Japan International Cooperation Agency (JICA)

Ministry of Natural Resources
Republic of Malawi

No.

FINAL REPORT
OF
THE MASTER PLAN STUDY
ON
SUSTAINABLE MULTIPLE-USE
RESOURCE MANAGEMENT
OF
NKHOTAKOTA WILDLIFE RESERVE, MALAWI
(DATA)

January 1997

Japan Overseas Forestry Consultants Association (JOFCA)
Pasco International Incorporated

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Contents

1. Data Concerning Social and Economic Conditions of Malawi

Table 1 Malawi's Population and Rate of Increase

	1977			1987			Annual increase
	Total	Male	Female	Total	Male	Female	
Northern Region	648.853	306.864	341.989	911.787	441.290	470.497	3.4
Central Region	2.143.716	1.044.321	1.099.395	3.110.986	1.521.234	1.589.752	3.7
Southern Region	2.754.981	1.322.404	1.432.487	3.965.734	1,904.612	2,061.122	3.7
Nationwide	5.547.460	2.673.589	2.873.871	7.988.507	3.867.136	4.121.371	3.7

Source: Malawi Population and Housing Census 1987, Summary of Final Results Vol. 1

Table 2 Birth and Death Rates per 1000 Persons in Malawi

Birth Rate	46.7 ‰
Death Rate	16.9 ‰
Infant Death	13.4 ‰
Natural Increase	33.0 ‰

Source: "Malawi in Figures 1994"

Table 3 Populations around the Reserve by District

(persons)

Year	1977	1987
Nkhotakota	94,370	158,044
Kasungu	194,436	323,453
Ntchisi	87,437	120,860
Mzimba	301,361	433,696

Source: The figures for 1977 and 1987 were drawn from the Malawi Government, Malawi Population and Housing Census 1987, Vol.1

Table 4 Population by Age (%) according to the 1987 Census

	0-14	15-64	65 or older	Unknown
Malawi	46.0	49.7	4.2	0.1
Central Region	46.6	49.4	3.9	0.1
Kasungu District	44.7	52.4	2.9	0.0
Nkhotakota District	45.2	50.8	4.0	0.1
Ntchisi District	47.7	47.8	4.4	0.1
Northern Region	46.1	49.6	4.3	0.0
Mzimba District	45.7	50.0	4.3	0.0

Source: Malawi Government, Malawi Population and Housing Census 1987, Vol.1

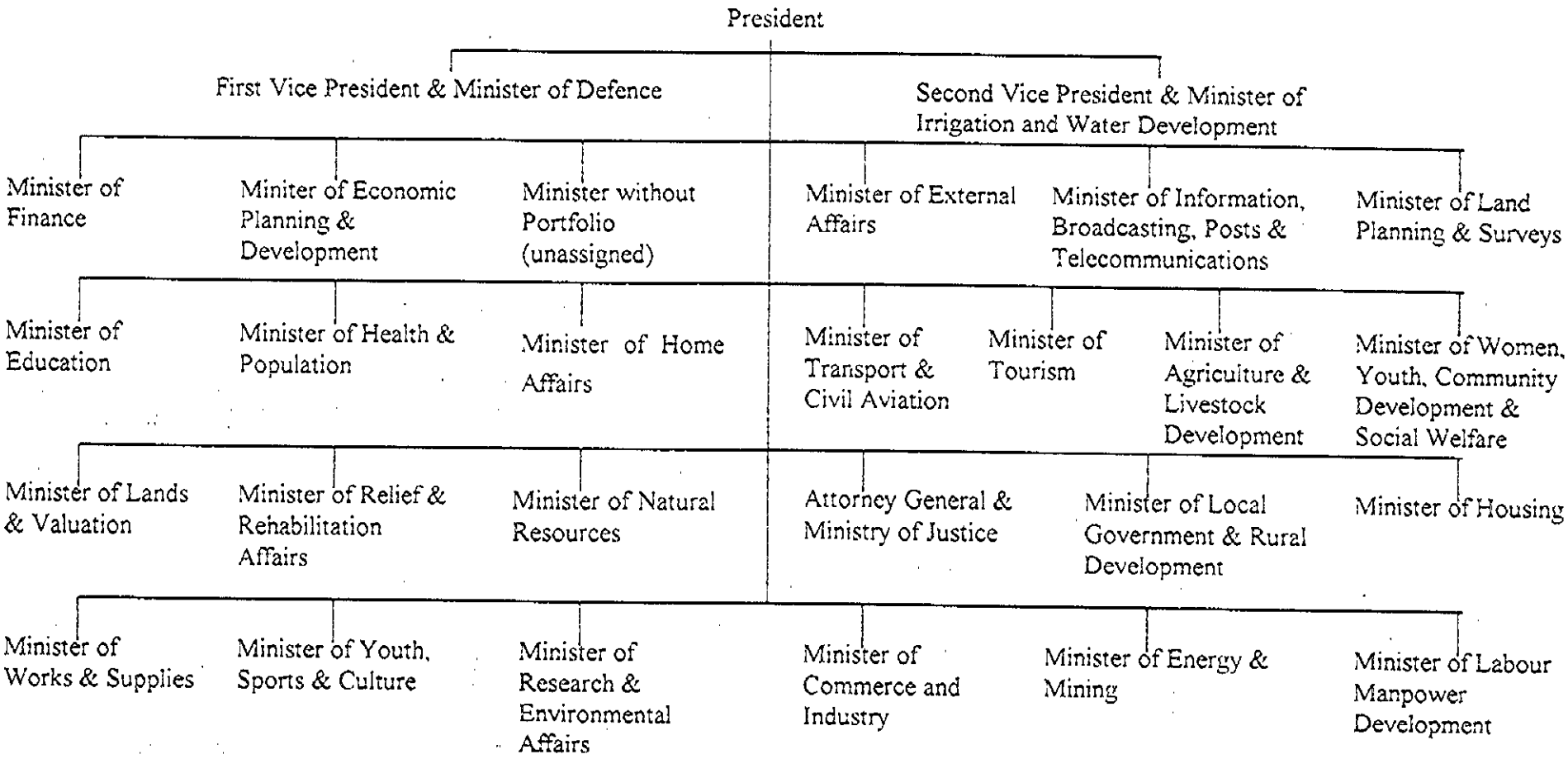


Fig. 1 Organization Structure of the Malawi Government Administration

Table 5 Changes in Consumer Price Indexes

Year	1991	1992	1993	1994	1995
All Commodities	108.2	133.4	163.8	220.5	404.2
Foods	108.4	138.9	175.6	242.9	468.6
Beverages	106.5	137.4	180.1	259.8	463.6
Clothing	104.8	114.4	126.2	149.3	231.9

Source: Monthly Statistical Bulletin, January 1994, January 1995 and February 1996
Note: Beverages include tobacco, and clothing includes footwear.

Table 6 Malawi's GDP by Sector

(million MK)

Sector	1988	1989	1990	1991	1992
Agriculture	318.7	326.6	323.5	364.6	275.0
Industry	102.8	110.6	124.0	128.1	131.8
Expendables	19.1	20.7	23.1	24.5	26.1
Construction	38.1	40.5	41.5	44.3	39.3
Distribution	102.0	113.8	132.7	147.7	141.0
Transportation & Communications	51.6	53.7	57.6	60.4	57.5
Business Services	54.8	59.8	67.1	71.9	71.9
Real Estate	37.7	39.8	42.5	43.9	44.9
Government Works	182.8	184.7	187.5	193.3	191.7
Social Services	39.8	41.1	42.5	43.9	45.9
Adjusted Value (-)	21.1	23.1	25.9	27.8	27.8
Total	926.4	968.3	1,016.2	1,095.0	997.3
Per capita (MK)	112.4	113.8	115.7	120.8	107.3

Source: National Statistical Bulletin (National Statistical Office) 1994

Table 7 Cultivated Areas and Output of Main Crops in 1993

Crop		Area	Output	Productivity
Maize		1,327,000 ha	1,997,000 tons	1,504 kg/ha
	Indigenous	997	979	982
	Hybrid	326	1,012	3,101
	Compo	4	6	1,494
Rice		39	72	1,859
	Faya	27	42	1,574
	IET 4094	4	15	4,066
	IR 1561	1	7	5,298
Tobacco		44	33	730
	Dark Fired	21	11	519
	Burley	20	21	1,037
	Others	3	1	500
Grandnuts		61	32	524
	Chalimbana	55	28	502
	Manipinta	1	2	1,421
	Others	5	2	600

Source: Annual Bulletin (Ministry of Agriculture Statistics) 1993

Table 8 Values of Crops through ADMARC

(million MK)

Crop	1988	1989	1990	1991	1992
Tobacco	10.5	9.8	41.6	19.9	34.3
Peanuts	10.9	0.4	4.1	8.7	0.6
Maize	23.3	57.4	53.5	160.3	13.0
Rice	1.5	3.3	2.8	1.5	0.5
Cotton	15.2	20.3	24.8	54.7	11.1

Source: Malawi in Figures (National Statistical Office) 1993

Table 9 Output of Main Crops in Estates

(thousand tons)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Tobacco	72.5	75.0	86.3	101.0	113.4	127.2	130.4	-	-
Tea	31.9	40.2	39.5	38.9	40.5	28.1	39.5	35.1	34.2
Sugar	172.0	174.5	162.2	189.3	191.1	200.4	114.2	203.0	426.6

Source: Monthly Statistical Bulletin, January 1994, January 1995 and February 1996

Note: The output of tobacco represents only those sold at auction.

Table 10 Industrial Production Indexes

100 for 1984

	Weight	1988	1989	1990	1991	1992	1993	1994	1995
All commodities	100	106.6	115.8	131.8	138.6	137.0	129.2	122.9	124.5
Domestic production	63	107.5	120.1	133.8	140.7	138.1	123.6	116.0	113.8
Consumer goods	45	111.3	122.8	137.0	146.8	142.9	131.5	148.6	125.6
Foods, beverages, tobacco	13	127.6	152.1	162.5	150.0	158.8	162.0	150.0	156.3
Clothing, footwear, textile	9	64.2	66.4	76.8	114.7	99.4	79.5	69.8	56.6
Others	23	120.5	128.3	146.0	157.5	151.0	134.7	130.0	135.4
Building materials	18	98.0	113.3	126.0	125.4	126.2	103.8	86.7	84.1
Production for export	23	95.2	95.1	117.8	123.4	116.6	121.9	109.1	122.4
Power and water supply	14	121.7	130.8	145.5	154.0	164.0	166.5	176.3	176.0

Source: Monthly Statistical Bulletin, January 1994, January 1995 and February 1996

Table 11 Workers by Sector

Sector	Total	Mlimi	Employed	Family-sized management	Self-employed	Employer	Un-employed
Total	3,457,753	2,684,045	549,130	11,366	166,801	1,061	45,350
Professional/ technician	47,846	190	43,185	70	3,599	24	778
Administration/ management	3,172	4	2,980	7	123	26	32
Clerical work	39,795	102	38,744	37	286	12	614
Sales	75,924	92	15,575	3,129	56,544	219	365
Services	98,997	237	95,206	252	2,020	34	1,248
Agriculture, forestry & fishery	2,939,034	2,682,827	203,410	4,418	45,121	524	2,734
Manufacturing/ transportation	171,337	375	112,426	1,407	54,476	174	2,479
Others	81,648	218	37,604	2,046	4,632	48	37,100

Source: National Statistical Office, 1993, Malawi Population and Housing Census 1987, Volume III Economic Characteristics, p.455-458

Table 12 Malawi's Export Values

(million MK)

Year	Total value of exported domestic products	Tea		Tobacco		Sugar		Subtotal	
		Value	Share	Value	Share	Value	Share	Value	Share
1984	431	113	26.2	226	52.4	29	6.7	368	85.4
1985	411	91	22.1	185	45.0	52	12.7	328	79.8
1986	450	69	15.3	245	54.4	42	9.3	356	79.1
1987	601	61	10.1	373	62.1	63	10.5	497	82.7
1988	742	80	10.8	475	60.0	69	9.3	624	84.1
1989	730	101	13.8	458	62.7	65	8.9	624	85.5
1990	1,106	125	11.3	778	70.3	77	7.0	980	88.6
1991	1,299	104	8.0	982	75.6	80	6.2	1,165	89.7
1992	1,401	107	7.6	1,030	73.5	98	7.0	1,335	95.3
1993	1,370	157	11.5	938	68.5	69	5.0	1,164	85.0
1994	2,722	261	10.0	1,689	62.0	224	8.2	2,174	80.0
1995	5,996	414	7.0	3,915	65.3	405	6.8	4,734	80.0

Source: National Statistical Office. Monthly Statistical Bulletin, June 1994 and February 1996

Table 13 Trends in Malawi's Trade

(million MK)

Year	Total value of imports	Exports			Balance
		Domestic products	Reexported products	Total	
1983	363	283	6	289	-74
1984	382	431	10	441	+59
1985	506	411	11	422	-84
1986	479	450	14	464	-15
1987	658	601	13	613	-45
1988	1,080	742	10	752	-328
1989	1,399	730	12	742	-657
1990	1,575	1,106	28	1,134	-620
1991	1,976	1,299	34	1,333	-643
1992	2,592	1,401	40	1,441	-1,151
1993	2,405	1,370	40	1,410	-995
1994	4,264	2,722	82	2,812	-1,458
1995	7,255	5,996	197	6,193	-1,062

Source: National Statistical Office. Monthly Statistical Bulletin. June 1994 and February 1996

Table 14 Tobacco

(Output in tons)

Year	Estate		Smallholder	
	Output	kg/ha	Output	kg/ha
1990	64,019	1,150	14,001	449
1991	75,013	1,196	15,735	541
1992	118,000	1,200	12,523	500

Source: Tobacco Control Commission (Lilongwe 1992)
Note: Figures reflect only the Frue Cured variety, cultivated by an overwhelming number of estates and smallholders.

Table 15 Sugar Cane

(Output in 1,000 tons)

Year	Estate		Smallholder	
	Output	ton/ha	Output	ton/ha
1990	189,261	12.62	8,361	10.05
1991	191,125	12.74	10,078	10.05
1992	243,895	16.15	10,033	11.75

Note : There were no statistics available on local maize in 1990/1991.
Source: Dwanga Sugar Corporation and Smallholder Sugar Authority Dwanga

Table 16 (a) Cultivated Area (ha) and Output (tons) of Local Maize

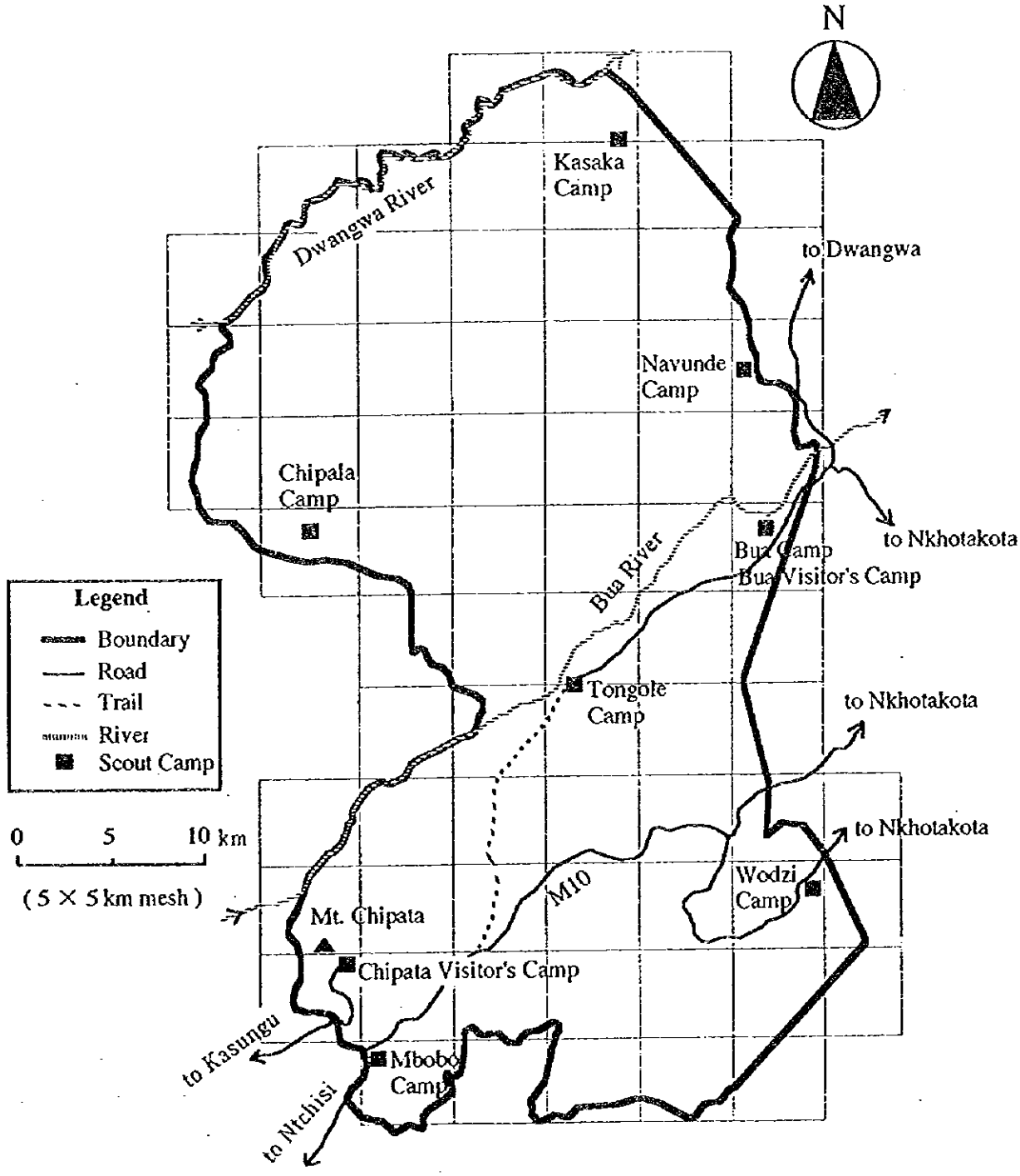
District		1988/89	1989/90	1990/91	1991/92
Kasungu	(area)	59,948	68,400	-	70,000
	(output)	65,943	74,615	-	48,441
Ntchisi	(area)	26,333	25,823	-	24,256
	(output)	41,869	28,405	-	17,552
Nkhotakota	(area)	7,600	7,700	-	7,950
	(output)	8,360	6,100	-	3,187
Mzimba	(area)	32,704	35,509	-	32,123
	(output)	19,622	26,486	-	16,662

Table 16 (b) Cultivated Area (ha) and Output (tons) of Hybrid Maize

District		1988/89	1989/90	1990/91	1991/92
Kasungu	(area)	8,494	11,750	12,967	12,874
	(output)	22,084	30,550	35,011	20,221
Ntchisi	(area)	2,810	3,702	5,875	8,089
	(output)	10,762	10,921	22,014	19,458
Nkhotakota	(area)	1,500	2,200	2,790	3,106
	(output)	4,800	6,380	7,812	3,466
Mzimba	(area)	3,950	9,649	5,898	5,984
	(output)	12,810	28,461	15,561	12,078

Source: Annual Bulletin (Ministry of Agriculture Statistics) 1993
Note : There were no statistics available on local maize in 1990/1991.

2. Locations of Scout Camps in the Reserve



A Location Map of Scout Camps

3. Aerial Survey Method of Major Wild Animals

Aerial Survey Method of Major Wild Animals

The objective of this survey was to obtain the population estimates, densities and distribution of major wildlife species in the Nkhotakota Wildlife Reserve. Data was collected by experienced DNPW observers from an aerial survey using a rotary wing aircraft.

1 Study Method

The study area included the whole of the reserve area and was divided into grid cells as described in the following sections.

(1) Survey area

The area for the purposes of this survey was decided according to Universal Transverse Mercator (UTM) grid alignment as described in the following paragraph. The extent of the area was to include the reserve boundary as defined in 1:50,000 topographical maps to each half grid cell unit where the boundary falls within the transects were to be flown (Fig. 1). Details of transect limit decisions are as follows.

The following options were assessed on deciding the start and end points for the transects flown on the grid cell center.

