis	1(6)	3		3		7(10)

Appendix 1b cont.

SPECIES	MOGBAI	KOYE	WEMAGO	MAHOI	GOLA WEST	TIWAI
Uapaca heudelotii					2	
Vitex micrantha	2	5	2		5	5
Vitex sp				1		
Xylia evansii		1	(2)			
Xylopia ?acutiflora		6				1
Xylopia aethiopica						2
Xylopia elliotii	1					
Xylopia parviflora	8					
Xylopia quintasii	6	12		1		1
Xylopia staudtii		3(3)	1			
Xylopia sp	1			3		
unidentified	1	10(1)	6(1)	5	1	2
No of species	53	76	66	61	64	56
No of trees	306	431	419	367	466	301

Figures in parentheses are trees greater than 40 cm gbh

Appendix 2a. LARGER MAMMALS RECORDED IN THE GOLAS AND ON TIWAI

		Mo	Ko	We	Ma	GW	Ti
RARE SPECIES							
Forest elephant	Loxodonta africana cyclotis	1	1	1	1	0	0
Chimpanzee	Pan troglodytes verus	r	+	1	1	1	1
Temminck's squirrel	Epixerus ebii jonesi	1		1			
Leopard	Panthera pardus leopardus						
Golden cat	Felis aurata celidogaster	r					
Pygmy hippopotamus	Choeropsis l. libericus			+	r		1
Bongo	Tragelaphus euryceros	+					
Zebra duiker	Cephalophus zebra	1					
Yellow-backed duiker	Cephalophus sylvicultor						1
Jentink's duiker	Cephalophus jentinki	r					
FOREST SPECIES							
Tree hyrax	Dendrohyrax arboreus	1	1	1	1	1	1
Giant forest squirrel	Protoxerus strangeri	1	1	1	1	1	1
Red-footed sun squirrel	Heliosciurus rufobrachium	1	1	1	1	1	1
Diana monkey	Cercopithecus d. diana	1	1	1	0	1	1
Red colobus	Procolobus badius badius	1	1	0	0	0	1
Black-and-white colobus	Colobus p. polykomos	1	1	1		?	1
Olive colobus	Procolobus verus			1			1
Dwarf galago	Galago demidovii	1	1	1	1	1	1
Long-tailed pangolin	Manis tetradactylus			1			1
Cusimanse	Crossarchus obscurus	1	1	1	1		1
Forest genet	Genetta pardina						1
Bay duiker	Cephalophos dorsalis	1	1	1			
OTHER SPECIES							
Red side-striped squirrel	Funisciurus pyrrhopus	1	1	1	1	1	1
Small green squirrel	Paraxerus poensis	1	1		1		
Three-striped mouse	Hybomys trivirgatus			1		1	1
Brush-tailed porcupine	Atherurus africanus		+				1
Giant rat	Cricetomys gambianus					1	1
White-bellied pangolin	Manis tricuspis						1
Potto	Perodicticus potto						1
Sooty mangabey	Cercocebus atys atys	1	1	1	1	1	1
Green monkey	Cercopithecus aethiops sabaeus						1
Campbell's monkey	Cercopithecus c. campbelli	1	1	1	1	1	1
Spot-nosed monkeys	Cercopithecus p. petaurista	1	1	1		1	1
Cape clawless otter	Aonyx capensis						1
Dwarf mongoose	Herpestes sanguinus						1
Egyptian mongoose	Herpestes ichneumon	1					
Marsh mongoose	Atilax paludinosus						1
African civet	Viverra civetta						+
Royal antelope	Neotragus pygmaeus					1	+
Bushbuck	Tragelaphus scriptus			1		?	1
Blue duiker	Cephalophus monticola	1	1	1	+	?	1
Bush pig	Potamochoerus porcus	1				1	1

1. Animal or evidence of it noted during surveys
r-reliable report of animals presence
+-evidence of the animal nearby
0-animal absent.

Appendix 2b RECORDS OF BIRDS IN THE GOLA FORESTS AND ON TIWAI

		Mo	Ko	We	Ma	GW	Ti	Hab'
Podicipedidae								
Little grebe	Podiceps ruficollis						1	R
Ardeidae								
Cattle egret	Ardeola ibis						1	F'/S
Reef heron	Egretta gularis						1	R
Ciconiidae								
White-necked stork	Ciconia episcopus				1	+	1	F/S(R)
Threskiornithidae								
Hadada ibis	Bostrychia hagedash				+		1	R
Accipitridae								
Palm-nut vulture	Gypohierax angolensis	1				1	1	F/S
Harrier hawk	Polyboroides radiatus	+	1			1	1	F/S
Lizard buzzard	Kaupifalco monogrammicus						1	F/S
Osprey	Pandion haliaetus						1	R
West African little sp'hawk	Accipiter erythropus						1	F'
Phasianidae								
Latham's francolin	Francolinus lathami	1	1	1		1	1	F
Crested guineafowl	Guttera edouardi						1	F/G
White-breasted guineafowl*	Agelastes meleagrides	1	1				1	F
Charadriidae								
White-headed plover	Vanellus albiceps						?	R
Glareolidae								
Collared pratincole	Glareola nuchalis						1	R
Columbidae								
Red-eyed dove	Streptopelia semitorquata						1	F/S
Tambourine dove	Turtur tympanistria					1	1	F
Blue-headed dove	Turtur brehmeri	1	1	1	1	1	1	F
Green fruit-pigeon	Treron australis	1				1	1	F/S
Psittacidae								
Grey parrot	Psittacus erithacus					1	1	F
Musophagidae								
Green-crested touraco	Touraco persa	1	1	1	1	1	1	F/G
Giant plantain-eater	Corythaeola cristata	1	1	1	1	1	1	F/G
Cuculidae								
Yellow-billed coucal	Ceuthmochares aereus		1	1			1	F/S
Senegal coucal	Centropus senegalensis						1	S
Strigidae								
Pel's fishing owl	Scotopelia peli	1						F/G
Caprimulgidae								
Nightjar	Caprimulgus sp					?		F/S

Appendix 2b cont.

