UNITED NATIONS DEVELOPMENT PROGRAMME

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Report to the
Government of

BOTSWANA

AN ECOLOGICAL SURVEY OF NORTHEASTERN BOTSWANA

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

ROME, 1968

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Report
to the
Government of
Botswana
on
An Ecological Survey
of Northeastern
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Based on the Work
of
G. Child

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INTRODUCTION

The present survey followed a request by the Bechuanaland Government to the ood and Agriculture Organization of the United Nations for assistance, in terms of the Expanded Program for Technical Assistance, with a survey of the wildlife industry in the north east of the territory. This arose from the recommendations f the two FAO/IUCN Africa Special Project Consultants, who toured the country at he request of the Government, in October and November 1962, to advise on the wild- life resources.

The terms of reference agreed to between the Bechuanaland Government, now the overnment of the Republic of Botswana, and FAO, in June 1965, were as follows:

> "To advise the Government on and to formulate realistic plans for the conservation and utilization of Bechuanaland's game herds. To survey the Chobe Game Reserve and the surrounding game areas with a view to determining what conservation measures should be adopted, planning the development of the reserve as a tourist facility, ascertaining the permissible annual game harvest and investigating the prospects of game ranching."

These terms of reference were enlarged at the request of the Minister for Mines, ommerce and Industry, the Hon. Mr. A.M. Dambe in August 1965, to include any matters elating to wildlife, particularly in northeastern Botswana. They were further expanded when the author was asked to represent wildlife interests on a team investi- ating the possibilities for expanding the livestock industry in the Northern State ands, early in 1966. This team had the following terms of reference:-

> "To conduct an investigational survey and report on the possibility of opening up areas in the Northern Crown lands for the development of the cattle industry, bearing in mind the desirability of conserving game in areas where game can be sustained, for the purpose of tourism and for the processing and marketing of game meat, without endangering the cattle industry."

In February 1967, the author was honoured to represent the Republic of Botswana as its delegate at the second session of the ad hoc Working Party on Wildlife Management of the African Forestry Commission in Fort Lamy.

The author served on the assignment from its inception on June 1st, 1965 until its conclusion on June 30th, 1967. He was joined by Senior Expert Mr. L.W. Swift for two weeks in August 1965, and by a German Associate Expert, Dr. W. von Richter, from October 1966.

The survey sought primarily to determine the situation regarding various species of large mammals native to northeastern Botswana, and the condition of their habitats, as a basis for suggesting suitable management and for indicating possible lines along which the wildlife industry could be developed. Determining the trends in animal numbers and the conservation values in the habitats required the recognition of syndromes, using evidence from various aspects of the ecosystem and taking into account the detailed history of an area. This information is included in Part I, which reports most technical aspects of the survey, while the remainder of the report covers suggestions for the utilization of the resource.

Some 50,000 miles were covered in and around the mission area, of which over 35,000 miles were by road. Most tracks in northeastern Botswana were driven at least once and several cross-country traverses were also undertaken. Many government

officials, traders, hunters, tribesmen and bushmen were interviewed in English, a vernacular language or through interpreters, and special care was always taken to avoid the use of leading questions. Much of the information in this report is based on their intimate knowledge of specific areas augmented by appropriate cross-checks by personal observation. In the case of bushmen, in particular, this information often included accurate observations over a number of generations from a limited area, and frequently when such people were asked about conditions in places over 30 or 40 miles away, the reply was to the effect that that was another territory about which they knew little and could not therefore offer an opinion. This rendered such unbiased observations especially valuable, despite the difficulty of assigning accurate dates to particular events. If this report contributes to an understanding of wildlife and its problems in northeastern Botswana it is through the recording and limited interpretation of much which is locally common knowledge to many of the rural people.

Acknowledgments

The author is deeply grateful to all those people in Botswana who facilitated the present survey, particularly the Minister of Commerce, Industry and Water Affairs, the Hon. J. Haskins Esq., and members of his Ministry, which includes the Game Department. Mr. C.P. Hepburn, Warden of the Chobe Game Reserve, and his staff, including Game Scout Majoto Mothoiwa and Mr. Tommy Maikano were particularly helpful with the field work and preparation of this report. Mr. P. Henry, Forest Officer, and his staff assisted with the preparation of maps and Dr. M. Bachmann, Chief Tsetse Control Officer, and his staff, especially Mr. P. Smith, were of great help by providing records and material from Tsetse Control Hunting on the Maun Front and by assisting with the analysis of this data.

Mr. R.H. Smithers, Director of the National Museums, Rhodesia, kindly arranged leave of absence for the author and assisted the survey materially by providing the services of a trained technician and by supplying essential equipment, including a land rover, before government transportation became available. The Director of National Parks, S. Africa, and his staff in the Kalahari Gemsbok National Park provided the opportunity for a valuable, if brief, survey of desert conditions.