1) To where the transect line crosses the boundary
2) To the full length of each grid cell where the transect line crosses the boundary
3) To the maximum length of where the boundary reaches in each cell
4) To the full length of each grid cell within which any portion of the reserve falls
5) To the full length of each half grid cell unit within which any portion of the reserve falls

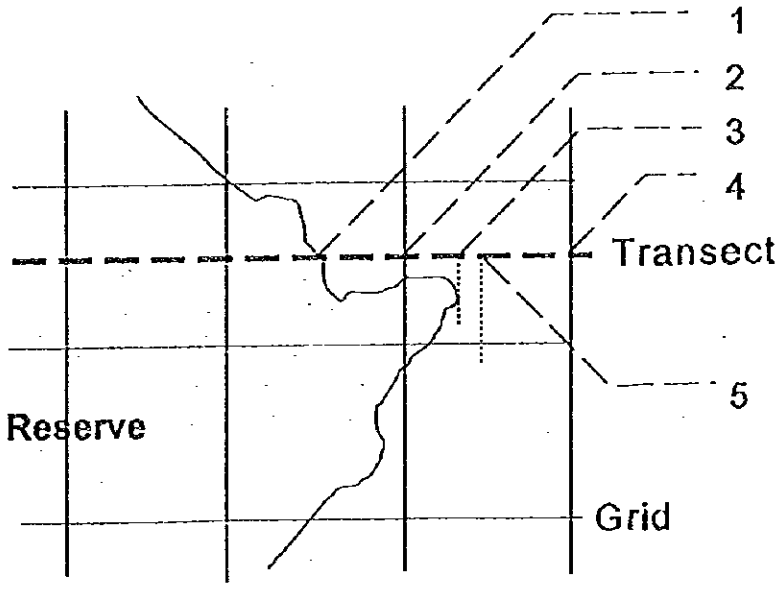


Fig. 1 Transect Limit Decision

The fifth option was considered most applicable due to difficulties in determining the exact boundary on the ground. It also retained possibilities to adjust data when found necessary at a later stage, while it maximizes the use of flight hours.

Planned transect flight lines were drawn on 1:50,000 maps and coordinates were examined where each transect crossed the reserve boundary as defined in the maps. Each grid unit was then determined according to the above mentioned criteria.

(2) Study Grid

Based on the experience and knowledge of the Study Team's animal survey chief in the area, the Reserve was divided according to an arbitrary "best fit" principle between scout patrol blocks (5 km grid) and the UTM grid to the closest 1000 units. The resulting 5 km grid was further divided into a 2.5 km grid for the purpose of the study. Figures 2 and 3 show the study UTM grid and its comparison with the "Scout Patrol" grid UTM grid coordinates were employed for referencing information as well as navigation using a portable Ensign GPS™ (Trimble Navigation Limited). In addition to UTM coordinates, geodetic coordinates were also assigned to the study grid (Table 1a, b) to seek compatibility with the Pixis GPS™ (Sony), also to serve as a back up option in case of Ensign GPS failure.

Geodetic coordinates were given to matching UTM coordinates by assigning the center reference point to [36 609000 L 8581000] and drawing lateral and longitudinal UTM base line from the center point.

Conversion of base line coordinates was done by inputting UTM coordinates into Ensign GPS (Trimble Navigation Limited) and converting the reading into latitude/longitude display. Geodetic datum used in the study area was ARC 1950 for Malawi location, with the following constants for Molodensky Datum Transformation procedure.

ΔX=-161 ΔY=-074 ΔZ=-317

Conversion was performed according to a custom datum created by the above constants inputted into the GPS.

Longitudinal UTM grid coordinates were input on the [L 8581000] baseline from [36 586500] to [36 636500] at 2500 unit intervals. The converted geodetic longitude reading was assigned to each UTM grid point, while the grid latitude was uniformly assigned the center reference reading. The same procedure was followed to obtain geodetic latitude readings on the [36 609000] baseline from [L 8541000] to [L 8611000].

(3) Grid errors

Deviation between UTM and geodetic grids in the study area were calculated as to be approximately 160 m at its maximum. This fell within the GPS error margin and the two grid systems were therefore assumed to be identical for the purpose of the survey.

UTM grid north and true north deviations were in the range of 11' to 16' at the centers of 1:50000 sheets used in the study and were assumed negligible for survey purposes.

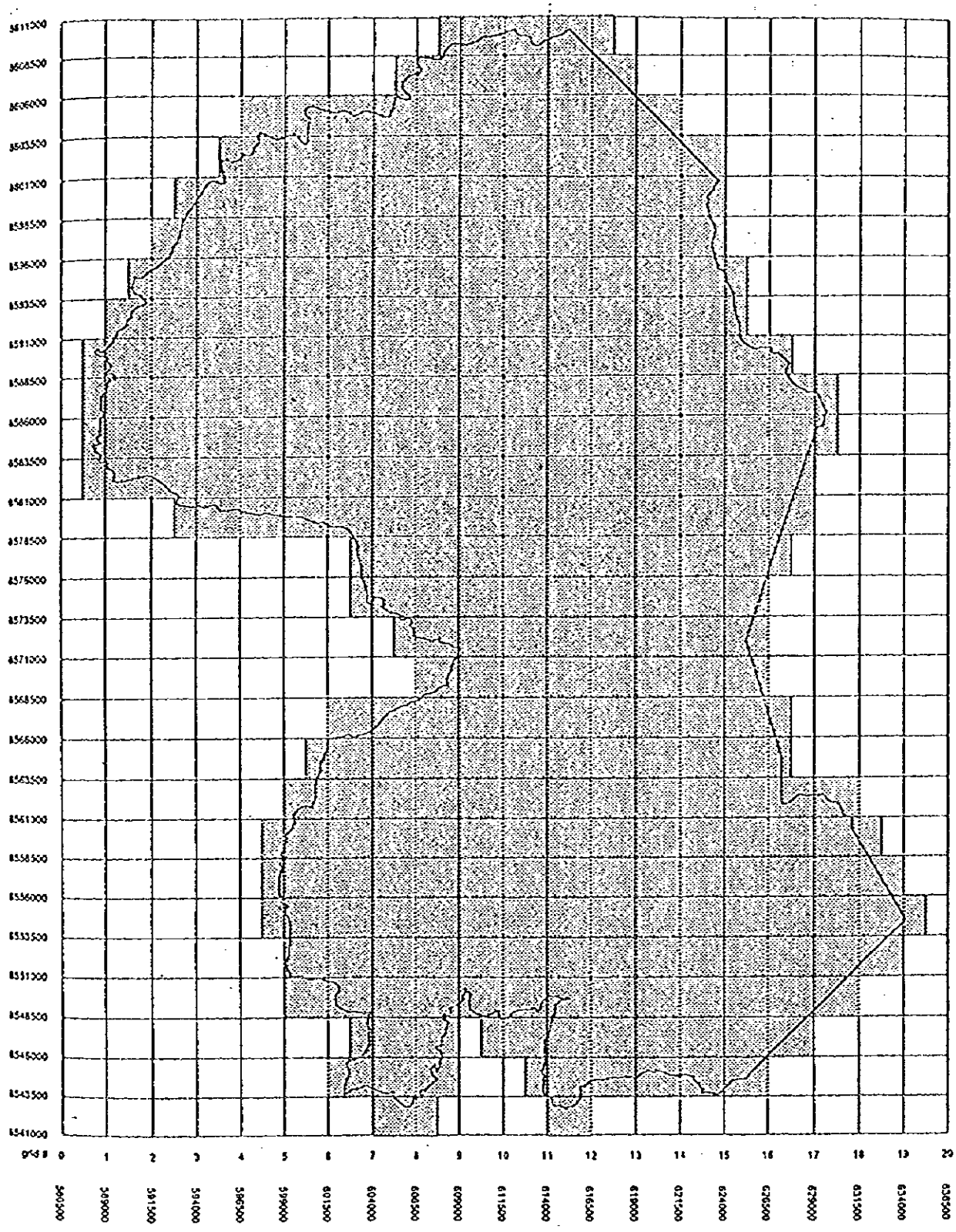


Fig. 2 Survey Area and Grid (UTM)

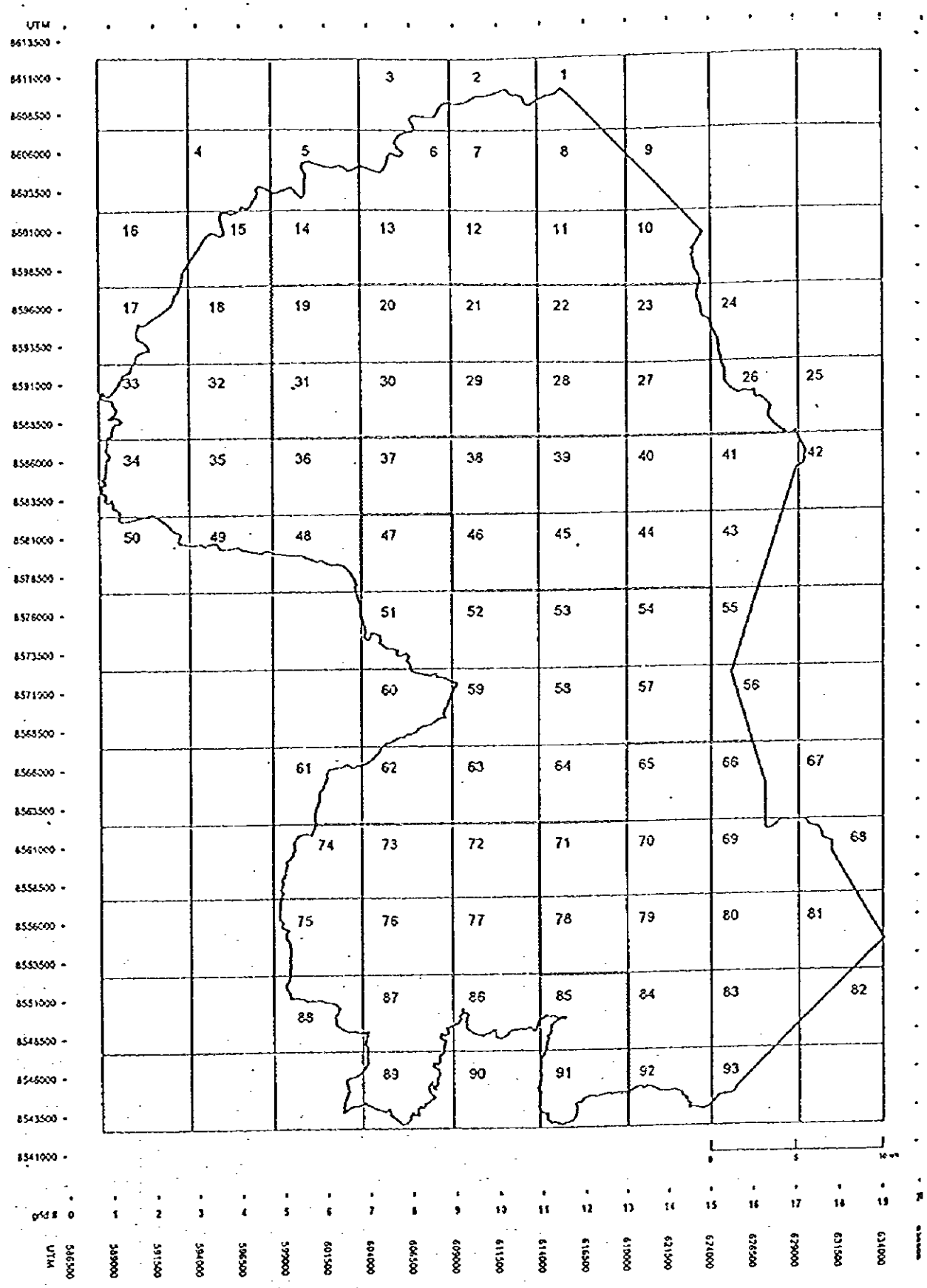


Fig. 3 Comparison of "Patrol Grid" to Survey Grid (UTM)*
NB: "Patrol Grid" alignment based on approximation from hand-sketch on DNPW wall.

Table 1 a. Survey Grid UTM - Geodetic Coordinate Conversions (Y baseline)

[UTM] 36	L	Lat (S)	Lon. (E)	spacing	transect	spacing	X	Y
609000	8611000	12° 33.770'	034° 00.203'	-	-	-	09	28
609000	8608500	12° 35.127'	034° 00.208'	1.357'	12° 34.449'	-	09	27
609000	8606000	12° 36.483'	034° 00.213'	1.356'	12° 35.805'	1.357'	09	26
609000	8603500	12° 37.839'	034° 00.218'	1.356'	12° 37.161'	1.356'	09	25
609000	8601000	12° 39.195'	034° 00.224'	1.356'	12° 38.517'	1.356'	09	24
609000	8598500	12° 40.551'	034° 00.229'	1.356'	12° 39.873'	1.356'	09	23
609000	8596000	12° 41.908'	034° 00.234'	1.357'	12° 41.230'	1.357'	09	22
609000	8593500	12° 43.264'	034° 00.240'	1.356'	12° 42.586'	1.357'	09	21
609000	8591000	12° 44.620'	034° 00.245'	1.356'	12° 43.942'	1.356'	09	20
609000	8588500	12° 45.976'	034° 00.250'	1.356'	12° 45.298'	1.356'	09	19
609000	8586000	12° 47.333'	034° 00.256'	1.357'	12° 46.655'	1.357'	09	18
609000	8583500	12° 48.689'	034° 00.261'	1.356'	12° 48.011'	1.357'	09	17
609000	8581000	12° 50.045'	034° 00.266'	1.356'	12° 49.367'	1.356'	09	16
609000	8578500	12° 51.401'	034° 00.272'	1.356'	12° 50.723'	1.356'	09	15
609000	8576000	12° 52.757'	034° 00.277'	1.356'	12° 52.079'	1.356'	09	14
609000	8573500	12° 54.114'	034° 00.283'	1.357'	12° 53.436'	1.357'	09	13
609000	8571000	12° 55.470'	034° 00.288'	1.356'	12° 54.792'	1.357'	09	12
609000	8568500	12° 56.826'	034° 00.294'	1.356'	12° 56.148'	1.356'	09	11
609000	8566000	12° 58.182'	034° 00.299'	1.356'	12° 57.504'	1.356'	09	10
609000	8563500	12° 59.538'	034° 00.304'	1.356'	12° 58.860'	1.356'	09	09
609000	8561000	13° 00.895'	034° 00.310'	1.357'	13° 00.216'	1.357'	09	08
609000	8558500	13° 02.251'	034° 00.315'	1.356'	13° 01.573'	1.357'	09	07
609000	8556000	13° 03.607'	034° 00.321'	1.356'	13° 02.929'	1.356'	09	06
609000	8553500	13° 04.963'	034° 00.326'	1.356'	13° 04.285'	1.356'	09	05
609000	8551000	13° 06.319'	034° 00.332'	1.356'	13° 05.641'	1.356'	09	04
609000	8548500	13° 07.676'	034° 00.337'	1.357'	13° 06.998'	1.357'	09	03
609000	8546000	13° 09.032'	034° 00.343'	1.356'	13° 08.354'	1.357'	09	02
609000	8543500	13° 10.388'	034° 00.348'	1.356'	13° 09.710'	1.356'	09	01
609000	8541000	13° 11.744'	034° 00.354'	1.356'	13° 11.066'	1.356'	09	00
Average spacing				1.356'		1.356'		

Table 1 b. Survey Grid UTM - Geodetic Coordinate Conversions (X baseline)

[UTM] 36	L	Lat (S)	Lon. (E)	spacing	mid-point	spacing	X	Y
586500	8581000	12° 50.088'	033° 47.827'	-		-	00	16
589000	8581000	12° 50.083'	033° 49.209'	1.382'	033° 48.518'	-	01	16
591500	8581000	12° 50.079'	033° 50.591'	1.382'	033° 49.900'	1.382'	02	16
594000	8581000	12° 50.075'	033° 51.974'	1.383'	033° 51.283'	1.382'	03	16
596500	8581000	12° 50.070'	033° 53.356'	1.382'	033° 52.665'	1.383'	04	16
599000	8581000	12° 50.065'	033° 54.738'	1.382'	033° 54.047'	1.382'	05	16
601500	8581000	12° 50.060'	033° 56.120'	1.382'	033° 55.429'	1.382'	06	16
604000	8581000	12° 50.055'	033° 57.502'	1.382'	033° 56.811'	1.382'	07	16
606500	8581000	12° 50.050'	033° 58.884'	1.382'	033° 58.193'	1.382'	08	16
609000	8581000	12° 50.045'	034° 00.266'	1.382'	033° 59.575'	1.382'	09	16
611500	8581000	12° 50.040'	034° 01.649'	1.383'	034° 00.957'	1.382'	10	16
614000	8581000	12° 50.039'	034° 03.031'	1.382'	034° 02.340'	1.383'	11	16
616500	8581000	12° 50.029'	034° 04.413'	1.382'	034° 03.722'	1.382'	12	16
619000	8581000	12° 50.023'	034° 05.795'	1.382'	034° 05.104'	1.382'	13	16
621500	8581000	12° 50.017'	034° 07.177'	1.382'	034° 06.486'	1.382'	14	16
624000	8581000	12° 50.011'	034° 08.559'	1.382'	034° 07.868'	1.382'	15	16
626500	8581000	12° 50.005'	034° 09.941'	1.382'	034° 09.250'	1.382'	16	16
629000	8581000	12° 49.999'	034° 11.323'	1.382'	034° 10.632'	1.382'	17	16
631500	8581000	12° 49.993'	034° 12.705'	1.382'	034° 12.014'	1.382'	18	16
634000	8581000	12° 49.986'	034° 14.087'	1.382'	034° 13.396'	1.382'	19	16
636500	8581000	12° 49.980'	034° 15.469'	1.382'	034° 14.778'	1.382'	20	16
Average spacing				1.382'		1.382'		

2 Survey Planning

(1) Transect Setting and Alignment

Conventional fixed wing transect sampling methods were followed aimed at maximum accuracy and precision per unit effort in counting multiple species. Transects were flown in an east-west direction for the reason that most valleys run in a north-south direction aligned to the Great Rift Valley. Transects flight plans were drawn onto 1:50,000 map sheets according to the study area boundary in 2.5 km and 1.25 km intervals for northern and southern strata respectively as described in detail in the following section.

Each transect was assigned a number corresponding to the longitudinal UTM grid reading where it was planned to fly. This was to enable exact identification of the transect in terms of navigational purposes as well as data storage, thus preventing problems of "lost flight plans" or "unknown" transect placements.

(2) Stratification

An initial total of 28 transects were flown at 2.5 km intervals over the center of all grid cells as the first "series 2500" to examine the general wildlife distribution inclination noted in previous studies and to justify their stratification procedures. Stratification in this survey was performed according to the number of observations per cell (Fig. 4) dividing the Reserve into two blocks, namely northern and southern blocks. The southern block observations per cell and observations per sample area were more than twice of these in the northern block.

An additional set of 12 transects at 2.5 km intervals offset by 1.25 km to the north (series 1250) were flown in the southern block resulting in a final coverage by 1.25 interval transects. Former "series 2500" transects of the southern block were reassigned "series 2500b" with transect spacing descriptions corrected to 1.25 km, and combined with "series 1250" data. The resultant transect flight plan of all transects is given in Fig. 5.

(3) Aircraft and observer/recorder

Animals were counted from a rotary wing aircraft Aerospatiale écureuil AS 350 L1 of the Malawi Army Air Wing flying at 300 ft (91.4 m) ground height and 40 knots (74.1 kph) ground speed. Observers were recommended from the DNPW as experienced in the practice and accountable for accurate observations of the native species. The observers were not changed during the survey creating a safe margin on consistency of observations.