		Mo	Ko	We	Ma	GW	Ti	Hab'
Trogonidae								
Narina trogon*	Apaloderma narina		1	1				F
Alcedinidae								
White-bellied kingfisher	Alcedo leucogaster					1	1	F
Malachite kingfisher	Alcedo cristata	1	1					F/S
Giant kingfisher	Ceryle maxima	1			1		1	F/S
Pygmy kingfisher	Ceyx picta	1		1			1	F/S
Senegal kingfisher	Halcyon senegalensis		1			1	1	F/S
Chocolate-backed k'fisher	Halcyon badia		1					F
Meropidae								
White-throated bee-eater	Merops albicollis	1					1	S
Black bee-eater	Merops gularis						1	F/S
Blue-headed bee-eater *	Merops muelleri	+				1		FC
Coraciidae								
Broad-billed roller	Eurystomus glaucurus						1	S
Blue-throated roller	Eurystomus gularis	1	1				1	F
Bucerotidae								
Black dwarf hornbill*	Tockus hartlaubi	1	1				1	F
Red-billed dwarf h'bill	Tockus camurus	1	1	1	1		1	F
Allied hornbill	Tockus fasciatus					1	1	F/G
White-crested hornbill *	Tropicanus albocristatus		1	1	1	1	1	F/G
Yellow-casqued hornbill*	Ceratogymna elata	1	1		?	1	1	F
Black-casqued hornbill *	Ceratogymna atrata		1	1			1	F
Brown-cheeked hornbill *	Bycanistes cylindricus			1	1			F/G
Piping hornbill	Bycanistes fistulator			1	1	1	1	F/S
Capitonidae								
Naked-faces barbet	Gymnobucco calvus						1	F
Duchaillu's yellow bar'	Buccanodon duchaillui				1			F
Speckled tinker-bird	Pogoniulus scolopaceus						1	F/S
Lemon-rumped tinker'	Pogoniulus bilineatus						1	F/S
Picidae								
Little green woodpecker *	Campethera maculosa	1			1		1	F
Brown-eared woodpecker	Campethera caroli				1			F
Buff-spotted woodpecker	Campethera nivosa	1	1	1		1	1	F/G
Fire-bellied woodpecker	Mesopicus pyrrhogaster		1	1		1	1	F
Eurylaemidae								
Rufous-sided broadbill	Smithornis rufolateralis	1	?	1	1	1	1	F
Pittidae								
Angolan pitta	Pitta angolensis						1	F
Motacillidae								
Mountain wagtail	Motacilla clara		?					F
African pied wagtail	Motacilla aguimp	1	1					F/S
Laniidae								
Red-billed shrike	Prionops caniceps	1	1		1	1	1	F

Appendix 2b cont.

		Mo	Ko	We	Ma	GW	Ti	Hab'
Oriolidae								
Black-headed oriole	Oriolus brachyrhynchus	1	1	1	1	1	1	F
Dicruridae								
Drongos	Dicrurus adsimilis/atripennis	1	1	1	1	1	1	F/S
Sturnidae								
Copper-tailed glossy starling*	Lamprotornis cupreocauda					1		F
Forest chestnut-winged starl'	Onychognathus fulgidus						1	F
Corvidae								
Pied crow	Corvus albus						1	G/S
Campephagidae								
Blue cuckoo-shrike *	Coracina azurea				1	1		F
Red-shouldered c-shrike	Campephaga phoenocea				1			F/S
Pycnonotidae								
Common garden bulbul	Pycnonotus barbatus						1	G/S
Little green bulbul	Andropadus virens	1					1	F/G
Yellow-whiskered bulbul	Andropadus latirostris	1		1	1			F/G
Honey-guide bulbul	Baeopogon indicator		1					F/G
Icterine bulbul	Phyllastrephus icterinus				1	1		F
Common bristle-bill	Bleda syndactyla			1	1		1	F
Green-tailed br'-bill	Bleda eximina	1		1	1		1	F
Bearded bulbul	Criniger barbatus		1	1	1	1	1	F
White-bearded bulbul	Criniger calurus	1	1	1		1		F
Nicator	Nicator chloris						1	F/G
Swamp palm bulbul	Thescelocichla leucopleurus	+						F
Turdidae								
Fire-crested alethe	Alethe diademata		1	1	1	1	1	F
Forest robin	Stiphrornis erythrothorax	1	1	1	1	1	1	F
White-tailed ant-thrush	Neocossyphus poensis	1		1	1	1	1	F
Fraser's rusty thrush	Stizorhina fraseri		1			1	?	F
Timaliidae								
Blackcap akalat	Malococincla cleaveri			1				F
Brown akalat	Malococincla fulvescens	1				1		F
White-breasted akalat	Malococincla rufipennis			1				F
Capuchin babbler	Phyllanthus atripennis	1						F
Sylviidae								
Green hylia	Hylia prasina	1	1	1	1	1	1	F
Muscicapidae								
Ussher's flycatcher	Muscicapa ussheri						1	F
Forest flycatcher	Fraseria ocreata	1		1				F
Black flycatcher	Melaenornis edoliodes						1	S
Senegal puff-back flyc'	Batis senegalensis						1	S
Chestnut wattle-eye	Platysteira castanea	1		1	1	1	1	F
Golden-bellied wattle-eye*	Platysteira concreta	1	1					F
Chestnut-capped flyc	Erythroceros mccalli	1	1	1		1	1	F
Red-bellied paradise fly'	Tersiphone rufiventer	1	1	1	1	1	1	F/G

Appendix 2b cont.

