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KENYA: TANA RIVER GAME RESERVE

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ACKNOWLEDGEMENTS

A number of people helped greatly in the preparation of this report. Katherine Homewood provided the information on Mangabeys as well as much early discussion on the problems of conservation in the area. Jim Allaway planned and analysed the aerial census data and wrote the sections on the aerial survey and on elephants. He and Susan Singer were also a constant source of assitance and encouragement while writing. Messrs. David Parker and Steve Nicholls amassed an impressive checklist of birds for the appendices. Mr. Samuel Kibua of the East African Herbarium provided most of the plant identifications and Dr. W.G. Sombrock of the Soil Survey Unit patiently elucidated the features of flood plain geomorphology for me. Mr. Jumar Galana has been my frequent guide, companion and instructor on all matters of local information and customs. I wish to acknowledge and thank all these people.

Drs. E. Trump and T. Struhsaker kindly commented on the draft manuscript. My study of the Tana Red Colobus and its habitat was Tom Struhsaker's conception and through his support it has obtained three years of generous financial backing from the Conservation Committee of the New York Zoological Society. I am extremely grateful to this organisation and its director, Mr. W. Conway. My local sponsor has been the National Museums of Kenya and I am grateful to Mr. R. Leakey for his early support and recognition of the importance of the lower Tana. The African Wildlife Leadership Foundation kindly payed for the publication of this report.

This is also an opportunity to acknowledge some of the civil servants and others who have done the work of establishing the Tana River Game Reserve in its early stages.

The Game Department and Mr. J. Mutinda, the Chief Game Warden, have been responsible for the initiative in this area and other parts of Eastern Kenya where an imaginative series of new Game Reserves is being created. The early appointment of the first warden, Mr. J. Mkunga, is evidence of the high priority attached to the Tana River Game Reserve. However, it would never have reached even its present embryonic state without the tireless efforts on all its aspects of Mr. K. Smith, Senior Game Warden (Development). Mr. J. Barrah has always dealt with the inevitable beaurocratic hurdles in Nairobi. Mr. S. Kiambi, the Game Warden (Hola) has tactfully handled many local political and administrative problems concerning the reserve, and provided much other support. The reserve has also benefited from the cordial and enlightened support of two successive District Commissioners, Mr. E.K. Kinguru and Mr. D.A. Musilla. The chiefs of Gwano

and Ndera locations, Mr. J. Heribai and Mr. H.M. Mujhinda, respectively have patiently explained the Government's position to all concerned. The Tana River District Council was responsible for the original request to the Government for gazattement of the reserve and the Clerk to the Council, Mr. J.M. Nderi, has handled the leasing of a campsite for tourist development within the reserve.

The reserve owes a special debt to the Primate Specialists Group of I.U.C.N. and the World Wildlife Fund for backing the reserve both politically through the prestige of their support, and financially with a land-rover and a grant of $ 5000 to enable some initial development to be carried out in 1975.

Last, but not least, the future of the reserve ultimately depends on the residents of Gwano and Ndera locations. For the most part, though naturally with some reservations, they have accpeted the idea of the reserve. It is greatly to be hoped that this trust is continued and eventually justified.

While this report has the general support of the Game Department it is not an official document and responsibility for the recommendations and opinions expressed rests with the author.

CHAPTER 1. INTRODUCTION

1 - 1. Scope and objectives of the report

The management of a Game Reserve, as compared to a National Park, is made especially difficult by the legal requirement of a Game Reserve to take account of human interests in the area. Under these circumstances it is essential that decisions within the Reserve are made in the context of human land-use problems in the broader area outside its boundaries. An ecological perspective is thus required which encompasses the physical structure of the environment, its vegetation, fauna, human land-use, and the dynamic interactions of all these. This report is an attempt to provide such a synthesis for the Tana River Game Reserve in a form suitable for non-scientist administrators of the Reserve. Its specific objectives are:-

1. To describe the ecology of the Reserve and its surroundings. This is divided into the environmental background, the vegetation and the fauna - chapters 2,3 and 4, respectively. While for the most part these chapters are purely descriptive some practical implications of the information are mentioned in passing.
2. To assess current land-use and its impact on the vegetation and fauna of the area. This is treated in chapter 5. from the standpoint of anticipated management problems.
3. On the basis of the above to make proposals for development in the Reserve and, where relevant, in the surrounding area (chapter 6.).

The methods used to provide the information are not described in detail except for topics which should be monitored as part of the routine management of the Reserve. References, however, are made to relevant published work and some of the topics covered will be elaborated in greater detail in theses in preparation by the author and others (see section 6 - 5).

1 - 2. Rationale for the Reserve.

The Tana River Game Reserve occupies 171 km.^{2} astride the lower Tana river in Eastern Kenya at approximately 1°55' South and 40°5' East (see map 1.). The primary purpose of the Reserve is to conserve the best remaining patches of riverine forest on the lower Tana. These are the only true representatives of this habitat type in East Africa and have been

recommended for inclusion in U.N.E.S.C.O.'s Man and the Biosphere Programme for the Conservation of representative and unique ecosystems.

The forests are also the home of a number of rare animals, including the Tana river varieties of Red Colobus, Colobus badius rufomitratus, and Crested Mangabey, Cercocebus galeritus galeritus. These varieties are listed in the I.U.C.N. Red Data Sheets (Simon 1966)as "rare" and "critically endangered", respectively. The total geographical range of these animals on the Tana is about 70 km. between the villages of Wenje and Garsen. An attempt to effectively conserve the whole of their remaining range was felt to be impractical. Hence efforts have been concentrated on a small area of the best remaining forests subject to least pressure from human land-use. The Reserve is estimated to contain about 55% of the remaining populations of both the Red Colobus and Mangabey monkeys.

Only 39% of the Reserve lies within the river flood plain, the remainder being dry plains country. The ecology of this region differs from that of the flood plain in nearly every respect making for a fundamental division of habitats, tourist attractions and management problems. During the dry seasons high densities of many ungulates, and most notably Elephants and cattle are found in the flood plain and adjacent dry plains area within reach of the river. The conservation of a sample of this habitat and its indigenous fauna was a secondary reason for the establishment of the Reserve.

1 - 3. Legal status and boundaries

The Tana River Game Reserve was gazetted in January, 1976 as a County Council Game Reserve administered on behalf of the County Council by the Game Department of the Ministry of Tourism and Wildlife under the Wild Animals Protection Act (1962), Section 3(2). Previously the land had been partly County Council Trust Land and largely State Land. The first warden Mr. J. Mkunga, was posted to the Reserve in November, 1975.

The Reserve lies within the administrative locations of Gwano and Ndera in the Tana River District of Coast Province. It straddles the river so that 49% of its area is on the West (Right) bank and the remainder on the East (Left) bank (See Map 2.). The best available survey of Kenya map of the area is Sheet 178 (Mnazini) in series Y733 at a scale of 1:100 000. However many villages are misplaced or misnamed on this sheet including the boundary village of Makere which should be where Maroni is placed.

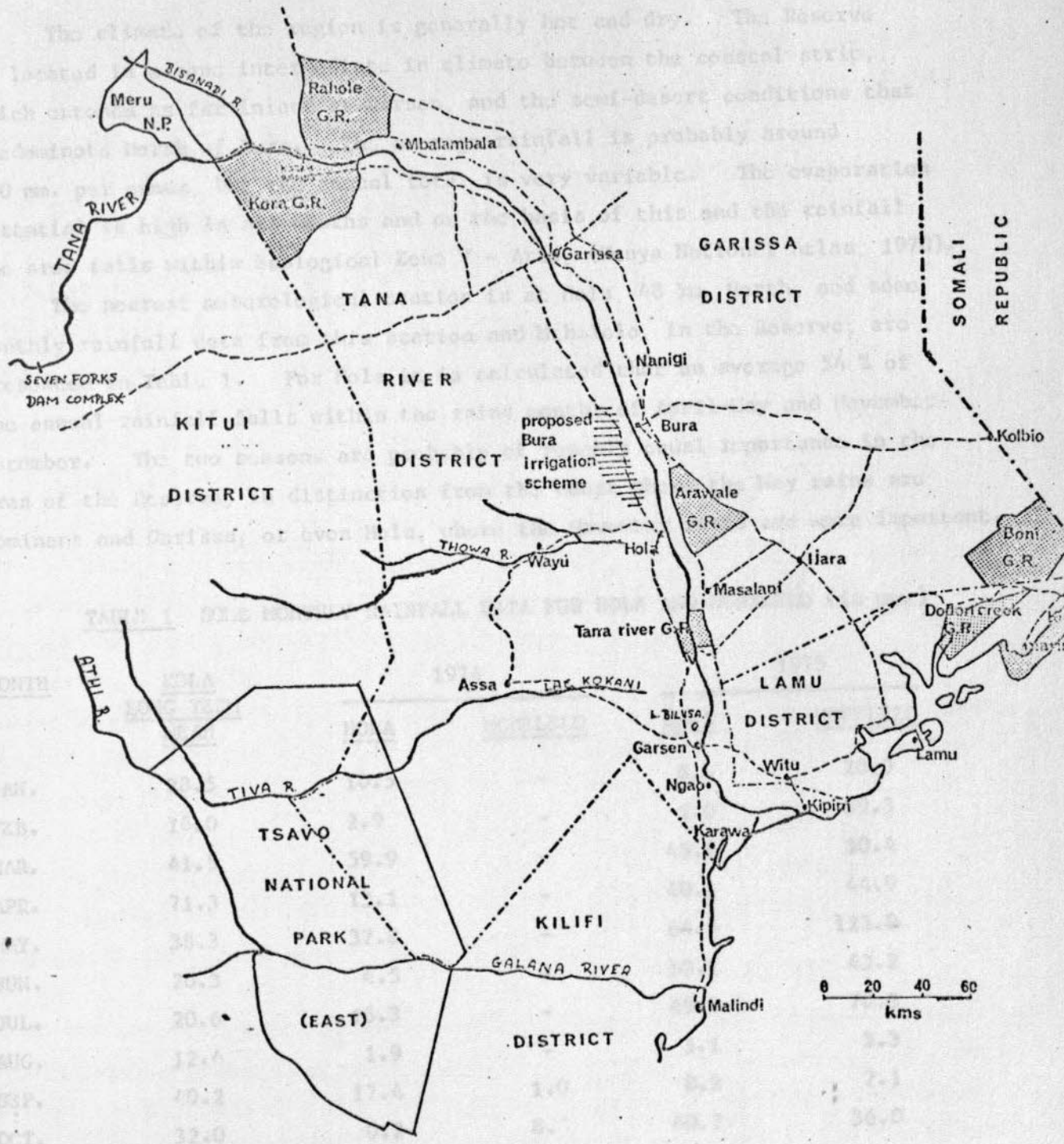
The western boundary of the Reserve is the present line of the Garsen - Hola road and the eastern boundary is the undemarcated boundary between Tana

River District of Coast Province and Garissa District of North-Eastern Province. This follows a sinuous line roughly 5 km. (3 miles) from the main axis of the river's course i.e. its imaginary course without meander loops. The northern boundary on the East bank is the undemarcated boundary between Gwano and Kinakomba locations, 1 km. North of the village of Wenje. The northern boundary then follows the present course of the river downstream as far as a point 100 m. South of the village of Makere ya Gwano. From here it runs due West until it strikes the main road at a point 6.6 km. south of the Wenje turning and 11.7 km. South of Trig. point S.K.T. 18.

The southern boundary on the West bank is difficult to describe accurately. It follows that of the Ida-Sa-Godana co-operative ranch from a point on the main road 1.4 km. North of S.K.T.19 to a point on the track to Mnazini about 4 km. from the main road. In between, the boundary runs on a bearing of 70° for 1.8 km. and then turns to bearing 150° for 6.6 km. until it strikes the Mnazini track as described. It follows this track East for 1 km. and then turns due North to the apex of a prominent bend in the river immediately adjacent to a substantial patch of forest (the Mnazini South block). On the East bank the southern boundary is an East-West line on latitude co-ordinate 87.2 on Survey of Kenya map series Y'33, sheet 1'8 (Mnazini). This line is about 3 km. North of the village of Kitere and touches the southern edge of a prominent seasonal lake, called Lemu.

While the general location of the Reserve was proposed on biological grounds, the boundaries were variously determined by other existing, gazetted boundaries, political feasibility and administrative convenience. They are thus arbitrary from a biological standpoint and some implications of this are discussed in Sections 4 - ' and 5 - 2(b).

MAP 1. THE LOWER TANA REGION IN EASTERN KENYA



CHAPTER 2. ENVIRONMENTAL BACKGROUND

2 - 1. Climate

The climate of the region is generally hot and dry. The Reserve is located in a zone intermediate in climate between the coastal strip, which extends as far inland as Garsen, and the semi-desert conditions that predominate North of Bura. The average rainfall is probably around 550 mm. per annum, but the annual total is very variable. The evaporation potential is high in all months and on the basis of this and the rainfall the area falls within Ecological Zone V - Arid, (Kenya National Atlas, 1970).

The nearest meterological station is at Hola, 48 km. North, and some monthly rainfall data from this station and Mchelelo, in the Reserve, are presented in Table 1. For Hola it is calculated that on average 54 % of the annual rainfall falls within the rainy months of April-May and November-December. The two seasons are probably of roughly equal importance in the area of the Reserve, in distinction from the coast where the May rains are dominant and Garissa, or even Hola, where the November rains are more important.

TABLE 1 SOME MONTHLY RAINFALL DATA FOR HOLA AND MCHELELO (in mm.)

MONTH	HOLA LONG TERM MEAN	1974		1975	
		HOLA	MCHELELO	HOLA	MCHELELO
JAN.	28.5	10.5	-	8.4	28.0
FEB.	16.0	2.9	-	2.0	39.3
MAR.	41.5	59.9	-	45.2	30.4
APR.	71.3	13.1	-	40.1	44.9
MAY.	38.3	37.8	-	64.5	125.9
JUN.	26.3	4.5	-	50.1	43.2
JUL.	20.6	15.3	-	49.0	78.3
AUG.	12.4	1.9	-	3.1	3.3
SEP.	40.2	17.4	1.0	8.2	7.1
OCT.	32.0	0.2	8.[illegible]	40.2	36.0
NOV.	90.3	49.0	145.4	82.5	52.4
DEC.	55.2	28.2	44.3	38.6	9.5
TOTALS	472.6	240.7	-	431.9	498.3

The hottest months are during the North-East monsoon when average daily maximum temperatures between January and March are about 35°C. (95°F.) During the South-East monsoon the weather is distinctly cooler and often cloudy during the period May-August. Wind speeds are also higher and the visitor is not likely to find the heat oppressive even in the middle of the day. The wind direction at this time is in fact usually from the South or S.S.E. and during the N.E. monsson it rarely veres North of East. South-East is thus probably the best local alignment for airstrips.

2 - 2. Drainage, Geology and Soils

The area of the Reserve is part of a vast, sedimentary plain which stretches as far West as the hills of Ukambani in Kitui district (See Map 1.). This plain is virtually featureless and slopes very gently Eastwards towards the Tana. In the vicinity of the Reserve it reaches the river at an altitude of 25 - 40 m. (80 - 125 ft.) above sea level.

A number of river courses drain across from the Kitui hills, but none has a permanent surface water flow. The largest of these is the Thoa or Galole river, which flows via Waldena and Wayu to join the Tana at Hola. Its course is quite impressive at Wayu, where it supports a gallery forest of Acacia elatior but peters out to flood plain grassland before reaching Hola. The Tiva is the nearest such river to the Reserve and it behaves in a similar manner to the Thoa. It is an important element in the ecology of the northern part of Tsavo East National Park, but only rarely carries water as far as the Tana, where it is known as Lac Kokani. It enters the Tana flood plain near Mwina and is crossed by a bridge 13 kms. South of the Mnazini turning.

On the East bank of the river, except for a few kilometres from the river, drainage is away from the river in a South-East direction towards the many creeks that enter the sea in the Lamu archaepelago.

The only true rock outcrops in the region are the Walu limestone ridges running roughly parallel with the river 20 km. East of it between Masalani and Mnazini and elevated 15 - 30 m. (50 - 100 ft.) above the surrounding plains. The nearest of these is only 4 km. from the Reserve and about 11 km. due East of Kitere. This limestone is of lower Miocene age (approximately 20 M.yrs. old) and represents a ridge above a rocky plain which underlies the whole region at great depth - the end-tertiary peneplain (Saggerson and Baker, 1963; Matheson, 1969). Geologically younger outcrops of the soft stone Gypsum occur in various places, the nearest to the Reserve being opposite Masalani on the West bank. This particular deposit has been quarried for road construction

but the murram is of very poor quality. The nearest good quality murram source on the West bank is the coral limestone between Ngao and Karava.

Apart from these outcrops and the flood plain, the plains consist of unconsolidated sediments mostly laid down in a shallow sea which covered the region in Pliocene times (13 - 3 M.yrs. ago). Sombroek et al (in press) have divided these into three major zones each of which was eroded or redeposited in a different way after the retreat of the Pliocene sea: a higher level "red sand plain", typical of parts of Tsavo and eastern Kitui, an intermediate level "white-dot plain" and a lower level "grey clay plain". The "white-dot" plain consists of coarse white sands and begins some 40 km. West of the Reserve. Within that distance the soils on both sides of the river are crudely classified as part of the "grey clay plain". These are brown or grey in colour and both saline and alkaline chemically, particularly below 50 cm. They are poorly drained and prone to cracking when dry. They might commonly be called "black-cotton" soils, although this term is more properly applied to a fine and powdery dark grey clay, which is most common on the East side of the river. While such soils are indeed widespread away from the flood plain and particularly in slightly depressed areas, the situation is complicated within the Reserve by extensive areas of compacted yellow-brown sandy soils. These are found on the sloping terrace edge adjacent to the flood plain and along much of the main road between Mnazini and Nchelelo. It would appear that these may represent the filled in surface of an earlier and wider flood plain and are thus not of marine origin (ILACO, 1975). These soil differences are important determinants of the dry plains vegetation and this is described in Section 3 - 3. They are also important factors in the alignment of roads-sandy soils are much less treacherous in wet weather than clay types.

2 - 3. The Tana river

Before describing the local features of the river and its flood plain in the Reserve it seems appropriate to give a brief account of the river as a whole.

The Tana is Kenya's longest and largest river. It has a length of some 650 km. (390 miles) following the main outline of its course and 1,012 km. following every bend. The total catchment area is 96,700 km^2 but the vast bulk of its input comes from the South and East slopes of the Aberdares, Mt. Kenya and the Nyambeni hills. The silt load in the main river and in many of the tributaries is very high and has increased in recent years due to forest destruction and bad agricultural practise in the mountain valleys.

At the Seven Forks hydro-electric dam complex at Kamburu an estimated 51% of the maximum flow has entered the river (Acres/Ilaco, 19'5). From this point to the Koreh rapids is usually considered the middle reach of the river. In this section it flows as a wide, shallow river dropping through several rapids as it cuts through the hard rocks of the Basement Complex. The last permanent tributary is the Rojewero, in Meru National Park. In addition to the National Park, the Tana in this region also borders two game reserves, Kora Game Reserve in the North-West corner of Tana River District and Rahole in Garissa District. Below Koreh rapids the river opens into the Hameye swamp above Mbalambala and begins to turn southwards. This is also the start of its meandering lower course to the coast through a very flat and mature valley. It passes the towns of Garissa, Bura and Hola before reaching the Reserve 55 km. North of Garsen. Bura is the site of a proposed major irrigation scheme on the West bank (See Section 5 - 2(c)). Below Garsen the flood plain begins to open into a wide grassy delta characterized by traces of many old courses. One of these can be traced upstream as far back as Mnazini, running parallel with the present course and about 4 km. West of it. This holds near-permanent water in its lower section, known as Lake Giritu and opens onto a wide, shallow swamp - Lake Bilisa.

Until comparatively recently the mouth of the river was at Mto Tana in the middle of the delta. However, in the 18'0's a narrow channel, the Belazoni canal, had been dug between the Tana and the Ozi creek by the Sultan of Witu. This was widened between 1895 and 1899 as a famine relief project by the new colonial administration and a large flood in 1899 adopted it as the main course (Rowlands, 1955). Since then the river has continued to disgorge at Kipini and the Mto Tana exit has progressively silted up. The remains of a still older mouth can be seen at Mto Kilifi, nearer Karava (Williams, 19'2).

Below its last permanent tributary in Meru National Park the river loses water by evapotranspiration and seepage in the arid climate of the lower course. It has been estimated that these losses between Koreh and Nanigi alone may amount to 22.5 $m.^3$ per sec. or 28% of the mean annual minimum flow at Garissa (Acres/ILACO, 19'5). Garissa is the only long established guaging station and has records going back to 193'. The mean dry season flow in March at this point is 80 $m.^3$ per sec., with 30 $m.^3$ per sec. occuring as a once in ten year event on average. The flow, however, is highly seasonal depending on the rains in the upper catchment. The mean May flow is usually about five times that in March.

In April 1974 most farm land flooded, though not all the farmland in the vicinity of the Reserve. We may consider this near the critical level for flooding. This event corresponded to a maximum daily flow at Garissa of

471 $m.^3$ per sec. By comparing this figure with earlier flow data it appears that such an event has been equalled or exceededonce every 1.9 rainy seasons, which is almost once a year on average. 64% of these floods have occured in the April-May rains and the remainder in the second rains. The flood of November 1972 covered all the brown clay parts of the flood plain and may be considered a large flood. Such a flood or greater has occured 14 times in 41 years or an average of once in 2.9 years.

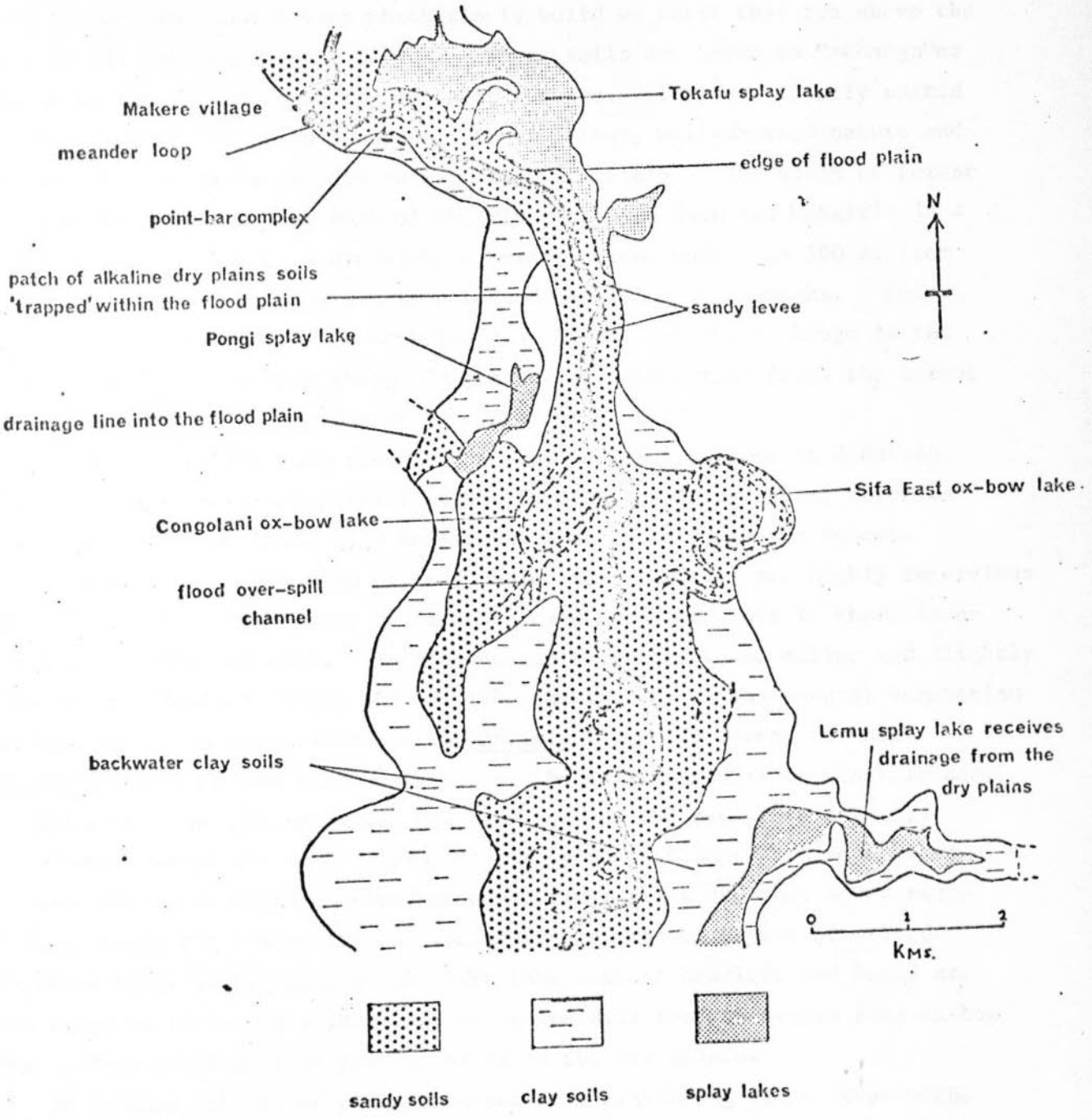
Finally, some mention must be made of the great flood of 1961-1962, which began in October 1961 and stayed up until January, 1962. The maximum flow at Garissa was measured at 2,418 $m.^3$ per sec. which is nearly three times the mean maximum flow recorded each year between 1944 and 1972. Such a flood has been esimated to be a one in 80 year event (ILACO, 1975). Downstream it washed away several villages, destroyed all crops, caused numerous changes in the river course and broke a section of the sand-dunes near Lke Tana which separate the delta from the sea. Its impact is still visible on several aspects of the flood plain vegetation. The size and frequency of flooding is thus of great importance to all aspects of the flood plain environment. A practical consideration is that during times of flood transport in the flood plain is limited to canoe and foot. Mosquitoes are also rife.