To these individuals and organizations the author is most grateful.

SUMMARY

The controlled exploitation of wildlife has become the primary form of land use in northeastern Botswana during the six years since the Chobe Game Reserve was proclaimed and the region was opened up for organized recreational hunting. The present ecological survey of the wildlife potential was requested by the Government as a basis for appropriate forms of management and the planned development of the resource.

The area is sparsely peopled, but the contrasting habitats, ranging from permanent swamps, through grassland to variously wooded types, including well developed woodland, has a varied and locally dense large mammal fauna. The erratic rainfall and generally poor sandy soils renders the habitats sensitive to modification by past land use. The mismanagement of fire and domestic livestock and the commercial exploitation of timber in the northeast, are three important factors leading to the widespread deterioration in conservation values, which are usually evident from the declining vigour of perennial grasses and the accompanying widescale scrub encroachment. These

changes in the habitat are reflected by changing trends in the dependant animal populations. The future numerical strength of sensitive grazing species is threatened through the disappearance of their specialized habitat. Certain stages in the process of deterioration are beneficial to other species which may prosper, at least temporally, but this induced prosperity often leads to overpopulations and further destruction of the habitat.

The technical basis for these generalizations is elaborated in Part I of the report, which also describes the vegetation in the Chobe Game Reserve and includes pertinent information on the distribution and general biology of the individual species, together with specific recommendations for further investigation and for management. A list of the avifauna known to occur in the Chobe Game Reserve is included in an appendix to this part. Parts II, III and IV of the report indicate ways in which the wildlife industry could be managed and developed in accordance with the results of the survey.

Part II outlines the history of the Chobe Game Reserve since its inception in 1961, and describes moves to elevate it to full national park status. This requires certain changes in the arbitrary straight line limits of the Reserve in order to exclude other forms of land use and so that the National Park contains a more truly representative selection of the flora and fauna of northeastern Botswana.

An additional strip of easily developed land including attractive plains country should be added along the eastern border, but two areas should remain as game reserves outside the proposed national park. The Magwigwe sand ridge should form the western boundary south of the Tsantsana Molapo, thus excluding the northwestern corner of the reserve, and an area of relatively good woodland adjacent to the southern border of the Kachikau Enclave, should remain a game reserve so as to allow for logging. A meeting of representatives of interested Government Departments recognized that the rational form of land use for the Chobe flats within this enclave would be to incorporate them into the national park/game reserve complex. This would, however, create sociological difficulties unless the 3,000 inhabitants could be persuaded to move to alternative agriculturally attractive areas. Bound up with this problem is the need to consider including more of the Linyanti swamp and swamp edge in the park. The Mababe depression is an obvious ecological unit which, it is recommended, should all come under the control of the Game Department, although it might be premature to extend the national park to encompass the whole depression at this stage. The sourthern Mababe is a hunting area earning valuable revenue from the safari industry; conventional tourist development will not penetrate this far for some time, so it is suggested that the area should become a game reserve or controlled hunting area in the meantime. Finally, it may be advisable to exclude certain areas of Kalahari woodland in the southeast of the park, if the timber justifies commercial logging.

A clearly defined policy is needed as a framework for the administration, management and development of the future park and a tentative policy statement is suggested as follows:

(1) Biological management should be based on present knowledge. Further detailed exploration should be designed to describe the flora and fauna and to determine the trends in conservation values and in animal numbers.

(2) Improper burning practices are perhaps the major depressive element in habitats throughout the Chobe Game Reserve and surrounding areas. It is suggested that the control of fires should have high priority in the biological management of the future national park. To be effective fire protection needs to be adequate to prevent all or the great majority of undesirable burns. It is therefore proposed that major emphasis should be directed towards excluding fire from two areas in the northeast and east of the park, and that firebreaks should be developed in conjuction with game

viewing roads in order to minimize expense. Cooperation should be sought with the Forest Department in order to gain maximum coverage, and strict control is needed over people using roads through the park, and the areas where they may be permitted to have camp fires.

(3) There is little need for specific erosion control in the Chobe Game Reserve except along the face of the sand ridge area overlooking the Chobe flats. Here attempts should be made to stabilize the soil shifted by game descending to water, through the protection of the worst affected areas by laying felled vegetation along the contour, to encourage the recolonization of these areas by perennial grasses.

(4) It will be necessary to manipulate habitats to some extent to counteract the harmful results of past land use. This should be directed towards improving the habitats of endangered species, diversifying the modified vegetation near the Chobe flats and to limited improvement of visibility along some roads. These aims may sometimes be met simultaneously and an opportunistic approach is advocated wherever labour or fire are to be employed, in order to reduce costs and favour more effective burns.