		Mo	Ko	We	Ma	GW	Ti	Hab'
Nectarinidae								
Yellow-chinned sunbird	Anthreptes rectirostris						1	F'
Collared sunbird	Anthreptes collaris		1		1		1	F
Olive sunbird	Nectarinia olivacea		1		1		1	F/G
Olive-bellied sunbird	Nectarinia chloropygia						1	F/S
Ploceidae								
Maxwell's black weaver	Ploceus albinucha			1	1			F
Village weaver	Ploceus cucullatus						1	F/S
Red-vented malimbe	Malimbus scutatus		1	1	1		1	F/S
Blue-billed malimbe	Malimbus nitens	1	1		1	1	1	F
Red-headed malimbe	Malimbus rubricollis						1	F/G
Estrildidae								
Crimson seed-cracker	Pirenestes ostrinus				1			F/G
Grey-crowned negro finch	Nigrita canicapilla				1			F
Black-and-white manakin	Lonchura bicolor						1	F
		41	39	34	37	38	80	

* endangered/rare/uncommon species
1 species present
\+ species in the vicinity of the survey site
? identification uncertain

Bird habitat preferences (Hab'):

F- primary closed forest; F'-secondary forest; FC-forest clearing
F/G-forest and its gallery extensions; F/S-forest and savanna;
S-savanna; R-riverine.

Appendix 2c List of bird species seen on Tiwai by other researchers.

Long-tailed shag	Halietor africanus
Great white egret	Egretta alba
Yellow-billed egret	Egretta intermedia
Goliath heron	Ardea goliath
White-faced tree duck	Dendrocygna viduata
Spur-winged goose	Plectropterus gambensis
Hartlaub's duck	Pteronetta hartlaubi
Hooded vulture	Necrosyrtes monachus
Great sparrowhawk	Accipiter melanoleucus
West african goshawk	Accipiter tachiro
Gabar goshawk	Melierax gabar
Long-tailed hawk	Uritriorchis macrourus
Black kite	Milvus migrans
West african cuckoo falcon	Aviceda cuculoides
Double-spurred francolin	Francolinus bicalcaratus
White-spotted pygmy rail	Sarothrura pulchra
Finfoot	Podica senegalensis
Collared pratincole	Glareola nuchalis
African skimmer	Rynchops flavirostris
Gaboon bronze-naped pigeon	Columba malherbii
Levaillant's cuckoo	Clamator cafer
Common cuckoo	Cuculus canorus
Black-throated coucal	Centropus leucogaster
Pel's fishing owl	Scotopelia peli
Blue-breasted kingfisher	Halcyon malimbica
Chocolate-backed kingfisher	Halcyon badia
Yellow-billed barbet	Trachyphonus purpuratus
European swallow	Hirundo rustica
Lesser striped swallow	Cecropis abyssinica
African pied wagtail	Motacilla agiump
Blue cuckoo shrike	Coracina azurea
Green-backed twin-spot	Mandingoa nitidula
Yellow-mantled weaver	Ploceus tricolor
Crested malimbe	Malimbus malimbicus
Red-headed malimbe	Malimbus rubricollis

Sightings reported by G.H.Whitesides, J.F.Oates, G.L.Dasilva.

APPENDIX 3: Rain forest tree planting

The most basic solution to deforestation is to plant trees. Although this was not a major aim of the project, there was scope to direct a small amount of funds towards a pilot project that involved collecting seeds, nursing seedlings and planting them out.

In the course of the botanical surveys, and at other times, Forest Division personnel collected ripe seeds of rain forest trees. These seeds were taken to nurseries in Bo and Kenema where they were stored and some of them were germinated with a view to planting out in the Arboreta in Bo and Kenema. These would provide two genetic stores for future breeding programmes.

The initial success in seed collection and germination led to an expansion of this part of the project. In Kenema, about 500 trees were planted into polythene potting bags for planting in the nursery and distribution to other areas in Eastern Province. In Bo, the Agronomist of the Bo-Pujehun Rural Development project greatly assisted by providing land in their nursery for forest tree seedlings. These seedlings can be distributed with other tree crops in Southern Province.

The trees were chosen largely according to what species were fruiting when collectors were in the forest. However, four basic criteria were used to guide selection. Species had to be useful and/or rare and included high-quality timber species, preferred fuelwoods, medicinal plants and trees that provided dyes. The latter two types of tree have been selectively removed from large areas of forested land.

By the end of the 1985/6 fruiting season, 500 seeds from nine species had been sown in Kenema and 450 seeds from seven species had been collected in Bo:

Kenema:
Khaya anthotheca
Oldfieldia africana
Detarium senegalense
Heritiera utilis
Brachystegia leonensis
Uapaca guineensis
Chrysophyllum sp
Lophira alata
Albizia ferruginea

Bo:
Terminalia ivorense
Terminalia superba
Pycnanthus angolensis
Heritiera utilis
Afzelia africana
Nesogordonia papaverifera
Nauclea diderichii

APPENDIX 4

Faunal Survey of Sierra Leone: Record sheets.

These record sheets are designed for observations of all animals that are seen at a survey site. The survey site can be any size, as long as a species that is seen in one part of it can occur in any other part. If two types of vegetation occur in an area, or if there are different degrees of hunting pressure, a survey area should be sub-divided into different survey sites accordingly. The duration of a survey may vary from a few hours to years.