2 - 4. Structure and dynamics of the flood plain

Meandering rivers and their flood plains follow a pattern which is basically similar all over the world and some knowledge of this is essential to an understanding of the Tana River Game Reserve.

The edge of the flood plain is usually about 3 - 5 m. below the adjacent dry plains terraceland and is thus clearly visible both on the ground and on aerial photographs. Map 3. is drawn from a photograph of the flood plain between Makere ya Gwano and Baomo and will serve to illustrate the main features. Makere village is situated on the apex of a river loop or meander. While the ultimate cause of meanders is not clear the way they develop is by undercutting of the bank on the outward, convex side of a bend where the water is flowing fastest. This happens mainly when the river is high and has both a fast flow and a heavy load of silt with which to erode the banks. As material on the outside bank is removed other silt is deposited on the inside of the bend where water is shallow and slow-moving. This is often deposited in irregular bands corresponding to particular flood levels, in which case the area of deposition is known as a point-bar complex. This may be seen at Guru where the original river course is now some 300 m. back from the apex of the present bend. Eventually loops are cut off at their necks leaving ox-bow lakes, whose ends quickly become silted up (e.g. Congolani

MAP 3. STRUCTURE OF THE FLOOD PLAIN BETWEEN MAKERE AND BAOMO



ox-bow which was cut off in the 1961 floods). However, ox-bows refill during times of flood and are extensively used by the Pokomo for fishing and for farming.

When the river floods it deposits its silt load differentially across its flood plain. Away from the river banks there is a rapid decrease in the flow and most of the sediment is deposited within 200 m. of the bank. This is particularly true of the courser sediment particles of sand and silt. These areas form sandy levees which slowly build up until they are above the level of all but exceptional floods. Their soils are known as "mchanga"or "biali" to the Pokomo depending on their texture. They are ideally suited to the growth of forest on account of their porous, well-drained nature and proximity to the river and its surrounding watertable. The strip of forest on sandy soils on the West bank of the river between Guru and Mchelelo is a typical example. In most areas where forests occur more than 500 m. from the river, old ox-bow lakes can be detected on aerial photographs. (e.g. the big forest at Sifa on the East bank). Often, though, a change in the river course leads to some change in the forest composition (e.g. the recent decline of the Pachystella forest in Congolani West).

Further away from the river banks less sediment is deposited during floods and it is of finer particle size, forming low-lying areas, relative to the river bank of brown clay soils, known as "hakala" to the Pokomo. These soils crack deeply when dry and, below this surface, are highly impervious when wet, so that flood water rests on them and evaporates off if there is no immediate drainage channel. In consequence they tend to be saline and slightly alkaline, particularly below 100 cm. from the surface. The natural vegetation in these backwater areas varies from Garsinia (Type IV) forest to thick Terminalia bushland and is exemplified by the area just West of Mchelelo near the Pongi lake, or the extensive bushland zone on the road into Mnazini.

Certain areas are so low-lying that they contain semi-permanent lakes. These are the first areas to flood when the river rises and they never stay dry long enough for a vegetational succession to proceed beyond grassland. Such areas (e.g. Tokafu lake on the East bank between Mchelelo and Guru) are known technically as splay lakes and are quite different in origin from ox-bow lakes. They are important grazing areas in the dry season.

In summary, the flood plain consists of a meandering river lined with ox-bow lakes and splay lakes. Two basic soil types are found across the flood plain and their pattern of deposition is altered by frequent changes in the river course over a period of a few decades. This forms the geomorphological basis of a complex ecosystem, highly varied both from place to place and through time.

TABLE II. INVENTORY OF FORESTS IN THE RESERVE AND THEIR POPULATIONS OF COLOBUS AND MANGABEYS

FOREST NAME	NUMBER OF CONSTITUENT PATCHES	TOTAL AREA (HA.'s)	AREA OF EACH FOREST TYPE I	II	III	IV	V	VI	AREA USED BY COLOBUS (HA.'s)	NUMBER OF GROUPS MIN.	MAX.	AREA USED BY MANGABEYS (HA.'s)	NUMBER OF GROUPS MIN.	MAX.
WENJE E.	1	625	125		375	125			0			500	2	4
MARONI E.	1	35	35						35	1	1	35	1	1
KWECHI	2	55				55			0			0		
MAKERE E.	2	15			15				0			0		
GURU W.	2	100	50		25			25	100	6	8	100	3	4
GURU E.	1	10	10						10	1	2	10	1	1
MCHELELO	1	15	15						15	2	2	15	2	2
MCHELELO E.	2	10	10						10	1	1	0		
CONGOLANI W.	3	90			90				90	1	1	90	1	1
CONGOLANI	1	45	45						45	3	4	45	2	2
SIFA E.	1	150	50	50	50				150	4	7	150	2	3
SIFA W.	1	30	30						30	1	1	30	1	1
HADRIBU	1	10			10				10	1	1	0		
MARIADADI		15			10	5			0			5	1	1
BAOMO E.	3	40	20	10		10			40	1	2	40	1	1
BAOMO N.	1	25	25						25	2	3	25	1	2
BAOMO S.	1	220	40	80	100				220	5	8	220	5	6
LEMU	1	30				30			0			30	1	22
NKOMBENI	1	40				40			0			0		
KITERE W.	1	15	15						15	2	2	0		
MISCELLANEOUS	4	15				15			0			0		

TABLE II (Continued)

MNAZINI N.	1	50	50						50	3	3	50	2	2
MNAZINI S.	1	70		30	35	5			70	3	3	70	2	2
MISCELLANEOUS	3	40			40				0			0		
TOTALS IN RESERVE	40	1,750	470	190	705	355	5	25	915	37	49	1,415	28	36
TOTALS IN WHOLE RANGE OF COLOBUS AND MANGABEYS	169	3,915	575	280	1,240	1,485	125	45	1,590	62	90	2,170	46	64
RESERVE FIGURES AS % OF WHOLE RANGE	23.7%	44.7%	81.7%	67.9%	56.9%	23.9%	4%	55.6%	57.6%	59.7%	54.4%	65.2%	60.9%	56.3%

CHAPTER 3. VEGETATION

3 - 1. General

The classification and mapping of vegetation is notoriously difficult and unsatisfactory and this is particularly true of a very heterogeneous habitat such as this Reserve, where local variations in soil and water conditions can be very subtle. It is, however, of considerable intrinsic interest and vital to an understanding of the animal and human use made of the area. A basic distinction is made between the vegetation of the flood plain which is largely dependent on river water for its maintainance and that of the dry plains which survives on rainfall alone. An annotated preliminary checklist of the trees and shrubs of the Reserve is given in Appendix A. and Map 4. is a vegetation map of the Reserve. Both should be consulted in conjunction with the written descriptions below.

3 - 2. Flood plain

In the last chapter the natural basis for a division of flood plain vegetation into three major classes was described. These will be discussed in turn and sub-types distinguished.

Forest

Forest is here defined as any vegetation type with an abundance of trees over 10 m. A distinction between forest and woodland based on canopy continuity is not useful here since many areas in which evergreen "forest" tree species dominate, in fact have a very open canopy. Forest occupies 31% of the flood plain area of the Reserve and thus 7% of the whole Reserve. Six sub-types are distinguished and the classification, area and rare primate fauna of all patches within the Reserve are listed in Table II.

Mixed evergreen forest (Type 1) is characterised by a relatively high diversity of tree species in the upper canopy. *Sorindeia obtusifoliolata*, *Sterculia appendiculata*, *Albizia gummifera*, *Ficus sycomorus*, and *Diospyrus mespiliformis* are common. Many, though not always a majority are evergreen in their lifeform. While the main canopy is usually at around 15 - 25 m. (50 - 75 ft.), emergents, such as *Sterculia appendiculata* or *Oxyystigma msoo* are common and may reach 35 m. (110 ft.) or more. The thickness of the understory is variable, depending mainly on the thickness of the upper canopy. Such forests are invariably found within 500 m. of the present course of the river and are best developed on high sandy levees, though the

sand may be covered with a thin surface layer of darker loam and leaf litter. Such areas of well-developed forests have usually been stable in location relative to the river for a considerable time - at least 50 years.

An important variant of mixed forest is one dominated by the large evergreen species Pachystella brevipes (Type II) with Majidea zanguebarica and Alangium salicifolium often common in the understory to 10 m. (33 ft.) In this forest type the upper canopy is usually closed. It is found exclusively on high sandy levees, near the river, which are rarely, if ever liable to flooding. It appears to be very sensitive in this respect. An area of Pachystella forest in Congolani West has died completely following the cutting off of the Congolani ox-bow in 19[illegible]1, which removed the forest from the river by 1 km. The same floods inundated some Pachystella forests which have all since died (e.g. parts of Baomo East and, most dramatically the Bubesa forest, South of the Reserve).

A third forest, Acacia/Diospyrus (Type III) is rather variable in its species dominance but is characterised by such species as Acacia clavigera (also known as A. Robusta) Diospyros mespiliformis, Mimusops fruticosa and Cordia goetzii. Some areas (e.g. parts of Mnazini South) are dominated purely by A. clavigera. In certain other areas co-dominance is shared with A. elatior (e.g. parts of Congolani West). This is about the southern limit of the range of A. elatior on the Lower Tana, but further North towards Garissa it is easily the dominant tree species while A. clavigera is absent. Both species occur in Meru National Park where the rainfall is higher again (Ament, 1975). Type III forests generally have a rather high (25 - 30 m.), open canopy and are found 500 - 1000 m. away from the river on soils intermediate between the sand of the riverbanks and the fine clays of the backwater areas.

In the true backwater areas, on clay soils subject to regular, though light flodding a different forest type occurs, Garsinia (Type IV). This is characterised by the abundance of Garcinia livingstonei, Cynometra suahliensis and Cola clavata. Together with the occasional Mimusops or Diospyros these form a closed canopy at 13 - 1[illegible] m. (40 - 50 ft.). The undergrowth is usually light or absent due to the dense canopy overhead, but open spaces, where they occur are quickly colonized by a dense tangle of the bush Grewia bicolor. There is no evidence that floods per se keep down undergrowth although they do tend to remove leaf litter (Cf. Andrews et al., 1975). This forest type is frequently found around ancient ox-bows whose original sandy banks are overlain with more recent clay deposits. It predominates along most of the Giritu old course of the river from Mnazini to Lake Bilisa. Its survival must require a considerable

tolerance of flooding and, in the dry season, the ability to use a water table both stagnant and slightly saline. It often grades into Terminalia bushland but I suspect it differs from the latter in being located above a sub-surface sandy soil layer.

Two further forest types occur within the Reserve. Cultivation forest (Type V) is a late secondary association immediately identifiable by the presence of Mango trees, Mangifera indica, or aggregations of Borassus palm, Borassus aethiopum (e.g. the northern part of Mnazini South). Ficus sycomorus, Trichilia roka and Afzelia cuanzensis are natural forest coloniser species commonly present also.

Disturbed forest (Type VI) is a rubbric covering forests o variable species composition but very open canopy and evidence of extensive damage by floods, fire or elephants. The wild Date palm, Phoenix reclinata often forms dense stands.

One final forest type on the lower Tana should be mentioned although it does not occur in the Reserve. This is a low dense forest dominated by the broad-leafed evergreen species, Barringtonia racemosa (Type VII) with Mimusops also commonly present. It is only found below Kulesa where the climate becomes noticeably more humid. It occurs near the river banks but in the delta the levees are less clearly distinguished either in height or soil type from the backwater areas and the levee soils are usually a dark brown, sandy clay.

Flood plain Bushland

Bushland at present occupies 42% of the flood plain area of the Reserve. Two types may be distinguished. By far the most extensive is a thick deciduous bushland heavily dominated by Terminalia brevipes. This species is commonly confused with the Henna bush, Lawsonia inermis. The latter species also occurs in this habitat but is much less common than Terminalia. The canopy is usually at about 5 - m. (15 - 20 ft.) though emergent trees of Garcinia or other species occur where it grades into Garcinia forest. Undergrowth is generally sparce but clumps of the straggling shrub Cyathula sp. occur in places together with the very poisonous Exocaecaria veninifera and other species. This type is found on heavily flooding brown clay soils and together with Garcinia forest is the main natural vegetation of the backwater swamps. In the South of the Reserve and beyond these two types must once have covered large areas of what is now secondary grassland.

A second type of bushland, Phoenix (Type II), is a successional stage leading from grassland to forest or vica versa. It springs up on areas of

cleared forest which have been farmed and returned to fallow. However, its succession back to forest is frequently prevented by fire. Its thickness and composition is variable but Phoenix reclinata is usually the dominant element and Pluchea discorides, Harrisonia abysinnica and Combretum constrictum are common. Phoenix reclinata is a species remarkable for its ability to survive repeated burning. On the other hand it also survives the succession back to forest and may be found in deeply shaded places.

Flood plain Grassland

Land with less than about 5% woody cover occupies 18 km.^{2} or 27% of the flood plain area in the Reserve and has been mapped as "open land". Of this possibly 1 - 1.5 km.^{2} is composed of occupied farms and the river adds another 2.25 km.^{2}, but the great majority is grassland. However, unlike some flood plain ecosystems, such as the Kafue in Zambia (Sheppe and Osborne, 1971), most of the grassland North of Garsen is secondary rather than edaphic (i.e. a natural vegetation on these soils). The reasons for thinking this are:-

1. The boundaries of forests on aerial photo raphs appear arbitrary and follow no discernable contours. The replacement of forest or bushland by open land can be seen by comparing older and more recent sets of photographs.
2. A comparison of soils inside and outside forests at one such site reveal no significant differences below the humus layer.
3. The effect of fire and subsequent grassland encroachment around forests has been witnessed and photographed several times.

At least two types of flood plain grassland can be distinguished. The first occurs on brown clay soils and, in certain heavily flooding areas, may be edaphic. This type is dominated by Echinocloa haplaclada, Sporobulus helvolus, and Panicum maximum. The grassland grows 2 - 3 m. high after flooding and dies back only slowly if the next wet season fails to bring a flood. Where flood water remains for most of the year in ox-bows and the lowest parts of splay lakes, these develop a profuse vegetation of water plants. The water lily, Nymphaea caerulea often carpets the surface with white flowers in the morning. As the ponds dry up true water plants are replaced by sedges, grasses, and small shrubs, such as Abutilon usambarense.

Another type of entirely secondary grassland with a greater species diversity occurs on sandy soils near the river, which are less prone to flooding. Digitaria milaniana, Cynodon dactylon, Sporobuvlus marginatus, Cenchrus ciliaris and Eragrostis superba are common. When undisturbed by

fire this type of grassland tends to proceed rapidly to Phoenix bushland (Type II).

3 - 3. Dry Plains

The vegetation of the dry plains in the Reserve area has been classified as Bushed Grassland in the content of the Tana River District as a whole (F.A.O., 1973). For the present purposes a more detailed classification is needed and four categories have been discriminated, using the criteria of Pratt, Greenway and Gwynne (1966) for rangeland vegetation.

Woodland

Woodland is restricted to the immediate edge of the flood plain and some of the drainage lines leading to it, where these occur on sandy rather than clay soils. It is thus a minor, though attractive habitat type. The discontinuous canopy at about 10 - 15 m. (35 - 45 ft.) is made up of Terminalia spinosa, Newtonia orlangeri, Acacia tortilis and Manilkara mochisia. The bush layer underneath is rather dense and diverse with Thylacium thomasii and Dobera glabera prominent species.

Bushland

Bushland is distinguished from bushed grassland by its proportion of woody cover, which should be above 20%. In practise this means a bush type thick enough to prevent one driving around in it. However it is often difficult to distinguish by species composition from bushed grassland.

A dry, deciduous bushland (Type I) occurs as a distinct vegetation type in the West of the Reserve near the main road. This area of well-drained sandy soils is dominated by Acacia reficiens which forms a semi-continuous canopy at 4 - 5 m. (14 - 17 ft.). A. bussei is also characteristic and Salvadora persica and Boscia coriacea are common. Commiphora sp. is locally common in both this and Dobera (Type II) bushland.

This second type often occurs in depressed areas of fine grey clay soils with impeded drainage. Dobera glabera is usually the dominant species and Cordia tenax is abundant along with Thespesia danis and Haplocoelum mombassense. In areas where the clays tend to crack deeply when dry the small shrub Abutilon usambarense is common. This vegetation type is found along most of the drainage lines leading to the flood plain, where it merges in

Terminalia flood plain bushland. Its area on the East bank would be much greater but for a large fire in 1962 which converted most of the East bank to the status of bushed grassland.

Bushed grassland

This is the most common vegetation type and is found probably naturally in most places that have neither very sandy or clay soils. The bushes are rarely more than 5 m. (15 ft.) in height and are sufficiently spaced to allow one to drive among them, though with considerable detours. The two evergreen species Dobera glabera and Salvadora persica are co-dominant on the West bank, but Dobera alone dominates on the East bank. Species diversity increases with proximity to the flood plain, presumably because of improved drainage. Cordia gharaf, Grewia tenax, Thylacium thomasii, Strychnos sp. and Sansiviera sp. are always common. Grasses are also prominent here and the main species include Chloris roxburghiana, Sporobulus helvolus, Schoenfeldia transiens, Enteropogon macrostachysus and Tragus berteronianus.

As pointed out in the F.A.O. Range Development report Bushed Grassland is the dominant vegetation type in this area of the Tana River District and extends most of the length of the cutline running W.S.W. from the Reserve airstrip almost as far as the Tiva river. Further West still (e.g. the area accessible from the Pumwani cut-line) this bushed grassland on clayey soils gives way to a huge region of A. reficiens bushland on white sandy soils, as described in Section 2 - 2.

Dry Plains Grassland

A small section of the dry plains on the West bank of the Reserve could be termed grassland (less than 2% woody cover). However, the grass species and soil conditions are similar to those found in bushed grassland and the area was clearly bushed grassland at the time of aerial photographs taken in 1961, but had become grassland by 1969. This change was due to fire in 1962 assisted by the cutting of bush for charcoal burning and the construction of cattle bomas. The burning in question was apparently at the same time as that which opened up most of the East bank Dobera bushland to bushed grassland. In 1962, after the exceptional rains of 1961, the grass cover was sufficient to sustain extensive and high temperature fires in many areas. Normally under prevailing patterns of rainfall and grazing pressure by domestic stock, fires on the dry plains are not widespread and do little

damage to tree cover. The effect of burning on the vegetation thus seems to be a function of rainfall the preceeding season, though doubtless areas outside the dry-season grazing range of water-dependant species are more susceptible that those nearer the river, because they are less heavily grazed.

The F.A.O. report (op.cit.) considers this process of the conversion of bushland to bushed grassland to grassland to be in progress in several parts of the South of the district.

3 - 4. Flood plain vegetation dynamics and forest conservation

In describing the vegetation types in the Reserve attention has been drawn to the seral stage that they occupy in a succession - in other words what vegetation they may be derived from or heading towards. These changes are of such importance to the management of the Reserve that an attempt has been made to quantify recent gross changes within the flood plain. A comparison of aerial photographs taken in 1970 and 1979 revealed a net loss of 13.3% of forest land within the whole range of the rare monkeys. Later photographs of the forests taken in April 1974 revealed a further net loss of 2.7% of the area remaining in 1979. A disproportionate amount of these losses occured in the area that is now the Game Reserve.

Most of the loss of forest was to open land, which means that the forests were cleared or burned. A further loss to bushland occured as a delayed result of the 1961 floods which killed the roots of trees in certain low-lying forests.

The very high rate of forest loss between 1961 and 1979 had, in part, a political explanation. The activities of the So. ali "shifta" bandits between 1963 and 1966 caused all the Pokomo farms on the East bank to be abandoned. The displaced farmers then had to clear new land on the West bank, precipitating a spree of forest clearance. 88% of the forest loss in this period was on the West bank, though only 59% of the forest land was located there. Of the subsequent forest loss 83% has also occured on the West bank, so this may represent a more longstanding pattern of land-use or a reluctance of the displaced farmers to return to the East bank.

The destruction of forest is made more serious in its potential effects on regeneration and forest fauna by the very patchy distribution of remaining forests. Diamond (1975) in assessing the practical implications of recent work on island biogeography has stressed that a single large "island", which is what a forest patch can be considered, is much better able to maintain its species diversity than an equivalent area of

small islands. For various reasons species of plants and animals are more likely to become extinct on small islands than large. Now the total area of forest within the Reserve is 17.5 km.^{2} broken up into 40 patches whose mean size is only 44 ha. (Table II). It should also be remembered that the edges of forests are inadequate habitat for many forest animals and that only 760 ha. or 37% of the total forest area is prime evergreen forest (Types I and II). There are several patches of apparently suitable habitat which contain neither or only one of the two rare monkey species. Mangabeys have large ranging requirements and are not found in very small patches widely separated from others (e.g. Kitere West or Madribu patches). Colobus do not readily migrate over open ground and are thus poor coloniser species. This may account for their absence from the large Wenje forest, if it had once previously been destroyed but subsequently regenerated. Thus the fragmentation of remaining patches may be more serious for the conservation of these monkeys, than the crude figures for forest loss alone might suggest.

A crucial aspect of vegetation dynamics concerns the regeneration of forests. If the canopy tree species are not able to replace themselves then a change in the vegetation is already in progress. There are a number of forests in which the absence of saplings of canopy species is so marked that their canopy is bound to become much more open as the present generation of large trees die of old age (e.g. Mchelelo and Baomo South patches). This process can be seen at an advanced stage in part of Congolani West where the cause is very likely a change in the river course, as suggested above. However, this can not be the explanation in other forests located beside the present course of the river. Many of these forests show signs of elephant damage to the understory and this could be an explanation for the paucity of saplings in these same forests. This suggestion is supported by the observation that forests on the East bank (e.g. Sifa and Mnazini patches East) seem to show better regeneration of saplings and also less elephant damage. During the aerial survey of October 1975 elephant density was considerably lower on the East than the West bank and this may be typical, although on this occasion water was still plentiful away from the river this side but not on the West bank. These problems are currently the subject of a study by Mr. J. Allaway and it would be premature to draw firm conclusions. There are also other possible explanations. For example, it could be that mature forests on high levees naturally become senescent because they are now above the level of all but exceptional floods. Flooding may be a requirement for the germination and development of some tree species. Another possibility

is that pollination or seed germination success is inadequate for reasons connected with the small size of remaining patches.

Nevertheless, if it were found that Elephants are indeed preventing forest regeneration, this would pose a serious management problem for the Reserve, which would very likely be aggravated by the special protection afforded Elephant by Game Reserve status. Some guidelines for possible management strategy are discussed in Section 4 - 6.