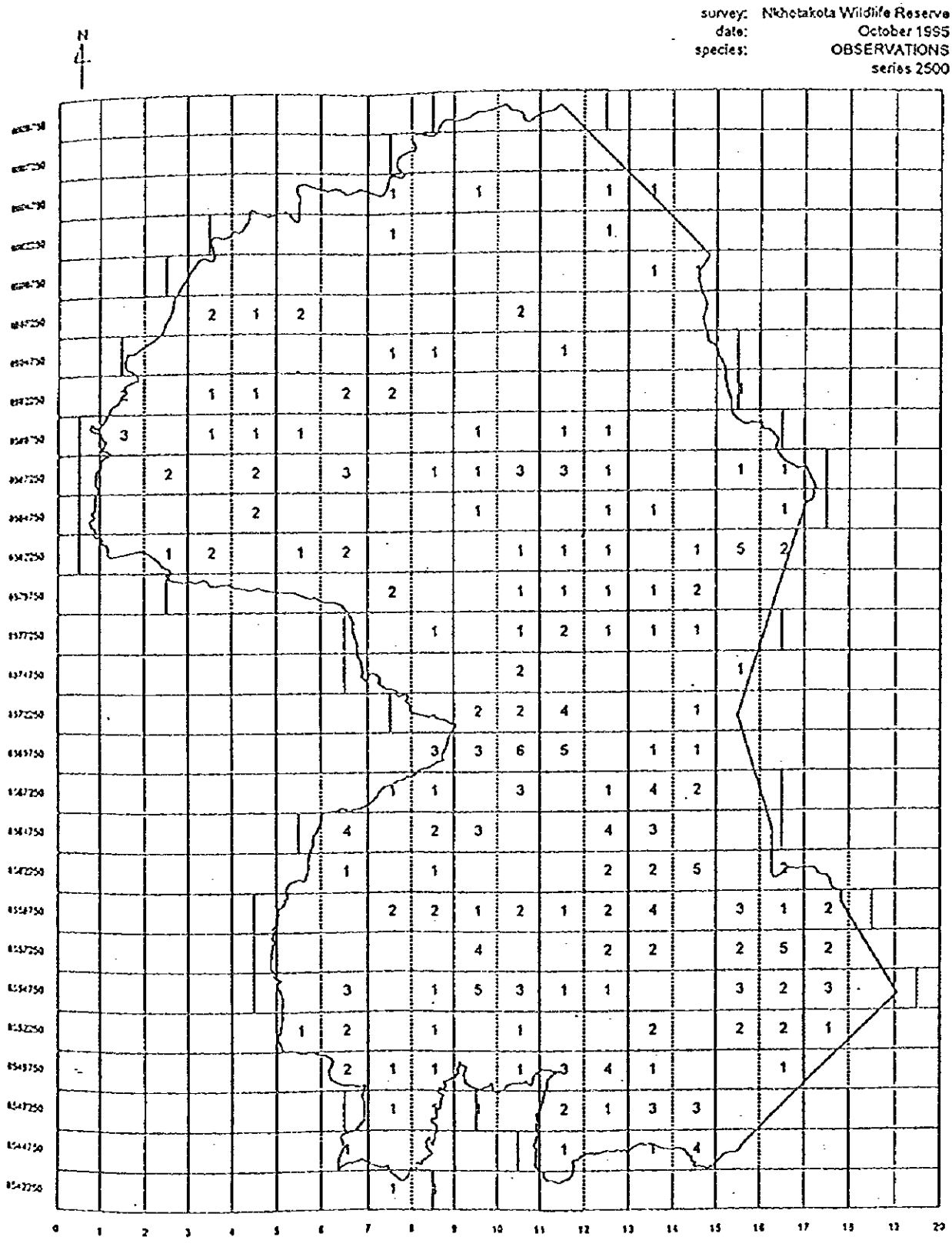


Fig. 4 The Number of Obervation per Cell

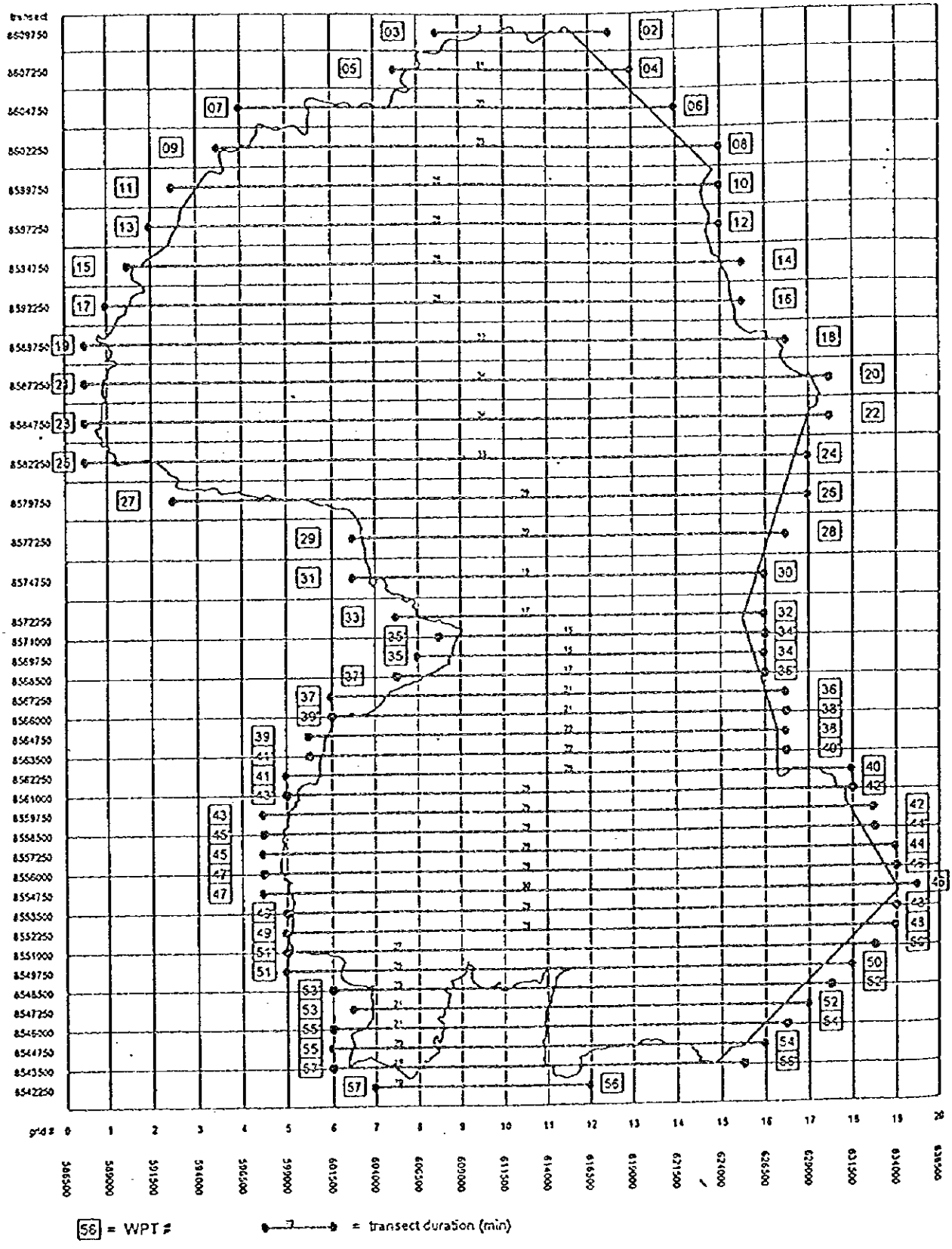


Fig. 5 Flight Plan of All Transects (October 1995)

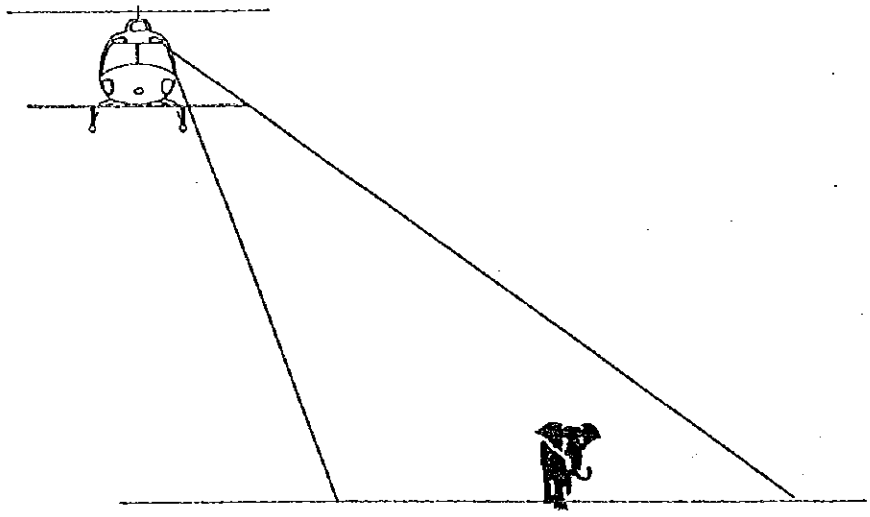


Fig. 6 Transect Marker

1) Transect markers

In order to follow basic methods of fixed-wind transect sampling surveys, several modifications were made to the aircraft. Preparations were made to install transverse beams to the aircraft's landing gear, onto which transect markers attach as on wing struts of fixed wing aircrafts (Fig. 6). Fabrication of the device was conducted through extensive technical assistance from the Malawi Army Air Wing engineers. While technical matters were mostly solved, procurement of the aircraft's manufacturer clearance on additional attachments did not materialize during the given time schedule, resulting in the team of abandoning the external device at the last stage.

An alternative internal device was adopted using a sight frame (Fig. 7) to fix the eyepoint, and windscreen transect markers. Being aware of a previous helicopter survey conducted in Malawi resulting in poor quality output, particular attention was given to properly fix the transect width.

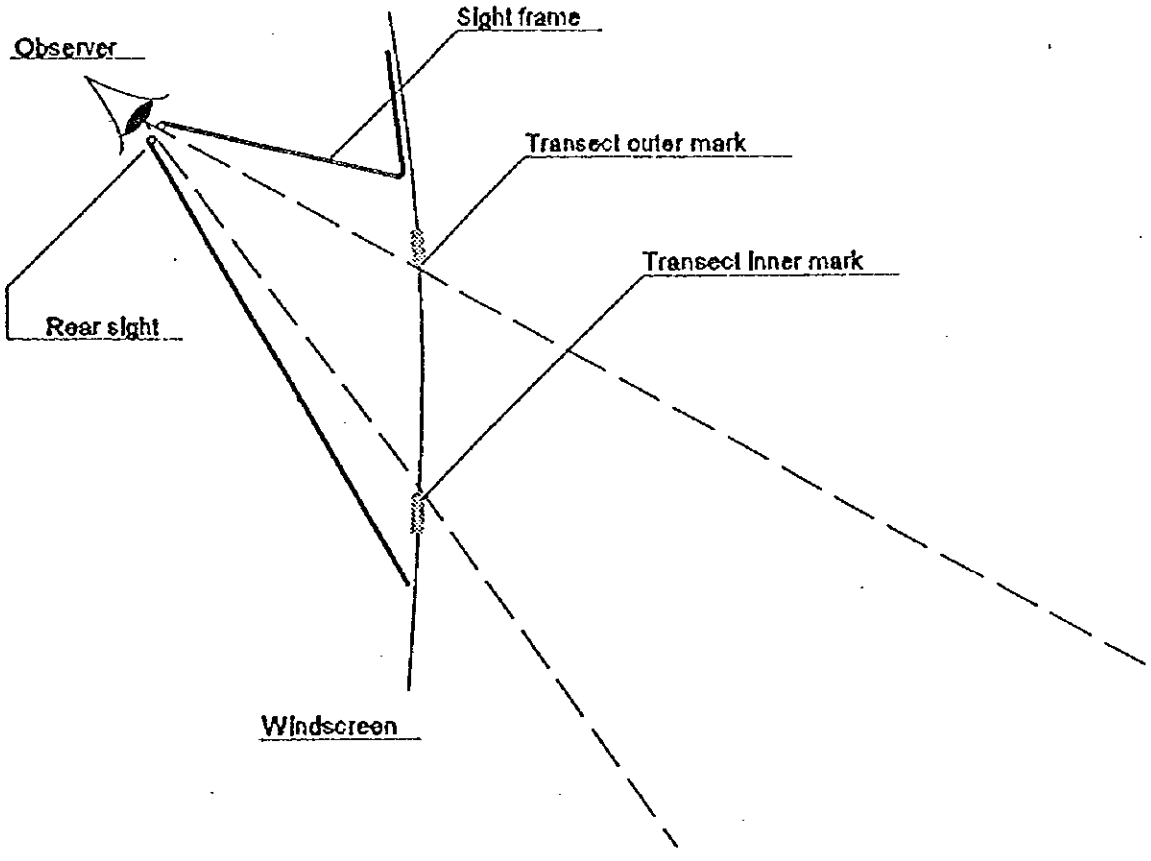


Fig. 7 Sight Frame

The sight frame was fabricated from heavy gauge steel wire, and was adjusted to allow the rear sight to be exactly where the observer's eyepoint settles when at a fully comfortable observation posture. After final adjustments, the frame was secured to the aircraft windscreen of the observer's seats. The observer seat's sliding door was prohibited from being fully opened during the operation,

preventing the sight frame from distortion or misalignment.

Observations were done with a fixed eyepoint through the rear sight and between transect markers (Fig. 8). Marker measurements were taken twice on pre-operation and post-operation occasions to allow the collection of transect measurements when the observer is closest to the actual posture taken during operation.

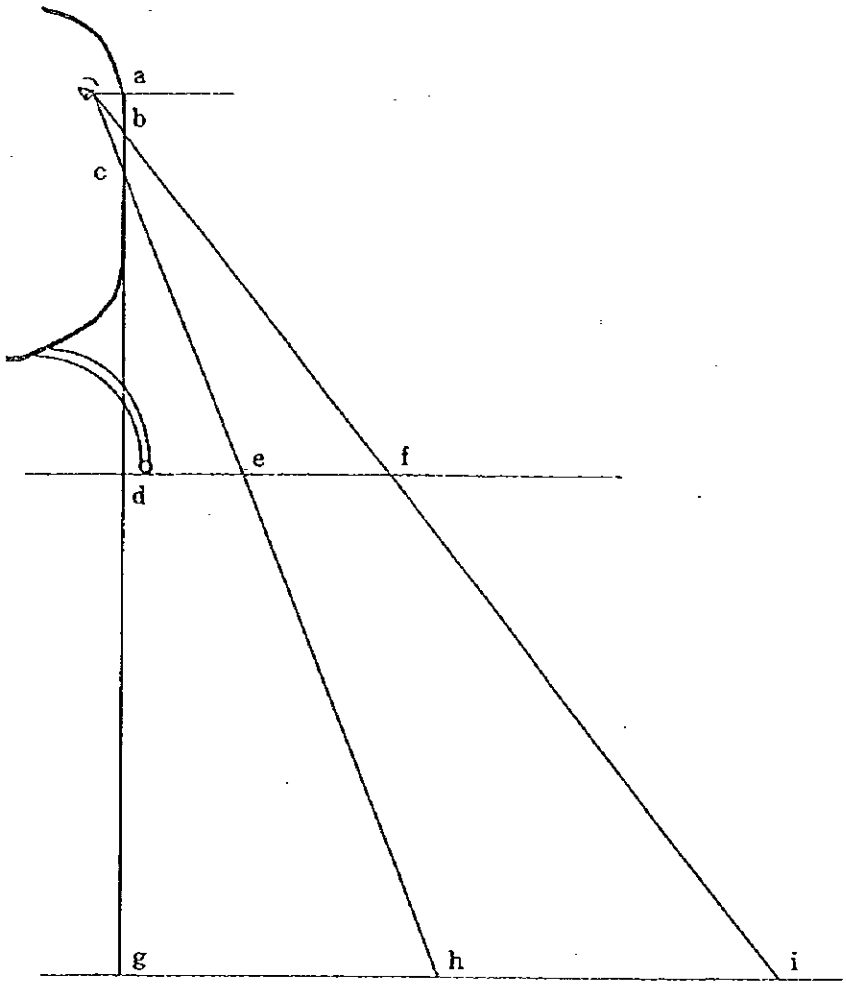


Fig. 8 Transect Marker Measurement

2) Calibration

Calibration of transect strip width was done by observing white and red markers placed every 10 m and 50 m respectively, each made of 90 x 50 cm cloth nailed to the Nkhotakota airstrip to a total length of 600 m. Observed markers were recorded according to a calibration data sheet with ground height simultaneously recorded for each pass. Careful examination was conducted on calibration of flight results and compared against the above mentioned transect marker measurements. The measured transect marker strip width nearest to the overall fly-by average was applied as calibrated strip width for each side, assuming the observer's posture during measurement is identical to that of actual observation when airborne. Resulting left and right calibrated strip widths were 83 m and 74 m respectively. Although hovering observations were conducted on four passes, calibration measurements were later discarded in the process. This was due to the tendency of larger strip widths, i.e., 13% (right observer) to 33% (left observer) wider compared to 40 knot fly-by averages. The tendency was most probably caused by elaborate efforts to see as many markers as possible by shifting the eyepoint, an exercise which does not occur during normal observations.

3 Aerial Survey Operation

A total of 29.1 hours was flown in an 8-day operation. included in the total flight hours are general testing, calibration, positioning, and hippopotamus surveys outside of the Reserve.

(1) Transect Strip Width

The calibrated strip width of 300 feet ground height were adjusted for actual observation strip widths during operation. Actual ground height readings from the radar altimeter were regularly recorded at 1.25 km intervals. The mean ground height was calculated from the readings and applied to the calibrated strip width to obtain mean actual strip width for each transect.

(2) Observation and Recording

Routine aerial survey operations in Malawi are conducted with each observer acting as a recorder for his own observation while the front seat observer is occupied with navigation and other general observations. As this study demanded the observers to be fully concentrated in observation, recording was done by an independent recorder seated between the two rear seat observers. Although the initial observation/recording design required the front seat team member to navigate, observe and record, intercom settings were not complete at the time of the survey to allow full interactive communications among all team members on board the aircraft, forcing the partial separation between front and rear seats.

The GPS was attached to the front windshield for receiving signals and the display was not visible from the rear seat. Therefore grid positions were notified to rear seat recorder by an audible call accompanied by visual display of a flip card indicating the grid number each time the aircraft crossed a grid line. Communication was

confirmed by a physical tap by the rear seat recorder. Additionally, random checking of the rear seat activities by the front seat team member was done to keep general operations in control.

Each team member's responsibilities were as follows:

Front seat recorder/navigator

- Navigate pilot to fly planned transect at prescribed ground height and ground speed.
- Notify rear seat of transect start and end.
- Notify rear seat recorder of grid position.
- Record survey and transect particulars to data sheets.
- Record regular observations.
- Overall coordination of operations.

Rear seat observer:

- Continuously observe from transect start to end, the wildlife species and their number that fell between transect markers on respective side and call out for each observation.
- Observe and call water points during transect.
- Observe and call any significant illegal activity or its evidence.

Rear seat recorder

- Record rear seat observations.
- Record grid position
- Record survey and transect particulars to data sheets

4. Animal Population Estimate by Aerial Survey

Table 1 Overall Estimates (October 1995)

spp	sum(y)*	R*	var(Y)	SE(Y)	Y	95%CL	CL%
buffalo	68	0.36	71670	268	601	542	90
bushbuck	29	0.15	4598	68	285	137	48
bushpig	9	0.05	970	31	71	63	88
duiker	181	0.95	30623	175	1770	354	20
eland	2	0.01	257	16	23	32	143
elephant	74	0.39	594509	771	1037	1560	150
grysbok	4	0.02	183	14	32	27	86
hartebeest	-	-	-	-	-	-	-
hippo	-	-	-	-	-	-	-
klipspringer	-	-	-	-	-	-	-
kudu	11	0.06	2783	53	87	107	122
reedbuck	40	0.21	8454	92	351	186	53
roan	44	0.23	18814	137	424	277	65
sable	22	0.12	3975	63	181	128	70
warthog	80	0.42	15412	124	771	251	33
waterbuck	23	0.12	10388	102	244	206	85
zebra	31	0.16	6877	83	246	168	68
-	-	-	-	-	-	-	-
baboon	309	1.62	891102	944	3555	1909	54
leopard	1	0.01	56	8	8	15	191
lion	2	0.01	222	15	16	30	190
-	-	-	-	-	-	-	-
(pitfall)	58	0.30	14044	119	726	240	33

n = 40 sum(z)* = 191

N* = 435 t(0.05, n-1) = 2.023

Z* = 2077 sample intensity* = 9.2%

ND: * : not used for estimate calculations

Note: SPP Fauna species

SUM (Y) Total animal count

R' Population density

Var (Y) Population estimate variance

SE (Y) Standard error in population estimate

Y Population estimate

95% CL 95% confidence limit

CL % Percentage of 95% confidence limit to population estimate

Table 2 Northern Block Estimates (October 1995)

spp	sum(y)	var(y)	var(zy)	R	var(Y)	SE(Y)	Y	95%CL	CL%
buffalo	9	5.06	0.94	0.11	15856	126	133	268	202
bushbuck	8	0.67	0.49	0.10	1942	44	118	94	80
bushpig	-	-	-	-	-	-	-	-	-
duiker	49	8.86	2.73	0.60	21446	146	722	312	43
eland	1	0.06	0.04	0.01	200	14	15	30	205
elephant	66	192.65	7.12	0.80	593531	770	973	1642	169
grysbok	-	-	-	-	-	-	-	-	-
hartebeest	-	-	-	-	-	-	-	-	-
hippo	-	-	-	-	-	-	-	-	-
klipspringer	-	-	-	-	-	-	-	-	-
kudu	-	-	-	-	-	-	-	-	-
reedbuck	5	0.50	0.15	0.06	1582	40	74	85	115
roan	11	2.10	1.05	0.13	6046	78	162	166	102
sable	1	0.06	0.13	0.01	193	14	15	30	201
warthog	20	2.87	0.46	0.24	9108	95	295	203	69
waterbuck	9	2.40	0.28	0.11	7680	88	133	187	141
zebra	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
baboon	162	282.12	12.39	1.97	792295	890	2369	1697	79
leopard	-	-	-	-	-	-	-	-	-
lion	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
(pitfall)	39	4.93	2.02	0.47	11853	109	575	232	40

n = 16 sum(z) = 82 t(0.05, n-1) = 2.131

N = 236 var(z) = 2.84

Z = 1213 sample intensity = 6.8%

Note: SPP Fauna species

SUM (Y) Total animal count

R' Population density

Var (Y) Population estimate variance

SE (Y) Standard error in population estimate

Y Population estimate

95% CL 95% confidence limit

CL % Percentage of 95% confidence limit to population estimate

Table 3 Southern Block Estimates (October 1995)