There are several reasons for using these surveys sheets:

a) The primary aim is to ensure that field observations are recorded in a systematic way to prevent the loss of valuable information which might not be published immediately.

b) The sheets provide a useful framework for training Wildlife Rangers in field survey techniques.

c) Copies can be left with local Governments and Universities, which is much appreciated since reports often take some time to be produced.

d) They provide a database, indicating changes over time, which specialists can consult (e.g. ornithologists collating bird records for books).

Instructions

Information in the first row will document the geographical distribution of a species. Information in the second row should allow assessment of which species can tolerate habitat disturbance or hunting. The remaining rows give biological information.

Surveyor:	Name, institution and/or address
Sheet ref:	State the type of animals to which the records refer (e.g birds, mammals, reptilesetc). Give each sheet a separate number.
Region:	Administrative area (county, district, forest reserve, national park etc) and/or geographical region (e.g estuary, mountain)

Locality:	Name of survey site (e.g. village, river, hill etc). Draw sketch map on back of sheet if necessary.
Long and Lat:	Longitude and Latitude in degrees, minutes and seconds.
Grid number:	Co-ordinates of the 10km metric grid (UTM series).
Map type/number:	Reference number of maps used.
Altitude:	Height above sea level (feet or metres). Note whether terrain is steep, moderately sloping, flat or swampy.
Vegetation:	Name the vegetation present (each vegetation area represents a different survey site). Use botanists' terms if possible (e.g. mangrove, lowland evergreen forest, Imperatta grassland etc) and name the commonest trees. Note the height of the commonest trees.
Disturbance:	State whether human disturbances to the vegetation are: i) **light** (e.g. collection of wild fruits and tubers, rattan palms, local buildling materials etc) with little overall change to the vegetation; ii) **moderate**, with most of the primary vegetation in tact and small areas grazed, cut, burned or planted; iii) **severe**, with most of the area, grazed, burned, felled or planted; iv) **total**, area grazed, cut, burned or planted. Give dates of disturbance and name crops in cultivated areas.
Hunting:	State proximity of villages and access routes used by hunters (e.g. roads, paths, rivers). Note indirect evidence of hunting: skins and skulls in near-by villages, local reports. Note direct evidence: traps, snares, shot-guns, dogs, native weapons or fire-arms.

Date:	day, month and year
Time:	Hour and minutes on 24-hour clock.
Species:	Full generic and specific name. Sub-species if known.
Accuracy:	A - certain; B - fairly certain; C - uncertain of accurate species identification.
Sign:	If animal is not seen, state evidence for species' presence e.g. calls, footprints, hair, feathers
Number:	Record the number of animals seen in social groups and, in brackets, the estimated number,
Age and sex:	Give age or size of animals (e.g. adults, sub-adults, juvenile etc). Male or female.
Notes:	Record items in the diet of animals, behaviour associated with breeding (e.g courtship, nest-building), moulting patterns, use of special habitats (e.g. streams, dead tree stumps), associations of different species with each other. State whether diagrams, tape-recordings or photographs were made, or skins, nests, eggs etc were collected. Note where these things can be found.

FIELD OBSERVATIONS Name and address .. .. Sheet ref .....

.....

COUNTRY	REGION	LOCALITY	LONG	LAT	GRID NO.	MAP REF.

ALTITUDE	VEGETATION	DISTURBANCE	HUNTING

Reference used in identification of species (book) .....

DATE	TIME	SPECIES	ACC	SIGN	NO.	AGE/SEX	NOTES

BIBLIOGRAPHY

Ajayi S.S. and Tewe O.O. 1980. Food preference and carcass composition of the grass cutter (Thyronomys swinderianus) in captivity. **Afr.J.Ecol.** 18:133-140

Anon 1981. Techniques for the study of primate ecology. National Academy of Sciences, Washington D.C., U.S.A.

Asibey E.O.A. 1974. Wildlife as a source of protein in Africa south of the Sahara. **Biol. Cons.** 6(1):32-39

Ashton P.S. 1976. Factors affecting the development and conservation of tree genetic resources in South-east Asia. In "Tropical trees: variation, breeding and conservation" (eds J. Burley and B.T. Styles).

Atlanta 1978. Feasibility study on forest development, Sierra Leone (Vol 1)

Bernard-Reversat F., Huttel C. and Lemee G. 1978. Structure and function of evergreen ecosystems of the Ivory Coast. pp 557-574 in "Tropical forest ecosystems" Unesco/UNDP, Paris.

Booth A.H. 1977. Small mammals of West Africa. Longman, London

Burnham K.P., Anderson D.R. and Laake J.L. 1980. Estimation of density from line transect sampling of biological populations. **Wildlife Monograph** 72 pp202.

Clarke J.I. 1969. Sierra Leone in maps. Hodder and Stoughton Ltd, London

Cole N.H.A. 1980. The Gola Forest in Sierra Leone: a remnant tropical primary forest in need of conservation. **Enviro. Cons.** 7(1):33-40

Collar N.J. and Stuart S.N. 1985. Threatened birds of Africa and related islands. ICBP/IUCN Red Data Book, Part 1 (Third edition).

Davies A.G. and Payne J.P. 1982. A Faunal Survey of Sabah. World Wildlife Fund Malaysia, Kuala Lumpur.

Davies A.G. and Oates J.F. 1985. Ecological approaches to integrated rural development. Abstract of a paper presented at Man and Biosphere Seminar, Bunumbu, Sierra Leone.