CHAPTER 4. THE FAUNA

4 - .1. General

This account of the fauna of the Tana River Game Reserve will perforce be almost entirely restricted to birds and mammals and will concentrate on species either peculiar to this part of Kenya or of particular importance for management. Annotated check lists of birds and mammals are given in appendices B and C, respectively. The avifaunal list is kindly due to Messrs. David Parker and Steve Nicholls of Bristol University. Further information on birds of the lower Tana is presented by Mrs. J.F.H. Horne in Andrews, Groves and Horne (1975). Some data on small mammal trapping are also to be found in this paper.

As in previous chapters a basic distinction is made between the flood plain and the dry plains. Most of the species characteristic of the flood plain are relatively sedentary in habits and many are restricted to the remaining forest patches. Most of the wildlife of the dry plains, by contrast, is markedly seasonal in its distribution and only concentrated in the area of the Reserve during the dry seasons.

4 - 2. Fauna of the forests

The forests and their fauna are the main justification for the Reserve and some unspecialized account of their natural history seems warranted.

In any forest the majority of the primary production is tied up in the largely undigestable form of lignin in the tree trunks. Leaves are often of low nutritive value and defended against folivores by various poisons, known as secondary compounds. For example, the leaves of the common forest Acacia, A. clavigera, contain substances which release Hydrocyanic acid on hydrolysis in the stomach. Only animals with specialized digestive systems can regularly eat such leaves. The majority of such species are insects but in the Tana forests the Red Colobus, Colobus badius, is a good example of a vertebrate leaf-eater. Its biology is discussed in more detail below together with that of the Mangabey, Cercocebus galeritus. Both the Mangabey and Sykes' monkey, Cercopithecus mitis, feed extensively on the fruits of trees, for which they compete with various frugivorous bird species. Of these the large and raucous Trumpeter Hornbill, Bycanistes bucinator, Fisher's Touraco, Touraco fischeri, and the Green Pigeon, Treron australis are prominent. One of the most interesting features of fruit eating by animals is the function it serves the parent tree species which has evolved the fruit.

Some species, such as the common Fig, Ficus sycomorus, are highly asynchronous between individuals and produce fruit nearly all the year round. Its dispersal requirements as a coloniser species in areas of forest regrowth probably benefit greatly from the seeds being passed through a vertebrate gut and deposited far from the parent tree. Certain other tree species such as Majidea zangueberica and several common species of Mimosoideae, e.g. Acacia clavigera and Albizia gumnifera, produce fruit in a highly synchronized proliferation. Now, fruits may be eaten leaving the seeds intact or the seeds may be chewed and destroyed - sometimes known as seed predation. Synchrony of fruiting by species whose seeds are regularly destroyed (e.g. Albizia gumnifera) may be a strategy for swamping the effect of the seed-eaters. Alternatively synchrony of fruiting may be an indirect result of selection pressure for synchrony of flowering which functions to minimize the effect of flower eating (e.g. by Colobus or Sykes).

Much fruit drops to the ground uneaten and the foraging of windfalls in the leaf litter is an important element of the diet of Mangabeys and also of the abundant Red Bush Squirrel, Paraxerus palliatus. At this lower level in the forest a number of browsing mammals also feed on the leaves of young trees and shrubs. Of these, the Elephant, Loxodonta africana, is by far the most important and is discussed elsewhere. Bushbuck, Tragelaphus scriptus, and Bush Pig, Potomochoerus porcus, occur but are rarely seen, though the frequent diggings of the latter suggest they are not uncommon. Red Duiker, Cephalophus harveyi, is more commonly seen, often in association with Mangabeys.

The grass production of the forest is mainly exploited by Elephant, buffalo, Synceros caffer, baboons, Papio Cynocephalus, and Waterbuck, Kobus ellipsiprymnus, though these species also use the forest for other reasons not directly connected with food. Elephant and Buffalo are often seen resting in shady spots and Baboons sleep in the forest at most seasons.

The only predator of monkeys which is much in evidence is the Crowned Hawk Eagle, Stephanoaetus Coronatus. This has been seen to prey on Sykes' monkey and its proximity produces an immediate alarm and defensive reaction from the other species. Other witnessed instances of predation on monkeys involved Pythons, Python sebae, which have been seen to take both Mangabey and Sykes (Homewood, pers. com.) and a Crocodile, Crocodilus miloticus, which was seen to take a Baboon drinking at the riverside. (Singer, pers. com.) Nocturnal uproars by baboons may sometimes be due to the presence of Leopard, Panthera pardus, but I have only sighted this species once. By the account of the Game Warden, Mr. K. Smith, it used to be common in the area but suffered much from trapping in the 1940's.

Genrally speaking the animal density in the forests is exceptionally high. The Mchelelo study area, for example, contains two groups of Colobus, two groups of Manganbey and four groups of Sykes' in 17 Ha. of forest. It is also used less intensively by two or three groups of baboons. Considering the three main forest species alone their numbers amount to about 180 in 17 Ha. or 1,050 per km.^{2}. This represents a biomass of approximately 3,500 kg. per km.^{2}, which is close to the mean annual biomass of large mammals found on the Serengeti ecosystem (Watson et al., 1969). The recent history of forest reduction, however, suggests that such exceptional densities may be temporary and not sustainable in the long term. It has also been tentatively suggested (Section 3 - 4) that the current seasonal concentration of elephants in the forests may only be sustained at the expense of the regenerative capacity of the forest.

Possibly the most interesting aspect of the Tana forest fauna is its zeographical affinities. Taxonomic affinities between different regions can suggest historical connections between them and thus illuminate the origin of the fauna. This subject is reviewed together with evidence from tree species distribution by Andrews et al.(1975), from which this summary is drawn. It would seem that most of the tree species of the Tana forests are widely distributed in coastal forest or over East Africa generally. A few, such as Garcinia livingstonia and Diospyros mespiliformis, extend their range into Zaire but are widely distributed in East Africa and not necessarily confined to lowland forests. Only the large and uncommon tree, Oxystigma msoo has a very local distribution on the East African coast and generic affinities with West and Central Africa. Meanwhile, the Tana poplar, Populus ilicifolia has its closest relative on the river Euphrates in Iraq. In distinction from the plants, several animal species are endemic in East Africa to the Tana and Sokoke forests near Malindi (e.g. the common Red-tailed Ant Thrush, Neocossyphus rufus) or to the Tana alone (e.g. the Tana Mangabey). Populations of both these species have their nearest relatives 1,000 km. away in the forests of Zaire, (the Grey-cheeked Mangabey, Cercocebus albigena, of Uganda is not closely related to C. galeritus.). The distribution of the Red Colobus is even more instructive. It is widely distributed in West and Central Africa, but has only three very small populations in East Africa, East of the shoulders of the Western Rift Valley in Uganda and Tanzania. All of these are distinguished at the subspecies level and in addition to the Tana, the other two are on Zanzibar and the Uzungwe mountains of Southern Tanzania. The Zanzibar subspecies is therefore the nearest to the Tana, but this beast is very different in apperance and is not considered taxonomically close. In revieving this and other evidence the authors (op.cit.) conclude that the Tana populations

of Colobus badius and Cercocebus galeritus and certain other species reached the Tana by way of a "northern" forest route from Western Uganda via the Kenya highlands.

Because the degree of taxonomic divergence in these species is small, even though the parent populations live in a very different habitat, it is likely that dispersal from central African forests happened quite recently. Judging from Hamilton's review of available evidence on the history of vegetation in East Africa (in Lind and Morrison, 1974), the most likely periods for a recent forest connection appear to be 30,000 - 25,000 years ago and about 10,000 - 7,500 years ago. The subject, however, is still open to speculation.

4 - 3. The Tana Red Colobus and Mangabey

The Tana Red Colobus and Mangabey are the subject of Ph.D. theses in preparation by the author and Katherine Homewood, respectively.

The geographical ranges of both species coincide closely and amount to some 58 km. for the Mangabey and 53 km. for the Colobus between the villages of Wenje and Garsen. Immediately beyond the northern limit of the Mangabey at Kanjonga, 4 km. North of Wenje, is a stretch of 15 km. in which the forest has been almost totally cut. Beyond this forest is more abundant and some (e.g. at Pumwani, just South of Hola) fits the description of mixed forest and is very similar to forest within the known range of the two rare monkeys. Baboon, Vervet and Sykes' monkeys are all present. The absence of Red Colobus and Mangabey may be due to past hunting or local extinction in a location isolated from the rest of the population. Further North still there is a gradual reduction in species diversity and canopy structure and a change in floristic composition (e.g. Acacia elatior replaces A. clavigera). These changes reflect the increase in the aridity of the climate and would account for the general northern distribution limits of both monkeys, which are essentially rain forest species.

South of Garsen there are very few potentially suitable forests and all have been visited, but without sightings or reports of the two monkeys. However, since the type specimen of the Mangabey was reportedly shot by Karl Peters in 1879 near the junction of the Ozi and Tana rivers (Allen and Lawrence, 193), the present absence of this species at least must be considered a recent local extinction.

The data on present distribution and density of groups of these species within the Reserve is presented in Table II. I have visited most of the 139 patches of forest in their whole range and, in addition to notes on the vegetation of each, I made an estimate of the minimum and maximum likely

number of groups of each species in each patch. For some forests the exact number is known. This method was compared with estimates derived from repeated linear censuses through representative forests. For various reasons connected with the patchy nature of the environment, direct estimates for each forest patch are considered more accurate than extrapolation from linear census data.

The number of Colobus groups lies between 32 and 90, and of Mangabey between 46 and 64. By multiplying these figures by the mean group sizes found during detailed studies of a few groups, total population estimates of 1,400 - 2,025 for Red Colobus and 1,200 - 1,760 for Mangabey are arrived at. Of these it is estimated that about 54 - 59% of the Colobus population and 5[illegible] - 60% of the Mangabeys are contained within the Reserve.

The Red Colobus is easily seen and quite different in appearance from the better known Black and White Colobus, Colobus guereza. It spends nearly all its time in tall trees where it lives in groups of, on average, 22.5 animals but varying from 10 - 50. The great majority contain only one adult male, but a few contain two. Males usually leave the group as young juveniles and live solitarily or in small temporary all-male parties. However, the composition of reproductive groups is not very stable compared with that of most monkey species and even adult females occassionally leave one group and join another. Groups seem to have an annual home range varying in size from 5 to about 40 Ha. depending on the nature of the forest patch. There is usually relatively little overlap in home range between groups, but aggressive interactions are rare and the situation cannot properly be described as territorial.

3[illegible]% of the annual diet is composed of Young Leaf with fruit (25%) as the second most important food item over the whole year. In one group studied Ficus sycomorus was the most important species, contributing 29.4% to the annual diet. However, there is considerable seasonal variation in the diet which can be related to differences in the availability of food items and is reflected in seasonal differences in ranging pattern. The months of June and July, immediately after the long rains are the time of least abundance of young leaf and fruit and at that time the animals often consume more mature leaf. and have a more diverse ranging pattern.

In nearly all respects the population on the Tana conrasts strongly with those studied elsewhere in the Western Rift valley of Tanzania and Uganda (Clutton-brock, 1972 and 1974; Struhsaker 1975). In these areas the animal lives in very stable groups averaging 50 individuals and including several adult males. Home ranges are generally larger and completely overlapping between groups. The diet shows less seasonal variation and fruit is not reported as being so prominent. All these differences may be related to the very different nature of the vegetation in a true rain forest, compared with

the specialized and relict conditions of the Tana gallery forests. The Red Colobus on the Tana can be viewed as a population living close to the limits of the habitat requirements of the species.

The Crested Mangabey is a very different sort of monkey. Homewood's study group spent 65% of their annual time budget between 0 and 2m. from the ground. They are thus semi-terrestial in their habits in contrast to the highly arboreal Colobus. Groups are slightly larger averaging 26 individuals with a much higher proportion of adult males than those of the Colobus, usually at least three in each group. A dominance hierachy exists between the males but all may copulate with oestrus females. Socially solitary males are uncommon. The density of groups varies greatly between forest patches as do ranging patterns but all parameters of ranging behaviour are larger than comparable ones for Colobus. Two study groups had annual home ranges of 53 and 17+ Ha., respectively. The small annual home range occured in very high density conditions at Mchelelo in which two groups share a forest of only 17 Ha. in size, though they occassionally forage outside in the surrounding flood plain bushland (Type II).

70.8% of the observed diet was made up of fruit with seeds contributing a further 10.4% and young stems 11%. Invertebrates were seen to be foraged for 2.4% of the diet but insects present in fruit may significantly increase the animal content of the diet. 68 food species have been identified, but the two main species in both study areas were Ficus sycomorus and Phoenix reclinata, Ficus making up over 17% of the annual diet in both cases. Doum palm nuts and grasses were also prominent. However, dietary and ranging parameters varied greatly between months, apparently with a different seasonality to the Colobus. This may be due to the differing times of year for the peak production of fruit and young leaf in the forest. When fruit is abundant Mangabey groups range widely and sometimes mingle peacably with other groups at fruiting trees. When fruit is less common they forage more on the ground and defend a smaller home range against other groups. It is argued that this adaptability in feeding and ranging behaviour and intergroup relationships is particularly suited to gallery forest conditions where the production of many food it ms varies not only seasonally but also more irregularly with the flood regime. In other forest types the Mangabey may not be able to compete adequately with other broad-niched species such as Sykes' monkey, Vervet and Baboons. This may account for its present day absence from any other part of East Africa.

4 - 4. Aspects of the fauna of the river and flood plain lakes

Apart from the forests another well defined section of the fauna is that

based directly on the river and seasonal lakes.

22 species of fish have been recorded as occuring in the Tana downstream of Garissa (Whitehead, 1959). Most of these are widespread in the eastern watershed of Africa. Between them they support a large and diverse population of fish-eating birds, a substantial number of Crocodiles and a small local fishery. The results of two low-water season censuses by boat of waterbirds, Crocodiles, Hippopotami and canoes between Wenje and Mnazini are presented in Table III.

Both local fishing catches and waterbird populations vary enormously with the river flow. At low season flocks of several hundred White-faced Tree Duck, Dendrocygna viduata, may be seen on the exposed sand-bars in the river but the numbers of fish-eating birds appears to be at a low level in this part of the river. At times of flood many species of fish enter the ox-bow and splay lakes to breed. Such conditions of large shallow lakes over recently flooded and decomposing vegetation must be immensely productive. At such times all the lake areas are surrounded by fish-eating birds along the whole length of the lower Tana, and particularly in the delta. It is not known from what distance the birds migrate, but the fish-eating birds are clearly a very mobile element of the community. The delta is famed for its large Heronry near Garsen (North, 1959). In fact, its location moves from time to time and in July 1975 it was no longer found in its described locality near the village of Idsowe. It is quite possible that several such breeding sites exist in the delta area and that this one just happens to be the only one descibed, because of its accessibility from the Garsen - Malindi road. The rest of the area is extremely inaccessable after floods.

Crocodiles are difficult animals to census even when travelling quietly by canoe. . They are most visible when basking on sand bars and this habit varies greatly with time of day, weather and the height of the river. Three counts over a 5 km. stretch of the river between Makere and Mchelelo have varied between 3 and 26. The upper figure suggests a minimum estimate of 5.2 per km. of river in this section. However, the census data have shown marked differences in density in different sections of the river. They are much more frequently seen away from inhabited banks. The Guru - Sifa section of the river is the longest stretch without any bankside farms in the Reserve and this may thus be the highest density zone.

Hippopotami seem to be restricted on the river almost exclusively to this same section, which is usually inhabited by about 25 - 35 animals. A major splay lake, Tokafu, runs parallel with the river in this section on the East bank and is apparently the area most used by them for grazing. Both Crocodiles and Hippo are also found on a large and beautiful lake, called Lamu,

TABLE III. RESULTS OF A RIVER CENSUS OR CANOES, HIPPO, CROCODILES AND WATERBIRDS

SPECIES	RECENSUS	1st CENSUS		TOTAL NOS.	DENSITY
	Wenje-Nchelelo	Wenje-Nchelelo	Nchelelo-Nkano	Wenje-Nkano	per Ki.
	(10/3/75)	(10/4/75)	(10/4/75)	(10/4/75)	
	17 km.	17 km.	14 km.	31 km.	31 km.
CANOES	-	41	32	73	2.4
HIPPOPOTAMUS	c.20	c.25	3	c.28	
CROCODILE[1]	10	3	4	7	0.23
WHITE-FACED TREE DUCK	22	c.1,000	c.800	c.1,800	c.58
WATER DIKKOP	18	11	37	48	1.5
SACRED IBIS	1	14	34	48	1.5
NIGHT HERON	3	25	7	32	1.03
SPUR-WING PLOVER	8	8	19	27	0.9
PIED KINGFISHER	16	14	6	20	0.6
YELLOW-BILLED STORK	6	7	10	17	0.5
HADADA IBIS	1	4	7	11	0.35
GREY HERON	3	4	6	10	0.32
BLACK-HEADED HERON	21	2	8	10	0.32
MALACHITE KINGFISHER	0	5	5	10	0.32
WOOLY-NECKED STORK	7	10	0	10	0.32
COMMON SANDPIPER	10	7	3	10	0.32
KNOB-BILLED GOOSE	0	0	10	10	0.32
GREAT WHITE EGRET	0	7	1	8	0.26
AFRICAN DARTER	14	7	1	8	0.26
HAMMERKOP	2	4	1	5	0.16
EGYPTIAN GOOSE	2	3	2	5	0.16
YELLOW-BILLED EGRET	0	0	3	3	0.1
MARSH SANDPIPER	0	2	1	3	0.1
LITTLE BITTERN	0	0	2	2	0.065
PINK-BACKED PELICAN	0	2	0	2	0.065
LITTLE EGRET	0	1	1	2	0.065
GREY-HEADED KINGFISHER	6	2	0	2	0.065
SPOONBILL	0	1	0	1	0.03
FISH EAGLE	1	0	1	1	0.03
OSPREY	0	0	1	1	0.03
Sighted on recensus only:-					
CHOCOLATE HEADED KINGFISHER		8			
SADDLE-BILLED STORK		3			

1. The figures for Crocodile are extremely low. In one other census specifically for this purpose a count of 2[illegible] was obtained between Nakere and Nchelelo, a distance of about 5 km. They do seem to be particularly abundant in this stretch and are also found away from the river in the Kwechi flood channel and in L. Le u.

3 km. East of Baomo. This lake is essentially a flood plain splay lake, but also receives considerable rainwater drainage from the East bank dry plains and very seldom dries out completely.

4 - 5. Fauna of the Dry Plains

Many of the general features of the use of dry bush and plains habitat surrounding a permanent watersource have been elucidated in Amboseli (Western, 1973) and are probably applicable to the Tana. The timing and scale of migration to the riverine zone by water-dependent members of the community can be expected to be a function of the amount and distribution of standing water away from the river as the dry season progresses. However, there are great species differences in degrees of water dependence. For example, waterbuck are restricted to the flood plain at all times except the height of the rains. The quality of grazing and the extent of competition with domestic stock doubtless add many further complications.

Since the rainfall in any wet season is rarely evenly distributed on both banks away from the river, the relative abundance of wildlife on each side will vary from season to season. Generally, however, rainfall is higher on the East bank and alternative water sources more numerous, particularly towards the coast. The seasonal migration pattern is thus more complicated on that side and, probably, on average, less wildlife uses the riverine zone. This can be properly established only by repeated aerial censuses.

A further important difference between the two sides of the river concerns the distribution of particular species and subspecies. Whereas the river is a creator of habitat for the forest fauna, it is a divider of habitat for dry plains species. A few range discontinuities and taxonomic differences in the large mammal fauna are listed in Table IV. There are also a number of marked differences in relative abundance of particular species between the two banks. For example, Peters Gazelle is abundant on the West bank but rare on the East.

TABLE IV. SOME DIFFERENCES IN THE LARGE MAMMAL FAUNA BETWEEN THE WEST AND EAST BANKS OF THE RIVER IN THE VICINTY OF THE RESERVE.

TYPE OF DIFFERENCE	WEST BANK	EAST BANK
RANGE LIMITS OF SPECIES	Absent	Hunters Antelope, Damaliscus hunteri
SUBSPECIES DIFFERENTIATION	Masai Giraffe, Giraffa camelopardalus tippelskirchi	Reticulate Giraffe, G.c.reticulata.
	In fact the giraffe on the West bank are highly variable and often have reticulate patterning.	
	Fringe-eared Oryx, Oryx beisa callotis	Beisa Oryx, Oryx beisa beisa

Of particular interest is the Hunter's Antelope, Damaliscus hunteri, which is the only full species of mammal endemic to the region. Its geographical range is limited in Kenya to southern Garissa and Lamu districts, but extends just over the border into southern Somalia. The main foci of its population are apparently around Kolbio and in the area between Masalani, Bura and Ijara (Duncan et al., In press). Part of the latter area has recently been gazetted the Arawale Game Reserve. Arawale is the Somali name for Hunter's antelope. The species is also occassionally seen in the Tana River Game Reserve. Its ecology and behaviour are currently the subject of a study of Mr. T. Bunderson and such more will hopefully be learned about it and also about the seasonal dynamics of the southern Garissa/Lamu region.

Data on the seasonal dynamics of the whole of the Tana River District and parts of Kitui and Kilifi have been collected by Mr. J. Allaway and the Research Division of the Game Department in a series of four systematic aerial surveys between September 1974 and June 1975. The information from these is being analysed by Mr. J. Alaaway as part of his current study of elephant ecology in the region (See below).

However, in view of the importance of monitoring local changes in the distribution and density of large mammals, and particularly elephant and cattle, a more detailed aerial survey of the Reserve was carried out on October 20th and 21st, 1975. This was financed by the World Wildlife Fund using the New York Zoological Society's Cessna 180, piloted by Dr. D. Western. The aim of the survey was to provide a baseline set of data on the late dry season distribution and abundance of wildlife and domestic stock in and around the Reserve. It is strongly recommended that this be repeated at regular

intervals, preferably annual or less, as part of the basic management of the Reserve. The survey should be conducted as late in the dry seasons as possible but before any showers have fallen. The two dry seasons differ in length and severity and a comparison of the February-March season with September-October would be valuable.

The general rationale and methodology for systematic aerial surveys is described by Croze and Gwynne (1975). However, experienced assistance should be sought in organizing and conducting the survey and analysing the data afterwards.

The area surveyed was a rectangle of 2,000 km.^{2}, 40 km. in length down the river and 50 km. in width. This was flown in alternate East-West transects spaced at 2.5 km. intervals. At a height of 300 ft. and a calibrated strip width of 200 m. on each side of the aeroplane this gives a 16% sample of the total area surveyed. The transect is envisaged as running through the middle of a series of 2.5 by 2.5 km./quadrats. Various computer programmes are available for the analysis of these data to give density distribution maps for all species and for total biomass and correlation of these data with environmental parameters, such as grass greenness, bush cover, proximity to water etc.

The most northerly transect passed through Masalani village on the river (the cutline to Masalani police post in Garissa District is a good landmark to begin at); the most southerly transect crossed the river just South of the village of Bubesa. Flight maps used will be loaned to the Warden so that the survey can be duplicated in detail in other years. The map sheets needed are Thowa, Mnazini and Chirte Hiyasa (Sheets 167,168 and 178, respectively, Series Y633), and Wema (Sheet 179/1, Series Y731).

Estimates of the numbers of animals within the surveyed area (both sides of the river combined) are given in Table V.

This method of estimating numbers is more appropriate for some species than others. Animals which are small (e.g., dikdik) or often under cover (e.g., crocodiles or warthogs) are likely to be underestimated. The estimates for species which are very unevenly distributed through the region (e.g., buffalo) will be more imprecise than those for evenly distributed species (e.g., gazelle); this is reflected in the width of the confidence limits. This census is likely to have been most accurate for elephants, dead elephants, cattle, zebra, ostrich and gazelle.