spp	sum(y)	var(y)	var(zy)	R	var(Y)	SE(Y)	Y	95%CL	CL%
buffalo	59	44.52	2.39	0.54	55814	236	468	489	104
bushbuck	21	1.94	-0.07	0.19	2656	52	167	107	64
bushpig	9	0.77	0.24	0.08	970	31	71	64	90
duiker	132	7.57	0.99	1.21	9178	96	1047	198	19
eland	1	0.04	-0.05	0.01	56	8	8	16	196
elephant	8	0.75	0.13	0.07	978	31	63	65	102
grysbok	4	0.14	0.11	0.04	183	14	32	28	88
hartebeest	-	-	-	-	-	-	-	-	-
hippo	-	-	-	-	-	-	-	-	-
klipspringer	-	-	-	-	-	-	-	-	-
kudu	11	2.09	-0.05	0.10	2783	53	87	109	125
reedbuck	35	5.30	0.34	0.32	6872	83	278	171	62
roan	33	10.33	1.27	0.30	12768	113	262	234	89
sable	21	3.16	0.87	0.19	3782	61	167	127	76
warthog	60	5.48	0.97	0.55	6305	79	476	164	35
waterbuck	14	1.91	-0.49	0.13	2708	52	111	108	97
zebra	31	5.78	1.17	0.28	6877	83	246	172	70
-	-	-	-	-	-	-	-	-	-
baboon	147	77.68	1.86	1.35	98808	314	1166	650	56
leopard	1	0.04	-0.05	0.01	56	8	8	16	196
lion	2	0.17	-0.03	0.02	222	15	16	31	194
-	-	-	-	-	-	-	-	-	-
(pitfall)	19	1.56	-0.17	0.17	2191	47	151	97	64