Diamond A.W. and Hamilton A.C. 1980. The distribution of forest passerine birds and Quaternary climatic change in Africa. **J.Zool.Lond.** 191:379-402

Douglas-Hamilton I. 1987. African elephants: population trends and their causes. **Oryx** 21:11-24

Field G.D. 1971. Birds of the Freetown Peninsula. Fourah Bay Press, Freetown

Field G.D. 1979. A new species of Malimbus sighted in Sierra Leone and a review of the genus. **Malimbus** 1:2-13

Franklin I.R. 1980. Evolutionary change in small populations. In "Conservation Biology" pp 135-149. (eds M.E. Soule and B.A. Wilcox) Sinauer Associates Inc. Mass, USA

Fox J.E.D. 1968. Exploitation of the Gola Forest. **J.West African Sci.Assoc.** 13:185-210

Galat-Luong A. 1983. Socio-ecologie de trois colobes sympatriques: Colobus badius, C.polykomos et C.verus du Parc National de Tai. Thesis Docteur de l'Universite Pierre et Marie Curie. ORSTOM, Paris.

Gordon O.L.A., Kater G. and Schwaar D.C. 1979. Vegetation and land use in Sierra Leone. UNDP/FAO Technical Report no. 2 AG:DP/SIL/73/002

Haltenorth T. and Diller H. 1980. A field guide to the mammals of Africa. Collins, London.

Harding R.S.O. 1983. Large mammals of the Kilimi Area, Sierra Leone. Special report to MAF pp28.

Johns A.D. 1985. Selective logging and wildlife conservation in tropical rain forest: problems and recommendations. **Biol. Cons.** 31:355-375

Jones T.S. 1951. Notes on the monkeys of Sierra Leone. Agriculture notes no. 22, Govt Printers, Freetown.

Jones T.S. 1960. Notes on the commoner Sierra Leone mammals. **Nigerian Field** 31(1):4-17

Jones T.S. and Cave A.J.E. 1969. Diet, longevity and dental disease in the Sierra Leone chimpanzee. **Proc.Zool.Soc.Lond.** 135:147-155

Kernan H.S. 1980. Assistance in Forestry Development, Sierra Leone. FAO TCP/SIL/8907(1)

Kuhn H-J. 1965. A provisional list of mammals of Liberia. Senikenberg. Biol. 46(5):321-340.

Kuhn H-J. 1966. Der Zebraducker, Cephalophus doria (Ogilby,1837). **Z.Saugetierkunde** 31(4):282-293

Lawton R.M. 1978. The management and regeneration of some Nigerian high forest ecosystems. pp580-588. In "Tropical Forest Ecosystems" Unesco-UNEP, Paris.

Lowes R.H.G. 1970. Destruction in Sierra Leone. **Oryx** 10:309-310

Martin C. and Asibey E.O.A 1979. Effect of timber exploitation on primate populations and distribution in the Bia forest area of Ghana. Paper presented at VIIth I.P.S. Congress, Bangalore, India.

Merz G. 1982. Untersuchungen uber Lebensraum und Verhalten des Afrikanischen waldefanten im Tai-Nationalpark der Republik Elenbeinkuste unter

dem Einfluss der regionalen Entwicklung. Dissertation an der Ruprecht-Kerls-Univetsitat Heidelberg.

Merz G. 1986. The status of the Forest Elephant Loxodonta a cyclotis (Matschie,1900), in the Gola Forest Reserves, Sierra Leone. **Biol Cons** 36:83-94

Oates J.F. 1980. Report on the survey of Colobus verus and other forest primates in southern Sierra Leone with comments on conservation problems. pp25 Unpub report.

Oates J.F. 1984. The niche of the Potto (Perodicticus potto) **Int.J.Primatol.**

Oates J.F. and Davies A.G. 1985. Primate Conservation in West Africa. In "Current issues in Primate Conservation (eds M.F. Stevenson, D.J. Chivers and C. Ingram) Primate Society of Great Britain.

Pearce D. 1987. Economic values and the natural environment. Denham Lecture, Department of Land Economics, University of Cambridge.

Phillipson J.A. 1978. Wildlife conservation and management in Sierra Leone. pp188. Special report to MANRF, Freetown.

Ralls K. and Ballou J. 1986. Captive breeding programmes for populations with a small number of founders **Trends in Evolution and Ecology** 1:19-22.

Richards P.W. 1972. The tropical rain forest: an ecological study. Cambridge University Press, U.K. (4th edition)

Richards P. 1985. The Indigenous Agricultural Revolution. Hutchinson, London.

Robinson P.T. 1971. Wildlife trends in Liberia and Sierra Leone. **Oryx** 11:117-122

Roth H.H. and Merz G. 1983. Conservation of elephants in Sierra Leone, with special reference to the management of the Gola Forest complex. pp24. Final report to IUCN (Project 3039).

Savill P.S. and Fox J.E.D. 1967. Trees of Sierra Leone. pp316. Govt Printers, Freetown.

Serle W., Morel G.J. and Hartwig W. 1977. A field guide to the Birds of West Africa. Collins, London.

Skorupa J.B. 1986 Responses of rainforest primates to selective logging in Kibale Forest, Uganda: A summary report. pp57-70 In Primates: the road to self-sustaining populations (ed K. Benirschke). Springer-Verlag, New York.

Small D. 1953. Some ecological and vegetation studies in the Gola Forest Reserves, Sierra Leone. Unpub MSC thesis, Queen's University, Belfast.

Soule M.E. 1980. Thresholds for survival: maintaining fitness and evolutionary potential. pp151-169. In "Conservation Biology" (eds M.E. Soule and B.A. Wilcox) Sinauer Associates Inc., Mass. USA

Southwood T.R.E., May R.M., Hassel M.P. and Conway G.K. 1974. Ecological strategies and population parameters. **Am.Nat.** 108:791-804

Thiollay J.M. 1985. The West African forest avifauna: a review. pp171-186 In "Conservation of Tropical Forest Birds" (eds A.W. Diamond and T.E. Lovejoy) ICBP Tech Pub no. 4, Cambridge, UK

Teleki G. 1980. Hunting and trapping wildlife in Sierra Leone: aspects of exploitation and exportation. pp84. Special report to MANRF, Freetown.