Maps No. V and No. VI show the density distributions of elephants and cattle, respectively, as examples of the capabilities of this kind of survey and because these species are of special interest. Particularly prominent are the much greater concentration of elephants on the West than on the East side (76% of the total counted). Both these distributions reflect the better

TABLE V. RESULTS OF AN AERIAL CENSUS OF WILDLIFE AND DOMESTIC STOCK IN THE VICINITY OF THE RESERVE

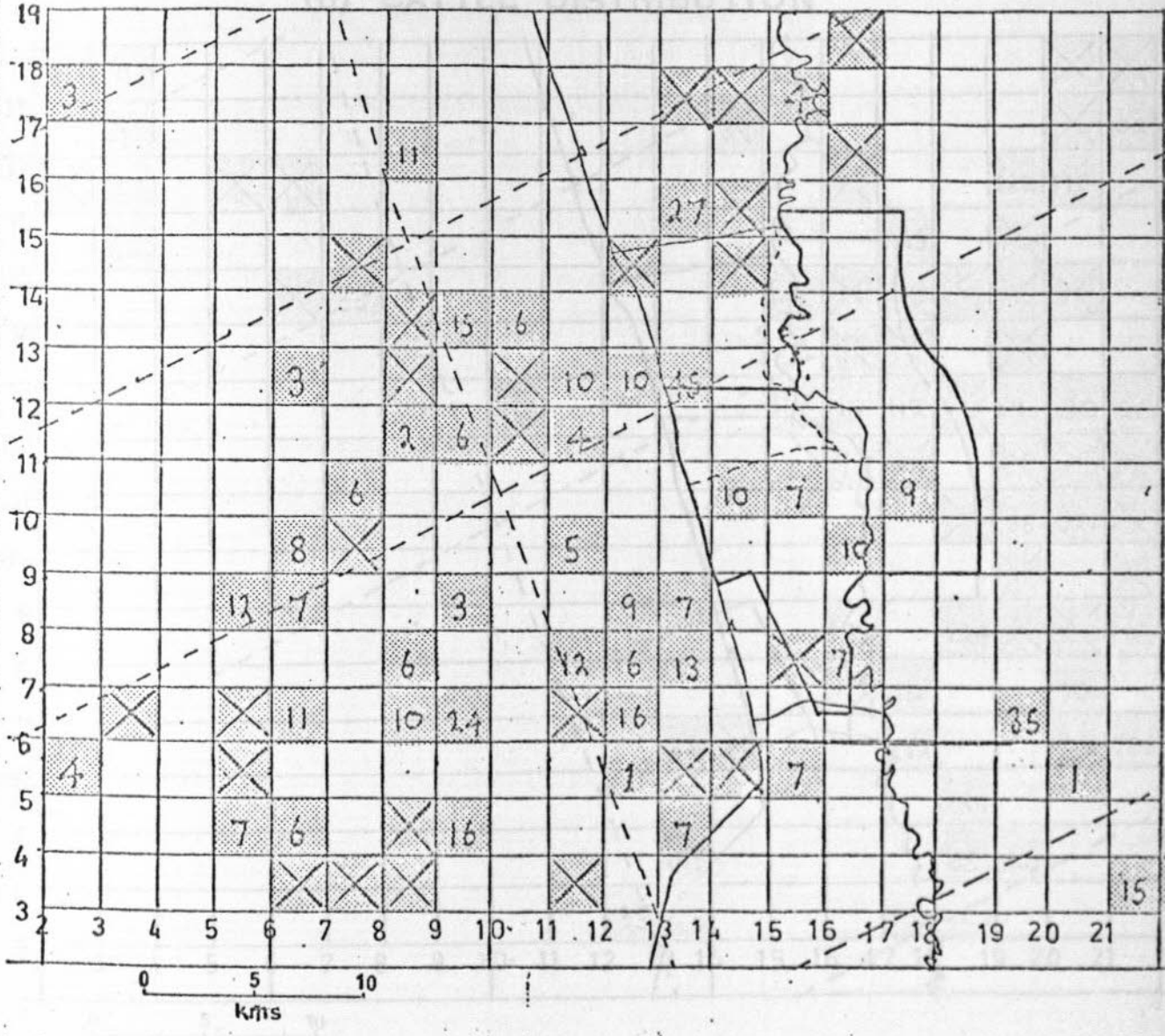
Species	Estimated Numbers in 2000km^2	Density per km^2	95% Confidence Limits, +/-
Elephants	2,682	1,341	41%
Elephant carcasses	104	0.052	42%
Elephant skeletons	293	0.146	27%
Cattle	29,638	14.819	46%
Sheep and Goats	8,891	4.445	71%
Giraffe	146	0.073	77%
Oryx	894	0.447	134%
Zebra	367	0.183	66%
Lesser Kudu	36	0.018	105%
Ostrich	447	0.223	44%
Peter's Gazelle	1,065	0.532	39%
Warthog	251	0.125	70%
Gerenuk	97	0.048	116%
Waterbuck	67	0.033	162%
Dikdik	238	0.118	46%
Topi	195	0.097	68%
Buffalo	924	0.462	110%
Hippopotamus	6	0.003	142%
Crocodile	6	0.003	178%

food resources of the East bank at that time. East bank elephants were apparently finding water and food further inland, and cattle, whose herders have some choice in the matter, were being grazed on the East bank in preference to the West. However, in the previous dry season the situation (for cattle at least) seemed to be the reverse; last April there were large numbers of cattle on the West bank in the area of the Reserve. Such differences between individual seasons emphasize the need for long-term and repeated monitoring in order to assess trends.

Map No. VII has been included to illustrate the usefullness of this type of survey and computer data analysis in understanding the distribution of species in the region. This map plots all the quadrants where grass was estimated to retain some greenness. Even visual comparison with Map No.VI helps explain the distribution of cattle; combined with the location of all water sources, it would explain even more.

MAP 5. RESULTS OF AN AERIAL CENSUS

(a) ELEPHANT DISTRIBUTION

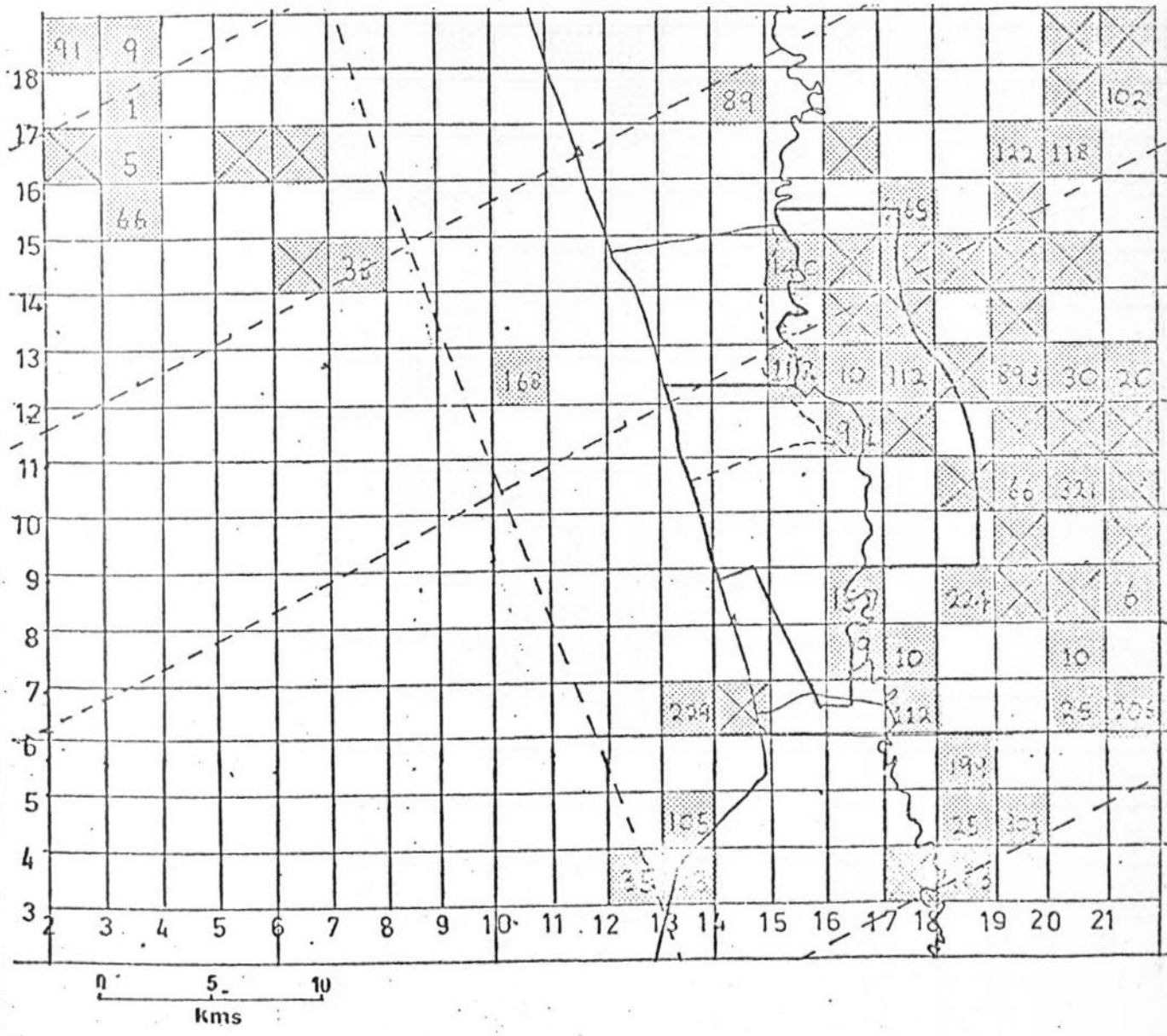


12 ELEPHANT CENSUSED WITHIN THE TRANSECT IN THIS CELL.

SIGHTINGS OUTSIDE THE TRANSECT.

MAP 6. RESULTS OF AN AERIAL CENSUS

(b) CATTLE DISTRIBUTION

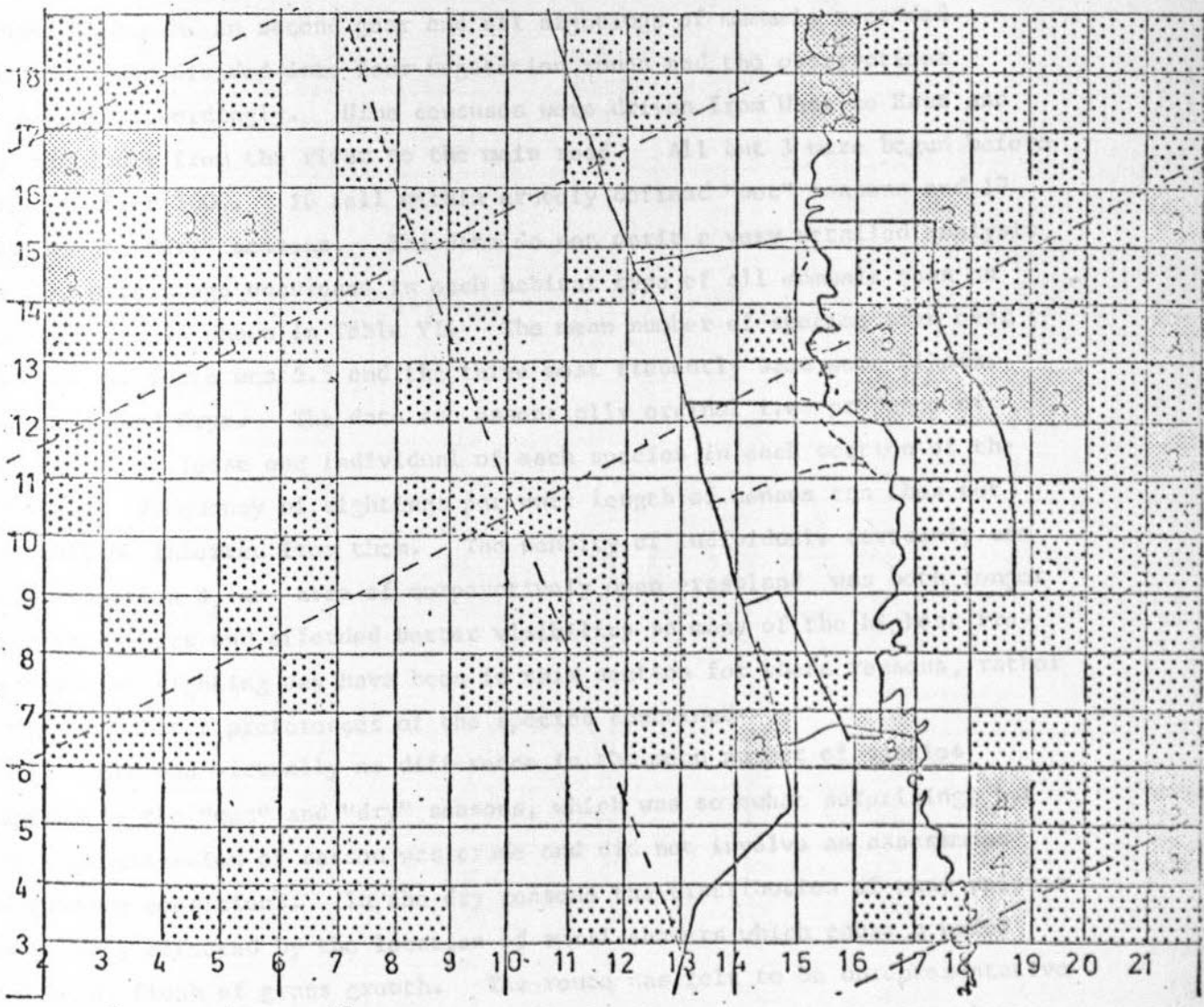


78 CATTLE CENSUSED WITHIN THE TRANSECT IN THIS CELL.

SIGHTINGS OUTSIDE THE TRANSECT.

MAP 7. RESULTS OF AN AERIAL CENSUS

(c) GRASS GREENESS



1 ON AN ARBITRARY SCALE FROM 0-10.

2 OR MORE.

In addition to the aerial survey, 34 ground censuses were carried out by car between March 1973 and April 1975 along the 9.5 km. of track between Mchelelo and the main road in the Reserve. The intention of these censuses was to give an indication of the average game viewing potential of the West side of the Reserve. During these drives the land-rover was driven at around 15 k.p.h. in second gear and all sightings of mammals recorded. The route was divided into four vegetation zones and the observations segregated accordingly. Nine censuses were driven from West to East and the remainder from the river to the main road. All but 3 were begun before 0900 or after 1600. 16 fell within crudely defined "wet" seasons and 17 were in the "dry" seasons. The data do not merit a very detailed analysis, but the percentage occurence in each habitat type of all mammals seen on these drives is shown in Table VI. The mean number of species seen over the 9.5 km. route was 5.5 and the three most freuently seen were Dikdik, Waterbuck and Oryx. The data are essentially ordinal i.e. presence or absence of at least one individual of each species in each section of the census. Frequency of sightings per unit length of census can thus not strictly be inferred from them. The density of individuals certainly can not. Section 3, an area of comparatively open grassland was both longer than the others and afforded better visibility so many of the highest frequencies of sighting may have been in this section for these reasons, rather than the habitat preferences of the species concerned.

There was virtually no difference in the mean number of species sighted in the "wet" and "dry" seasons, which was somewhat surprising, but the classification of season was crude and did not involve an assessment of grazing conditions. In the dry seasons the distribution of many species is greatly affected by the location of small showers which cause a brief and local flush of grass growth. The route was felt to be unrepresentative for some species, notably elephant and buffalo. In the dry season these species can usually be seen on the flood plain in the evening, the best area being the North-South track from Mchelelo to Nkano. Mr. J. Allaway has contributed the section that follows on elephants.

4 - 6. Elephants

The role of elephants in the Reserve deserves special attention: they probably have more influence on the ecology of the Reserve area than does any other wildlife species and they are a major wildlife resource in their own right. This section will give a sketch of the role of elephants in the Reserve and briefly discuss the principal ramifications for management. The

TABLE VI. PERCENTAGE OCCURRENCE ON CENSUS DRIVES OF SOME COMMON MAMMALS IN DIFFERENT HABITAT TYPES

CENSUS SECTION	1	2	3	4	Whole Route
LENGTH	2 km.	2 km.	3.5 km.	2 km.	9.5 km.
VEGETATION	grass-land/ bush-land.	bush-land/ wood-land.	bushed grass-land.	bush-land (Type I)	

SPECIES RANKED BY FREQUENCY OF SIGHTINGS IN ALL HABITATS COMBINED	INCREASING DISTANCE FROM WATER →					APPARENT GROSS HABITAT PREFERENCES
Dik-dik	0%	35%	35%	53%	79%	B.
Water Buck	38	44	3	0	68	A.
Oryx	0	18	50	9	59	B.
Wart-hog	15	41	24	3	55	A/B
Peter's Gazelle	0	6	53	3	53	B
Zebra	3	6	35	0	44	A/B
Baboon	23	12	3	0	35	A.
Gerenuk	0	3	18	12	32	B.
Lesser Kudu	0	3	6	3	23	B.
Cattle	0	0	21	6	23	B.
Giraffe	3	12	9	0	21	A/B
Black-Tip Mongoose	0	6	3	12	18	B.
Impala	3	12	3	0	18	A.
Elephant	6	3	3	9	18	C.
Vervet	0	3	6	0	9	B.
Buffalo	3	3	0	0	6	A.
Jackal	0	3	3	0	6	C.
Dwarf Mongoose	0	3	0	3	6	C.

KEY TO HABITAT PREFERENCES:-

A. Sects. 1 and 2. Flood plain and adjacent Dry plains bushland within 3 km. of river.

B. Dry plains grassland and bushland more than 3 km. from river.

C. No preference apparent or data inadequate.

information has been gathered during an on-going study of elephant ecology and interaction with human land-use in the lower Tana River region.

Elephants potentially inhabit most of the lower Tana River region and the area East of the river towards Somalia. Their actual use of different parts of the region is very seasonal and limited by the availability of drinking water and food. During and shortly after the rainy seasons they typically range throughout the region where rain pans or seasonal river courses contain water and new vegetative growth has occured; as the region dries up, they vacate vast areas and move closer to the few permanent water sources, including the Tana River.

Beyond this basic seasonal pattern, there appear to be areas of elephant concentration within the region. The Game Reserve is within what seems to be the largest dry-season concentration area on the West bank. This concentration seems to be centred near Garsen and to extend from approximately the area of the Reserve in the North to the thick bushland West of the delta in the South. Less information is available about elephant distributions and concentrations on the East side of the river. Elephant movements on each side of the river seem independent and determined separately by conditions in the inerior of each region. Rainfall patterns are often different in Tana River and Lamu - Southern Garissa Districts and would account for this. Present evidence indicates that movement across the river is minimal.

Few elephants are present in the Game Reserve during the rains (typically April-May and November) and for one or two months afterwards, the length of this period depending on the amount and extent of previous rainfall. Elephant use of the Reserve area progressively increases through the dry season; typically elephant use can be expected to be highest in September-October and February-March.

The detailed use by elephants of different parts of the Reserve area and different vegetation types is very complex, but a few basic temporal and spatial patterns are important to recognize. The river is the only source of drinking water by the latter part of the dry season, unless the previous rains or river floods have filled the scattered seasonal lakes on the flood plain. The number of actual drinking sites on the river is further limited by normally steep banks and, some places, by farms which block access. In August-September of 1975, for example, elephants could drink from the river at only twelve sites within the Reserve's approximately nineteen kilometres of West bank shoreline. Elephants usually drink after dark, mostly in the early part of the night, occasionally drinking will begin in late afternoon.

Elephants are relatively inactive from mid-morning to mid-afternoon. During this period they feed little, move short distances, and spend most of

their time stationery under the shade of trees. As a consequence of this, and perhaps to avoid disturbance by humans, most elephants spend mid-day in either forests or wooded bushland, and usually away from paths and roads much used by men.

Feeding and travelling usually begins in late afternoon and continues through the night and early morning. During this time, most elephants are steadily moving, often from resting places to water and on to other areas, feeding on the way. In addition, long-distance movements are common between the flood plain and the inerior, along networks or well-entrenched trails. These trails usually lead to watering sites on the river.

Elephants are both browsers and grazers and eat a great variety of plants-grasses, herbs, shrubs, vines, and trees-and plant parts-leaves, branches, fruits, bark and roots. They feed in all parts of the Reserve, but do not use all areas or vegetation types equally. Present information is too prelininary to evaluate the importance to elephants of the different types.

Map No. V illustrates some of the points mentioned above. It plots where elephants were seen during the October 1975 aerial survey, and shows the kind of distribution that can occur in late dry season. It also suggests some of the complexity of elephants' use of the Reserve area: for example, though all at some time must drink at the river, different elephants were spending the hod mid-day hours under trees only one or two or as much as thirty-five kilometres from the river.

Elephants interact with man in several ways within the Reserve, but the only two interactions of major significance are raiding of farms by elephants and killing of elephants by man. Raiding of farms by elephants occurs throughout the Reserve. The frequency of raiding seems to be determined by the degree of concentration of elephants along the river, the abundance of crops desired by elephants, and possibly by the abundance of other foods outside farms. Raiding almost always takes place at night. The elephants are discouraged by barbed wire or liane fences surrounding the farm on which debbies and other junk are strung so as to clatter when the fence is touched. This seems to be reasonably effective when reinforced by the owner shouting and hurling glowing doum palm nuts with a sling.

Killing of elephants by man is discussed in the next chapter. The effects of this mortality on the status of the elephant population and on the use by elephants of the Reserve have not yet been determined.

Although our knowledge of elephants and what they do in the area of the Reserve is still incomplete, some important ramifications for management are clear at this stage.

Firstly, the Reserve is an important part of the dry-season range of

a substantial portion of the elephant population of southern Tana River District, and probably of East bank populations as well. Two thousand, three hundred elephants were estimated to be within the West-bank area of the October 1975 aerial survey; most of these probably can be expected to use the actual Reserve at some time. The importance of the Reserve as dry-season habitat may increase as human land-uses - farming and hunting, principally - intensify in surrounding areas.

Secondly, elephants will have considerable direct value to the Reserve as a tourist viewing attraction. Elephants are numerous and frequently seen during dry seasons. They are presently quite skittish and often quickly disappear into thick vegetation. However, elephants in other areas, for example, Amboseli, have learned to recognize protected zones and behave much more tolerantly to humans within them.

Thirdly, many of the subtle ecological effects of elephants are important in the present workings of the natural community in the Reserve. Elephants consume many plant fruits and probably help seed dispersal of some species. The vast quantities of elephant dung produced are a stage in the recycling of much of the energy and mineral production of plants; great numbers of invertebrates depend on dung and are themselves food for many other animals, from other invertebrates to birds, civets, and mangabeys. The impact of elephants on vegetation also may well influence the food supply of other herbivores, in complex ways that are hard to unravel. Elephant trails ease movement of many species, including man, through thick vegetation and over long distances. All the combined influences of elephants on vegetation, furthermore, may at certain levels help maintain present vegetation types.

The significance to management of elephant impact on vegetation, however, may be the most important consideration and the most complex. Elephants consume a lot of plant material and frequently further damage plants during feeding. Obviously this is consumption of a resource which can be renewed seasonally. There is nothing of concern for management about elephant damage unless the impact is at such a level that it affects the present or future status of the vegetation. This may happen if elephants kill and damage more than is replaced, thereby inducing changes in the pattern of vegetation types. Such changes are still not necessarily cause for concern; in fact, many current ecological views of vegetation stress the dynamic nature of patterns or vegetation types and the artificiality of considering the pattern at any moment in time to be the "natural", "correct" one. Vegetation changes are particularly characteristic of a river flood plain such as the Tana's where the dynamic character of the river course is continuously affecting vegetation (See Sections 3 - 2.).

However, since conservation of riverine forests has been identified as the first priority of the Reserve, protecting the present and future status of forests is therefore of foremost concern to management. Because elephants obviously eat and otherwise damage some young and mature forest trees, it is important to know what their impact actually is. The main question at this stage is possible interference by elephants with forest regeneration. To assess this, elephant damage first must be measured and then related to the required rate of replacement of mature trees. The fact that many trees are damaged does not in itself mean that forest status is being affected; of the many thousands of seedlings produced, only a few are eventually needed to replace dying mature trees. Furthermore consideration must always be given to the probable interaction of elephant damage with other environmental influences on vegetation, such as changes in river course, fire and weather.