n = 24 sum(z) = 100 t(0.05, n-1) = 2.069

N = 190 var(z) = 1.21

Z = 864 sample intensity = 12.6%

Note: SPP Fauna species

SUM (Y) Total animal count

R' Population density

Var (Y) Population estimate variance

SE (Y) Standard error in population estimate

Y Population estimate

95% CL 95% confidence limit

CL % Percentage of 95% confidence limit to population estimate

5. Major Wild Animal Distribution Maps base on Aerial Survey

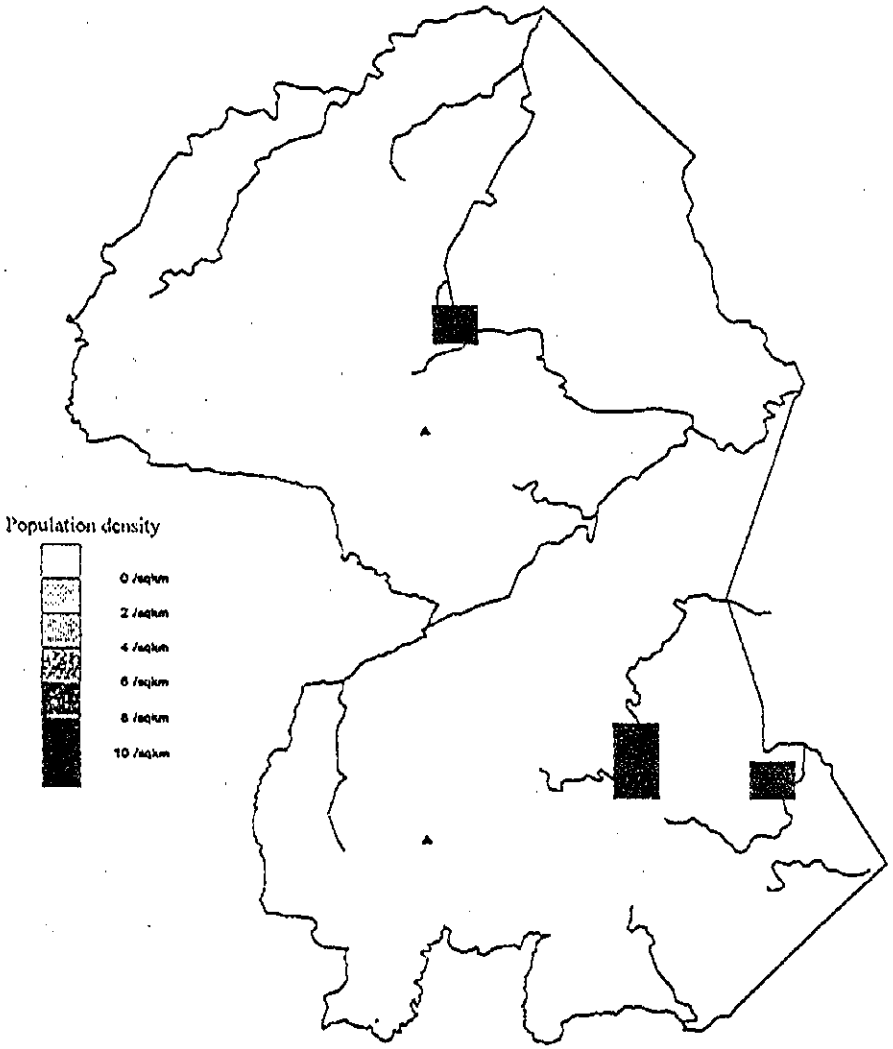


Fig. 1 Buffalo Distribution in Nkhotakota Wildlife Reserve

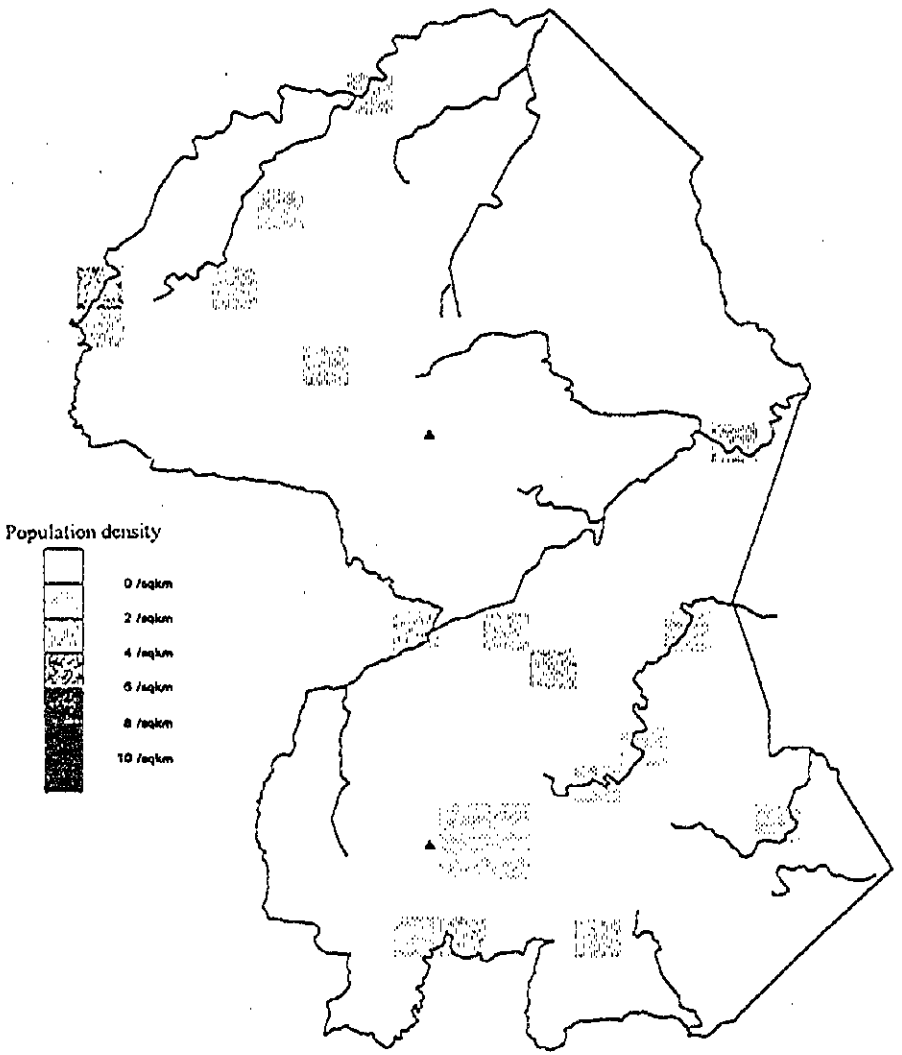


Fig. 2 Busbuck Distribution in Nkhotakota Wildlife Reserve

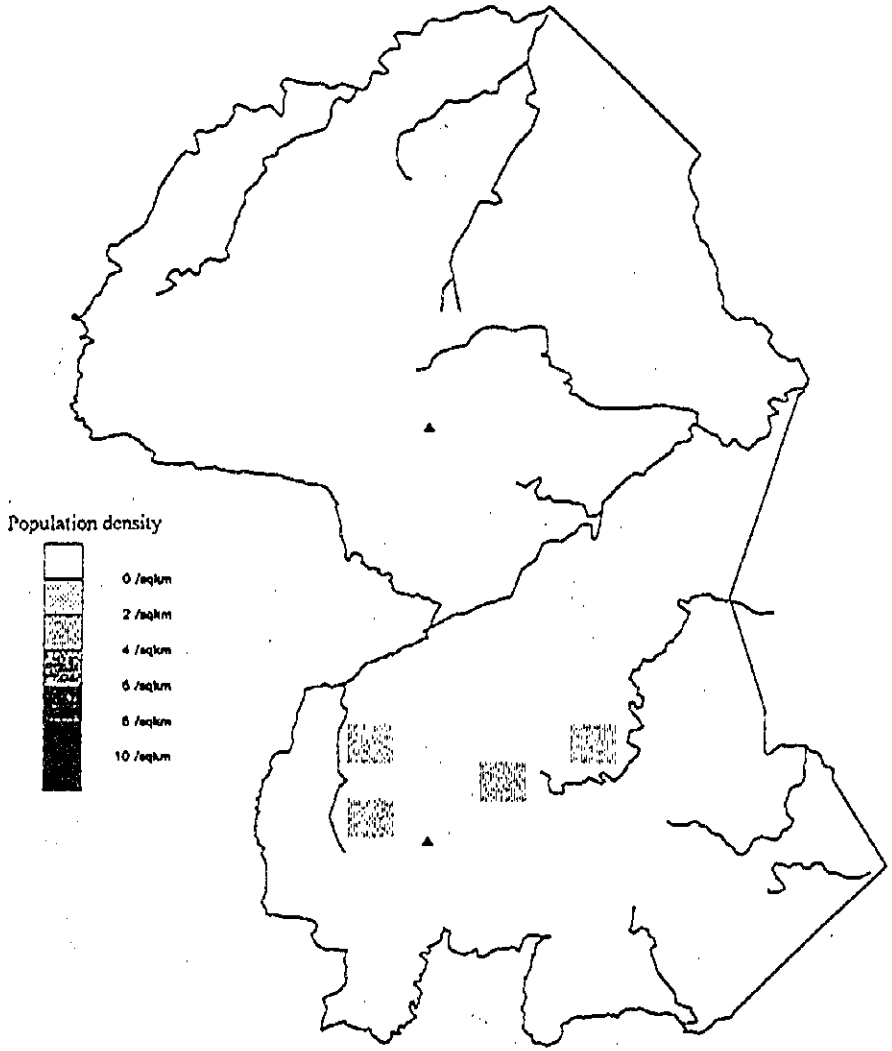


Fig. 3 Bushpig Distribution in Nkhotakota Wildlife Reserve

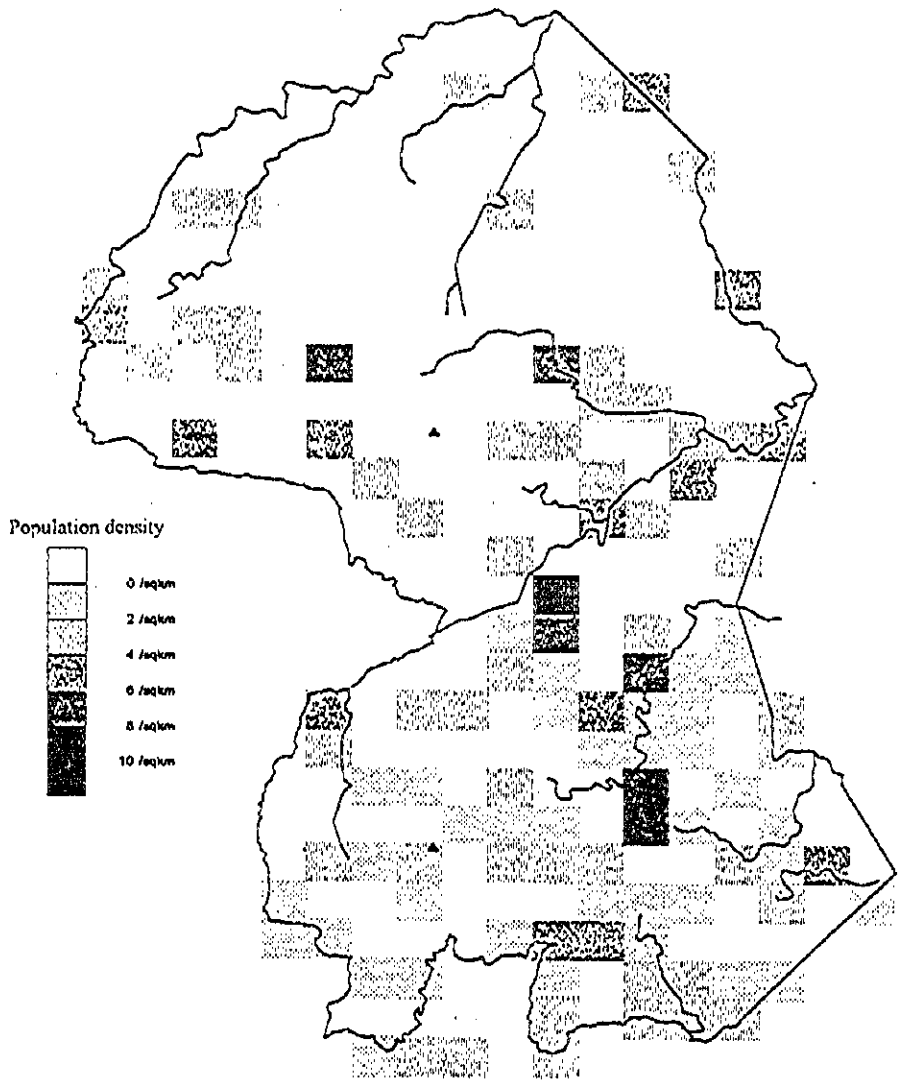


Fig. 4 Duiker Distribution in Nkhotakota Wildlife Reserve

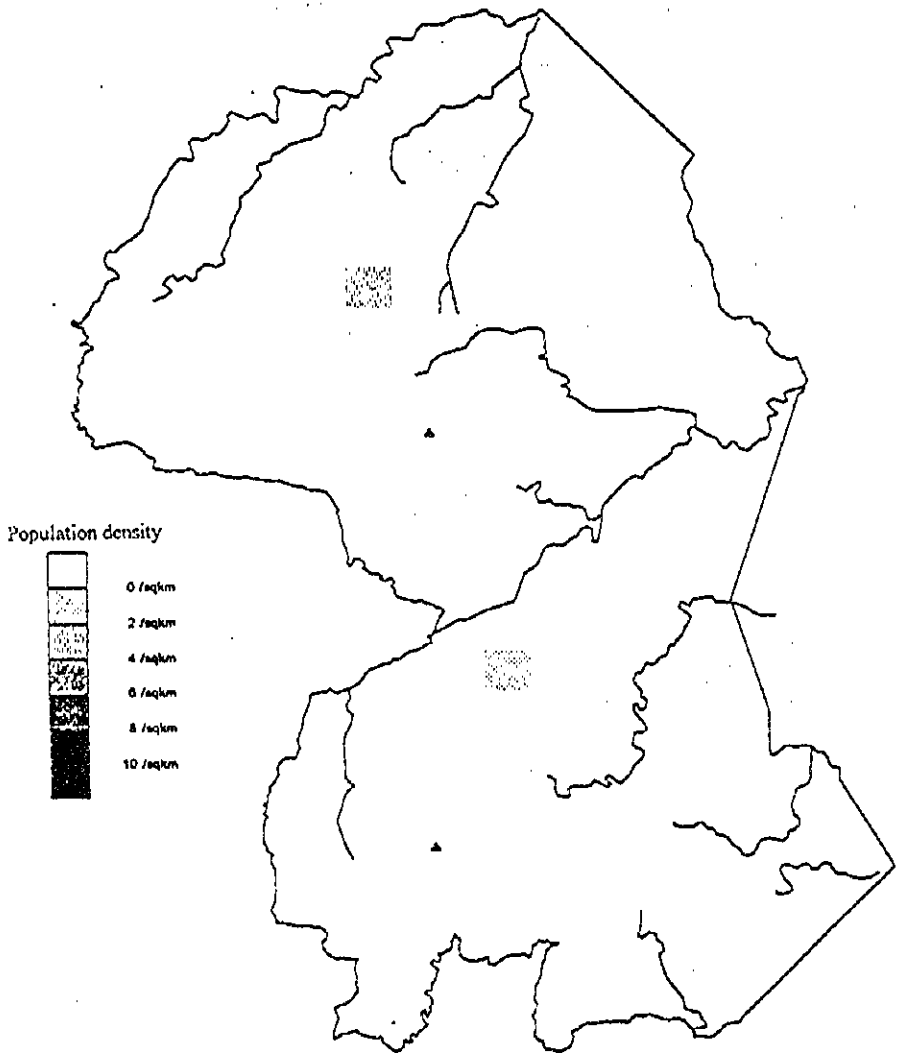


Fig. 5 Eland Distribution in Nkhotakota Wildlife Reserve

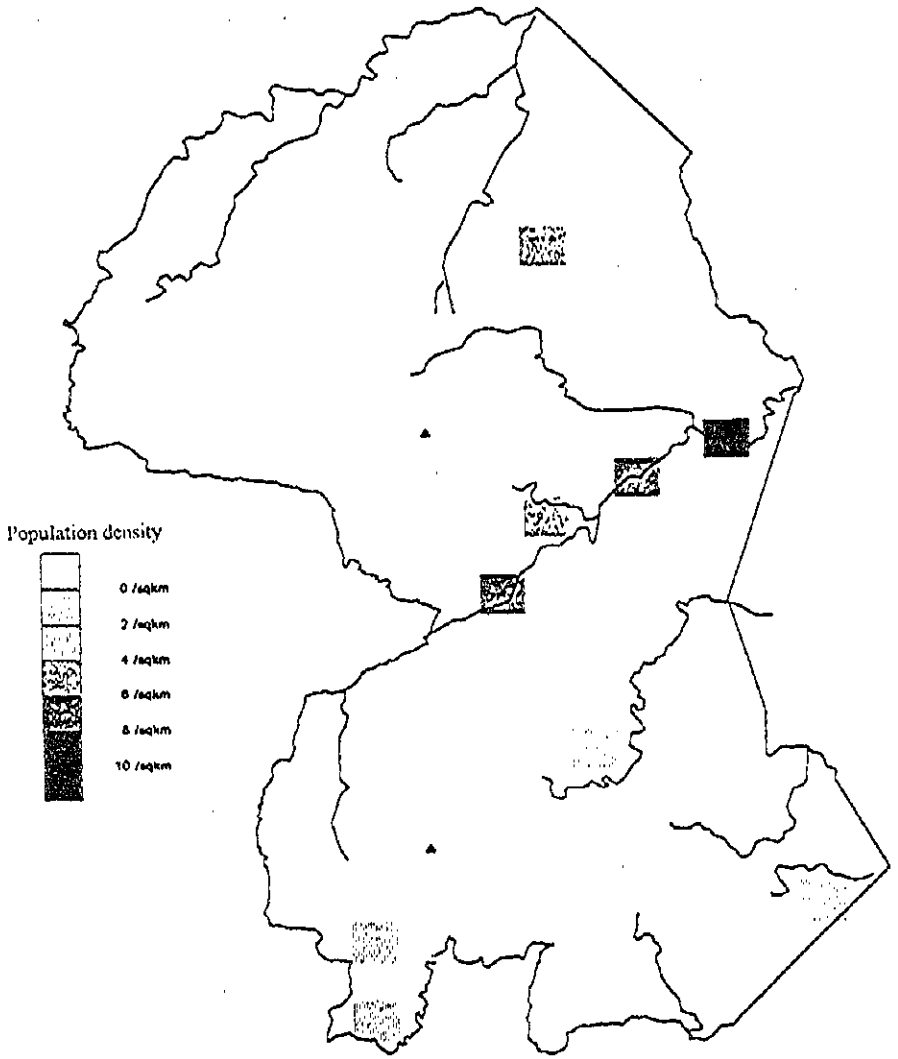


Fig. 6 Elephant Distribution in Nkhotakota Wildlife Reserve

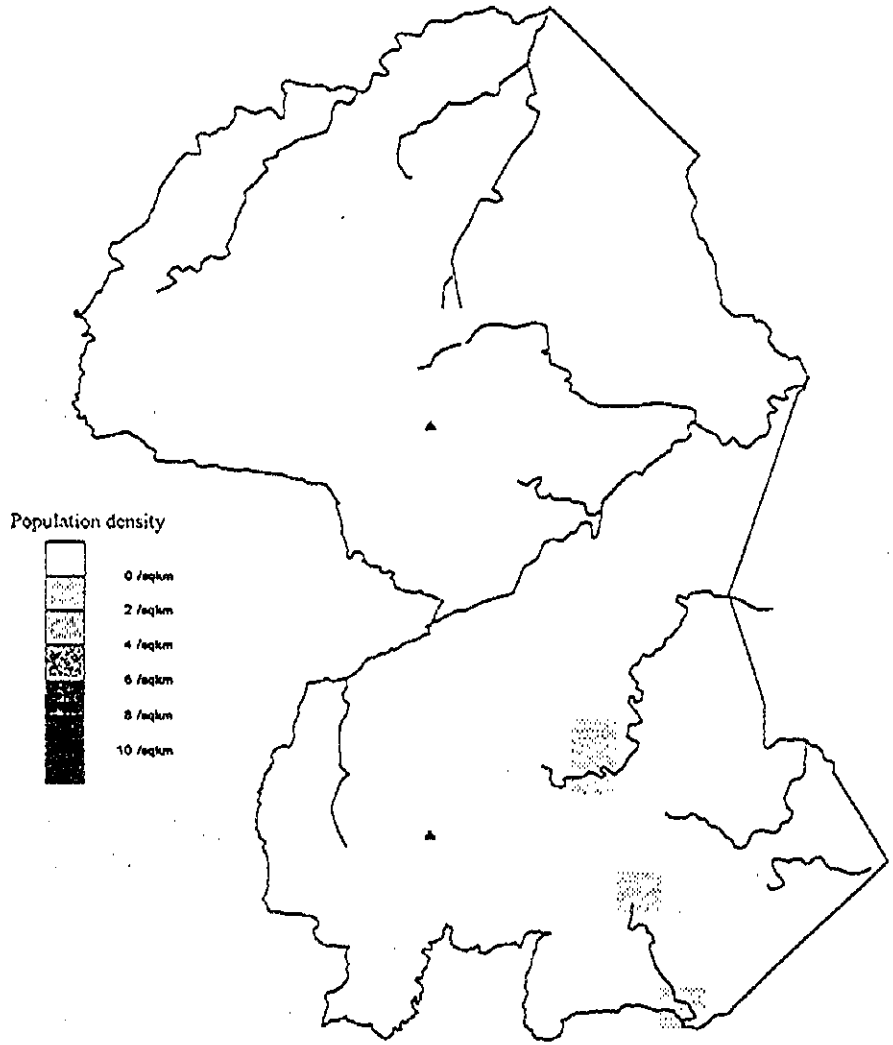


Fig.7 Grysbok Distribution in Nkhotakota Wildlife Reserve

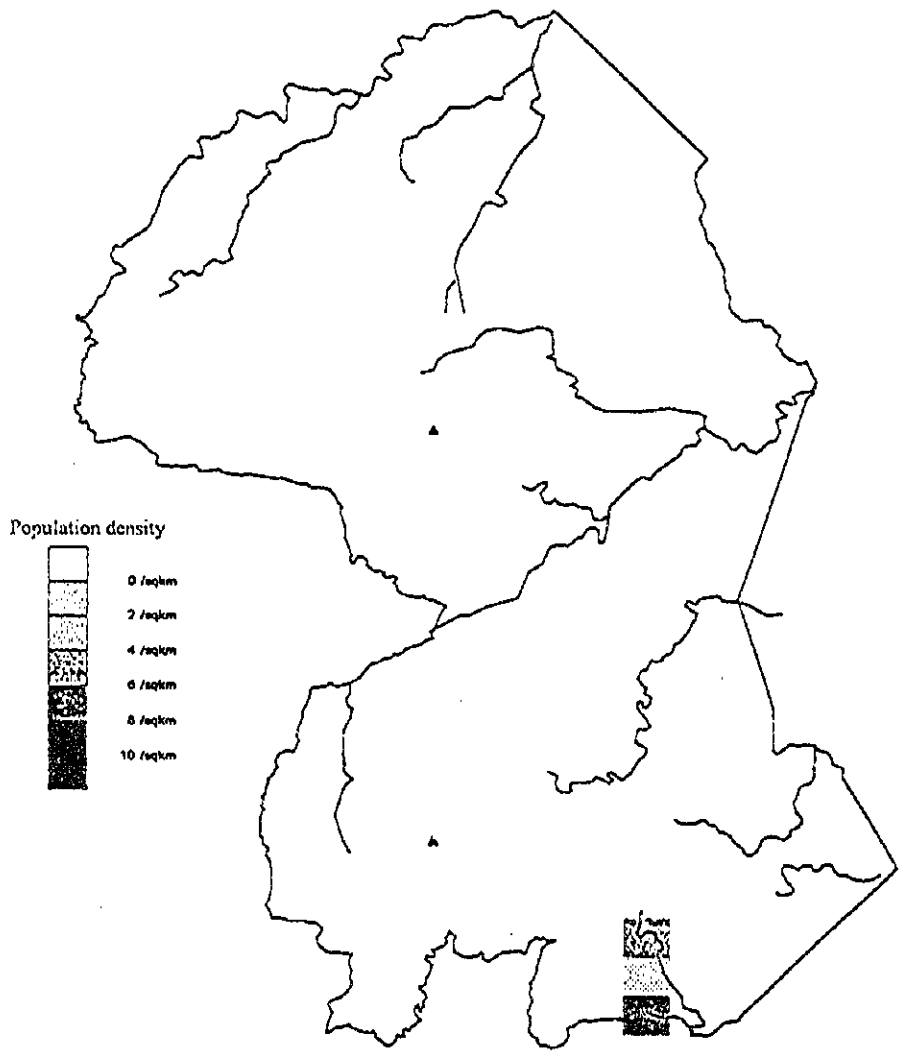


Fig.8 Kudu Distribution in Nkhotakota Wildlife Reserve

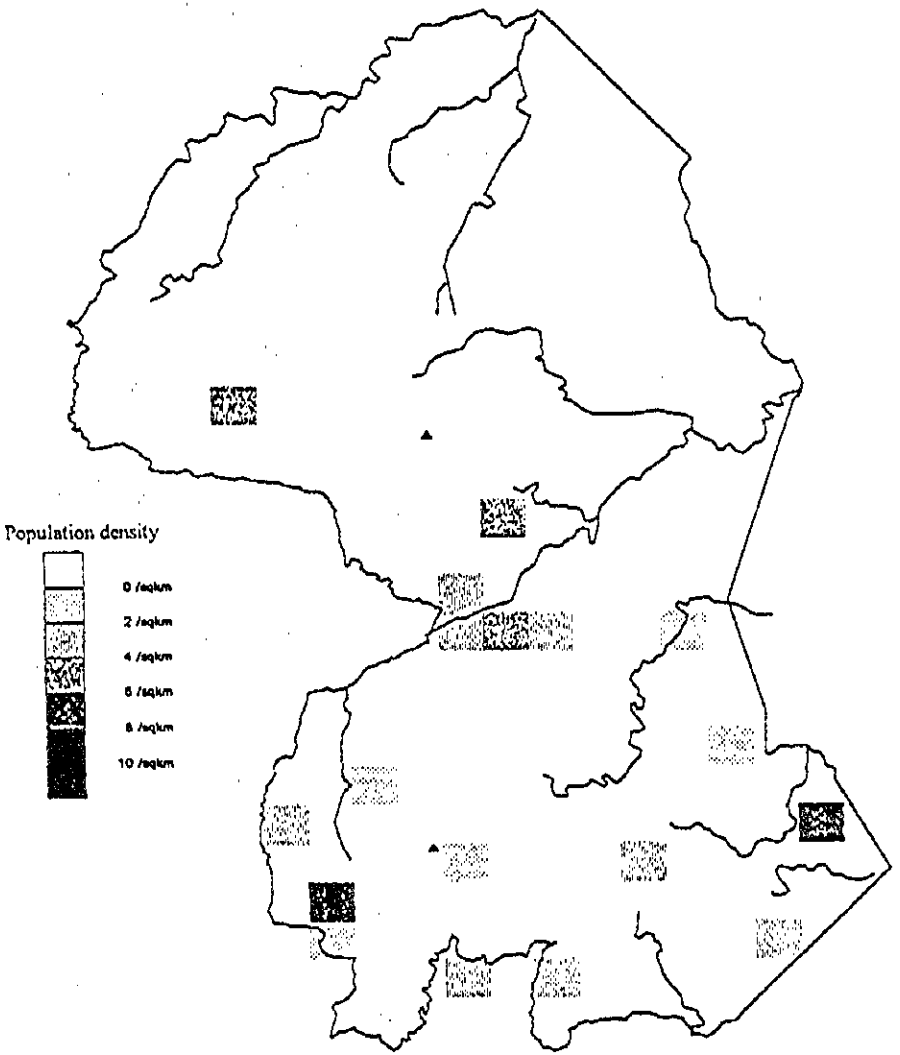


Fig.9 Reedbuck Distribution in Nkhotakota Wildlife Reserve

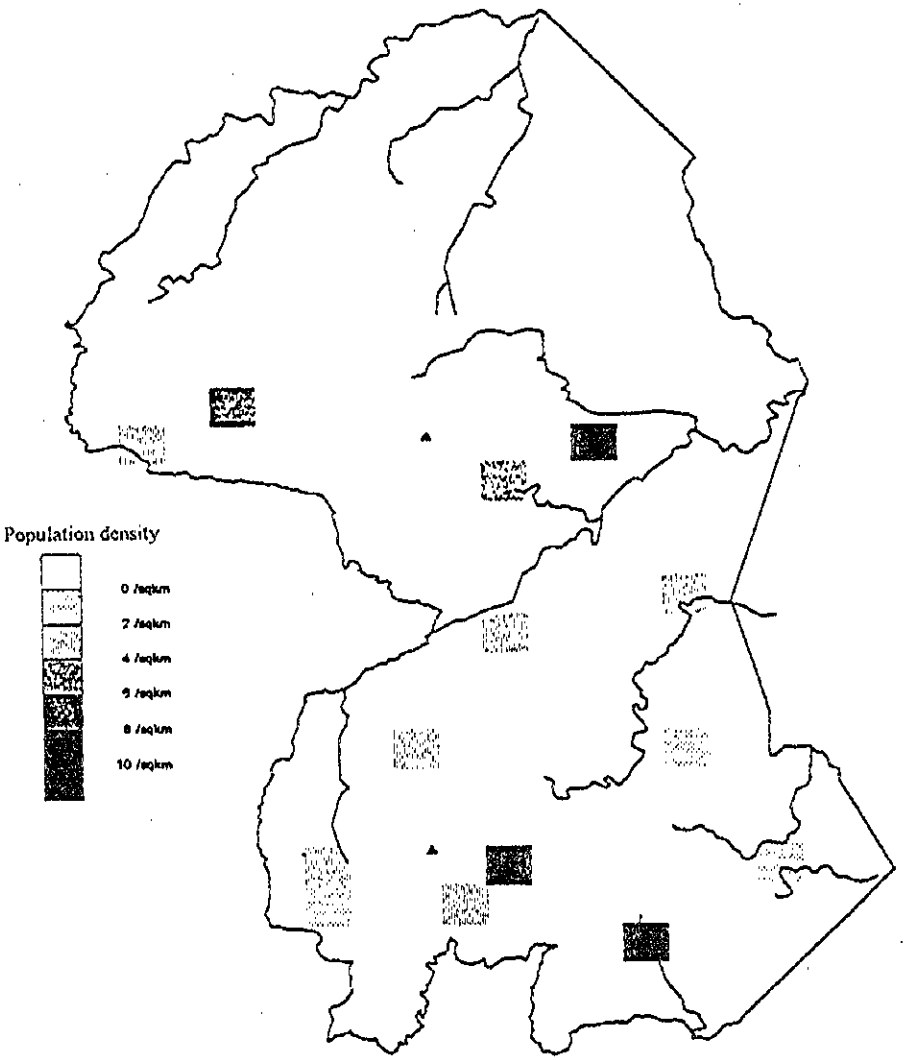


Fig.10 Roan Distribution in Nkhotakota Wildlife Reserve

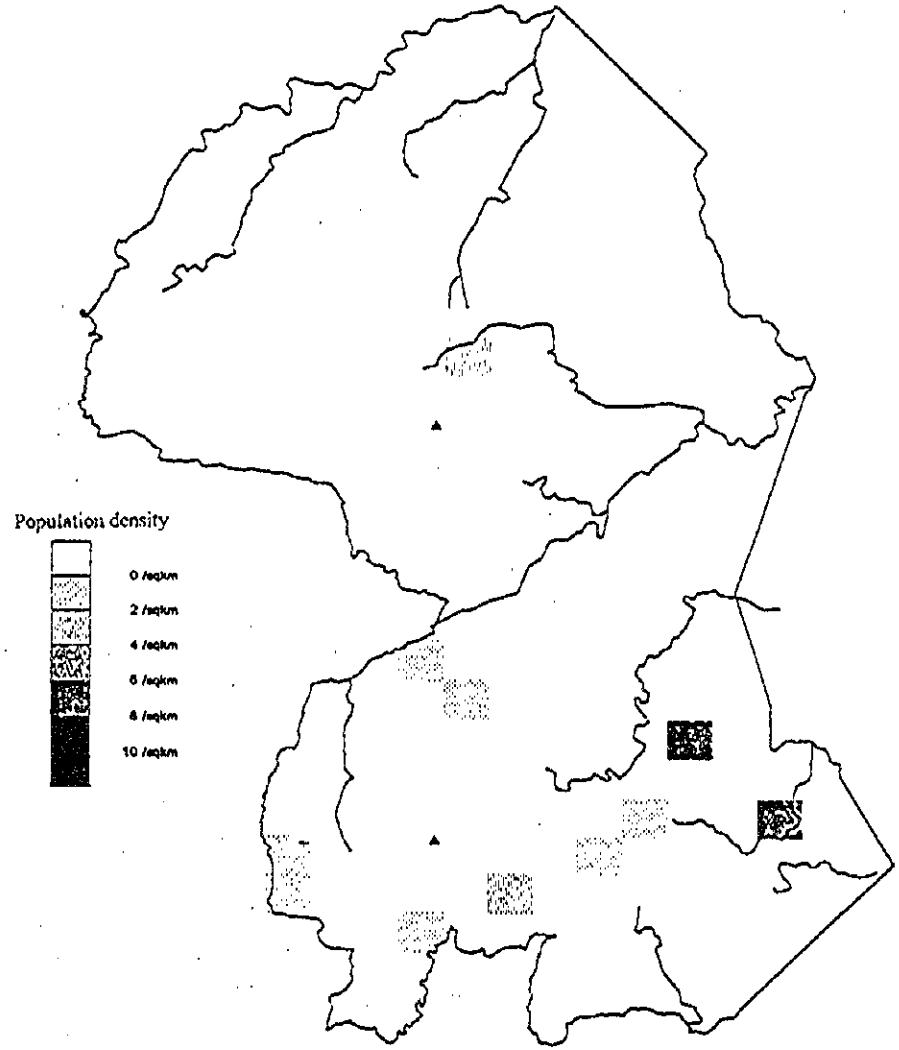


Fig. 11 Sable Distribution in Nkhotakota Wildlife Reserve

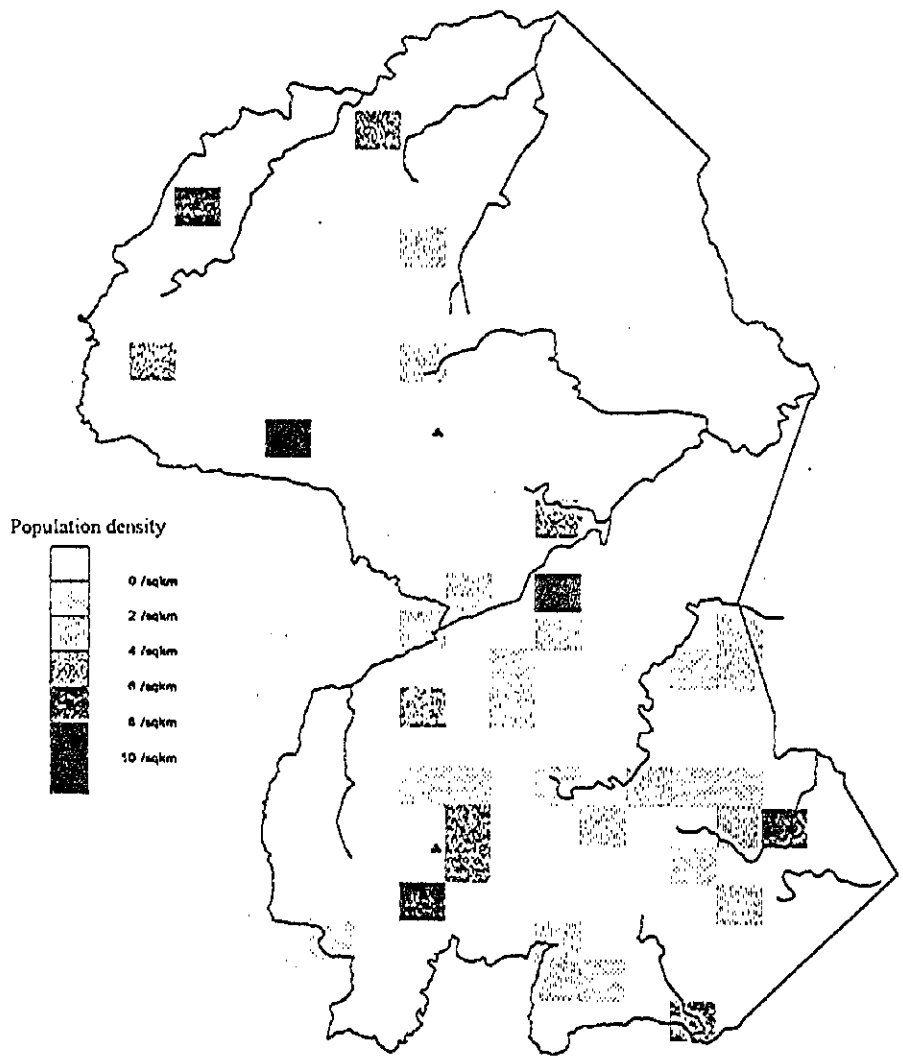


Fig. 12 Warthog Distribution in Nkhotakota Wildlife Reserve

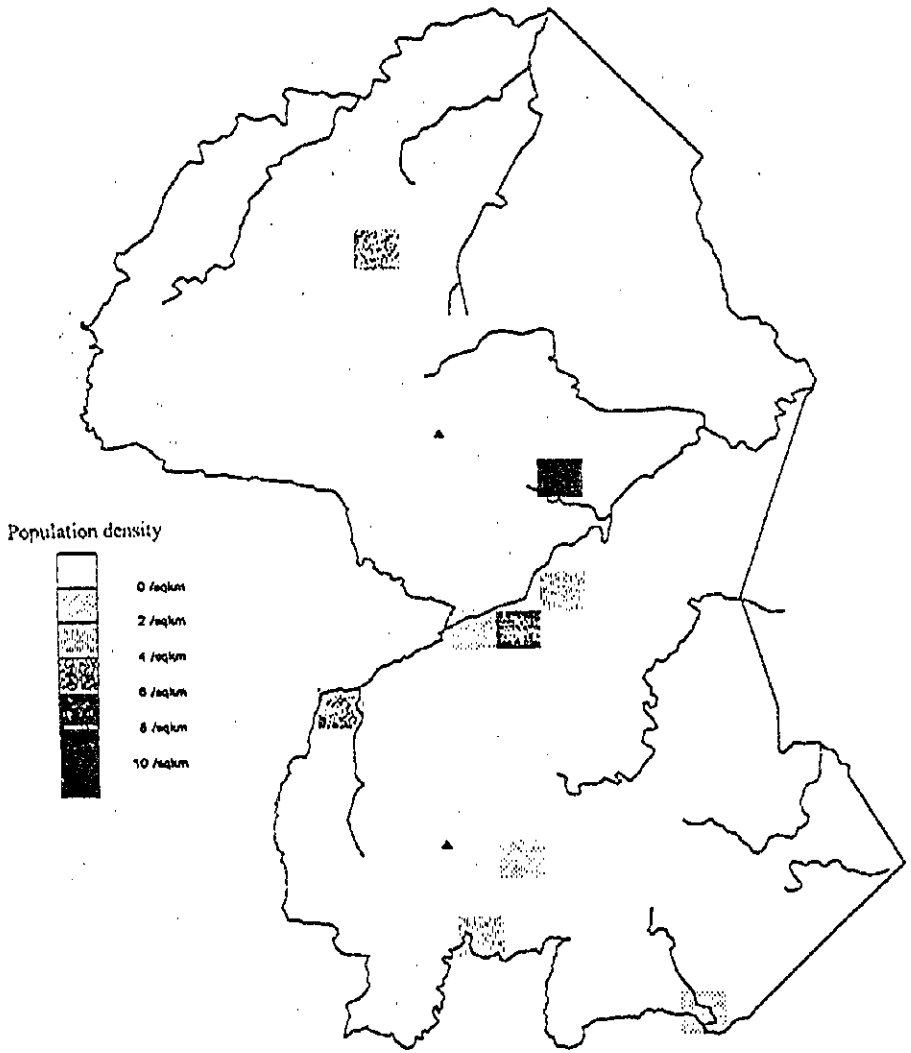


Fig. 13 Waterbuck Distribution in Nkhotakota Wildlife Reserve

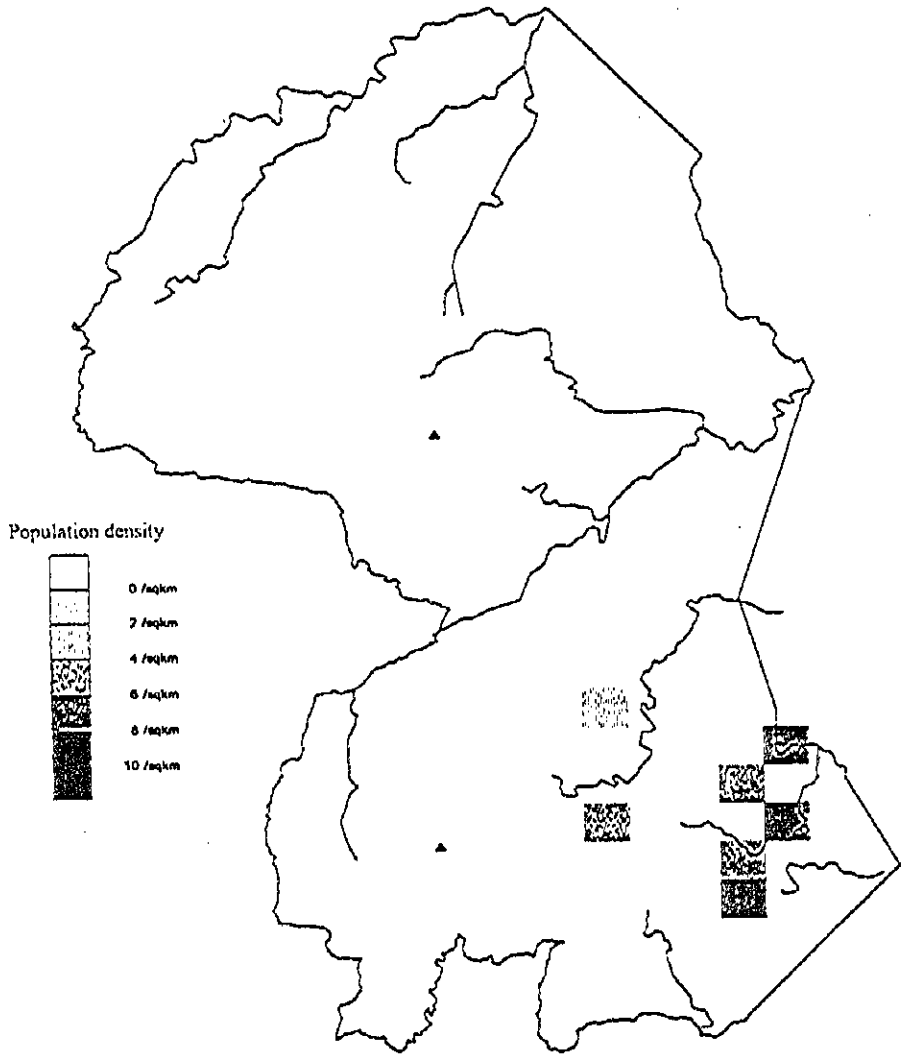


Fig. 14 Zebra Distribution in Nkhotakota Wildlife Reserve

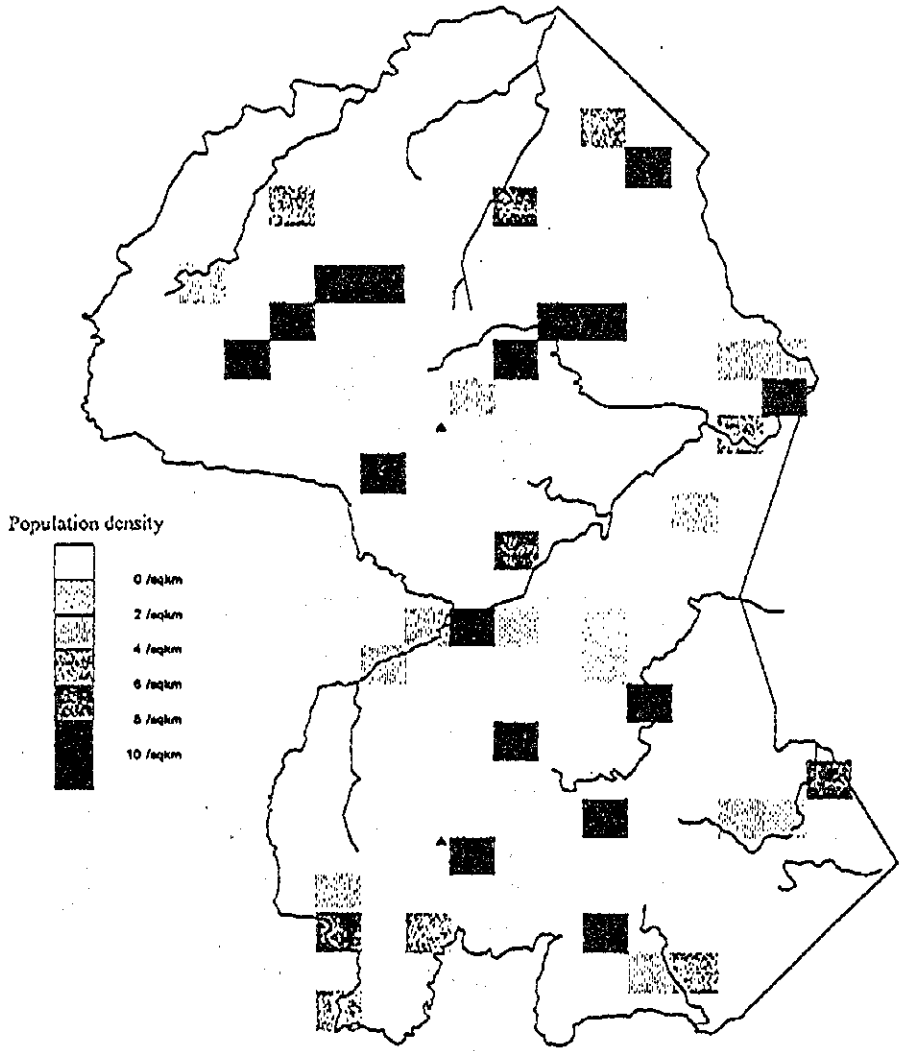


Fig. 15 Baboon Distribution in Nkhotakota Wildlife Reserve

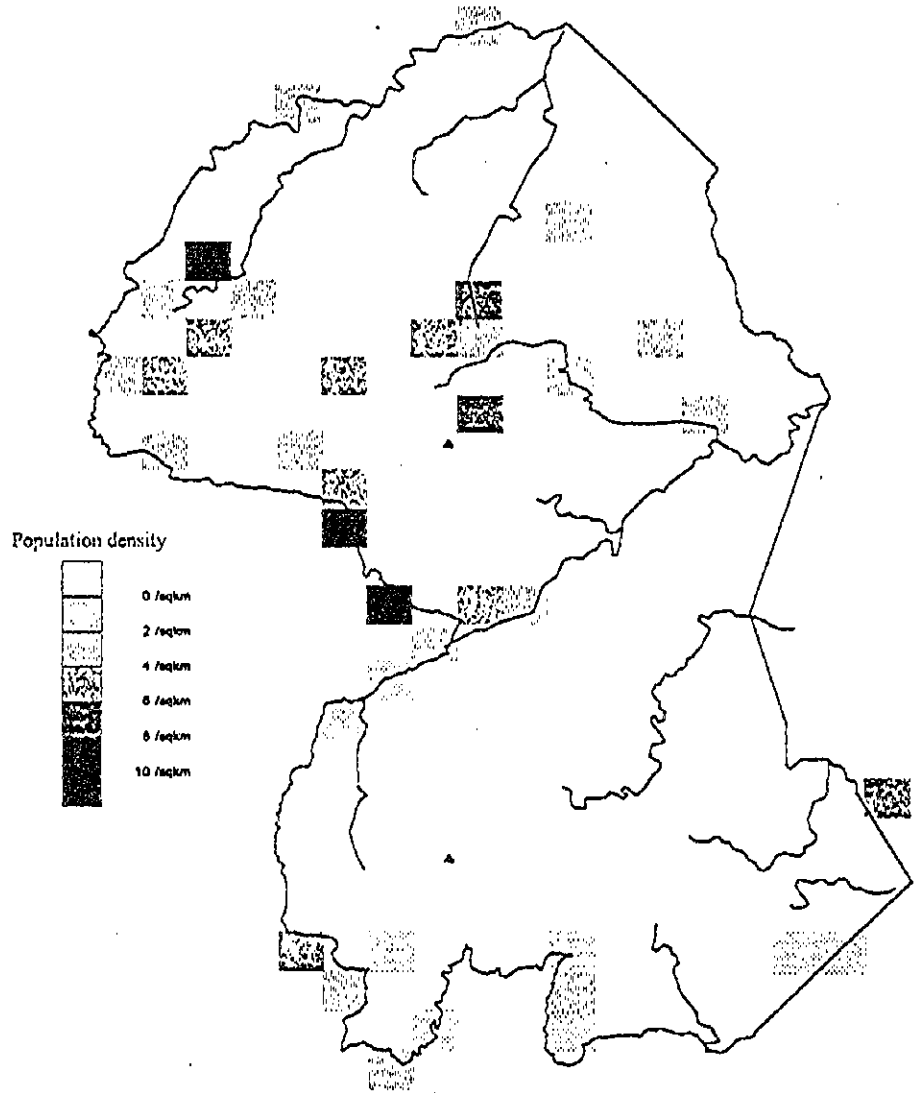


Fig. 16 Pitfall Distribution in Nkhotakota Wildlife Reserve

6. Results of Animal Ground Survey

Table 1 Pellet Groups Observed at Each River System

Area	ET	BU	SA	RA	WB	ZB	RB	BB	DK	WH	BP	GB
Bua	x		x	x	x			x	x	x		
Kaombe	x	x	x	x		x		x			x	
Wozi	x	x	x	x		x		x		x	x	
Dwafuni	x	x	x	x			x	x	x	x	x	x

ET: elephant BU: buffalo SA: sable antelope RA: roan antelope WB: waterbuck ZB: zebra
RB: reedbuck BB: bushbuck DK: duiker WH: warthog BP. bushpig GB: grysbok

Table 2 Number of Pellet Groups

Riverside

	Number of Pellet Groups per 100 Meters										
Location	ET	BU	SA	RA	WB	ZB	RB	BB	DK	WH	BP
Bua	3.0		0.6	1.8	2.4			0.4			
Kaombe	5.0	2.4									
Wozi	4.6	1.6	0.4	0.2		0.8		0.2			0.2
Dwafuni	0.8	1.0	0.4	0.4			1.6	1.2	0.4		

Woodland

	Number of Pellet Groups per 100 Meters										
Location	ET	BU	SA	RA	WB	ZB	RB	BB	DK	WH	BP
Bua	0.2		0.6		0.4			1.8	1.8		
Kaombe	1.0	0.2	0.4	1.0		0.6	0.8			0.4	
Wozi	0.2		1.2	0.2		1.0			0.2	0.4	
Dwafuni	2.6						0.2		4.4	0.2	0.2

Table 3 Record of Sightings

Species	Number	Sex	Age	Location
Bushbuck	5	1M 4F	5 AD	Bua River (near Bua camp, Bua bridge, Chitete)
Bushpig	6			Damboloyera dambo
Duiker	6	2M 1F 3?	6 AD	Wozi dambo, Wozi - Mbonekela Rd.
Eland	2	1M 1F	2 AD	Wozi - Mbonekela Rd.
Elephant	37		30 AD 7Y	Around Bua camp, Mpangamsithu
Roan antelope	1		1 AD	Wozi - Mbonekel Rd. (near Wozi camp)
Sable antelope	8	1M 7F	8 AD	Damboloyera dambo
Warthog	14		11AD 3Y	Wozi - Mbonekela Rd, Kaombe bridge, Dwafuni Valley
Waterbuck	19	8M 9F 2?	17AD 2Y	Bua River (ner Tongole camp/Bua camp), Kasukusuku hill
Zebra	6		6AD	Wozi - Mbonekela Rd.

M: male F: female AD: adult Y: young

Table 4 Measurements of the finished of Elephant (Adult Male)

Total length	Shoulder height	Front foot circumference	Hind foot circumference	Front foot diameter	Hind foot diameter	Ivory length and circumference
320	230	110	105	38 (L) 30 (S)	41 (L) 22 (S)	42 (tip - lip)* 22 (lip cir.)

* measured along the outer edge

Note: Left front leg had been wounded and swollen. It was reported on 23 August and was shot on 24 August near Lisitu confluence. The location was S 12° 49.188' and E 34° 08.268'. Only right ivory was measured as the left was in the water. Unit is in centimeters (cm).

7. List of Birds in the Nkhotakota Wildlife Reserve

List of Birds in the Nkhotakota Wildlife Reserve

FAMILY AND SPECIES (New species indicated with an asterisk)	SCIENTIFIC NAME
Family Phalacrocoracidae	
White-breasted Cormorant	*Phalacrocorax carbo*
Long-tailed Cormorant	*Phalacrocorax africanus*
Family Ardeidae	
White-backed Night Heron	*Goraschius leuconotus*
Green-backed Heron	*Butorides striatus*
Family Scopidae	
Hamerkop	*Scopus umbretta*
Family Ciconiidae	
Black Stork	*Ciconia nigra*
Woolly-necked Stork	*Ciconia episcopus*