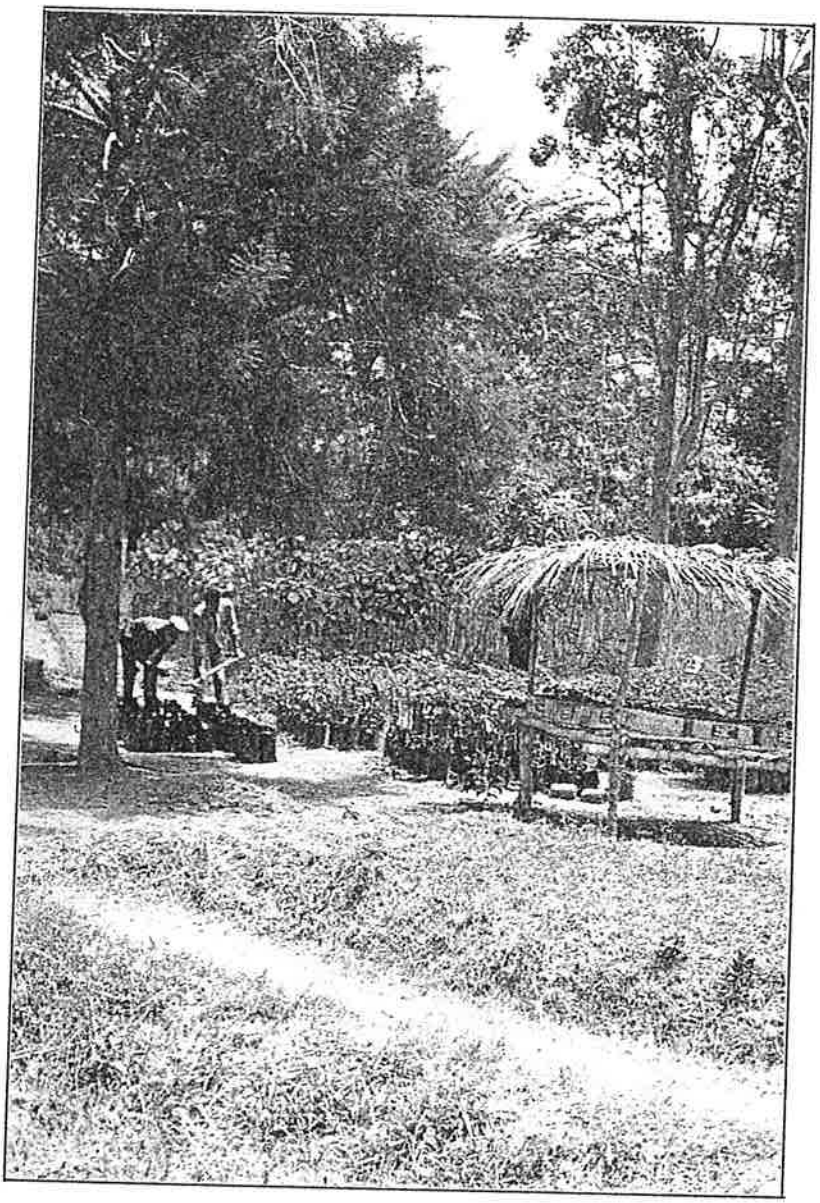
Tutin C.E. and Fernandez M. 1983. Recensement de Gorilles et des chimpanzes du Gabon. CIRMF, BP 769, Franceville, Gabon.

White J.A. 1972. Forest inventory of the Gola Forest Reserves. pp50 FAO TA 3155

Whitesides G. 1985. Nut-cracking by wild chimpanzees in Sierra Leone, W.Africa. **Primates** 26(1):91-94

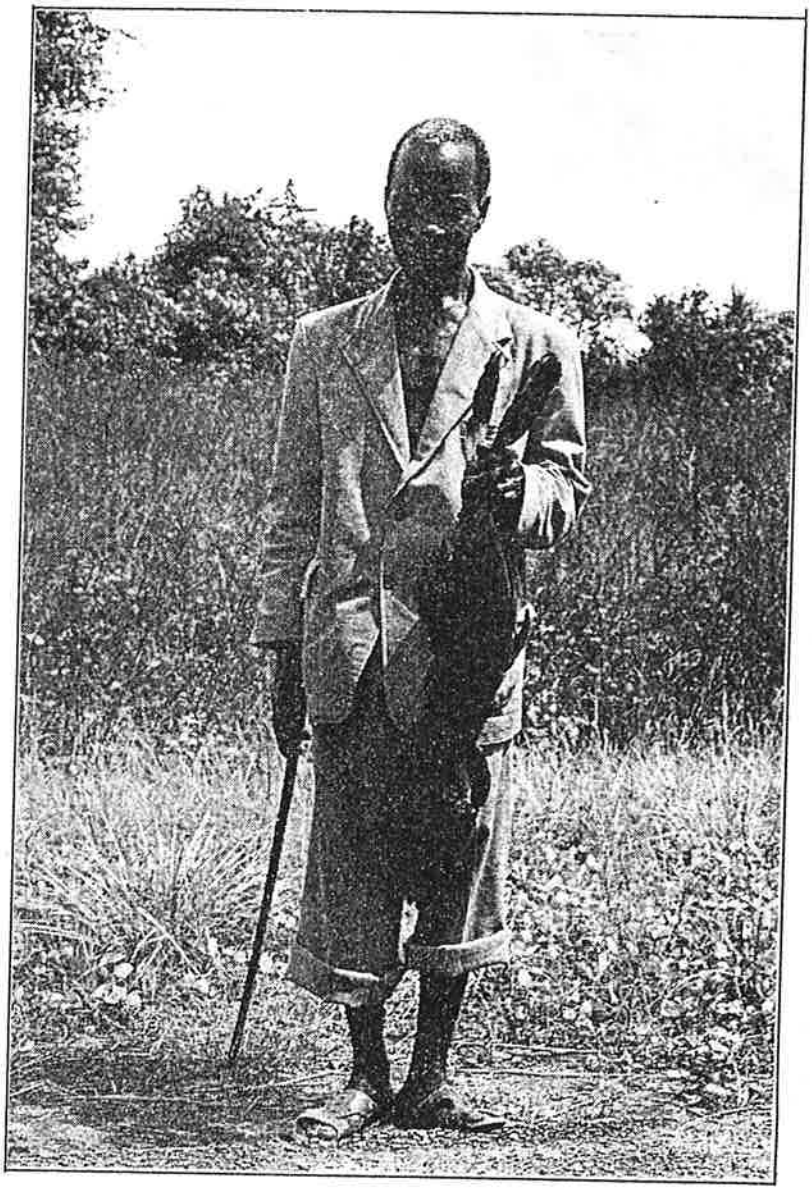
Wilkinson A.F. 1974. Areas to preserve in Sierra Leone **Oryx** 12(4):596-597