I have begun research to collect some of the information needed to assess elephant impact on forests - and on other vegetation types - but no conclusions can yet be drawn and it would be inappropriate to make specific recommendations at this time. This, however, is a question that will likely concern Reserve management for some time. The following guidelines are therefore suggested for coping with the possibility of undesirable elephant impacts:

1. What is an "undesirable impact" must be defined by explicitly stated objectives and priorities or Reserve management.
2. Whether an undesirable impact actually exists and how severe it is must be decided only on the basis of objective facts, not intuitive or qualitive judgements.
3. Research to produce these facts must be comprehensive and detailed enough to produce the information needed to properly assess this elephant impact on vegetation status, determine its fundamental causes, and evaluate interactions with other factors.

The lesson of the dying Acacia xanthophloea woodlands in Amboseli illustrates the danger of drawing conclusions from anything but carefully gathered and interpreted facts. For years most commentators on Amboseli blamed either elephant damage or overgrazing by cattle for the drastic decline in woodlands that was taking place. Researchers eventually found the cause to be a rise in the ground water table and saline poisoning of deep-rooted large trees; elephant damage was extensive, but the impact of elephants was only to accelerate the decline already occurring (Western and Van Praet, 1973).

If a detrimental impact is found to exist, using the above procedures, the following guidelines are suggested for choosing a course of action:

1. Assessment must be made of the probable future status of the impact, given possible changes in elephant use of the area (such as greater concentration within the Reserve as human land-use outside intensifies) and changes in other environmental influences (such as reversion of farms to forest, increasing available forest area).
2. The possibility must be considered that the problem may be relieved eventually in the absence of any positive action by management. For example, if the basic cause was thought to recently increased elephant density, such relief might result from reduction in regional elephant numbers due to other factors than action within the Reserve. A judgement must also be made as to whether such relief would be likely to occur before asomuch damage has been done that recovery from it would be dangerously difficult.
3. All alternative causes of action should be identified and as much information as possible gathered on experiences with them elsewhere. Doing nothing must be considered as one alternative, and evaluated with the others.
4. For each alternative course of action, the following points should be assessed on the basis of experience elsewhere and knowledge of the ecology of the Reserve and surrounding areas:

   (a) Would it actually work in these particular circumstances?
   (b) What would be the other likely direct and indirect effects of this action?

Particularly important would be possible effects on:

(i) Vegetation, wildlife, and other components of the ecological community of the Reserve and surrounding areas.
(ii) The status of elephant populations in the southern Tana River region.
(iii) Human land-use outside the Reserve, resulting from changes in elephant use of these areas.
(iv) Direct values through tourism of elephants to the Reserve.

   (c) Lastly, how efficient is each action, judging its effectiveness and relating this to monetary costs. As part of this, assessment must be made of manpower

cont. (c) needs and availability, and the period of time over which the action would have to be continued.

This final process is basically a balancing of pluses and minuses for alternative choices. Effectiveness at coping with the problem, ecological and natural resource impacts throughout the region and within the Reserve, and cost efficiency must all be balanced. Only on the basis of such an assessment - preceded by objective delineation of the problem - should any action be taken.

CHAPTER 5. HUMAN LAND-USE AND ANTICIPATED MANAGEMENT PROBLEMS

5 - 1. Direct threats to the fauna

Illegal hunting is a type of land-use clearly incompatible with any National Park or Game Reserve. In many it is regarded as the most serious threat to the integrity of the park.

The aerial survey demonstrated a substantial level of recent elephant mortality in the vicinity of the Reserve. Judging from the number of carcases found on the ground with wound marks, much of this mortality can be attributed to ivory poaching. Hunting of other species seems to be uncommon, although the probable past decimation of the leopard population has been mentioned. It is of interest that Rhino are still quite frequently encountered and I have found no recent carcases. The population here may be relatively unmolested at present.

The problem of poaching is a conventional one, there are well established methods for combating it and these should be more vigorously applied as the Reserve is developed and more resources are available. Neither of the two rare monkey species nor the other forest fauna is hunted to any significant extent if at all. Nevertheless they are severely threatened by destruction of habitat and it is with this subtler problem that this chapter is largely concerned.

5 - 2. Threats to the habitat

(a) Agricultural and other practises of the Pokomo.

As might be expected from the foregoing chapters human land-use in the flood plain and dry plains is very different and this is further reinforced by ethnic differences between the peoples concerned.

The flood plain is occupied by the Bantu-speaking Pokomo people whose traditional land stretches from Bura to the delta area. They are traditionally divided into 13 sub-tribes, some of which have remained in recent times as administrative locations. The two locations in which the Reserve is located, Gwano and Ndera, are examples. Some of the lower sub-tribes, known collectively as the Malachini, were affected by various Western missionary groups in the late 19th and early 20th centuries and were converted to Christianity. The upper Pokomo are mostly Muslim, though this is also a comparatively recent influence.

Their agricultural system is well adapted to the vagarities of the river

although there is no traditional irrigation technology. Each family has at least one shamba by the river bank and usually others in other locations, such as the backwater areas or in ox-bow lakes. In any one season each family usually cultivates between 0.3 and 1.5 Ha. (Townsend, 1975). The staple crops are maize and bananas. Bananas are grown on sandy levee soil beside the river and are the only dependable food source if both the floods and the rains fail. Maize is usually grown on slightly lower ground where there is a greater likelihood of floods. However, a reasonable crop can be obtained without floods if the rains are good. Rice is planted on low-lying backwater soils as the floods subside or occasionally in very narrow strips on the river bank just above the dry season water level. Greengram is commonly planted on the still damp clay soils after the rice has been harvested. Small quantities of sugar cane, cassava, tobacco and other crops are also grown together with Mangoe trees on sandy soils.

The twice annual harvest varies enormously with the frequency, height and pattern of the floods. In consequence the most sought after land for river bank shambas is low-lying and thus most likely to flood. The location of such land is most commonly on the inside of river bends and along new stretches of the river course, which have not yet built up a high surrounding levee. Due to the gradual accretion of sediment and the cutting off of ox-bows the location of this land changes over a period of years or decades. This is countered by a shifting pattern of agriculture with the resulting decline of forest described in Section 3 - 4. Thus while actively cultivated land occupies less than 5% of flood plain land (Watson et al., 1973) good riverside sites are at a premium and the apparent absence of land pressure is largely illusory. As a result there has been persistent destruction of prime forest for short term agricultural benefits. This was particularly manifest during the "shifts" troubles.

The areas of best developed forests (Types I and II) are not well suited to agriculture because they are above the normal level of floods. Their clearance rarely allows more than two or three years of good crops, based on the non-renewable fertility of the burned trees and the thin forest humus layer. After this time the sandy levee soils are leached almost white and this condition is recognized by the Pokomo as "kithangua".

In spite of this progressive forest destruction, the Reserve with its large potentially forested area relative to other parts of the flood plain is also relatively lightly populated by the Pokomo. It has not been possible to accurately map the distribution of currently cultivated land, but a family by family count suggests a total Pokomo population within the Reserve of 550 people on 88 farms. These are concentrated mainly on the East bank around

Maroni and on the West bank around the village of Baomo.

Every family has a house in the village as well as one on the farm, but most time is spent on the farm. This is particularly true when crops are ripening in January-February and July-August. At these times animals constitute a major threat to the crop and substantial losses are incurred. During the day children watch over the crop from raised observation platforms and chase off birds and Baboons with noise and sticks. At night Elephants, and to a lesser extent Buffalo, Waterbuck and Bush Pigs are a menace. Elephants are discouraged by barbed wire or liane fences surrounding the farm on which old debbies and other junk are strung so as to clatter when the fence is touched. This seems to be reasonably effective when reinforced by the owner shouting and hurling glowing Doum palm nuts with a sling. A more detailed assessment of the effect of Elephants and Baboons on agricultural productivity is being made by Mr. J. Allaway and Miss S. Singer, respectively, as part of their larger studies on these species.

In the long term on the Tana, as elsewhere, shortage of suitable land is a function of population increase. Between the 1951 and 1959 national censuses, this was running at 2.2% per annum for the Pokomo in the district which is less than the national average of 3.2% per annum but still very high. No population growth can be sustained indefinitely and present trends are sooner or later going to have the most tragic consequences for almost every aspect of human welfare, including Game Reserves and other conservation areas.

In addition to wholesale forest clearance less drastic damage to forests is caused by the cutting of saplings and undergrowth for building and other purposes and by the cutting of large trees for canoes. The species most sought for building purposes, such as Polysphaeria multiflora and Allangium salviifolium are mostly undergrowth species and thus not potential recruitment to the forest canopy. While their removal is undesirable it is considered a less serious threat to the forest than either wholesale clearance or canoe cutting. Canoes are hewn out of large felled trees and Table VII presents data and calculations to show the number removed from forests each year.

A census between Wenje and Mnazini by boat revealed 73 apparently servicable canoes at a density of 2.4 per km. It is calculated that 31.7 trees must be cut annually to maintain this fleet. A portion of the 73 counted may in fact have finished their useful life, therefore, inflating the annual replacement requirement. However, an unknown but probably substantial number of canoes are cut and sold downstream where remaining forests are fewer. If we accept a total figure of 41 then from the proportions of different tree species used and their life expectancy as canoes it

is calculated that some 13.3 Fig trees, Ficus sycomorus, must be cut every year. It will be recalled from Section 4 - 3. that this is the most important species in the diet of both Red Colobus and Mangabeys. Both Ficus sycomorus and the rare monkeys are most common in mixed forest (Type I). The majority of local canoes are cut in Type I forests within the Reserve. Now it has been found from a strip enumeration of such forest at Kchelelo that large specimens of this species of Fig occurs at a density of 0.02 per Ha. There are an estimated 470 Ha. of mixed forest in the Reserve (Table II) and so if all the Figs cut were taken from mixed forest within the Reserve and if there was no tree regeneration the total population of 385 trees would be decimated in under 29 years at the present annual take. None of these assumptions is strictly true but the calculation serves to show that the removal of mature trees, and particularly of this species, is not a trivial threat to the rare monkeys. Suitable tree species for canoes, such as Garcinia, Mimusops and Diospyros, are common outside the Reserve, and though they take longer to cut they last much longer than Figs and are thus a better long-term investment.

A final adverse interaction between the Pokomo and the forest is the tapping of Doum palm trees, Hyphaenae coriacea, to make palm wine. This need not be fatal to the tree if a few fronds only are removed, but when all the fronds are removed, the tree often dies. Trees treated in this way are not only unsightly but such interference with growth and reproduction also reduces the supply of nuts, which are fed on by Mangabeys, Sykes' and Baboons as well as Elephants and other species.

(b) Pastoral Land-use by the Orma and Somali

Two tribes of cushitic-speaking peoples are found within the Reserve. The Orma are a branch of the Galla, who dominated most of Eastern Kenya until the 1880's when their power was gradually usurped by the Somalis spreading from the North-East. (Talbot-Smith, 1921). Today the tribe is split into several small groupings in Kenya while the largest sector is found in Southern Ethiopia. The Orma are the most southerly group and occupy most of the South and West side of the lower Tana basin. The district boundary with Kitui District roughly demarcates their boundary with the WaKamba to the West.

At the 1969 census they numbered 16,000 in the district, some 13,000 fewer than the Pokomo, but apparently they have a higher rate of population increase. They are entirely Muslim in religion though this only dates back to the 1920's and 30's (Rowlands, 1955).

TABLE VII. ESTIMATED TREE REQUIREMENTS FOR DUG-OUT CANOES IN THE RESERVE

SPECIES	COMMON NAME	CUTTING AND CARVING TIME	USEFUL CANOE LIFE	PERCENT OF SUB-SAMPLE OF CANOES	EST. NUMBERS OF EACH SPECIES BETWEEN WENJE-NKANO	NUMBER OF TREES REQUIRED PER ANNUM FOR REPLACE-MENT
		(weeks)	(years)	(N=22)	(N=73)	
Populus ilicifolia	Mlalahi	3	2	31.8%	23.2	11.6
Ficus sycomorus	Mkuyu	3	1	18.2%	13.3	13.3
Mimusops fruticosa	Mguvwe	6	8	22.7%	16.6	2.1
Diospyros mespiliformis	Mkuru	3	3	9.1%	6.6	2.2
Garcinia livingstonii	Mchachozi	7	7	4.5%	3.3	0.5
Mangifera indica	Muembe (Mango)	4	5	13.6%	9.9	2.0
				TOTAL ANNUAL REQUIREMENT OF TREES		31.7

Tana River District has been estimated to carry a herd of 215,000 cattle and 55,000 shoats (Watson et al. 1973) of which the great majority are owned by Orma. This works out at over 10 head of cattle and 3 shoats per head of the tribe and the Orma have been estimated to be possibly the richest pastoral tribe in Kenya (F.A.O., 1973). The herds are very unevenly distributed and follow a broadly similar seasonal migration pattern to the water-dependent wildlife species of the dry plains. Early dry season foci of the population are around Wayu on the Thoa river, Assa near the Tiva and along the edge of the Tana flood plain. As the dry season progresses the majority of cattle are concentrated on the lush grasslands of the delta.

In most seasons the herds are divided between a milking herd and a dry herd. The milking herds contain lactating females and their calves while the dry herd consists of dry cows, heifers, weaned calves and males. The milking herd is always kept near permanent water along the Tana or around Wayu and Assa, while the dry herd ranges much further in pursuit of ephemeral water and unexploited grazing areas. In recent years the tendency towards a more settled existence has increased and from the air a line of bomas can be seen at most seasons in the Reserve running parallel with the river and between

6 and 10 km. from it. This distance is dictated by the need to water the milking herd daily. The dry herds are often watered only on alternate days.

By comparison with some other pastoral peoples, the Orma are not averse to a cash economy and are well integrated into the use of schools and other aspects of Government administration. A programme is currently under way to gazette large areas of the district as co-operative ranches. These then form the legal basis for making loans for water development and encouraging a more intensive, cash-orientated cattle economy. The only operational ranch to date is the Ida-Sa-Godana ranch, which adjoins all of the western and southern boundary of the Reserve.

Much of what has been said also applies to the Abdullah and Waldei Gabbra clans of the Somalis who occupy the East bank of the river in the Vicinity of the Reserve. The Somali are closely related in language of the Orma and are often difficult to distinguish in appearance. However, their huts are invariably low and of rough construction on the outside. The Orma huts, at least near permanent water, are beehive shaped and beautifully made. The situation is further complicated by the fact that both groups cross the river on occasion, but there has been a considerable net increase in Somalis on the West bank. This has occured only during the last six years with the relaxation of tensions with the Pokomo and with the Government associated with the "shifta" troubles. During January - March 1975 after the rains had failed on the East bank a very large influx occured from the East bank and nearly all the pastoralists in the Reserve were Somalis. In addition some 30 families settled in the flood plain on the East bank near Kchelelo and began to cultivate farms. Both of these are important and undesirable changes in the land-use in the Reserve. In the first place bringing cattle across the river is contrary to current quarantine regulations. Secondly, the Somalis tend to be intransigent respect to the observation of grazing rights, charcoal-burning regulations and the Game regulations. Their illegal hunting has occasionally been done with fire arms in recent months. Thirdly, any increase in agriculture exacerbates the same problems of forest survival associated with current Pokomo land-use.

However, the most serious management problems posed by pastoralists are common to both the Somalis and the Orma. The setting of dry season fires in the flood plain grasslands both maintains and increases their area (See Section 3 - 2) and is probably responsible for as much of the destruction of forests as clear felling for agriculture. The only difference from an administrative standpoint is that it is much more difficult to prevent fires and apprehend those who start them.

Another problem is caused by high densities of cattle in competition, both direct and indirect, with wildlife for available grazing. This presumably reduces the density of some species in the Reserve either by displacement to areas further from the river or, more permanently, by competitive effects on their population dynamics. Either way the viewing potential of the area is reduced. Rangeland in the vicinity of the Tana has been described as in "very poor condition" (F.A.O., 1973). While this is an unsupported and probably overgeneralised conclusion some local overgrazing undoubtably does occur. For some distance around bomas on the West bank in the early part of the dry season, the lush grass at the base of bushes contrasts strongly with the almost bare earth in exposed sites. While some sheet erosion is evident the very damaging gully erosion found in many other parts of pastoral Kenya is not found locally because of the flat terrain and consequent slow runoff of rainwater.

It is possible that this problem of over-use of the Reserve by cattle will become more serious on the West bank with effective enforcement of grazing rights within the Ida-Sa-Godana ranch and the L.M.D. holding ground at Wenje, both of which are adjacent to the Reserve. If nomadic cattle are excluded from these areas they may concentrate within the Reserve.

5 - 2(c) Changes in the river regime

There remain two possible threats to the habitat of the Reserve, which are less directly related to local human land-use. One concerns elephants and has been discussed in Section 4 - 3. The other concerns the river regime, which may be changed by storage regulation for hydro-electric and irrigation schemes upstream.

The Seven-Forks hydro-electric scheme on the upper river will consist of a series of three dams to provide the National Grid with electricity. These are called the Kamburu, Gataru and Kindaruma dams, respectively. Only the Kamburu dam has storage capacity. To date Kindaruma and Kamburu are functional and already provide an annual average of nearly 30% of the country's present electricity needs. The third dam at Gataru is to be opened shortly. The Bura irrigation scheme has not yet begun, but a detailed survey and plans have been drawn up (ILACO, 1975) and a final investment decision will shortly be made. The intention is to divert part of the river flow by a weir at Nanigi and run it along a 74 km. main canal to irrigate an area of 13,480 Ha. on the West bank in the vicinity of the present village of Bura. Individual farm plots will probably be of 1.25 Ha. in size, thus providing a living for some 10,785 tennants and

and their dependents. In all it is anticipated that 80 - 90,000 people will be attracted to the area, which is presently only sparcely inhabited by nomadic Orma people. This is very large scale development indeed. A Tana River Development Authority was established in 1974 to advise the Government on all aspects of the development of the Tana basin and its main task to date has been to integrate the development of hydropower and irrigation potential from the river. The possible adverse effects of these schemes on the downstream ecology are well within its brief and deserve detailed consideration. Both types of development must affect the river regime. The important questions are by how much and, secondly, what effect would changes of a given magnitude have on the downstream ecology.

An attempt to answer the first question has been made in the Bura Irrigation Scheme Feasibility Study (op. cit.). The report considers possible changes in the frequency and severity of minimum flows in March and of maximum flows at Nanigi, the proposed water extraction point for the scheme. Some key data on estimated minimum flows taken from the report are presented in Table VIII.

TABLE VIII. MINIMUM MARCH RIVER FLOW RATES AT NANIGI (Cu. mets. per. sec.)

	1 in 5 year event	1 in 10 year event
Estimated minimum flow at Nanigi prior to the Kamburu dams	37.0	30.9
Minimum flow with Kamburu dams i.e. at present	51.8	47.9
Proposed Bura scheme offtake	15.1	15.1
Remaining downstream flow when Bura scheme functioning	36.7	32.8

The dams at Seven Forks are planned to release a minimum discharge of 42.5 $m.^3$ per.sec. and since the inauguration of Kamburu in 1974 this has had the effect of slightly raising exceptionally low river levels, relative to what they would otherwise have been. The Bura irrigation scheme, if and when it is put into operation, will withdraw a constant 15.1 $m.^3$ per.sec., which is 19% of the present mean March flow of 80 $m.^3$ per.sec. The river will therefore always be lower than it would without the scheme. However, it is argued that this depreciative effect on exceptionally low levels is

almost exactly countered by the increase in minimum flows which has been in effect since the operation of the Kamburu dam. In other words extreme minimum flows will eventually be very similar to what they were prior to both the Bura and Kamburu schemes, whose effects will cancel each other out.

On the subject of peak flows the report argues that the Kamburu dam with an effective storage capacity of 123 x 10^6 $m.^3$ is inadequate to have more than a marginal effect on peak flows. It is not large enough to hold back a flood. The Bura offtake would be the same or possibly less in the west seasons than during the dry, since irrigation water would only be needed to supplement the rains. Hence it is claimed that the scheme would have only a marginal effect on the river. This contention is not supported by any quantitative prediction of the effects of either of these installations on downstream flood frequency.

However, the report does predict an intriguing affect of the construction of the Nanigi weir, which is not immediately obvious to the layman. Apparently the bed of the river will rise by siltation both above and below the weir. Immediately above the weir this rise is predicted to be of the order of 1 - 2 metres in 5 years. This will cause a local increase in flood frequency gradually backing up as far as Garissa.

The prediction of the effects of given changes in the river regime on the flood plain ecology is difficult and can only be made in qualitative terms. However, it does seem that flooding is more crucial than dry season minima as a determinant of vegetation. During the exceptionally low river levels of February and March 1974, when even the ferry at Garsen was grounded, there was no apparent interference with the production of young leaf on trees at Mchelelo, which occurs in some species at this time of year. Presumably, mature trees have a root system capable of drawing up water when the standing water table is 5½ metres down, as it was then. Smaller forest trees and shrubs in the forest are quiescent in the dry season and flood plain bushland is mostly deciduous. Perennial grasses dry out or are grazed down. In brief, all elements of the community can tolerate the lowered water table and providing any changes in the dry season flow are within the present range of variation, they are unlikely to be serious.

A reduction in the height and frequency of flooding, on the other hand, would almost certainly have a serious effect on the vegetation. In addition to swamping flood plain land, the floods deposit sediments, as in Section 2 - 4, which renew the fertility of the land. Floods are also the time when ox-bow lakes are cut off, so a reduction in floods would tend to stabilize the river in its present course, thus preventing the cycles of

senescence and rejuvenation in the vegetation pattern which are so characteristic of the flood plain ecosystem (Homewood, 1975).

Generally we may predict that the adverse effects on different components of the vegetation will be in inverse proportion to the depth of their root systems i.e. shallow-rooted ones will be more seriously affected than deep-rooted ones, sych as trees. In approximate order of sensitivity, the following changes are likely:-

1. A reduction in the quality of grassland in the flood plain and delta areas. This would have an immediate effect on the the quality of the delta as a dry season refuge for pastoralists and wildlife.
2. A reduction in the agricultural produce of the Pokomo. Rice and Greengram are the crops most dependent on floods, but maize would suffer also.
3. A decline in the flood plain bushland and forests based on old courses of the river, which are filled by the floods.
4. Possible interference with regeneration of sandy levee forest tree species. Some of these species may require flooding to germinate and develop properly. Stabilization of flood plain dynamics would also have a long-term effect on forest composition. Homewood (op.cit.) believes this would be particularly disadvantageous for Mangabeys which are specially adapted to unstable forest conditions.

Many of the mature forests are above the level of all but exceptional floods and thus, presumably, do not require floods for their maintenance. Indeed, one important species, Pachystella brevipes has died off in some areas where it was heavily flooded during 1961.

Agricultural and cattle productivity will thus be the most sensitive indicators of a deterioration in the flood plain environment. Because of the dependence of the human population on this productivity the effect of the Kamburu and Bura schemes on flood frequency should be the subject of a quantitative prediction from hydrological data. The assertion that they will have only a marginal effect needs to be substantiated.

With a view to the more distant future, the design of the Nanigi weir makes provision for a possible offtake of an additional 30 $m.^3$ on the East bank of the river (i.e. in addition to the West bank scheme) where preliminary studies indicate a large area of suitable soils. The report (op.cit.) suggests that exploitation of this further irrigation potential would require the construction of a large storage dam(s) in the upper reaches of the river,

by which to control the present floods and let water out slowly through the dry seasons. Such a dam, the Upper Reservoir Scheme is already at the planning stage (T.R.D.A., pers. comm.). In view of the very rapid increase in the country's population, if the Bura West scheme should prove a success, there is likely to be pressure for this East bank extension to be carried out. This would obviously involve much more drastic interference with the river than that required for the presently proposed scheme. This in turn might make the livelihood of the downstream inhabitants inviable. At present there are an estimated 40,000 people ultimately dependent on floods downstream of Nanigi. Their resettlement would be a heavy burden on the scheme, whose main function would be to settle surplus population from other parts of the country. Should an extension of the Bura scheme ever be mooted, this scenario would need careful assessment.