Family Accipitridae	
White-headed Vulture	*Trigonoceps occipitalis*
Palm-nut Vulture	*Gypohierax angolensis*
Bateleur	*Terathopius ecaudatus*
Brown Snake Eagle	*Circaetus cinereus*
Black Goshawk	*Accipiter melanoleucus*
African Goshawk	*Accipiter tachiro*
Augur Buzzard	*Buteo augur*
Steppe Buzzard	*Buteo buteo*
Lizard Buzzard *	*Kaupifalco monogrammicus*
Crowned Eagle	*Stephanoaetus coronatus*
Martial Eagle	*Polemaetus bellicosus*
African Hawk Eagle	*Hieraaetus fasciatus*
Ayres' Hawk Eagle	*Hieraaetus ayresii*
Wahlberg's Eagle	*Aquila wahlbergi*
African Fish Eagle	*Haliaeetus vocifer*
Yellow-billed Kite	*Milvus migrans*
Osprey	*Pandion haliaetus*
Family Falconidae	
Lanner	*Falco biarmicus*
Peregrine	*Falco peregrinus*
Taita Falcon	*Falco fasciinucha*

Family Phasianidae	
Coqui Francolin	*Francolinus coqui*
Shelley's Francolin	*Francolinus shelleyi*
Hildebrandt's Francolin	*Francolinus hildebrandti*
Red-necked Francolin	*Francolinus afer*
Family Numididae	
Helmeted Guineafowl	*Numida meleagris*
Family Charadriidae	
Three-banded Plover	*Charadrius tricollaris*
Family Scolopacidae	
Green Sandpiper	*Tringa ochropus*
Wood Sandpiper *	*Tringa glareola*
Common Sandpiper	*Tringa hypoleucos*
Family Burhinidae	
Water Dikkop	*Burhinus vermiculatus*
Family Columbidae	
Red-eyed Dove	*Streptopelia semitorquata*
Cape Turtle Dove	*Streptopelia capicola*
Laughing Dove	*Streptopelia senegalensis*
Tambourine Dove	*Turtur tympanistria*
Emerald-spotted Wood Dove	*Turtur chalcospilos*
Cinnamon Dove	*Aplopelia larvata*
African Green Pigeon	*Treron calva*
Family Psittacidae	
Brown-necked Parrot	*Poicephalus robustus*
Family Musophagidae	
Schalow's Turaco	*Tauraco schalowi*
Purple-crested Turaco	*Tauraco porphyreolophus*
Go-Away-Bird	*Corythaixoides concolor*
Family Cuculidae	
Red-chested Cuckoo	*Cuculus solitarius*
Black Cuckoo	*Cuculus clamosus*
Klaas' Cuckoo	*Chrysococcyx klaas*
Didric Cuckoo	*Chrysococcyx caprius*
Emerald Cuckoo	*Chrysococcyx cupreus*
Yellow-billed Coucal	*Ceuthmochares aereus*
Burchell's Coucal	*Centropus burchelli*

Family Strigidae	
White-faced Owl *	*Otis leucotis*
Spotted Eagle Owl	*Bubo africanus*
Pel's Fishing Owl	*Scotopelia peli*
African Wood Owl	*Strix woodfordii*
Family Caprimulgidae	
Fiery-necked Nightjar	*Caprimulgus pectoralis*
Freckled Nightjar	*Caprimulgus tristigma*
Pennant-winged Nightjar	*Macrodipteryx vexillaria*
Family Apodidae	
African Palm Swift	*Cypsiurus parvus*
European Swift	*Apus apus*
Little Swift	*Apus affinis*
White-rumped Swift	*Apus caffer*
Family Alcedinidae	
Pigmy Kingfisher *	*Ceyx picta*
Giant Kingfisher	*Ceryle maxima*
Pied Kingfisher	*Ceryle rudis*
Half-collared Kingfisher	*Alcedo semitorquata*
Malachite Kingfisher	*Alcedo cristata*
Striped Kingfisher	*Halcyon chelicuti*
Chestnut-bellied Kingfisher	*Halcyon leucocephala*
Brown-hooded Kingfisher *	*Halcyon albiventris*
Family Meropidae	
European Bee-eater	*Merops apiaster*
Blue-cheeked Bee-eater *	*Merops persicus*
Boehm's Bee-eater	*Merops boehmi*
Little Bee-eater	*Merops pusillus*
Swallow-tailed Bee-eater	*Merops hirundineus*
Family Coraciidae	
Lilac-breasted Roller	*Coracias caudata*
Racket-tailed Roller *	*Coracias spatulata*
Lilac-breasted Roller	*Coracias caudata*
Family Upupidae	
Hoopoe	*Upupa epops*
Family Phoeniculiae	
Red-billed Wood-hoopoe	*Phoeniculus purpureus*
Scimitarbill	*Rhinopomastus cyanomelas*

Family Bucerotidae	
Pale-billed Hornbill	*Tockus pallidirostris*
Crowned Hornbill	*Tockus alboterminatus*
Trumpeter Hornbill	*Bycanistes buccinator*
Southern Ground Hornbill	*Bucorvus leadbeateri*
Family Capitonidae	
Black-collared Barbet	*Lybius torquatus*
Whyte's Barbet	*Stactolaema whytii*
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*
Golden-rumped Tinkerbird *	*Pogoniulus bilineatus*
Moustached Green Tinkerbird	*Pogoniulus leucomystax*
Family Indicatoridae	
Scaly-throated Honeyguide	*Indicator variegatus*
Greater Honeyguide	*Indicator indicator*
Lesser Honeyguide	*Indicator minor*
Family Picidae	
Golden-tailed Woodpecker	*Campethera abingoni*
Cardinal Woodpecker	*Dendropicos fuscescens*
Bearded Woodpecker	*Thripias namaquus*
Family Alaudidae	
Flappet Lark	*Mirafra rufocinnamomea*
Family Hirundinidae	
European Swallow	*Hirundo rustica*
Wire-tailed Swallow	*Hirundo smithii*
Red-rumped Swallow	*Hirundo daurica*
Lesser Striped Swallow	*Hirundo abyssinica*
Grey-rumped Swallow	*Pseudhirundo griseopyga*
Rock Martin	*Hirundo fuligula*
House Martin	*Delichon urbica*
Eastern Saw-wing	*Psalidoprocne orientalis*
Family Dicruridae	
Fork-tailed Drongo	*Dicrurus adsimilis*
Family Oriolidae	
African Golden Oriole	*Oriolus auratus*
Black-headed Oriole	*Oriolus larvatus*
Family Corvidae	
White-necked Raven	*Corvus albicollis*
Pied Crow	*Corvus albus*