Trays in which rainforest seeds are being germinated.



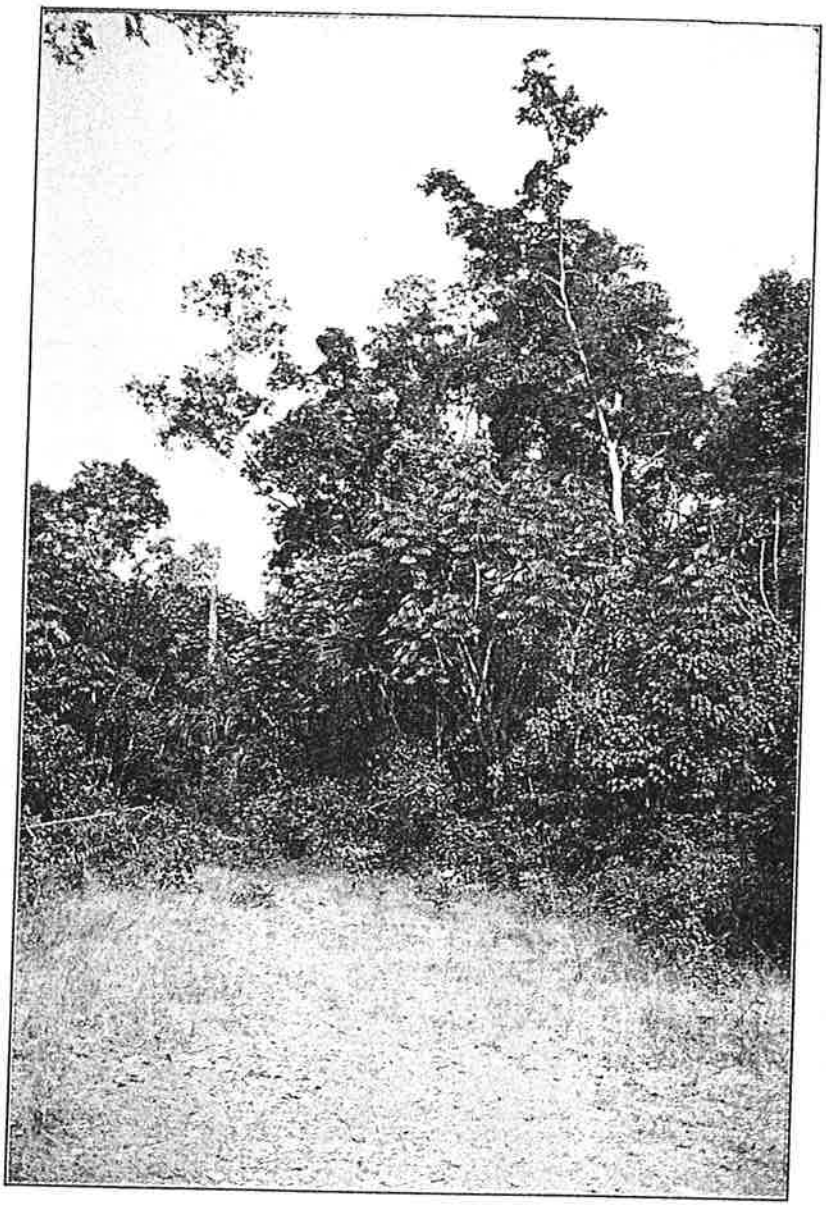
Transplanting seedlings into potting bags for subsequent replanting.

Red river hog trapped by farmers.