A different sort of speculation is prompted by the prediction of a local increase in flooding above the Nanigi weir. This area will become very favourable for agriculture and will probably attract greater settlement than at present, either by immigration from other parts of the river or by rejected applicants from the scheme. The forests of the area will thus be greatly at risk, yet at the same time their undisturbed survival would constitute an experiment on the effects of an increase of flooding. If the area had been studied prior to the construction of the weir i.e. now, a future study could be most instructive. The preliminary study could also identify the most important areas to be conserved.

Finally, to summarise the relevance of this section for the Tana River Game Reserve, it is probable, though not proven, that the existing Seven Forks and proposed Bura schemes will not have a significant effect on the habitat. In so far as they, or future schemes, do alter the downstream river regime, the agricultural and pastoral livelihood of the inhabitants is likely to be a more sensitive indicator of the change than the condition of the forests. The livelihood of the people will also be a much more effective political weapon against indiscriminate exploitation of the river than will the conservation of forests.

5 - 3. Recommendations for human land-use within the Reserve: a discussion

If it is accepted that the prime purpose of the Tana River Game Reserve is to conserve remaining flood plain forests, then it must be appreciated that this aim is not compatible with existing human land-use as outlined above. This is the central management problem of the Reserve. Regulations must be devised which are both effective and enforcable. To be enforcable

regulations must, in the final analysis, win the acceptance of the majority of people. Good public relations with local people are therefore an essential aspect of the proper management of the Reserve. Amongst other things this means a realization of the sacrifices being demanded of very poor people who are only doing what they have always done and considered their right to do. While enforcing changes in land-use on the one hand every effort must be made on the other to make the Reserve an alternative economic benefit to the residents of Gwano and Ndera locations and prevent their alienation to it.

It is suggested that control of human land-use should proceed in two stgaes, in which restrictions should be matched with tangible benefits whenever possible. Regulations can be made in some cases by the District Commissioner via Chief's Orders and also by edict of the Minister for Tourism and Wildlife. The Attorney General's office has recently determined that since a Game Reserve is gazetted by the Ministry, the County Council may not pass bye-laws for its administration, even though the Ministry is only acting on its behalf. The County Council, however, still plays an important role as receiver and spender of income from the Reserve and in laying down conditions on which a lease is granted for a private company to run a commercial camp in the Reserve.

The first stage in the establishment of the Reserve as a de facto conservation area is basically a freeze on existing land-use. A ban on further forest clearance and on burning has already been made by the District Commissioner. This also includes the cutting of large trees for canoes, charcoal burning and the use of palm trees in the Reserve for making palm wine. The boundaries of the Reserve are such that suitable areas for all these activities exist outside the Reserve but still within Gwano and Ndera locations. These restrictions should be extended to prevent any further farm extensions on fallowed land, since this is potential forest regeneration, or any immigration for settlement, as for example, the Somalis have done on the East bank in recent months. With respect to pastoral rights, at very least grazing within the flood plain must be stopped and drinking access limited to a few defined spots. This will minimize fires and trampling by cattle within the flood plain. However, eviction of pastoralists at an early stage may be more practicable and is discussed below. These are considered the minimum conservation requirements of the Reserve and must be enforced rigorously. The threat of eviction from the Reserve would be the ultimate deterrent to persistent offences by agriculturalists.

On the other hand rights of passage by local residents and fishing rights in the river and seasonal lakes should be guaranteed for local residents

using traditional methods (e.g. no nylon nets). Honey gathering should be permitted providing it does not involve buring or other destruction. The right to cut stakes for building purposes may be conceeded although the Warden should be able to direct it (e.g. to determine which species of bush and from which forest patches.).

The most important demonstration of good faith by the Government will be in the provision of employment to people in Gvano and Ndera locations. If the jobs are given to outsiders when they could be given to local people, this will be seen as a betrayal and the Game Department can expect little voluntary co-operation with land-use regulations. Further, employment opportunities should be spread evenly among the Pokomo villages in the two locations and also, where suitable, offered to the Orma based in the location (e.g. at Wenje). Employment opportunities are likely to be in three main categories - as game scouts, employees of the commercial camp and as labourers. At present 9 labourers and a driver are employed as a labour team and this type of employment will continue under the direction of the Warden. Discriminatory employment clauses are not acceptable for inclusion in the lease for the commerical camp but the leasee must nevertheless be prevailed upon to employ local residents of these two locations whenever reasonably possible. Game Department employees are obviously subject to transfer to any part of the Republic, but it is suggested that for the number of scouts posted to the Reserve an equivalent number are recruited within Tana River District and some from the immediate vicinity of the Reserve.

Another way in which the Reserve can be a local benefit is through the bed-night revenues to the County Council which can be used to finance local community projects, such as improved schools and dispensaries etc. Initially these are being charged at the rate of 10% or 10/- per bed night, whichever is more. Experience in other districts, however, shows that the benefits of such revenues often completely fail to find their way back to the part of the district in which the money is raised. This is a matter in which the District Commissioner, as Hon. Chairman of the County Council, could exert some influence. One possible solution would be for a certain percentage, perhaps one half, of revenue to be ear-marked for projects within the two locations concerned. If action is taken on the second stage recommendations for one or more menor irrigation schemes in the area, the money could form the basis of a communal contribution to the scheme.

Finally, a few local residents have shown an interest in becoming shareholders in the tented camp. Provision should be made for such local investors. The proposed leasee also favours the idea of their inclusion

in the enterprise.

A second stage in the establishment of the Reserve with respect to agricultural threats should be delayed for 3 - 5 years until the success of the first stage can be assessed and the financial benefits of the Reserve are apparent. If the Reserve is accepted and its regulations observed both in spirit and in detail a second stage may not be necessary: a remarkable example of co-existence between destructive human land-use and conservation will have been achieved. If, however as is more likely, conflicts and infringements of regulations still arise it must be accepted that the Reserve will have a greater chance of survival with a minimum of human habitation. Further, in order to relieve Elephant density in existing forest patches and minimize the fragmentation of forests (See Section 3 - 4) it is highly desirable that succession be allowed to proceed towards forest in all areas, including those that are now shambas. In brief, people should be enticed to leave by the offer of an alternative livelihood outside the Reserve.

Judging from reactions to my enquiries, this could be achieved willingly, if the project was properly conceived and organised. At present people in the area have no wish to take part in the proposed Bura irrigation scheme, although this attitude might change if it was seen to be a success and the opportunity was offered. A small proportion of the plots on the Bura scheme will no doubt be reserved for residents of Tana River District and priority of access should be given to present residents of the Reserve.

A better alternative for the present purposes would be one or two minor irrigation schemes in the locations of Gwano and Idera, but outside the Reserve, and on which priority of settlement was again given to anyone who has traditionally lived in the area of what is now the Reserve. Minor irrigation schemes are notoriously difficult to organize and run successfully. The first problem is the siting and design of the scheme and a second usually concerns the maintenance of machinery. A scheme is currently in operation at Wema near Garsen with technical assistance being provided by various overseas aid organizations and the U.N.D.P./F.A.O. Minor Irrigation Schemes Project. Its progress should be followed carefully. The soils in that area have been surveyed by Sombroek et al. (1974). The present scheme is sited on brown clay basin land but soils intermediate between these and sandy levee soils are recommended as ideal. As far as I can judge, extensive areas of both these soil types exist just South of Mnazini on the West bank of the river and are mostly not used for agriculture at present. There is relatively little unused flood plain land outside the Reserve in Gwano location, and the adjacent areas of the dry plains

are probably only of marginal suitability if they correspond to either the "low terrac land" or "regular valley sides" described by Sombroek et al. (1973) for the Tana between Bura and Mbalambala. However, any further consideration of irrigation possibilities should be preceeded by a professional survey by the Soil Survey Unit of the Ministry of Agriculture. With respect to the problem of maintaining punping equipment, consideration should be given to the possibility of lifting water by wind-powered pumps. These are mechanically simple and the fuel is the cheapest known. Considering the time needed to survey, plan and finance any irrigation schemes, contacts and enquiries should be initiated immediately with the Ministry of Agriculture and the Tana River Development Authority.

The problem of relocating pastoralists is different in that they are traditionally nomadic and very few are permanently resident in the area of the Reserve. As stated before it is Government policy to divide up pastoral lands in the district into group ranches. Thus, it is argued pastoralists can be completely excluded from the Reserve and absorbed onto the new ranch lands. This would certainly be desirable since there is at present no part of the lower Tana basin from which cattle are excluded, except the very arid Kora Game Reserve, which is strictly outside the lower Tana. One small, undisturbed area would allow some assessment of the effect of cattle grazing and particularly the management policies of the new group ranches on range condition. It would also probably become a magnet for wild grazing animals and thus provide improved game viewing in the Reserve, although the possibility of an elephant problem is appreciated, as discussed in Section 4 - 3.

It is the author's opinion that the new group ranches will experience considerable difficulties on account of most of the district being too arid to support substantial herds of cattle on anything but a very extensive ranging pattern. This is in line with the F.A.O.'s report on Range Development in Tana River District (Ch.5 PP 44) ...."the traditional nomadic approach i.e. opportunistic grazing movements relies heavily upon the few favoured areas therefore it is recommended that there be no intensive ranching development which would exclude general access to these areas". If this prediction is correct then there is likely to remain a considerable number of cattle either not absorbed on to ranches or migrating from gazetted ranchlan in search of better grazing. This means that any attempt to exlude cattle grazing and pastoral settlement from the Reserve, while desirable from an ecological standpoint, may be difficult to enforce. On the other hand uncontrolled cattle grazing would be intolerably destructive in the circumstances and attempts to limit grazing without excluding it altogether would

be even more difficult to enforce. It is therefore recommended that all pastoral settlement and grazing be excluded from the Reserve. This is particularly important on the West bank which is easier to administer and more important to the development of tourism.

5 - 4. Summary of land-use recommendations

STAGE I

Enforce a ban within the Reserve on:-

1. All forest clearance and extension of shambas into fallowed land.
2. All burning.
3. The cutting of large trees for canoes.
4. The tapping of palm trees for palm wine.
5. Grazing of domestic stock within the flood plain, access to the river for being restricted to a few defined spots.

Conceed within the Reserve, subject to the above restrictions being observed:-

1. The right of established farms and their owners and families to remain.
2. The right to cut undergrowth saplings of non-canopy tree species in specified forests for building and domestic use.
3. Rights of passage to local residents.
4. Rights of local residents to fish and collect wild honey.

At the same time as the above, and equally important, every means should be used to provide employment and other benefits in Gwana and Ndera locations. Specifically it is suggested that:-

1. All labouring jobs are offered to residents of these locations.
2. Any leasee of the concession for a tented camp within the Reserve should employ residents of these locations whenever reasonably possible.
3. The Game Department should employ from Tana River District and preferably this area as may new scouts as are posted to the Reserve.
4. One half of all revenue accruing to the County Council from the Reserve should be used to finance projects in the two locations concerned.

STAGE II - to start after 3 - 5 years

1. Develop one or more small scale irrigation schemes in the two locations with the capacity to absorb at least the families currently in the Reserve. Offer priority of settlement to these people.
2. If feasible under the circumstances that emerge, ban all domestic grazing and settlement within the Reserve.

CHAPTER 6. DEVELOPMENT PROPOSALS

6 - 1. General

It will be apparent from the last chapter that a major effort must be made to develop the Tana River Game Reserve for tourism and thus justify the Reserve locally in terms of employment and revenue.

The tourist potential of the Reserve will be almost exclusively restricted to the dry seasons. Firstly, while the Garsen-Garissa road is likely to be upgraded to all-weather status within the next five years, at present it is often impassable to saloon cars during the rains. The same applies to tracks within the Reserve. Secondly, mosquitoes make outdoor evening activity a misery during the rains and for about one month afterwards. This is particularly the case if the river has flooded. Outside of these periods mosquitoes are not a serious problem. Finally, conventional game viewing and particularly for Elephant is much better in the dry than the wet seasons. Forest and riverine fauna, though, can be seen at all seasons.

While the Reserve on both sides of the river must eventually be administered and developed, the West bank is considered a higher initial priority because it is much more accessible and is the side from which most, if not all visitors will enter.

6 - 2. The road system, viewing circuits and boundary tracks.

Communications within and outside the Reserve are fundamental to its adminstration and development for tourism. Roads and an airstrip have been the main priority during the initial development programme sponsored by World Wildlife Fund in 1975.

The approximate alignment of tracks completed or proposed within the Reserve are shown on Map 2. together with the location of the airstrip, the proposed site of the headquarters and other installations. The total proposed track system comprises 55 km. on the West bank and about 40 km. on the East bank, excluding boundary cut lines. Of this some 45 m. on the West bank has been completed to date. The tracks have been cleared to a width of about 5 m. and follow a gently winding course, so as to give maximum opportunity for game viewing. The tracks will require periodic grading, ideally after each rainy season. Since use of the Reserve will be highly seasonal it is not anticipated that murraming of the roads will be necessary or desirable. Even if it is decided to murram certain sections,

those sections within the flood plain must be left since murram will be washed away or buried after substantial floods.

On account of the small and divided area of the Reserve it has not been possible to develop very many circuits within it, but track does pass through sections of all the main habitat types and most of the features of the flood plain ecology can be seen.

The northern boundary line on the West bank reaches the river at Makere at the site of four grave stones dated between 1899 and 1910. These belonged to the families of German Neukirchen missionaries who set up a mission here in 1898, but moved to Mola in 1912 (Rowlands, 1955). The main North-South track on the West bank runs from here along the edge of the flood plain past the turning to the tented camp and into the flood plain between there and Mchelelo. The forest edge at Mchelelo is completely open due to locally very alkaline soils and the track runs alone this strip, past the splay lake called Pongi and into the Congolani West forest. This is the only substantial forest patch crossed by road and is mainly of interest on account of the totally senescent area of ex-Pachystella forest adjacent to the Congolani ox-bow lake (See Sections 2 - 4 and 3 - 2). South of Congolani the track follows a deep flood channel that was gouged during the formidable floods of 1961. After passing through 1.5 km. of flood plain bushland the road emerges on to an open area, known as Mariadadi. This was cleared of a natural Type III forest in 1956 in the hopes that the Government would give a pump for a cotton irrigation scheme. The scheme was ill-advised and soon abandoned - a sad example of forest clearance for short term gain, in this case three years' crop without irrigation. At the southern end is another belt of dead trees whose death was due to the very heavy flooding during 1961. Here we have examples within 3 km. of each other of trees killed by too much and too little water. At this point the track crosses another track from the main Garsen-Mola road into Baomo. This was cut in the 1930's to provide access to a prison camp at the North end of the Baomo South forest patch. The original site was washed away in a flood in 1947 (Rowlands, 1955). A site near this by the river is suggested as a good spot for visitors with their own camping gear. Continuing South on the main track, it enters a low-lying brown soil part of the flood plain and runs parallel with and West of the large Baomo South forest and the two Mnazini patches until it joins the track from Mnazini village to the main road. All this southern section of road is liable to flooding and is extremely treacherous after rain. A small circuit at Nkano gives access to two attractive ox-bows and the rather diverse forest types of this area. This would be another possible

campsite or site for a ranger post in the South of the Reserve.

One important game viewing track runs parallel with this main track but outside the flood plain between the Ilchelelo and Baomo tracks. This winds through attractive bushed grassland and a strip of woodland. A further such track could be aligned near the main road in the grassland zone where Orma and Somali bomas are usually located.

For visitors wishing to diversify their game viewing by car, the cut-lines made in 1975 by Rodgers Ltd. during their oil prospecting activities are of great potential as they give ready access to areas well away from the river where a number of large mammals may be seen that are rarely sighted within the Reserve (e.g. Eland and Topi). At certain seasons conventional game viewing is likely to be much better here than near the river. A particularly attractive circuit would proceed West along the Maroni cut-line that crosses the airstrip, continues over the main road and then crosses another North-South cut-line 9 km. beyond. The westerly cut-line continues for another 32 km. until it ends near the Tiva. However, rather than follow this cul-de-sac it is suggested that visitors turn South 6.5 km. until a prominent East-West elephant trail is crossed. This could easily be upgraded to a proper track, but is quite negotiable even at present. It emerges on to the main road near the Baomo track. The Reserve can be re-entered at this point and a return to the commercial camp or any other part of the Reserve made by one of the routes already described. The total circuit from the commercial camp would be just under 50 km. and provide access to an excellent diversity of viewing opportunities. However, all the driving outside the Reserve would be on land belonging to the Ida-Sa-Godana ranch and permission would have to be agreed by means of a request to the ranch from the County Council and the Game Department. The ranch already derives considerable income from hunting concessions on its land and it is not thought that there would be any objection to free use of its land.

Tracks on the East bank have not yet been aligned in detail, but it is suggested that a main North-South track is cut from Masalani in the North to Kitere in the South, following the edge of the flood plain. Such a track already exists for 13 km. from Masalani police post as far South as Kivukoni. Most of the dry plains zone adjacent to the flood plain is fairly open as far South as Ilchelelo and would need little clearance. From there to Kitere is only a further 14 km. following the flood plain. Access from this track to the river could be made near the commercial camp site. The track to Masalani police post from Ijara is good, but that from Ijara to Kitere is presently very eroded. A new cut-line is due to be cut shortly on the East bank in exact continuation of the Maroni cutline and this will

tented campsite. The success of this venture is central to the economic success of the Reserve and thus its viability as a conservation area. It was therefore conceeded that an area of undergrowth in prime forest habitat with shady overhead canopy would have to be cleared. The area chosen was by the river near the boundary of the Reserve, above flood level and rarely likely even to be cut off. The exact site was selected beacuse of the presence of a young and shady stand of Bligia unijugata by the riverbank. This species does not seem prone to dropping large bracnhes, unlike some more common forest species, such as Acacia clavigera or Ficus sycomorus. The view of the opposite bank is forested but the strip is no more tha 50 m. wide and backs onto seasonal grassland. It is thus very vulnerable to burning which would detract considerably from the attraction of the site. This must be prevented at all costs. In addition to firm action against any burning in the area it would be worth cutting a fire-break in the grass immediately behind the forest strip to further forestall this possibility.

Another exception to the principles of site selection in a small reserve is the existence of two small research houses by the river at Nchelelo. This area was cleared for farms in 1966 and abandoned in 1969. Regeneration towards forest is progressing and this area should certainly not form the nucleus of the Reserve headquarters. Such an action would involve reclearance of the area and thus interfere with the Reserve's prime aim of forest conservation to an unacceptable degree. There is, however, a good case to be made to leaving these existing buildings for research purposes and one has been loaned indefinitely on this understanding. The nearby forest patch of 17 Ha. has been studied intensively for 3 years and it is important that continuity of research in the same study area be maintaine Behavioural research involving long hours of observation is greatly facili- tated by the proximity of the research worker's dwelling to his study area and this also minimizes the need for car travel in the Reserve. The same applies to other research that involves intensive ecological sampling of this area by foot.

When the Reserve H.Q. at Nakere is sufficiently developed to require a treated water supply from the river, the nearest access point is at Nakere and it is suggested that the water is also made available to the village. This would be seen as a most welcome spin-off of the establishment of the headquarters near that village.

The proximity of the tented camp to Nakere would also allow some non-essential camp staff to live in Nakere and commute to work daily, thus reducing the area of forest that must be given over to accomodation of camp employees.

The siting of one or more entrance gates on the West bank is a problem since there are at present four access tracks into the Reserve. It is suggested that the initial gate be at the entrance to the Mchelelo track. In such a small Reserve this may be adequate. If a further gate was wanted it could be located at the Chief's office near the main road on the track into Mnazini.

A more important priority than a second gate on the West bank would be a gate and rangerpost on the East bank. The best site would probably be Kitere. Communication with the East bank and between different points on the river would be greatly facilitated by a boat and outboard motor for use by the administration only. At times of flood this would be the only means of access to most parts of the river.

6 - 4. Development for tourism

6 - 4. (a) Tourist potential and position on circuit.

The major potential source of visitors to the Reserve is undoubtedly Malindi, 100 km. to the South. Some 18,000 tourists stayed in the town during the 1974-75 season (Mr. C.I. Norby, pers.comm.). Most of these were German, Swiss and French tourists who spend most of their vacation on the coast. However, many take excursions to various National Parks and the two major air companies in the town between them flew an estimated 5,000 tourists on game park tours in that season. The market for such tours is still considered to be underexploited, and the Tana River Game Reserve, by virtue of its diverse attractions and proximity to Malindi is very favourably placed to exploit it.

For the visitor going by road to Lamu, the Reserve is 53 km. off his way from Garsen. Air tours which combined a visit to the Reserve and to Lamu would be very attractive. Other means of access are from Garissa which is 200 km. North of the West bank road. East bank access is less good but entrance via the Masalani cut-line and exit by the Kitere track to Ijara offers the possibility of a detour circuit between Garissa and Lamu. The possibility of a connecting road from Garsen to Kitere has been mentioned. The East bank will become more important as the other new game reserves in the area are developed. The Arawale and Boni Game Reserves are particularly well placed to be included in a single safari. Eventually it is intended that an Eastern Kenya safari circuit may emerge which would include Meru National Park, Kora and Rahole Game Reserves upstream of Garissa, Arawale and Boni Game Reserves in southern Garissa District with

incorporated into a tourist guide book covering the whole of the Reserve. There is good reason to believe that may tourists appreciate the opportunity to understand an area in a more profound sense than simply watching large mammals in pleasant surroundings. On account of its habitat diversity within a small area this Reserve offers a great opportunity for education in ecology.

Rather longer walks could also be organised, but the Michelelo study area forest should under no circumstances be used for conducting tourists. It is also not recommended to use the forest between Michelelo and Guru on account of the high density of big game species that use it. The only other forests, in fact, whose guided use by tourists might be considered are the two Mnazini patches because they offer a great diversity of forest types in a small area.

Boat trips on the river are also likely to be a great attraction. The section of the river which is most attractive and where most fauna can be seen (See Section 3 - 4) is between Makere and Baomo. It is suggested that the organization of these trips be left to the commercial camp. If visitors embarked at the camp or Makere they could drift downstream as far as either Congolani or the Baomo camp site, where they could be picked up by car after a trip of two or three hours. The most attractive type of craft is a pair of dugout canoes lashed together. However, by encouraging a market for canoes their use conflicts with policy on forest conservation. Their use is therefore reluctantly recommended against. Outboard motors should certainly not be allowed; they frighten animals, particularly Crocodiles, disturb the peace and conflict with the requirement to maximise local employment. Their use is only justified by the occasional need for fast transportation by Game Department personnel (e.g. to investigate and control fires or poaching).

A number of entrepreneurs have occasionally shown interest in much longer boat safaris, say between the Reserve and Kipini at the coast. My experience suggests that most visitors begin to feel bored and hot after about three hours on the river. Below Mnazini there is virtually no forest on the riverbanks and the river flows monotonously between high grassy banks.

A different type of special attraction which should be developed is a market for local crafts. The Pokomo of the lower Tana are noted for the quality of their woven mats, of which there are two good quality types, the "mchacha" and the "mlingo". Both of these and the traditional

wooden combs undoubtedly have commercial potential, whose only outlet at present is via shops on Lamu. The tented camp for tourists would be a much more ready market and would spread money directly to women who make these things. The sums of money would not be large but they would be tangible benefits to a large section of the community. The mats are made from Phoenix Reclinata and the combs from Hunteria zeylanica. Both of these are bush species common outside the Reserve, so the development of a commercial market for them will not conflict with forest conservation.

6 - 4.(c) Accomodation

The main accomodation for visitors to the Reserve will be the commercial tented camp. At the time of writing a lease is being negotiated through the County Council for use of the proposed campsite area by King-fishersafaris of Malindi in conjunction with Lawfords Hotel and Root-Leakey safaris.

The bed capacity of the establishment is one means of controlling the scale of development and the number of visitors to the Reserve.

While it is desirable that tourism within the Reserve be promoted it must be remembered that at 84 km.^{2} the West bank of the Reserve is a very small area and thus its tourist capacity is going to be limited. It is most unlikely that visitors will travel long distances to a "remote" part of the country with less blatant attractions than the vast herds of the Mara or the scenery of Samburu and tolerate high density viewing conditions. It is suggested that about 20 beds be the maximum permitted in the commercial camp.

The same line of argument that would limit the bed capacity of a commercial tented camp would also exclude any subsequent building of a lodge. In the case of a lodge the argument is further reinforced by the inadvisability of building any large and permanent structure in the flood plain. The reasons will be obvious from Section 2 - 3.