Family Paridae	
Miombo Grey Tit	*Parus griseiventris*
Rufous-bellied Tit	*Parus rufiventris*
Family Timaliidae	
Arrow-marked Babbler	*Turdoides jardineii*
Family Campephagidae	
White-breasted Cuckoo-shrike	*Coracina pectoralis*
Black Cuckoo-shrike	*Campephaga flava*
Family Pycnonotidae	
Black-eyed Bulbul	*Pycnonotus barbatus*
Little Green Bulbul	*Andropadus virens*
Yellow-bellied Bulbul	*Chlorocichla flaviventris*
Grey-olive Bulbul	*Phyllastrephus cerveiventris*
Yellow-streaked Bulbul	*Phyllastrephus flavostriatus*
Family Turdidae	
Familiar Chat	*Cercomela familiaris*
Arnot's Chat	*Thamnolaea arnoti*
Mocking Chat	*Thamnolaea cinnamomeiventris*
Miombo Rock Thrush	*Monticola angolensis*
White-browed Scrub Robin	*Erythropygia leucophrys*
Central Bearded Scrub Robin *	*Erythropygia barbata*
Starred Robin	*Pogonocichla stellata*
Red-capped Robin	*Cossypha natalensis*
Heuglin's Robin	*Cossypha heuglini*
Kurrichane Thrush	*Turdus libonyanus*
Family Sylviidae	
African Sedge Warbler	*Bradypterus baboecala*
Moustached Warbler	*Melocichla mentalis*
Willow Warbler	*Phylloscopus trochilus*
Tawny-flanked Prinia	*Prinia subflava*
Red-winged Warbler	*Heliolais erythoptera*
Yellow-breasted Apalis	*Apalis flavida*
Chestnut-throated Apalis	*Apalis porphyrolaema*
Bleating Bush Warbler	*Camaroptera brachyura*
Eastern Barred Warbler	*Camaroptera stierlingi*
Yellow-bellied Eremomela	*Eremomela icteropygialis*
Green-capped Eremomela	*Eremomela scotops*
Red-capped Crombec	*Sylvietta ruficapilla*
Long-billed Crombec	*Sylvietta rufescens*
Yellow-bellied Hyliota	*Hyliota flavigaster*
Red-faced Cisticola	*Cisticola erythrops*
Rock Cisticola	*Cisticola aberrans*

Rattling Cisticola	*Cisticola chiniana*
Croaking Cisticola	*Cisticola natalensis*
Neddicky	*Cisticola fulvicapilla*
Shortwing Cisticola	*Cisticola brachyptera*

Family Muscicapidae

Spotted Flycatcher	*Muscicapa striata*
Dusky Flycatcher	*Muscicapa adusta*
Ashy Flycatcher	*Muscicapa caerulescens*
Black Flycatcher	*Melaenornis pammelaina*
Chin-spot Batis	*Batis molitor*
Wattle-eyed Flycatcher	*Platysteira peltata*
White-tailed Blue Flycatcher	*Elminia albicauda*
Paradise Flycatcher	*Terpsiphone viridis*

Family Malaconotidae

Brubru	*Nilaus afer*
Southern Puffback	*Dryoscopus cubla*
Brown-headed Tchagra	*Tchagra australis*
Black-headed Tchagra	*Tchagra senegala*
Tropical Boubou	*Laniarius aethiopicus*
Orange-breasted Bush Shrike	*Telophorus sulfureopectus*
Grey-headed Bush Shrike	*Malaconotus blanchoti*

Family Motacillidae

Long-tailed Wagtail	*Motacilla clara*
African Pied Wagtail	*Motacilla aguimp*
Wood Pipit	*Anthus nyassae*
Striped Pipit	*Anthus lineiventris*

Family Laniidae

Fiscal Shrike	*Lanius collaris*
Souza's Shrike *	*Lanuis souzae*

Family Prionopidae

White Helmet Shrike	*Prionops plumata*
Red-billed Helmet Shrike	*Prionops retzii*

Family Sturnidae

Red-winged Starling	*Onychognathus morio*
Lesser Blue-eared Starling	*Lamprotornis chloropterus*
Amethyst Starling	*Cinnyricinclus leucogaster*

Family Nectariniidae

Collared Sunbird	*Anthreptes collaris*
Olive Sunbird	*Nectarinia olivacea*
Black Sunbird	*Nectarinia amethystina*

Scarlet-chested Sunbird	*Nectarinia senegalensis*
Yellow-bellied Sunbird	*Nectarinia venusta*
White-bellied Sunbird	*Nectarinia talatala*
Lesser Double-collared	*Sunbird Nectarinia chalybea*
Shelley's Sunbird	*Nectarinia shelleyi*
Purple-banded Sunbird	*Nectarinia bifasciata*
Family Zosteropidae	
Yellow White-eye	*Zosterops senegalensis*
Family Ploceidae	
Large Golden Weaver	*Ploceus xanthops*
Spotted-backed Weaver	*Ploceus cucullatus*
Spectacled Weaver	*Ploceus ocularis*
Olive-headed Weaver	*Ploceus olivaceiceps*
Red-headed Weaver	*Anaplectes rubriceps*
Black-winged Bishop	*Euplectes hordeaceus*
Yellow-rumped Widow	*Euplectes capensis*
Red-collared Widow	*Euplectes ardens*
Grey-headed Sparrow	*Passer griseus*
Yellow-throated Sparrow	*Petronia superciliaris*
Family Viduidae	
Broad-tailed Paradise Whydah	*Vidua orientalis*
Family Estrildidae	
Golden-backed Pytilia	*Pytilia afra*
Red-throated Twinspot	*Hypargos niveoguttatus*
Brown-backed Firefinch	*Lagonosticta rubricata*
Blue Waxbill	*Uraeginthus angolensis*
Swee Waxbill	*Estrilda melanotis*
Common Waxbill	*Estrilda astrild*
Bronze Mannikin	*Lonchura cucullata*
Red-backed Mannikin	*Lonchura bicolor*
Family Fringillidae	
Cabanis' Bunting	*Emberiza cabanisi*
Golden-breasted Bunting	*Emberiza flaviventris*
Cinnamon-breasted Rock Bunting	*Emberiza tahapisi*
Cape Bunting	*Emberiza capensis*
Yellow-eyed Canary	*Serinus mozambicus*
African Citril	*Serinus citrinelloides*
Stripe-breasted Seedeater	*Serinus reichardi*
Black-eared Seedeater	*Serinus mennelli*

8. Results of the Fish Survey

Table 1 Electrofishing Catches from Sampling Sites in the Dwangwa River System

SITE	1		2		3		4		5		6		7	
SPECIES	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)
Marcusenius livingstonii									1	4				
.Petrocephalus catostoma									2	6				
Pollimyrus castelnaui			4	11										
Hemigrammopetersius barnardi			1	1										
Barbus arcislongae			9	16										
Barbus atkinsoni			30	15										
Barbus bifrenatus							13	18						
Barbus johnstonii	4	24	13	153										
Barbus kerstenii			43	48	2	1			78	93				
Barbus lineomaculatus			3	6					1	2				
Barbus cf. lineomaculatus (A)			4	4			32	38						
Barbus cf. lineomaculatus (B)			73	37										
Barbus macrotaenia					28	26	34	15	9	6	1	1	1	1
Barbus paludinosus			20	27	65	55			41	160	5	16	74	78
Barbus trimaculatus			6	15			1	8						
Labeo cylindricus			25	244					36	710				
Opsaridium microcephalum			1	1	1	1					14	6		
Opsaridium sp. 'dwarf sanjika'			3	10										
Leptoglanis sp.			5	2					8	2				
Amphilius uranoscopus	3	76	1	7										
Clarias gariepinus			2	41	1	127			8	840			2	39
Chiloglanis neumanii	1	9	22	13					17	7			1	1
Aplocheilichthys johnstonii							76	29						
Astatotilapia calliptera			29	101	79	278	212	534	18	93	229	1,179	97	71
Oreochromis shiranus shiranus			1	1	16	77	3	38			8	68	1	29
Pseudocrenilabrus philander							12	26						
Serranochromis robustus.robustus							5	63						
Tilapia rendalli											2	14		
Tilapia sparrmanii							24	122						
Aethiomastacembelus shiranus			4	18					2	5				

Table 2 Electrofishing Catches from Sampiing Sites in the Bua River System

SITE	8		9		10		11		12		13		14	
SPECIES	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)	No.	Wt. (gm)
Barbus arcislongae							9	17						
Barbus johnstonii			49	300	36	33	473	2,666	21	20				
Barbus kerstenii			1	3			11	15						
Barbus lineomaculatus	51	46	5	5	4	7								
Barbus cf. lineomaculatus (A)							1	1						
Barbus cf. lineomaculatus (B)							1	1						
Barbus macrotaenia					10	8	2	2						
Barbus paludinosus			6	4					2	7				
Barbus trimaculatus	14	53	48	164	11	48	128	394	8	41				
Labeo cylindricus			4	24	6	67	3	32						
Opsaridium microcephalum	1	1	19	13	10	3	124	123	4	1				
Opsaridium sp. 'dwarf sanjika'							3	10						
Leptoglanis sp.	13	7	1	1			40	17						
Clarias gariepinus	1	21	12	1,136	7	265	12	445	1	29	1	35		
Chiloglanis neumanii			23	46			170	212						
Aplocheilichthys johnstonii					1	1								
Astatotilapia calliptera	102	184	84	215	143	229	236	415	5	22	82	235	9	23
Oreochromis shiranus shiranus	30	297	3	11	15	619	11	46			2	105		
Aethiomastacembelus shiranus			4	17	7	14	9	48						

Table 3 Electrofishing Catches from Sampling Sites in the Kaombe River System

SITE	15		16	
SPECIES	No.	Wt. (gm)	Wt. (gm)	No.
Hippopotamyrus discorhynchus	2	6		
Marcusenius livingstonii	7	19		
Marcusenius macrolepidotus	3	75		
Petrocephalus catostoma	4	6		
Brycinus imberi	14	37		
Hemigrammopetersius barnardi	34	11	1	1
Barbus atkinsoni	6	2		
Barbus bifrenatus	58	28		
Barbus kerstenii	6	6		
Barbus cf. *lineomaculatus* (A)	68	24	1	1
Barbus cf. *lineomaculatus* (B)	37	9	9	3
Barbus macrotaenia	1	1	21	8
Barbus paludinosus	45	74		
Barbus trimaculatus	46	127	2	3
Labeo cylindricus	18	106	3	25
Clarias gariepinus	6	300	2	39
Aplocheilichthys johnstonii	44	17		
Astatotilapia calliptera	15	18	50	76
Mylochromis sp. juvenile			1	3
Oreochromis shiranus shiranus	111	236	2	5
Oreochromis sp. 'chambo'	2	9	4	6
Pseudocrenilabrus philander	18	9		
Serranochromis robustus robustus	4	40		
Tilapia rendalli	1	1		
Tilapia sparrmanii	23	33		

9. Forest Survey Method

1. Growing Stock Survey

(1) Survey Plots

For this survey, a total of 27 stands were selected as sample plots, consisting of two plots in the evergreen broad-leaved forest, one plot in the semi-evergreen broad-leaved forest, and 24 plots in miombo forests.

(2) Size and Location of Study Plots

The size of plots is 50m x 50m (0.25ha) each as a rule, and partially 100m x 25m (0.25ha) depending on topography and vegetation. Prior to the selection of plots, sites for the survey were chosen as shown in Fig. 6-7. Site selection was determined by the objectives of the survey, the time required to sample each plot, the period of the survey and the road conditions.

(3) Trees Surveyed

Complete enumeration of all trees more than 5 cm in DBH (diameter at breast height) were done in all plots.

(4) Survey Items

- DBH: All trees were measured with a diameter gauge.
- Tree height: All trees in the evergreen and semi-evergreen broad-leaved forests were measured. In miombo forests, standard trees were selected by eye measurement from trees whose DBHs were average. After the cutting of these trees, their heights were measured at the same time as sectional volume measurement.
- Crown Density: Trees were classified into thick, medium and thin according to closedness and openness of their crowns

(5) Stumpage Volume Estimation

Based on the results of DBH measurement, basal area was calculated. Then, felled standing trees were subjected to sectional volume measurement according to the Smalian's formula. The volume of these standing trees was estimated, and the breast height form factor was determined in comparison with cylindric volume. The total standing tree volume in sample plots was calculated by the following formula :

$$V = G \times H \times F$$

where V: Stampage volume in standard area
G: Total basal area
H: Average tree height
F: Breast height form factor

As for the evergreen and semi-evergreen broad-leaved forests, where single trees were too large to make sectional volume measurement, the breast height form factor was determined according to the formula for broad-leaved trees used in Japan. The factor was substituted for F in the above formula to determine stampage volume. The formula to determine the breast height form factor is as follows:

$$F = \frac{mn^m}{(m+1)(n^m-1)}$$

where

m = 0.625 as a constant for each species.

$$n = \frac{Average\ height}{Average\ DBH}$$

(6) Branch Volume Estimation

First of all, the weight of all branches of the standing trees, which were felled for sectonal volume measurement, was measured. Then, samples were collected from these standing trees, and their weight and volume were measured. In comparison of these measurements, the branch volume of the standard tree was determined according to the following formula.

$$V = \frac{m \times g''}{g_s}$$

where V: Branch volume of standard tree
g_s: Weight of standard tree sample
m: Volume of standard tree sample

Branch volume percent was calculated according to the following formula on the basis of the ratio of branch volume to stumpage volume determined by the above formula.

$$A = \frac{V_b}{V_t} \times 100$$

where A: Branch volume percent (%)
V_b: Branch volume of standard tree
V_t: Stumpage volume of standard tree

The branch volume in the sample plot was calculated by multiplying the total stumpage volume in the sample plot by the branch volume percent. However, as far as the evergreen and semi-evergreen broad-leaved forests are concerned, branch volume could not be estimated because the weight of branches could not be measured.

2. Forest Type Survey

(1) Survey Plots

In 27 plots established in the growing stock survey, all species which appeared were identified. Typical forest types were selected in six plots in view of vegetation type, stand density, crop density, and crown density. These plots consists of one plot in the evergreen broad-leaved forest, one plot in the semi-evergreen broad-leaved forest, three plots in miombo forests and one plot in the riverside forest.

(2) Size and Location of Plots

The size of plots is as rectangular as 50m x 10m (0.05 ha) each. They were established in the same plots as in the growing stock survey except the riverside forest, in which one plot was established on a tributary of the Bua River near the Tongole Camp.

(3) Content of the Survey

The state of vegetation and forest types were surveyed, and a cross Sectional Profile and crown projection Diagram were prepared.

3. Dead Tree Survey

DBH of dead trees in the same plots established for the growing stock survey was measured . The total volume of dead trees in the sample plots was calculated using the breast height form factor obtained from the results of the growing stock survey. However, the branch volume of dead trees could not be measured because they decayed to varying degrees.

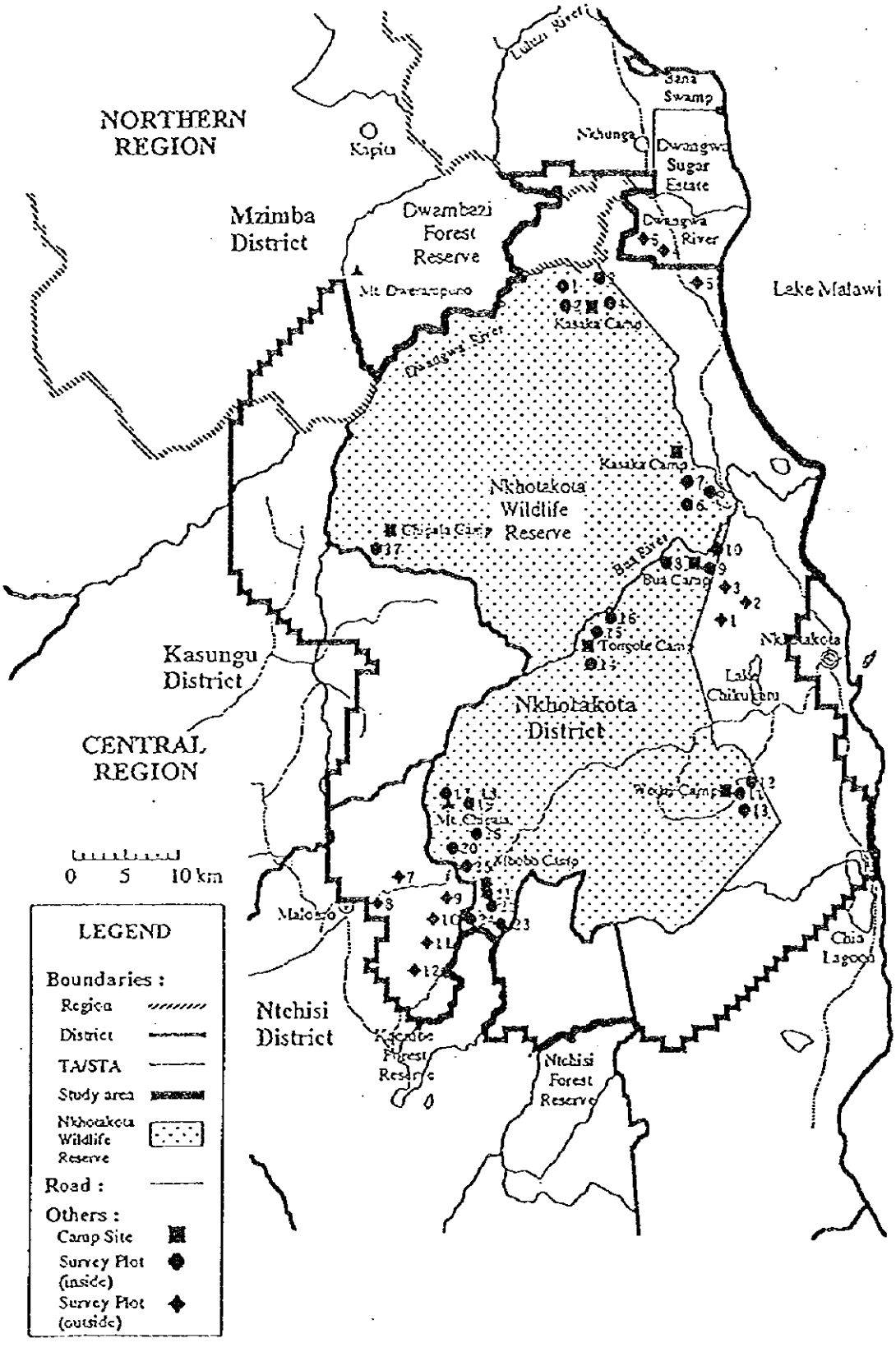


Fig. 1 A Location Map of Forest Survey Plots

4. Understory Vegetation Survey

(1) Survey Plots

The overall situation of understory vegetation by type was surveyed in the same plots at the same time as the growing stock survey.

In order to grasp understory vegetation in detail, nine quadrats were set in the dry season (July and August 1995) and thriteen quadrats were set in the rainy season (January and February 1996). Classifying these quadrats according to vegetation type, eight are in miombo forests and one in the seasonally wet grassland (dambo) in the dry season, while nine are in miombo forests, one in the dry grassland, and three in the seasonally wet grassland (dambo) in the rainy season.

(2) Size and Location of Plots

The size of quadrats is 2m x 2m each. As for miombo forests, quadrats were located within the plots established in the growing stock as far as possible in order to compare with forest types. The location of quadrats is shown in Fig. 6-8.

(3) Content and Method of the Survey

a. Survey on the State of Vegetation
   A field survey was conducted concerning all types of vegetation in the dry and rainy seasons.
b. Survey on the Species
   All plant species which appeared in the quadrats and during the reconnaissance around the quadrats were recorded. Because of difficulty in identifying plants in the dry season, the survey was conducted in the rainy season.

5. Fodder Plant Survey

In order to estimate the amount of fodder plants, understory plants (herbs on the floor and shrubs 1 m or lower) were cut, and the edible site (leaves) of upper trees was weighed in the light of wild animals' preferences. Moreover, exclosures were established in order to grasp the amount of understory plants grazed by wild animals.

(1) Survey Plots

a. Amount of Available Fodder Plants
   The quadrats set in the survey of understory vegetation were used.
b. Amount of Plants Grazed by Wild Animals

Five exclosures were established in miombo forests, while two were in seasonally wet grasslands (dambo).

(2) Size and Location of Plots

a. Amount of Available Fodder Plants
The quadrats set in the survey of understory vegetationwere used.
b. Amount of Plants Grazed by Wild Animals

The size of exclosures is 1m x 1m each. They were established near the quadrats set in the survey of understory vegetation as far as possible. The location of these exclosures is shown along with that of quadrats in Fig. 6-8.

(3) Content and Method of the Survey

a. Understory Vegetation
The total amount of understory vegetation was measured in the quadrats set in the dry season, while the air-dry weight of plants per species was measured in the quadrats set in the rainy season. In this way, the difference in the amount of resources between the dry and rainy seasons and the total amount of resources in the Reserve were analyzed.

However, in the evergreen broad-leaved forest that is as small as 54 ha, the amount of plant resources was omitted from the survey, but just plant species were identified. The semi-evergreen broad-leaved forest is also so small that its distribution cannot be distinguished in aerial photographs. Therefore, the amount of plant resources in the forest was omitted from the survey.