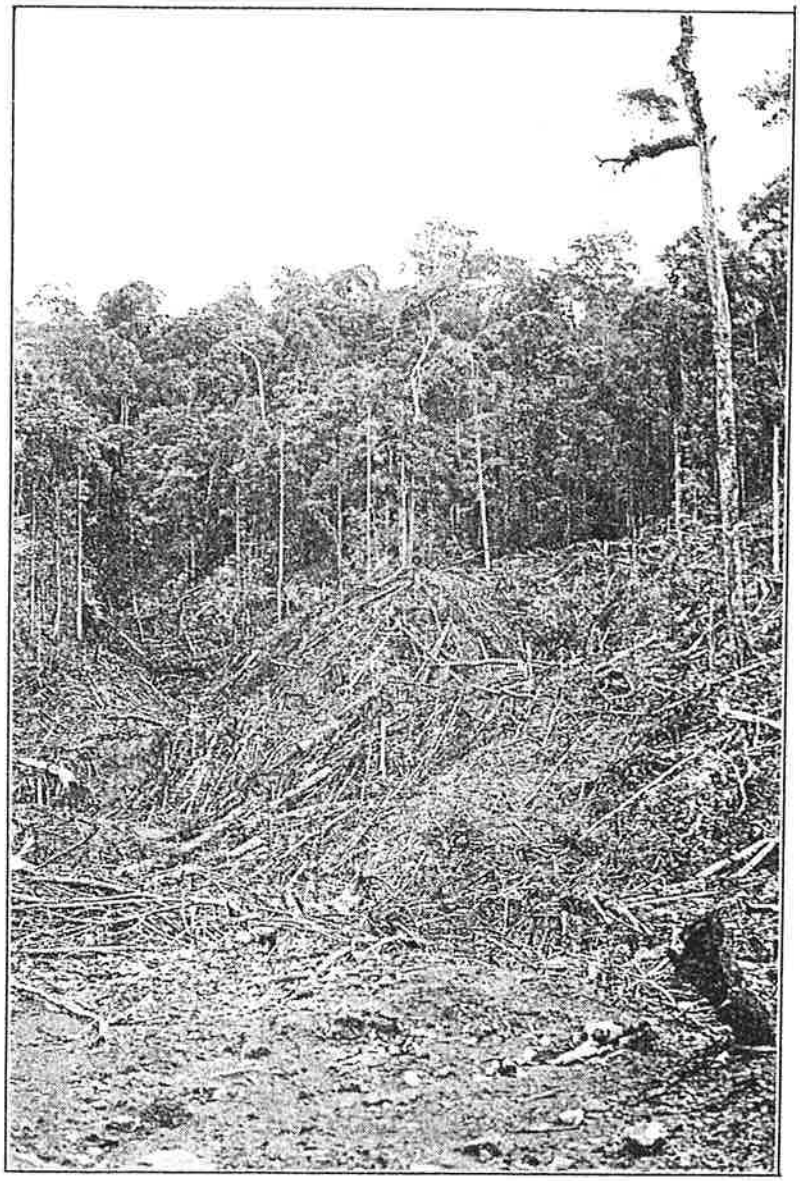


Giant plantain-eater for sale on the roadside.

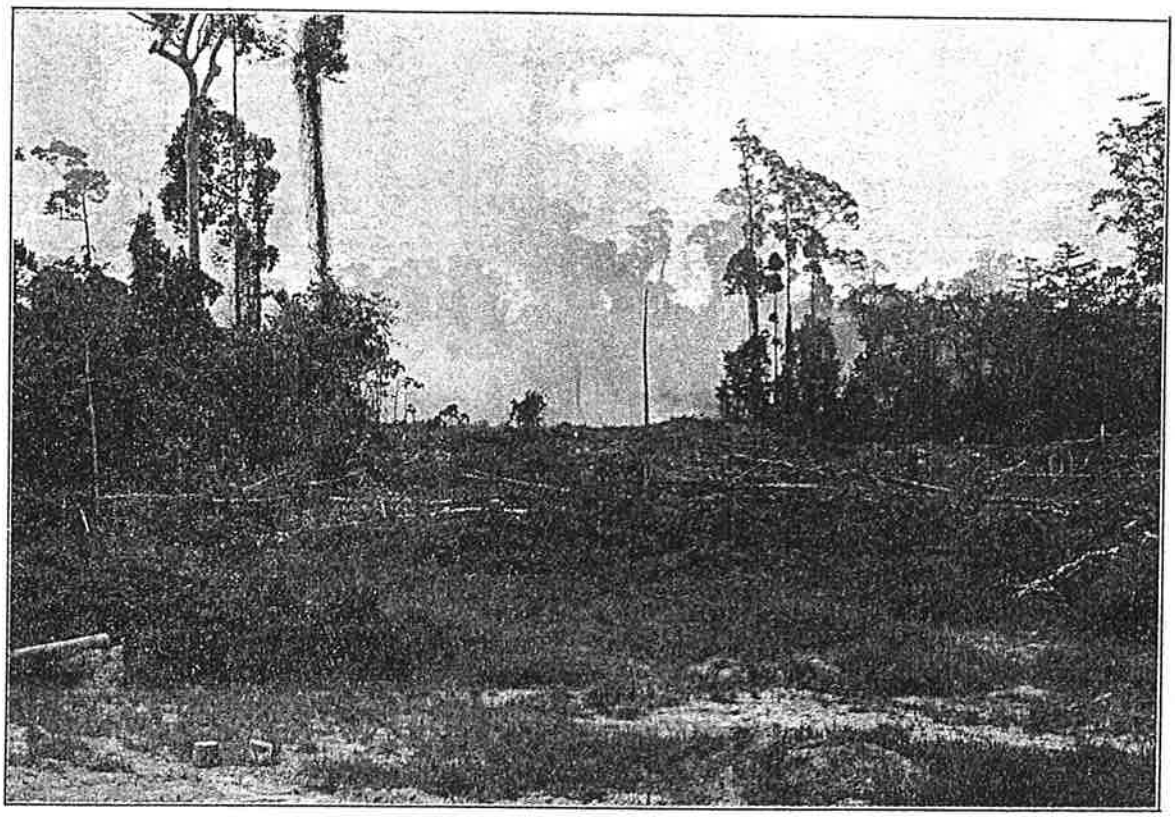
Closed-canopy evergreen rainforest.



Logged rainforest with small colonising trees, many lianas, and compacted soil on the logging road in the foreground.



Clear-felling of all trees in the dry season.



Burning of vegetation prior to planting.