A site for a campsite for visitors with their own equipment has been suggested at Baomo. Other possibilities exist at Mkano and Kitere. Initially the only facilties that need be provided are a long-drop lavatory and firewood, which should be collected outside the flood plain. River water is readily available at the Baomo site and drinking water could be collected from Makere, when a treatment plant has been constructed there. Later development of self-help bandas would require another water treatment plant at the campsite. This could also provide for a ranger post both to administer the campsite and guide visitors in the nearby Baomo South forest.

6 - 5. The role of research

It should be apparent from the description of this ecosystem in previous chapters, that it is one of the most complex contained within any National Park or Game Reserve in East Africa. In view of this and the considerable scientific investment already made in the Reserve, it is greatly to be hoped that research will play an important and constructive role in its management. To this end three general suggestions are made:-

1. Management should be actively involved in the monitoring of the Reserve so that the gathering and application of information do not come to be seen as distinct, much less contrary activities.
2. Research proposals should be vetted within a framework of priorities. A statement of priorities forces management to identify topics of importance and areas of ignorance and thus predisposes itself to give careful consideration to the conclusions of research on them. A broad framework exists in the Research Division of the Game Department's priorities for the Galana eco-unit and some more detailed suggestions are made below.
3. In making and assessing recommendations, both scientists and administrators should distinguish carefully between scientific facts, scientific judgements and their opinions (Douglas-Hamilton, 1973). Opinions and recommendations usually involve an ethical and aesthetic as well as a scientific component and therein lies the genuine basis for disagreement. Disagreements based on scientific facts and judgement are in principle resolvable and therefore unnecessary.

The following topics should be monitored as part of routine management:-

1. Climate. A screened meterological station should be established in co-operation with the East African Meterological Department. Rainfall data have been collected at Mchelelo only since September 1974 and maximum and minimum temperatures have been recorded but not under screen conditions. Other rain gauges should be kept at any ranger posts established.
2. River levels. A graduated post should be embedded in concrete in the river bed at Makere and read daily. More detailed hydrological data including flow ratings are collected now at Hola and elsewhere but immediately available height readings give an indication of the extent of floods in different parts of the Reserve and allow

comparison between seasons and years.

3. Aerial survey. The requirement and methodology for a systematic aerial survey to be carried out at least once a year in the late dry season was described in Section 4 - 5. When an aeroplane is available for this, time should also be taken to monitor on aerial photographs any destruction or regrowth of forests. Copies of the new set of aerial photographs for this area taken in 1975 should be acquired and referred to frequently. In addition, the date, extent and severity of any fires reported in the field should be plotted on a vegetation map.

4. Exclosures. In order to monitor the effect of large mammals and particularly Elephant and Cattle, on the vegetation, exclosures of perhaps 25 m. by 25 m. should be established at 3 locations shown on Map 4. These sites are considered representative of mixed forest (Type I), Acacia (Type III) and evergreen bushed grassland. They should be surrounded by standard game-proof ditches (2.5 m. deep, vertical on the inside and sloping on the outside), and include a fixed point for comparative photography of the plot. Scientific assistance should be sought with the initial enumeration of these areas and nearby control areas. Enumeration should ideally be repeated at least once a year. Even if not sampled regularly they are likely to be of great long-term value and the moats should be maintained carefully.

Research priorities

It has already been suggested that the two houses at Mchelelo be retained for use by research workers. It is also felt that this is the maximum number of houses that should be built in the Reserve. Some other workers living under canvas in other parts of the Reserve and temporary field assistants doing vacation projects may be acceptable additions to the research capacity of the Reserve.

Priority and every incentive should be given to students of Nairobi university in preference to overseas scientists and students. At present Kenyan scientists are seriously under-represented in ecological research in the country and this is surely an unhealthy state of affairs.

Research projects completed or in progress in the Reserve are:-

1. A study of the ecology and behaviour of the Mangabey from September 1972 - August 1974 by Miss K. Homewood whose main study area was the forests at Ukasio. This study is currently being written up for a

doctoral thesis at University College, London.

2. A study of the Red Colobus monkey and its habitat by the author from January, 1973 - December 1975. This is to be used for a Ph. D. thesis at Bristol University, England.

3. A study of Elephant ecology in Tana River District but centred on the Reserve by Mr. J. Allaway of Cornell University, U.S.A. This study was begun in October 1974 and is still in progress. It is to be submitted for a Ph. D.

4. A study of Baboon ecology by Miss S. Singer, begun in September 1975 and still in progress. This is to be used for an M.Sc. thesis at Cornell

5. In addition two-month studies have been carried out by undergraduate students from Bristol university on:-

   The ecology and social organization of Sykes' monkeys, by Miss C. Harcourt.

   The ecology of Green Wood Hoopoes, by Mr. D. Parker.

   The ecology of three species of Kingfishers, by Mr. S. Nicholls.

   The last two authors also carried out a general ornithological survey of the Reserve. (Appendix B).

In addition to follow-up work on the major studies completed or in progress, other studies would be valuable. Priority should be given both to studies of obvious relevance and to more academic studies that can be done nowhere else. The list therefore concentrates on the flood plain which is the unique feature of the Reserve, but it is by no means exhaustive:-

1. A major study of the Sykes' monkey to complement studies on the other three forest monkeys (Vervets are rarely found in forest here). This would be of great academic value, since the preliminary studies of Miss C. Harcourt suggest that this species may be intermediate in its feeding niche between the Mangabey and Colobus. The study of several species in the same habitat is one way in which the relationship between feeding ecology and social organization can be unravelled. If the same study area is used for each study, more forceful comparisons may be made between them. In addition, considerable preliminary work such as habituation of groups and clearing of trails is completed and background information on the habitat is available (e.g. enumeration of trees, long-term phenological data on their fruiting patterns etc.) Detailed

synecological studies in one habitat are also a preliminary to comparisons between habitats. The primate studies on the Tana have been closely associated with a similar but larger programme in the Kibale forest of Western Uganda, where two of the same species, Colobus badius and Cercopithecus mitis, also occur. A comparison between both species in both habitats may show parallel adaptations in aspects of their ecology and social structure. In this way we can begin to understand the demands that gallery forest makes on forest animals compared to a true rain forest, such as Kibale.

One interesting problem which should be included in a study of the Sykes' is why their geographical range on the Tana is so much larger than those of the Colobus and Mangabey. A study site further upstream where the forests are much simpler might provide answers. A study area upstream of the proposed Nanigi weir would be suitable and also serve the purpose of a baseline study in an area likely to be subjected to a changed flooding regime during the next ten to twenty years (See Section 5 - 2.(c)). The potential for an interesting future comparative study is obvious.

2. A botanical study of forest regeneration. This would involve quantitive sampling of different forests to elucidate more fully the state of regeneration of the different patches and types. Since each forest has a different combination of size, soil types, flood regime, Elephant damage and cutting history it may be possible to tease out the factors most important to their health and regneration. Such a study would be of great relevance to management since it would help to product the future of the forests and possibly lead to management recommendations. The study should also include forests outside the Reserve both upstream and downstream. The need for work at Nanigi applies to this study as much as that on Sykes' indeed more so; changes in vegetation are primary to changes in the adaptive strategies of animals. Gallery forest as a vegetation type has been very little studied and is of great importance as a modifier of microclimate and, in many places (e.g. the upper Tana) as a buffer against erosion.

threatened habitat on many river systems throughout the world. In addition to direct destruction, altered river regimes are increasingly common and the crudity of predictions of their effects for the lower Tana is a measure of our ignorance of the precise determinants of riverine forest.

3. Relating to both 1. and 2., a study of fruit-eating birds would be of great interest, since together with monkeys they are likely to be important in the dispersal of seeds and thus play a role in tree regeneration. There might also be interesting parallels between the adaptive strategy of frugivorous birds and monkeys, such as the Mangabey and Sykes', which have a large fruit component in their diet. Are the frugivorous birds, such as the Trumpeter Hornbill, exclusively frugivorous or,

like the monkeys, do they supplement their diet with other items? If not, how do they survive in these forests where fruit is rather seasonal in its production compared to rainforest?

4. Our ignorance about fish populations in the Tana was pointed out by Whitehead (1959) and the need for study in relation to the possible impact of a changed river regime stressed by Blankenship (1975). This area with its extensive splay lakes would be as good as any for a study. It might also lead to recommendations for improved fish productivity and the possibilities of fish "farming". It could also be tied in with the distribution, species composition and migration pattern of the fish-eating bird community.

5. The flood plain grasslands in the Reserve would be a good area for a study of the Common Waterbuck, since they are abundant and comparatively tame there.

It is greatly hoped that research workers will contribute to the management of the Reserve more detailed treatments of many of the topics discussed in this report and others not mentioned. Elephants and forest regeneration particularly merit management reports and in due course more detailed development plans should be drawn up, on the lines exemplified by Western and Thresher (1973) for the Amboseli ecosystem.

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APPENDIX A. PRELIMINARY CHECKLIST OF THE TREES AND SHRUBS OF THE RESERVE.

This list records probably no more than 60-70% of the trees and shrubs of the Reserve, but include all the more common species. The identifications were mostly made by the East African Herbarium, and specifically by Mr. S. Kibua who visited the area for a week in September, 1973.

The classification follows Dale and Greenway (1961) but the authorities for species have been omitted. For many families this work has been superceded by the Flora of East Africa, but it remains a comprehensive and widely available field guide and has been followed for this reason. Pokomo names are listed where known and information on life form and typical habitat are abreviated thus:-

Life Form		T - Tree S - Shrub or Forb	
Habitat Type	Flood plain forest	F-F	(If no numeral affixed the species has no known strong affinities with a particular forest type).
		F-F I	Mixed Evergreen forest
		F-F II	Pachystela
		F-F III	Acacia
		F-F IV	Garcinia
		F-F V	Cultivation
		F-F VI	Disturbed
		F-F VII	Barringtonia
	Flood plain Bushland	F-B I	Terminalia
		F-B II	Phoenix
	Flood plain Grassland	F-G	
	Dry Plains Woodland	D-W	
	Bushland	D-B	
	Bushed Grassland	D-B I	Acacia
		D-B II	Dobera

Species bracketed have been found within 20 km. of the Reserve and may occur there also.

FAMILY	GENUS	SPECIES	LIFE-FORM	HABITAT	POKOMO NAME
PAlmae	Borassus	Aethiopum	T	F-F.V	Mtapa
	Hyphaene	Coriacea	T	F-F.I,III,VI	Mkoma
	Phoenix	Reclinata	T	F-F.VI,F-B.II	Mkindu
Alangiaceae	Alangium	Salvifolium	T	F-F.VI,F-B.II	Mnunae
Amaranthaceae	Cyathula	Sp.	T	F-F.I	Mhandarako
Anacardiaceae	Lannea	Stuhlmannii	S	F-F	
	Rhus	Natalensis	T	F-F.I,II	Mniambembe
	Sorindeia	Obtusifoliolata	S	F-F	
Annonaceae	Uvaria	Sp.	S	D-B	Mbuyu
Apocynaceae	Adenium	Obesum	S	F-F	
	Carissa	Edulis	T	F-F,F-B.II	Mchunguchungu
	Hunteria	Zeylanica	S	F-F	Ufeke
	Rauvolfia	Mombasiana	S	F-F	
	Schizozygia	Coffaeoides		F-F.III	
	Strophanthus	Sp.	T	F-F.I,III,V	Mbwoka
Bignoniaceae	Kigelia	Aethiopum	T	F-F,F-B.II	
	Markhamia	Zanzibarica	T	F-F.I,III	Mdoko
Boraginaceae	Cordia	Goetzei	S	D-B	Mhali
	Cordia	Gharaf	S	F-F	
	Cordia	Ovalis	S	D-B	
	Ehretia	Sp.	T	D-B	Mpefu
Burseraceae	Commiphora	S.P.1	T	D-B	
	Commiphora	S.P.2	T	D-B	
	(Commiphora	Riparia)	T	F-F,F-B.II	Mgombakomfe
Caesalpin-aceae	Afzelia	Cuanzensis	T	F-F,F-B.II	Mtchyoko
	Oxystigma	Msoo	T	F-F.III	
	Cassia	Abbreviata	T	F-F.I	Mpakata
	Cassia	Singuena	T	F-F.I,III	Mwayu
	Cynometra	Webberi	T	D-B.I	
	Tamarindus	Indica	S	D-B	
Capparidaceae	Boscia	Coriacea	S	D-B	
	Cadaba	Stenopoda	S	D-B	
	Cadaba	Sp.	S	F-F,F-B,D-B	Alkagi
	Capparis	Tomentosa	S	D-B	
	Maerua	Grantii	S	D-B	
	Maerua	Calophylla	S	D-B	
	Maerua	Subcordata	S	D-W,B	Mukube
	Thylacium	Thomasii		F-F	
	Ritchiea	Capparoides	S	D-B	
Celastraceae	Maytenus	Senegalensis	S	F-F	
	Maytenus	Undatus		D-B	
Chenopodiaceae	(Su	Lonoica)	S	F-B.II	Mkyuu
Combretaceae	Combretu	Constrictum	S	D-B	
	Combretu		S	F-F.I	
	Combretum		T	F-B.I	Mkokola
	Terminalia	Brevipes	T	[illegible]	Mkhoka
	Terminalia	Spinosa		D-B	
	(Terminalia	Parvula)			

FAMILY	GENUS	SPECIES	LIFE-FORM	HABITAT	POKOMO NAME
			S	F-B.II	
Compositae	Vernonia	Sp.	S	F-B.II	Mnowwe
	Pluchea	Discorides			
Connaraceae	Agelaea	Setulosa	S	F-F	
			T	F-B.II,D-W	
Ebenaceae	Diospyros	Cornii	T	F-F,I,III,IV	Mkuru
	Diospyros	Mespiliformis	T	F-F.I	Mnwiza
	Diospyros	Natalensis	S	F-F.I	Mluhe
Erythroxy-laceae	Erythroxylum	Fischeri			
			T	F-F	Msasuzi
Euphorbiaceae	Antidesma	Venosum	T	F-F	
	Bridelia	Micrantha	S	F-F,D-B	Madowa
	Croton	Pseudopulchellus	S	F-F.II	
	Drypetes	Natalensis	S	F-F	
	Erythrococca	Bongensis		D-B	
	Euphorbia	Sp.	T	F-F,B-II	Mchalaka
	Excoecaria	Venenifera	S	F-B.I+II	
	Phyllanthus	Guineensis	S	F-B.II,D-B	Mkwamba
	Securineca	Virosa		F-F	
	Suregada	Zanzibariensis	T	F-F	Mpujo
Flacourtia-ceae	Oncoba	Spinosa	T	F-F	
	Dovyalis	Abyssinica	T	F-F.IV	Mchachozi
Guttiferae	Garcinia	Livingstonei	T	F-F	
Hernandiaceae	(Gyrocarpus	Jacquinii)	B	D-B	
Hypericaceae	Psorospermum	Febrifuga	T	F-F.VII	Mtole
Lecythidaceae	Barringtonia	Racemosa	S	D-B	
Loganiaceae	Strychnos	Decussata	S	F-F	Msarua
Lythraceae	Lawsonia	Inermis	S	F-B+G,D-B.II	Mazivani
Malvaceae	Abutilon	Longicuspe	S	F-B,D-B.II	Muoro
	Thespesia	Danis	T	F-F.I.III.V	Mvwahi
Meliaceae	Trichilia	Roka	S	D-B.I	
Mimosaceae	Acacia	Bussei	T	F-F.I,II	Munga
	Acacia	Clavigera = A.robusta	T	F-F.III	Mnangawa
	Acacia	Elatior	T	D-B.I	
	Acacia	Mellifera		D-B	
	Acacia	Nilotica	S	D-B.I	
	Acacia	Reficiens	T	D-W	
	Acacia	Tortilis	S	D-B.II	
	Acacia	Zanzibarica	T	F-F.I	Mganikololo
	Albizia	Glaberrima	T	F-F.I	Mchuchampili
	Albizia	Gummifera	T	D-B	
	Albizia	Anthelmintica	S	F-F	
	Mimosa	Pigra	T	D-W	Mkame
	Newtonia	Erlangeri	T	F-F.I	Chemeri
Moraceae	Ficus	Bussei	T	F-F.I	
	Ficus	Depauperata	T	F-F.I	Lvuma
	Ficus	Natalensis	T	F-F.I,V	Mkuyu
	Ficus	Sycomorus			

FAMILY	GENUS	SPECIES	LIFE-FORM	HABITAT	POKOMO NAME
Ochnaceae	Ochna	Thomasiana	S	F-F	
Papilionaceae	Indigofera	Schimperi	S	F-B.II	Mcharara
Portulaceae	Calyptrotheca	Taitensis	S	D-B	
Rubiaceae	Canthium	Zanzibaricum	S	F-F	
	Chassalia	Sp.	S	F-F	
	Coffea	Sp.	S	F-F	Mchome
	Lamprothamnus	Zanguebaricus	S	F-F	
	Pavetta	Sp.	S	F-F	Mrora
	Polysphaeria	Multiflora	S	F-F	
	Psychotria	Sp.	S	F-F	
Rutaceae	Teclea	Sp.	T	F-F	Mlalahi
Salicaceae	Populus	Ilicifolia	S	F-F,III,F-B.I	
Salvadoraceae	Azima	Tetracantha	T	F-B.II,D-B	Mkupha
	Dobera	Glabra	S	D-B	Miswaki
	Salvadora	Persica	S	F-F.I	
Sapindaceae	Allophylus	Alnifolius	T	F-F.I	Mubo
	Blichia	Unijugata	T	F-F	
	Chytranthus	Obliquinervis	S	F-F	Madachui
	Chytranthus	Sacleuxii	T	F-F	
	Deinbollia	Borbonica	S	D-B	Mhumbe Moupe
	Haplocoelum	Mombasense	T	F-F	
	Lecaniodiscus	Fraxinfolius	T	F-F.I,II	Mpume
	Majidea	Zanguebarica	T	D-I	
Sapotaceae	Manilkara	Mochisia	T	F-F.I,III,IV	Mnguuva
	Mimusops	Fruitcosa	T	F-F.I,II	Mchambia
	Pachystela	Brevipes	T	D-B.I	
Simaroubaceae	Balanites	Aegyptiaca	S	F-F,F-B.II	Chaima
	Harrisonia	Abyssinica	T	F-F.IV.	Mlohe
Sterculiaceae	Cola	Clavata	T	D-B	
	Sterculia	Africana	T	F-F.I	Mfume
	Sterculia	Appendiculata	S	F-F.IV,F-B.II	Mkole
Tiliaceae	Grewia	Bicolor	S	D-B	
	Grewia	Tembensis	S	D-B.I	
	Grewia	Tenax	S	D-B	
	Grewia	Villosa	S	F-F,I	
	Grewia	Stuhlmannii	S	F-F	
	Grewia	Tormentosa	S	F-F	
	Triumfetta	Kirkii	S	F-F.I	
Thymelaeaceae	Synaptolepsis	Wightii	S	F-F	
Ulmaceae	Celtis	Guineensis	S	F-F	
	Trema	Sp.	S	F-F.III,F-B	Mvanafankuku
Verbebaceae	Premna	Elliptica			
Violaceae	Rinorea				

APPENDIX B. ANNOTATED CHECKLIST OF BIRDS OF THE TANA RIVER GAME RESERVE

This checklist was made by Mr. D.Parker and Mr. S.Nicholls during a 7 - week study between July and September, 1975. A few other sightings have been added by C.W.M. bringing the total to 248 species. The major gaps remaining are among the Palearctic migrants.

For the purposes of annotating species' abundance and habitat preferences, habitats have been classified as follows:-

A. Wet land: River, sandbars, bankside vegetation, splay lakes, ox-bows, other standing water and swamp vegetation.

B. Riverine forest: Defined as in Chapter 3.

C. Floodplain bushland and open land: — " —

D. Dry plains vegetation - all types: — " —

Scales of abundance have been opperationally defined thus:-

0. - None seen

1. - Less than 5 sightings during the period of the survey (due allowance must be made for shy, retiring species which may be more common than inclusion in this category would suggest).

2. - Not common, but not hard to find in the appropriate habitat.

3. - Common.

4. - Abundant. This category is reserved for species markedly more abundant than others. Most of these are in the harsher dry plains environment outside the flood plain.

These scales of abundance are intended to broadly relate to the true numbers of the birds concerned. Thus the abundance ratings of birds of prey, for example, will always be lower than those for some species of passerines because of their different positions in the ecosystem. However, the abundance of predators and other large birds has been slightly exaggerated to emphasise differences in abundance between such species.

BIRDS OF THE TANA RIVER PRIMATE GAME RESERVE ; SPECIES PRESENT AND HABITAT PREFERENCES. CENSUS CARRIED OUT JULY 20 TO SEPTEMBER 9 1975.

BIRD SPECIES	1. WETLAND HABITAT	2. RIVERINE FOREST	3. FLOODPLAIN BUSH + GRASSLAND	4. DRY BUSHLAND
Ostrich. Struthio camelus polybdophanes.	0	0	0	1
White-necked Cormorant. Phalacrocorax carbo	1	0	0	0
Long-tailed Cormorant. Phalacrocorax africanus.	2	0	0	0
Darter. Anhinga rufa.	1	0	0	0
Pink-backed Pelican. Pelecanus rufescens.	1	0	0	0
Grey Heron. Ardea cinerea.	3	0	0	0
Black-headed Heron. Ardea melanocephala.	3	0	0	0
Goliath Heron. Ardea goliath.	2	0	0	0
Purple Heron. Pyrrherodia purpurea.	2	0	0	0
Great-white Egret. Casmerodius albus.	3	0	0	0
Yellow-billed Egret. Mesophoyx intermedius.	2	0	0	0
Little Egret. Egretta garzetta.	1	0	0	0
Buff-backed Heron. Bubulcus ibis.	2	0	0	0
Squacco Heron. Ardeola ralloides.	1	0	0	0
Green-backed Heron. Butorides striatus.	3	0	0	0
Night Heron. Nycticorax nycticorax.	2	0	0	0
Little Bittern. Ixobrychus minutus.	2	0	0	0
Hammerkop. Scopus umbretta.	2	0	0	0
Woolly-necked Stork. Dissoura episcopus.	2	0	0	0
Open -bill Stork. Anastomus lamelligerus.	2	0	0	0
Saddle-bill Stork. Ephippiorhynchus senegalensis.	1	0	0	0
Marabou Stork. Leptoptilos crumeniferus.	2	0	1	0
Wood-Ibis. Ibis ibis.	3	0	0	0
Sacred Ibis. Threskiornis aethiopicus.	3	0	1	0
Hadada Ibis. Hagedashia hagedash.	2	0	0	0
Glossy Ibis. Plegadis falcinellus.	1	0	0	0
African Spoonbill. Platalea alba.	1	0	0	0
White-backed Duck. Thalassornis leuconotus.	2	0	0	0
Red-bill Duck. Anas erythrorhyncha.	2	0	0	0
White-faced Tree-Duck. Dendrocygna viduata.	2	0	0	0
Fulvous Tree-Duck. Dendrocygna bicolor.	1	0	0	0
Knob-billed Goose. Sarkidiornis melanotos.	2	0	0	0
Egyptian Goose. Alopochen aegyptiacus.	2	0	2	0
Secretary Bird. Sagittarius serpentarius.	0	0	0	1
White-backed Vulture. Pseudogyps africanus.	0	3	2	2
White-headed Vulture. Trigonoceps occipitalis.	0	1	1	1
Hooded Vulture. Necrosyrtes monachus.	0	3	2	2
Lanner. Falco biarmicus.	0	0	1	0
African Hobby. Falco cuvieri.	0	1	1	0
Red-necked Falcon. Falco chiquera.	0	1	1	0
Pigmy Falcon. Poliohierax semitorquatus.	0	0	1	0
Cuckoo Falcon. Aviceda cuculoides.	0	0	1 m	0
Black Kite. Milvus migrans.	0	0	0	1
Black-shouldered Kite. Elanus caeruleus.	0	1	1	0
Bat-eating Buzzard. Machaerhamphus alcinus.	0	0	1	1
Tawny Eagle. Aquila rapax.	0	0	1	1
Wahlberg's Eagle. Aquila wahlbergi.				