The total amount of fodder plants available in the Reserve was estimated by multiplying the area of forests by type based on the interpretation of aerial photographs by the numbers drawn from the results of the survey.

b. Amount of Upperstory tree Leaves
The total weight of leaves of standard trees in eleven plots in miombo forests was measured during the survey of branch volume. The raw weight of leaves was used to analyze. The total amount of leaves available in the Reserve was estimated by multiplying the area of forest by type by the numbers drawn from the results of the survey.

c. Amount of Plants Grazed by wild animals

A follow-up survey was conducted in the exclosures set in the dry season about six months later (in the rainy season) and the results were compared with the previous ones.

6. Medicinal Plant Survey
Medicinal plants were surveyed in terms of plant species and use. A list of medicinal plants (draft) prepared in Japan on the basis of collected data was examined on site and other unlisted plants were added to the list by interviewing mainly scouts and local people.

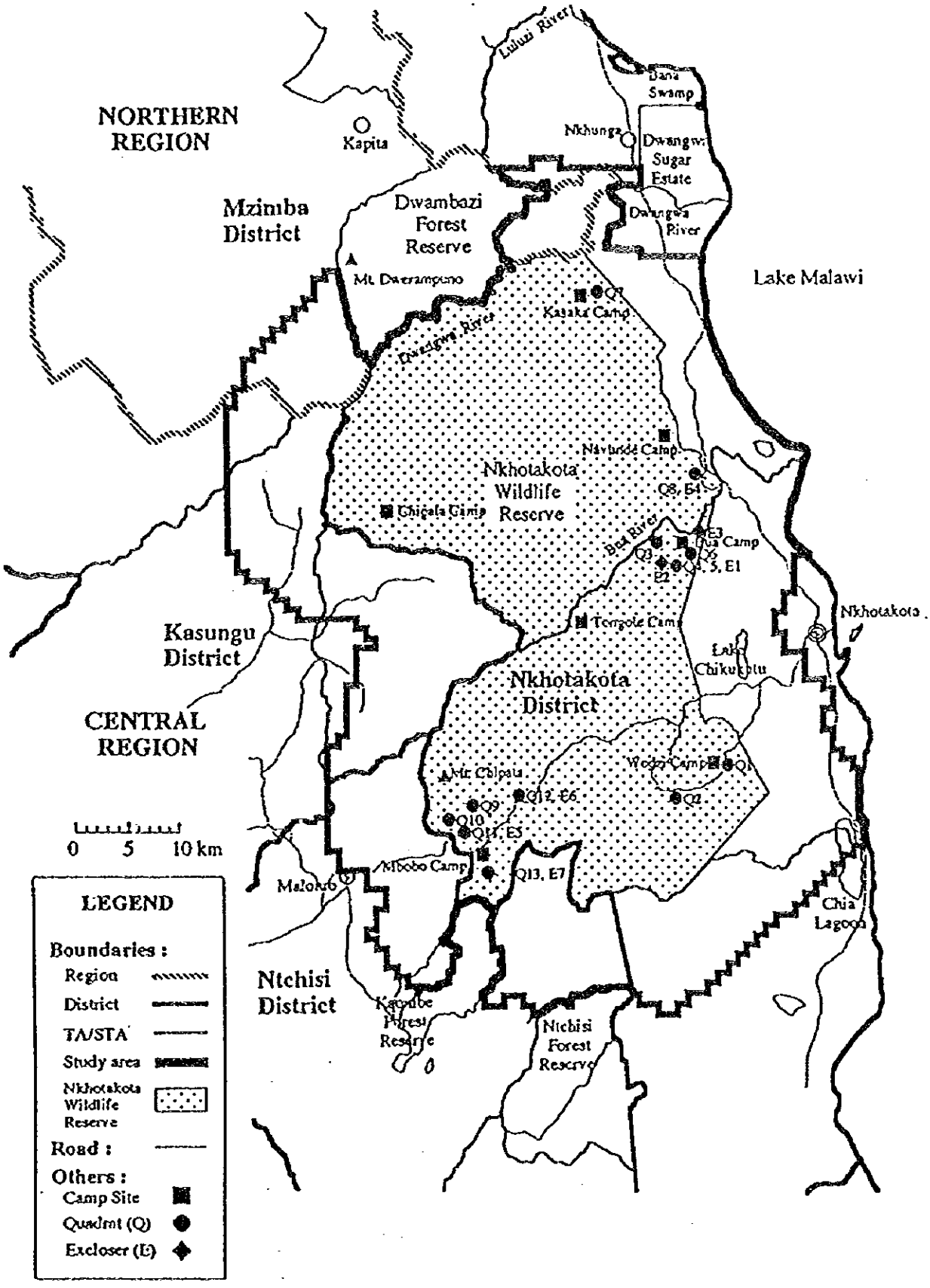


Fig. 2 A Location Map of Understory Vegetation Survey

10. Results of Forest Survey

Table 1 Average Stumpage Volume of Miombo Forests by Forest Type

		Crown Density		
		Dense	Medium	Low
Tree Height	High	51.128	49.473	37.315
	Medium	40.439	24.863	23.051
	Low	31.021	19.867	10.601

Table 2 Results of the Branch Volume Survey

Standard Tree No.	Plot No.	Species	Forest Type		Branch Weight (a)	Relative Density (b)	Branch Volume (c)	Stem Volume (d)	Branch Volume Percent
			Height	Density	(kg)	(kg/m^3)	(a)/(b) (m^3)	(m^3)	(c)/(d) (%)
1	1	*Uapaca nitida*	medium	thin	54 2	733.33	0.074	0.095	78.0
2	2	*Julbernardia globiflora*	low	thin	25.4	1,371.43	0.019	0.023	80.0
3	4	*Julbernardia globiflora*	medium	thick	35.1	1,200.00	0.029	0.045	64.5
4	5	*Julbernardia globiflora*	low	thick	10.4	1,181.81	0.009	0.021	41.4
5	7	*Brachystegia boehmii*	low	thin	16.5	1,120.00	0.015	0.025	58.5
6	8	*Julbernardia paniculata*	high	thick	97.6	1,101.74	0.089	0.108	81.8
7	11	*Brachystegia boehmii*	high	thin	148.2	1,025.02	0.145	0.199	72.8
8	16	*Uapaca kirkiana*	medium	medium	33.7	1,178.02	0.029	0.040	71.0
9	21	*Uapaca kirkiana*	low	medium	23.7	1,080.65	0.022	0.038	57.8
10	25	*Julbernardia paniculata*	medium	thick	30.1	1,132.34	0.027	0.060	44.1
11	27	*Julbernardia paniculata*	low	medium	13.5	1,236.97	0.011	0.021	51.8

Table 3 Branch Volume Percent by Crown Density

	Crown Density		
	Thick	Medium	Thin
Percent (%)	59.2	6.77	73.3

Table 4 Volume of Dead Tree by Forest Type

(Unit: m^3/ha)

		Crown density		
		Dense	Medium	Low
Tree Height	Heigh	0.7032	0.4508	0.4064
	Medium	0.3057	0.0590	1.1672
	Low	0.1614	0.5346	0.1241

Table 5 Results of the Herb Survey

Dry Season

Plot		Vegetation	Forest Type		Weight (g/4m²)
			Height	Density	Total
Q1	Tongole Camp	Miombo	Medium	Medium	425.0
Q2	Mbobo Camp	Miombo	Low	Medium	740.0
Q3	Chipata Camp	Miombo	Low	Medium	728.2
Q4	M10 Road	Miombo	High	Medium	585.0
Q5	Chipata Centre	Miombo	Medium	Medium	645.8
Q6	Bua Camp	Dambo	-	-	3,938.4
Q7	Bua Camp	Miombo	Medium	Low	315.0
Q8	Bua Camp	Miombo (Reverside forest)	Low	Low	215.0
Q9	Navunde Camp	Miombo	Low	Low	560.0

Rainy Season

Plot		Vegetation	Forest Type		No. of Species	Weight (g/4m²)	Weight (g/4m²)	Weight (g/4m²)
			Height	Density		Fodder	Non-Fodder	Total
Q1	Wodzi Camp	Miombo	High	Low	11	115.0	83.5	198.5
Q2	Wodzi Camp	Grassland	-	-	6	154.6	49.7	204.3
Q3	Bua Camp	Miombo	High	Dense	7	399.3	49.7	448.9
Q4	Bua Camp	Dambo	-	-	3	2,881.2	0.0	2,881.2
Q5	Bua Camp	Dambo	-	-	3	3,328.1	0.0	3,328.1
Q6	Bua Camp	Miombo	Medium	Low	3	217.6	20.0	237.6
Q7	Kasaka Camp	Miombo	Medium	Dense	7	247.0	60.0	306.9
Q8	Navunde Camp	Miombo	Low	Low	7	353.1	35.3	388.4
Q9	Chipata Centre	Miombo	Low	Dense	11	95.0	61.3	156.3
Q10	Chipata Centre	Miombo	Low	Dense	17	227.3	40.9	268.1
Q11	Chipata Centre	Miombo	Medium	Medium	14	238.1	101.7	339.9
Q12	M10 Road	Mimbo	High	Medium	8	329.3	107.0	436.3
Q13	Mbobo Camp	Dambo	-	-	4	1,264.2	232.3	1,496.5

Table 6 Results of the Amount of Upper Tree Leaves

Plot No.of Growing Stock Survey	Forest Type		Weights (kg/tree)
	Height	Density	
1	Medium	Low	5.1
2	Low	Low	6.2
4	Medium	Dense	7.3
5	Low	Dense	2.6
7	Low	Low	2.8
8	High	Dense	20.3
11	High	Low	16.7
16	Medium	Medium	5.2
21	Low	Medium	3.2
25	Medium	Dense	7.1
27	Low	Medium	2.6

Table 7 Understory Plant Resource in the Reserve

		Miombo Forest			Grassland	Total
		High	Medium	Low		
Fodder	Resource amount (g/4m^2)	281.2	234.2	225.1	1,322.9	-
	Resource amount (kg/ha)	703.0	585.5	562.8	3,307.3	-
	Area by forest type (ha)	68,410	83,161	19,764	6,801	178,118
	Subtotal (ton)	48,092	48,691	11,112	22,493	130,388
Non-fodder	Resource amount (g/4m^2)	80.1	60.6	45.8	63.6	-
	Resource amount (kg/ha)	200.3	151.5	114.5	159.0	-
	Area by forest type (ha)	68,410	83,161	19,746	6,801	178,118
	Subtotal (ton)	13,699	12,599	2,261	1,081	29,640
Total	Resource amount (g/4m^2)	361.3	294.8	270.9	1,386.5	-
	Resource amount (kg/ha)	903.3	737.0	677.3	3,466.3	-
	Area by forest type (ha)	68,410	83,161	19,746	6,801	178,118
	Subtotal (ton)	61,791	61,290	13,373	23,574	160,028

Note: The amount of resources represents air-dry weight.

Table 8 Total Amount of Understory Tree Leaves

Tree Height	Density	Weight (kg/ha)	No.of Trees (per ha)	Total Weight (tons)	Area (ha)	Total Weight (tons)
High	Thick	20.3	564	11,449	23,676	271,071
High	Medium	18.5	416	7,696	37,191	286,222
High	Thick	16.7	344	5,745	7,543	43,333
Medium	Thick	7.2	859	6,182	40,637	251,234
Medium	Medium	5.2	488	2,538	32,091	81,434
Medium	Low	5.1	328	1,673	10,433	17,452
Low	Thick	2.6	948	2,465	14,890	36,701
Low	Medium	2.9	737	2,138	4,425	9,462
Low	Low	4.5	381	1,716	431	740
Total		-	-		171,035	993,649

Table 9 Existing Animals and Estimated Consumption of Fodder Plants in the Reserve

	Estimated Animal Count[1] (a)	Average Body Weight[2] (b)(kg)	Consumption[3] (c)	Consumption4 (d)=(b)x(c) (kg/day/head)	Consumption (e)=(a)x(d) (kg/day)	Consumption (f)=(e)x365 (ton/year)	Consumption rate (%)
Buffalo	601	525	2.5%	13.13	7,888.13	2,879	10.85
Bushbuck	285	51	2.5%	1.28	363.38	133	0.50
Bushpig[4]	71	83	-	-	-	-	-
Duiker	1,770	15	2.5%	0.38	663.75	242	0.91
Eland	23	575	2.5%	14.38	330.63	121	0.45
African elephant	1,037	3,550	1.5%	53.25	55,220.25	20,155	75.94
Grysbok	32	16	2.5%	0.40	12.80	5	0.02
Hartebeest	-	-	-	-	-	-	-
Hippopotamus	-	-	-	-	-	-	-
Klipspringor	-	-	-	-	-	-	-
Kudu	87	94	2.5%	2.35	204.45	75	0.28
Reedbuck	351	73	2.5%	1.83	640.58	234	0.88
Roan	424	265	2.5%	6.63	2,809.00	1,025	3.86
Sable	181	223	2.5%	5.58	1,009.08	368	1.39
Wathog[4]	771	84	-	-	-	-	-
Waterbuck	244	193	2.5%	4.83	1,177.30	430	1.62
Zebra	246	390	2.5%	9.75	2,398.50	875	3.30
Total	6,123	-	-	113.75	72,717.83	26,542	100.00

Notes 1) Data from the aerial survey in October 1996.
2) Collins "Mammals of Africa" 1984
3) Ratio of daily consumption (air-dry weight) to body weight
Cambridge University Press, The Asian elephant : ecology and managment, 1989
4) Excluding consumption by bushpigs and warthogs which graze a very small amount of herbs.

Table 10 Summary of Fuelwood Survey Results

Plot No.	Location	Forest Type	Tree Height	Density	No.of Trees per ha *1	Averag DBH (cm)	Avera Height (m)	Stem Volume (m^3/ha)
1	Kasaka Camp	Natural	Heigh	Medium	236	18.5	13.5	45.159
2	Kasaka Camp	Natural	Low	Medium	492	7.3	6.5	9.896
3	Kasaka Camp	Natural	Low	Medium	292	7.4	7.5	6.716
4	Kasaka Camp	Man-made	-	-	2,096	9.1	14.5	91.007
5	Dwangwa	Man-made	-	-	1,480	7.7	13.0	41.353
6	Kasaka Camp	Natural	Low	Dense	1,028	6.3	5.0	11.894
7	Mbobo Camp	Natural	Low	Medium	276	8.2	6.5	7.956
8	Mbobo Camp	Natural	Medim	Low	116	14.6	13.0	15.982
9	Mbobo Camp	Natural	Medium	Medium	248	15.2	13.5	41.867
10	Mbobo Camp	Natural	High	Low	176	17.2	16.0	33.964
11	Mbobo Camp	Natural	High	Medium	232	19.2	14.0	48.654
12	Mbobo Camp	Natural	High	Low	184	23.1	18.0	61.756

Note *1: Dead trees are not included.

11. List of Tree Species Identified in the Forest Survey

List of Tree Species Identified in the Forest Survey

FAMILY	BOTANICAL NAME	LOCAL NAME
Moraceae	*Ficus natalensis*	Kachere
	Treculia africana	Njayi
	Trilepsium madagascariensis	Kanungununngu
Moraceae, Apocynaceae	*Bosqueia phoberos, Strophanthus nicholsonii*	Kanungununngu, Mkombe
Proteaceae	*Protea* sp., *Faurea* sp.	Chiere
Amaranthaceae	*Amaranthus spinosus*	Kalindi, Bononguwe
Annonaceae	*Annona senegalensis*	Mpoza
Ochnaceae	*Ochna pulchra*	Mpatwe
	Ochna schweinfurthiana	Mgundanguluwe
Dipterocarpaceae, Caesalpinioideae	*Monotes africanus, Swartzia madagascariensis*	Mkalakate
Guttiferae	*Garcinia huillensis*	Mtundira, Musongwa
	Harungana madagascariensis	Mbuluni
Rosaceae	*Parinari curatellifolia*	Muula
Leguminosae	*Acacia nilotica*	Chiwirin
	Afzelia quanzensis	Msambamfumu, Mngongomwa
	Albizia adianthifolia	Mtangatanga
	Bauhinia petersiana	Mpapa, Mpandula
	Brachystegia boehmii	Mombo
	Brachystegia bussei	Mseza, Mchenga
	Brachystegia floribunda	Mvukwe, Faija
	Brachystegia longifolia	Mombo
	Brachystegia spiciformis	Mpapa
	Brachystegia stipulata	Mombo, Bobvu
	Brachystegia utilis	Msenga, Chitowe
	Burkea africana	Kawizi, Kawidzu, Mkalati
	Craibia brevicaudata	Mpindawago
	Dalbergia nitidula	Mkalasinga
	Dalbergiella nyasae	Mlundo
	Dichrostachys cinerea	Mpangala
	Entada abyssinica	Chisese
	Julbernardia globiflora	Kamponi
	Julbernardia paniculata	Mtondo
	Lonchocarpus capassa	Nyamakani, Mpakasa
	Newtonia buchananii	Sendele? (Msenjere), Mkwenyani
	Pericopsis angolensis	Mwanga
	Piliostigma thonningii	Msekese, Chitimbe
	Pterocarpus angolensis	Mlombwa
	Senna didymobotrya	Njere, Mjere
	Senna petersiana	Mtanthanyerere
	Tephrosia vogelii	Mthunthu, Mthuthu
Erythroxylaceae	*Erythroxylum emarginatum*	Chikango, Kapfupa, Mlungamo
Euphorbiaceae	*Bridelia micrantha*	Mpasa, Kapasa
	Croton macrostachys	Mbwani, Mthutu, Chiwalika
	Pseudolachnostylis maprouneifolia	Msolo
	Uapaca kirkiana	Msuku
	Uapaca nitida	Kasokolowe
Rutaceae	*Teclea nobilis*	Mkulukuku
Meliaceae	*Ekebergia benguelensis*	Mlyasefu, Musefu
	Trichilia emetica	Msikidzi, Msikitsi, Mwavi
	Turraea floribunda	Chikwisimbi
Anacardiaceae	*Lannea discolor*	Kaumbu, Chiumbu
	Lannea schimperi	Kaumbu
	Ozoroa reticulata	Mbewe

FAMILY	BOTANICAL NAME	LOCAL NAME
Melianthaceae	*Bersama abyssinica*	Chiwindu, Mkanga, Nkanga
Celastraceae	*Maytenus senegalensis*	Mchema, Mpabula
Icacinaceae	*Apodytes dimidiata*	Katole, Lifefe, Mchima, Mnyembedwe, Msusumba, Mtibulo
Sterculiaceae	*Dombeya rotundifolia*	Naduwa, Nchiu, Mchiu
Flacourtiaceae	*Flacourtia indica*	Mtudza
Myrtaceae	*Syzygium cordatum*	Nyowe
	Syzygium guineense	Mbunguzi, Mpeuma
	Syzygium sp.	Katope
Rhizophoraceae	*Anisophyllea pomifera*	Mfungo
Combretaceae	*Combretum fragrans*	Kalama wa ukazi
	Combretum molle	Kadale
	Combretum zeyheri	Kalama
	Terminalia stenostachya	Mkulu
Sapotaceae	*Bequaertiodendron magalismontanum*	Chiyira
Ebenaceae	*Euclea schimperi*	Mpukuso
Ebenaceae, Guttiferae	*Diospyros* sp., *Psorospermum febrifugum*, *Rhus longipes*	Mdima
Oleaceae	*Chionanthus baniscambei*	Kapanda
Loganiaceae	*Strychnos spinosa*	Dzai, Mteme
Apocynaceae	*Diplorhynchus condylocarpon*	Thombozi
	Rauvolfia caffra	Mvumbamvula, Mwimbi
Rubiaceae	*Breonadia microcephala*	M'ngona
	Oxyanthus speciosus	Chikanga, Msongwe (Yao)
	Polysphaeria lanceolata	Mpeko, Msepauta, Mtola
	Psychotria mahoni	Chipeta
	Randia sp., *Xeromphis obovata*	Chipembere
	Vangueria infausta	Mvilu, Mzilu
	Vangueria sp.	Mfulukutu
Boraginaceae	*Cordia abyssinica*	M'bwabwa
Verbenaceae	*Vitex doniana*	Msipsya
Scrophulariaceae	*Halleria elliptica*	Mpulupulu
Bignoniaceae	*Kigelia africana*	Mvunguti, Muungutwa
	Markhamia obtusifolia	Msewa, Mwanambewe
	Stereospermum kunthianum	Kabvunguti
Pedaliaceae	*Sesamum angolense*	Mkuyu, Mkuya
Liliaceae	*Dracaena laxissima*	Mchemani
?	*Chamaete cristata*	?
?	*Stenoleps lanceolata*	?
?	?	Chisimbwe
?	?	Chiwowo, Chiwowa
?	?	Kamilalumba
?	?	Kanamzuro
?	?	Kapilapila
?	?	Katele
?	?	Kigele
?	?	Mkunhumala
?	?	Mlengwe
?	?	Mlima
?	?	Nalenje? (Mlanje)

Note: Local names are mainly in Chewa language.