BIRD SPECIES.	1. WETLAND HABITAT.	2 RIVERINE FOREST.	3 FLOODPLAIN BUSH+GRASSLAND	4. DRY BUSHLAND
African Hawk-Eagle. Hieraaetus spilogaster.	0	0	1	0
Ayres' Hawk-Eagle. Hieraaetus dubius.	0	0	1	0
Crowned Hawk-Eagle. Stephanoaetus coronatus.	0	1	1	0
Long-crested Hawk-Eagle. Lophoaetus occipitalis.	0	0	1	0
Lizard Buzzard. Kaupifalco monogrammicus.	0	2	2	0
Brown Harrier-Eagle. Circaetus cinereus.	0	0	1	0
Black-chested Harrier-Eagle. Circaetus pectoralis.	0	0	0	1
Banded Harrier-Eagle. Circaetus cinerascens.	0	1	0	0
Grasshopper Buzzard. Butaster rufipennis.	0	0	1	0
Bateleur. Terathopius ecaudatus.	0	0	2	2
African Fish Eagle. Cuncuma vocifer.	2	0	1	0
Palm-nut Vulture. Gypohierax angolensis.	0	1	0	0
Little Sparrow-Hawk. Accipiter minullus.	0	2	1	0
African Goshawk. Accipiter tachiro.	0	1	1	0
Gabar Goshawk. Micronisus gabar.	0	1	1	0
Pale Chanting Goshawk. Melierax poliopterus.	0	0	1	2
Harrier-Hawk. Polyboroides typus.	0	2	2	0
Crested Francolin. Francolinus sephaena.	0	0	1	2
Scaly Francolin. Francolinus squamatus.	0	2	2	0
Quail. Coturnix coturnix africana.	0	0	1	1
Kenya Crested Guinea-Fowl. Guttera pucherani.	0	2	0	0
Vulturine Guinea-Fowl. Acryllium vulturinum.	0	0	0	2
Peter's Finfoot. Podica senegalensis.	1	0	0	0
Crested Bustard. Lophotis ruficristata. Kori Bustard Ardeotis kori	0	0	0	2
Spotted Thicknee. Burhinus capensis.	0	0	2	0
Water Thicknee. Burhinus vermiculatus.	2	0	0	0
Jacana. Actophilornis africanus.	2	0	0	0
Spur-winged Plover. Hoplopterus spinosus.	2	0	2	0
Blackhead Plover. Sarciophorus tectus.	0	0	1	2
Long-toed Lapwing. Hemiparra crassirostris.	1	0	0	0
Black-winged Stilt. Himantopus himantopus.	1	0	0	0
Ruff. Philomachus pugnax.	1	0	0	0
Common Sandpiper. Tringa hypoleucos.	2	0	0	0
Wood Sandpiper. Tringa glareola.	2	0	0	0
Marsh Sandpiper. Tringa stagnatilis.	1	0	0	0
Greenshank. Tringa nebularia.	1	0	0	0
Temminck's Courser. Cursorius temminckii.	0	0	0	1
Pratincole. Glareola pratincola.	2	0	0	0
White-winged Black/Whiskered Tern. Chlidonias leucoptera/ C. hybrida.	1	0	0	0
Black-faced Sandgrouse. Eremialector decoratus.	0	0	2	2
Lichtenstein's Sandgrouse. Eremialector lichtensteinii.	0	0	2	2
Red-eyed Dove. Streptopelia semitorquata.	0	3	3	0
Mourning Dove. Streptopelia decipiens.	0	2	2	0
Ring-necked Dove. Streptopelia capicola.	0	2	3	2
Laughing Dove. Stigmatopelia senegalensis.	0	0	1	3
Namaqua Dove. Oena capensis.	0	0	2	2
Tamborine Dove. Tympanistria tympanistria.	0	2	1	0

BIRD SPECIES	1 WETLAND HABITAT	2 RIVERINE FORESTS	3 FLOODPLAIN WOODLANDS	4 DRY WOODLAND
Emerald-Spotted Wood-Dove. Turtur chalcospilos.	0	0	2	4
Green Pigeon. Treron australis.	0	3	1	0
Black Cuckoo. Cuculus cafer.	0	0	1	0
Thick-billed Cuckoo. Pachycoccyx audeberti.	0	0	1	0
Emerald Cuckoo. Chrysococcyx cupreus.	0	0	1	0
Klaas' Cuckoo. Chrysococcyx klaas.	0	0	1	1
White-browed Coucal. Centropus superciliosus.	0	2	3	1
Yellow-Bill. Ceuthmochares aereus.	0	0	1	0
Fischer's Turaco. Tauraco fischeri.	0	2	0	0
White-bellied Go-away-bird. Corythaixoides leucogaster.	0	0	0	2
Lilac-breasted Roller. Coracias caudata.	0	0	3	1
Rufous-crowned Roller. Coracias naevia.	0	0	1	0
Broad-billed Roller. Eurystomus glaucurus.	0	3	1	0
Pied Kingfisher. Ceryle rudis.	3	0	0	0
Malachite Kingfisher. Corythornis cristata.	2	0	0	0
Brown-hooded Kingfisher. Halcyon albiventris.	2	0	1	0
Grey-headed Kingfisher. Halcyon leucocephala.	2	2	2	0
Striped Kingfisher. Halcyon chelicuti.	1	0	0	2
Madagascar Bee-eater. Merops superciliosus.	0	0	3	0
Carmine Bee-eater. Merops nubicus.	0	0	1	0
Little Bee-eater. Melittophagus pusillus.	0	0	3	0
White-fronted Bee-eater. Melittophagus bullockoides.	0	0	1	0
Trumpeter Hornbill. Bycanistes bucinator.	0	2	2	0
Silvery-cheeked Hornbill. Bycanistes brevis.	0	1	1	0
Grey Hornbill. Tockus nasutus.	0	0	1	1
Red-billed Hornbill. Tockus erythrorhynchus.	0	0	0	2
Yellow-billed Hornbill. Tockus flavirostris.	0	0	0	2
Von der Deckens Hornbill. Tockus deckeni.	0	0	2	3
Crowned Hornbill. Tockus alboterminatus.	0	2	2	0
Ground Hornbill. Bucorvus leadbeateri.	0	0	1	0
Green Wood-Hoopoe. Phoeniculus purpureus.	0	3	2	1
Scimitar-Bill. Rhinopomastus cyanomelas.	0	3	1	0
Abyssinian Scimitar-Bill. Rhinopomastus minor.	0	0	1	2
African Scops Owl. Otus scops senegalensis.	0	1	1	0
Verreaux's Eagle-Owl. Bubo lacteus.	0	1	0	0
Fishing-Owl. Scotopelia peli.	1	0	1	0
Donaldson-Smith's Nightjar. Caprimulgus donaldsoni.	0	0	2	2
Long-tailed Nightjar. Scotornis climacurus.	0	0	2	1
Speckled Mousebird. Colius striatus.	0	2	3	2
Blue-naped Mousebird. Colius macrourus.	0	0	2	2
White-headed Mousebird. Colius leucocephalus.	0	0	0	2
Narina's Trogon. Apaloderma narina.	0	2	0	0
Black-collared Barbet. Lybius torquatus.	0	1	2	0
Red-fronted Barbet. Tricholaema diadematum.	0	0	1	0
Brown-breasted Barbet. Lybius melanopterus.	0	2	3	0
Red-fronted Tinker-Bird. Pogoniulus pusillus.	0	1	2	0

BIRD SPECIES.	1. WETLAND HABITAT	2. RIVERINE FORESTS	3 FLOODPLAIN SCRUB/GRASSLAND	4 DRY BUSHLAND
Golden-rumped Tinker-Bird. Pogoniulus tilineatus.	0	1	0	0
D'Arnaud's Barbet. Trachyphonus darnaudii.	0	0	0	1
Scaly-throated Honey-guide. Indicator variegatus.	0	1	0	0
Lesser Honey-guide. Indicator minor.	0	1	0	0
Wahlberg's Honey-bird. Prodotiscus regulus.	0	0	0	1
Nubian Woodpecker. Campethera nubica.	0	1	2	1
Little Spotted Woodpecker. Camethera cailliautii.	0	2	0	0
Golden-tailed Woodpecker. Campethera abingoni.	0	2	1	0
Bearded Woodpecker. Thripias namaquus.	0	2	0	0
Palm Swift. Cypsiurus parvus.	2	3	0	0
Flappet Lark. Mirafra rufocinnamomea.	0	0	1	2
Pink-breasted Lark. Mirafra poecilosterna.	0	0	1	3
Fischer's Sparrow-Lark. Eremopterix leucopareia.	0	0	0	2
African Pied Wagtail. Motacilla aguimp.	3	0	0	0
Sandy Plain-backed Pipit. Anthus vaalensis.	0	0	2	2
Richard's Pipit. Anthus novaeseelandiae.	0	0	2	1
Golden Pipit. Tmetothylacus tenellus.	0	0	0	3
Yellow-throated Long-claw. Macronyx croceus.	0	0	1	0
Scaly Babbler. Turdoides squamulata.	0	2	3	0
Rufous Chatterer. Argya rubigigosa.	2	0	2	0
White-eared Bulbul. Pycnonotus dodsoni.	0	0	1	0
Northern Brownbul. Phyllastrephus strepitans.	0	2	2	0
Yellow-bellied Greenbul. Chlorocichla flaviventris.	0	0	2	0
Zanzibar Sombre Greenbul. Andropadus importunus.	0	0	2	0
Eurillas virens. Little Greenbul.	0	0	2	0
Ashy Flycatcher. Alseonax cinereus.	0	2	0	0
Pale Flycatcher. Bradornis pallidus.	0	1	2	0
South African Black Flycatcher. Melaenornis pammelaina.	0	0	1	0
Little Yellow Flycatcher. Chloropetella holochlora.	0	3	0	0
Black-headed Puff-back Flycatcher. Batis minor.	0	2	2	0
Black-throated Wattle-eye. Platysteira peltata.	0	2	0	0
Crested Flycatcher. Trochocercus cyanomelas.	0	2	0	0
Paradise Flycatcher. Tchitrea viridis.	0	3	2	0
Bare-eyed Thrush. Turdus tephronotus.	0	0	0	1
Red-tailed Ant-Thrush. Neocossyphus rufus.	0	2	1	0
White-browed Robin-chat. Cossypha heuglini.	0	2	3	0
Red-capped Robin-chat. Cossypha natalensis.	0	2	0	0
Morning Warbler. Cichladusa arquata.	0	1	2	0
Red-backed Scrub-Robin. Erythropygia zambesiana.	0	2	0	0
Eastern Bearded Scrub-Robin. Erythropygia quadrivirgata.	0	1	0	0
Brown Woodland Warbler. Seicercus umbrovirens.	2	1	0	0
Fan-tailed Warbler. Schoenicola brevirostris.	0	0	1	0
Black-headed Apalis. Apalis melanocephala.	0	2	0	0
Red-faced Crombec. Sylvietta whytii.	0	0	0	1

BIRD SPECIES	1. WETLAND HABITAT	2. RIVERINE FORESTS.	3 FLOODPLAIN BUSH & GRASS	4. DRY BUSHLAND
Grey-backed Camaroptera. Camaroptera brevicaudata.	0	2	2	0
Rattling Cisticola. Cisticola chiniana.	0	0	2	2
Winding Cisticola. Cisticola galactotes.	3	0	0	0
Tawny-flanked Prinia. Prinia subflava.	2	0	2	0
Pale Prinia. Prinia somalica.	0	0	1	0
Wire-tailed Swallow. Hirundo smithii.	3	0	2	0
Black Cuckoo-Shrike. Campephaga sulphurata.	0	3	0	0
Drongo. Dicrurus adsimilis.	0	3	2	2
Square-tailed Drongo. Dicrurus ludwigii.	0	2	0	0
Straight-crested Helmet-Shrike. Prionops plumata.	0	0	2	1
Retz's Red-billed Shrike. Sigmodus retzii.	0	2	2	0
White-crowned Shrike. Eurocephalus angiutimens.	0	0	1	4
Taita Fiscal. Lanius dorsalis. RED-BACKED SHRIKE. LANIUS COLLURIO	0	0	0	1
Tropical Boubou. Laniarius aethiopicus.	0	1/2	1/2	0 0
Black-backed Puff-Back. Dryoscopus cubla.	0	3	2	0
Puff-back. Dryoscopus gambensis.	0	1	2	0
Black-headed Bush-Shrike. Tchagra senegala.	0	0	2	2
Sulphur-breasted Bush-Shrike. Chlorophoneus sulfureopectus.	0	0	2	0
Grey-headed Bush-Shrike. Malaconotus blanchoti	0	1/3	1/0	0 0
Black-headed Oriole. Oriolus larvatus.	0	1/1	1/0	0 0
African Golden Oriole. Oriolus auratus				
Pied Crow. Corvus albus. ~ European Golden Oriole, Oriolus oriolus	0	0	0	3
Wattled Starling. Creatophora cinerea.	0	3	2	0
Black-breasted Glossy Starling. Lamprocolius corruscus.	0	2	2	0
Ruppell's Long-tailed Glossy Starling. Lamprotornis purpuropterus.	0	0	0	2
Golden-breasted Starling. Cosmopsarus regius.	0	0	0	2
Fischer's Starling. Spreo fischeri.	0	0	1	2
Superb Starling. Spreo superbus.	0	0	1/2	2 2
Magpie Starling. Speculipastes bicolor				
Red-billed Oxpecker. Buphagus erythorhynchus.	0	1	0	0
Yellow White-eye. Zosterops senegalensis.	0	0	0	1
Violet -breasted Sunbird. Cinnyris chalcomelas.	0	0	1	0
Mariqua Sunbird. Cinnyris mariquensis.	0	0	2	0
Variable Sunbird. Cinnyris venustus.	0	2	3	0
Amethyst Sunbird. Chalcomitra amethystina.	0	0	1	1
Hunter's Sunbird. Chalcomitra hunteri.	0	3	2	1
Collared Sunbird. Anthreptes collaris.	0	1	2	0
Violet-backed Sunbird. Anthreptes longuemarei.	0	0	0	2
Red-billed Buffalo-Weaver. Bubalornis niger.	0	0	2	4
White-headed Buffalo-Weaver. Dinemellia dinemelli.	0	2	2	0
Layard's Black-headed Weaver. Ploceus nigriceps.	0	0	1	0
Speke's Weaver. Ploceus spekei.	8	1	2	0
Golden Palm-Weaver. Ploceus bojeri.	2	0	1	0
Taveta Golden Weaver. Ploceus castaneiceps.	0	3	2	0
Dark-backed Weaver. Symplectes bicolor.	0	1	2	0
Golden Weaver. Xanthophilus subaureus.	2	0	0	0
Crosbeak Weaver. Amblyospiza albifrons.	2	0	0	0
Red-headed Quelea. Quelea erythrops.	2	0	0	0
Fan-tailed Widow-Bird. Coliuspasser axillaris.	2	0	2	0
Bronze Mannikin. Spermestes cucullatus.				

BIRD SPECIES	1. WETLAND HABITAT	2. RIVERINE FORESTS	3 FLOODPLAIN BUSH & GRASSLAND	4 DRY BUSHLAND
Rufous-backed Mannikin. Spermestes nigriceps.	2	0	2	0
Parasitic Weaver. Anomalospiza imberbis.	0	0	1	0
Green-winged Pytilia. Pytilia melba.	0	0	0	1
AFRICAN FIRE-FINCH. LAGONOSTICTA RUBRICATA. Red-billed Fire-Finch. Lagonostricta senegala.	1 2	1 0	1 2	0 0
Waxbill. Estrilda astrild.	1	0	3	0
Red-cheeked Cordon-bleu. Uraeginthus bengalus.	0	0	1	0
Pin-tailed Whydah. Vidua macroura.	0	0	2	2
Yellow-fronted Canary. Serinus mozambicus.	0	0	3	0
Brimstone Canary. Serinus sulphuratus.	0	0	2	0
Yellow-rumped Seed-eater. Serinus atrogularis.	0	0	3	0

APPENDIX C. CHECKLIST OF MAMMALS FOUND IN THE RESERVE

Classification follows Dorst and Dandelot (1970). The small mammal species are taken directly from Andrews et al. (1975), who did most of their collecting near Garsen. There is no reason to suppose that these species do not occur in the Reserve. Bracketed species have either been seen by the author or reliably reported within 50 km. of the Reserve and may well occur there.

INSECTIVORA	
SORICIDAE	
Crocidura sp.	White-toothed Shrew
RODENTIA	
SCIURIDAE	
Paraxerus ochraceus aruscensis	Huet's Bush Squirrel
Paraxerus palliatus tanae	Red Bush Squirrel
MURIDAE	
Thamnomys dolichurus	Tree Rat
Arvicanthis niloticus	Grass Mouse
Rattus rattus	House Rat
Praomys natalensis	Multimammate Rat
Acomys subspinosus wilsoni	Spiny Mouse
HYSTRICIDAE	
Hystrix sp.	Crested Porcupine
(*Atherus* sp.)	Bush-tailed Porcupine
PHOLIDOTA	
MANIDAE	
(*Manis temminckii*)	Cape Pangolin
PRIMATES	
GALAGIDAE	
Galago crassicaudatus	Greater Galago
Galago senegalensis braccatus	Lesser Galago
CERCOPITHECIDAE	
Papio cynocephalus	Yellow Baboon
Cercocebus galeritus galeritus	Crested Mangabey
Cercopithecus aethiops johnstoni	Vervet Monkey
Cercopithecus mitis albotorquatus	Sykes' Monkey
COLOBIDAE	
Colobus badius rufomitratus	Red Colobus Monkey
CARNIVORA	
CANIDAE	
Canis mesomelas	Black-backed Jackal
(*Otocyon megalotis*)	Bat-eared Fox
Lycaon pictus	Wild Dog

MUSTELIDAE	
Viverra civetta	African Civet
Genetta tigrina	Large spotted Genet
Herpestes ichneumon	Egyptian Mongoose
Herpestes sanguineus	Slender Mongoose
Atilax paludinosus	Marsh Mongoose
Helogale parvula	Dwarf Mongoose
HYAENIDAE	
Crocuta crocuta	Spotted Hyaena
FELIDAE	
Felix serval	Serval
(Felis libyca)	Wild Cat
Panthera leo	Lion
Panthera pardus	Leopard
(Acinonyx jubatus)	Cheetah
TUBULIDENTATA	
ORYCTEROPODIDAE	
(Orycteropodus afer)	Aardvark
PROBOSCIDAE	
ELEPHANTIDAE	
Loxodonta africana	African Elephant
PERISSODACTYLA	
EQUIDAE	
Equus burchelli	Burchell's Zebra
RHINOCEROTIDAE	
Diceros bicornis	Black Rhinoceros
ARTIODACTYLA	
HIPPOPOTAMIDAE	
Hippopotamus amphibius	Hippopotamus
SUIDAE	
Phacochoerus aethiopicus	Wart Hog
Potamochoerus porcus	Bush Pig
GIRAFFIDAE	
Giraffa camelopardalis camelopardalis	Kenyan Giraffe
G.c.reticulata	Reticulate Goraffe
TRAGELAPHINAE	
Tragelaphus imberbis	Lesser Kudu
Tragelaphus scriptus	Bushbuck
Taurotragus derbianus	Cape Eland
HIPPOTRAGINAE	
Oryx beisa beisa	Beisa Oryx
O.b.callotis	Fringe-eared Oryx
REDUNCINAE	
Kobus ellipsiprymnus	Common Waterbuck

ALCELAPHINAE	
Damaliscus korrigum	Topi
Damaliscus hunteri	Hunter's Hartebeest
ANTILOPINAE	
Litocranius walleri	Gerenuk
Aepyceros melampus	Impala
Gazella granti petersi	Peter's Gazelle
CEPHALOPHINAE	
Cephalophus natalensis	Red Duiker
NEOTRAGINAE	
Ourebia ourebi	Oribi
MADOQUINAE	
Rhynchotragus kirki	Kirk's Dik-Dik
BOVINAE	
Syncerus caffer	African Buffalo

APPENDIX D. HISTORICAL BIBLIOGRAPHY OF THE LOWER TANA

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WORLD WILDLIFE FUND.

PROJECT No. 1255 - TANA RIVER GAME RESERVE DEVELOPMENT PROGRAMME.

FINAL REPORT

2. Clive Marsh

"Mchelelo", P.O.Garsen, Via Malindi, Kenya

After 31st January 1976;-

Dept. of Psychology,

University of Bristol,

8 - 10, Berkeley Square, Bristol BS8 1HH,

ENGLAND.

3. Received from W.W.F. in 1975:- 1 short wheel-base Land-Rover S/Wagon.

$ 5000 in cash i.e. 34,166.30 K.sh.

4. PROGRESS ACHIEVED.

The objective of this project was to carry out initial development of the proposed Tana River Game Reserve for the Game Department of the Ministry of Tourism and Wildlife, Kenya. This was to concentrate on essential infrastructure and to employ people from the locality. It was also hoped to influence the Government to an early gazettement of the Reserve and appointment of a warden.

The rationale for this Game Reserve is primarily the conservation of some of the remaining habitat of the Tana river varieties of Red Colobus and Crested Mangabey monkeys. A two-year stydy of the Red Colobus and its habitat by the author and of the Mangabey by Miss K. Homewood had been instrumental in suggesting boundaries for the proposed Reserve.

ecialists Group of I.U.C.N.

A vehicle and funds were made available in July and August, 1975 and he development programme ran between September 1st and December 31st. complete set of camping equipment including tents and beds was purchased for a labour team of 10 men. The team comprised a headman, a driver, six labourers and two camp attendants. All were payed at good local rates with differentials such that the driver and headman were payed twice as much as the camp attendants. The men were selected evenly from different villages in the two administrative locations in which the Reserve is sited.

The Reserve area of approximately 175 km^2 is split roughly equally between the East and West banks of the river. The West side is much more accessible and was considered first priority for development. Previously there existed some 22.5 km. of tracks in the area, but important parts were inaccessible by vehicle. Improved access is essential both for the development of tourism and for the administration of regulations concerning the Reserve. A further 24 km. of track have been cut and 5 km. of the previous track has been substantially improved.

A second access requirement for a Reserve in a remote area is an airstrip and this was cleared to a length of 950m., just outside the boundary of the Reserve, but near both the proposed Reserve H.Q. and the commercial tented campsite.

A campsite for lease to a commercial enterprise was selected and some preliminary clearance done. This was both to demonstrate the potential of the site and establish the principle of camp clearance at a prime riverside site with minimum forest destruction. A consortium of three safari companies has applied to the Commissioner of Lands for a temporary lease of the site and their plans should be approved shortly. The company will also make provision for local shareholdings and will reasonably possible.

which was only announced on January 9th, 1976. However, prior to that the first Warden of the Reserve, Mr. J.Mkunga, was appointed by the Game Department in November 1975. In August the District Commissioner issued through Chief's Orders a ban on further forest clearance, cutting of large trees for canoes and burning within the Reserve. During the late dry season of September and October these regulations were widely ignored. It is hoped that by the next dry season in February and March that the Warden will be sufficiently established and backed to enforce them.

A final aim of the project has been in advising the on management policy options for the Reserve. A Management Plan has been writen which summarises relevant information on the Reserve and makes a number of suggestions for land-use and development in the area. This DOCUMENT is currently being published and will be sent to all recipients of the present report shortly after February 15th, 1976. In connection with its preparation an aerial survey of the Reserve and its surroundings was flown in October using W.W.F. funds. The systematic census enabled baseline estimates of the late dry season density of all the larger mammals to be made. Non-systematic flying was used to assess the extent of recent burning and forest clearance and plot the locations of pastoral settlements. The results of this survey and all other topics in this report are discussed in more detail together with relevant maps in the Management Plan.

The main aims of the project have all been achieved and with the Reserve gazetted and under the administration of a warden, propects for t future are encouraging. However, the enforcement of regulations for forest conservation has yet to be demonstrated and poses a major challeng

5. SUMMARY

Funds and a vehicle from W.W.F have been used for the last four months of 1976. A team of 10 men has been employed and supervised while clearing 24 km. of new tracks, an airstrip and the site for a [illegible] River Game Reserve. An aerial surve