(5) Development of much of the interior of the park will depend upon the provision of artificial waterholes for game during the dry season. However, this can lead to rapid deterioration of the habitats in the vicinity of such waterholes. It was therefore suggested that six bore holes should be sited around the headwaters of the Ngwezumba river, in order to gauge the effectiveness of providing water on a rotational basis. These holes are in relatively resilient grassland and a system of testing holes from pumping and of checking the effect on neighbouring vegetation is urged. It is also suggested that a better knowledge of the water resources and the ability for game to use mineralized waters would help the planning of tourist development in the Mababe depression and elsewhere.

(6) Finally, the need to keep records of all management procedures, as well as of changing trends in the habitats and their dependent animal populations, is stressed. The need for biological management and the desirability of entrusting the Game Department with the day-to-day administration of the Moremi Game Reserve is mentioned, and the suggestion that Nyai pan should form the nucleus of a third sanctuary is supported.

(7) Botswana is well placed to benefit from the rapid worldwide growth in tourism, and the Chobe Game Reserve is not far from the famous Victoria Falls. The attractiveness of the region would be enhanced if this and the Moremi Reserve, together with the Okavango swamps and Nyai pan could be incorporated in a single coordinated industry, and if Botswana and her neighbours could promote tourism on a regional basis. Suggestions are therefore made for the development of the Chobe and Moremi Reserves with these objects in mind.

Part III of the report considers certain aspects of recreational hunting in north-eastern Botswana, where it is organized on a system of concession areas, which are leased to safari companies who have exclusive non-resident hunting rights. The system has several advantages but requires that operators should report to the Government their detailed hunting successes, so that the safari business can be coordinated and a check kept on the animal resource upon which it is based. It is also desirable that the concession areas should be surveyed in more detail than has been possible during the present assignment.

This industry is very dependent upon the availability of lion as a trophy animal and a strong plea is made to avoid the unnecessary destruction of this valuable "problem animal" on a nationwide basis.

Part IV deals with subsistance hunting and the commercial exploitation of wild

animals and stresses the need for full control to be exercised over all hunting activities. The recent increases in the prices being paid for the hides and skins of wild animals makes the need for proper control of animal off-take rather urgent. A survey of the hide and skin industry is now in progress, with a view to recommending appropriate means of perpetuating this valuable harvest. The potential value of wildlife as a commercial source of protein is noted and, although there will be difficulties in realising this potential, it is urged that full consideration should be given to integrating wildlife management into the general patterns of land use.

The final section describes the recent encouraging steps towards better administration of the wildlife resource. It urges in-service training of Game Department personnel, outlines the conduct which should be expected from visiting wildlife research workers and emphasizes the need for making the results of past investigations readily available to future workers.

PART I

The Environment

Botswana is a land-locked country of some 220,000 square miles, in the center of the Southern African plateau and is occupied by 543,105 people (1964 Census: Campbell 1965). It is generally around 3,000 feet above sea level, but is separated from the coast by higher plateaux and mountain ranges, so that the climate is mostly arid or semi-arid. Coupled with the poor sandy soils and limited exploitable minerals so far developed, this has led to an economy dominated by the livestock industry, but in which wildlife is playing an increasingly significant role.

The Study Area

Most of the country is very flat and in the north this has caused an interesting series of interconnected river systems, which have a marked influence on the ecology of northeastern Botswana, the area with which this report is principally concerned. It is enclosed by the Chobe and Okavango rivers in the north and west and has a common boundary with Rhodesia in the east, while the old main road from Maun to Nata forms a convenient southern limit (fig. 1). Most of it is State Land, which is separated from Tribal Land in Eastern Ngamiland by a longitude passing through Makalamabedi. The State Land north of parallel 19°S is administered from Kasane, while the rest falls under the control of the District Headquarters in Francistown or Maun.

The distribution of the sparse human population is shown in figure 2, while figure 1 indicates the thin network of roads and motor tracks serving the area, the route by which Ngamiland cattle are exported on the hoof to Zambia via Kazungula, and the limits of the tsetse fly advance. Figure 3 illustrates existing hunting concession areas and game reserves.

The exploitation of wildlife has become the primary form of land use in northeastern Botswana since 1962, when the Government created the Chobe Game Reserve and encouraged safari hunting. The relative value of this industry, in terms of direct revenue to the Chobe District, is summarized in table 1. Crop production is largely of a subsistence type, and is limited to the settled areas. Livestock production is centered on settlements outside the tsetse fly belt, where both nagana and human sleeping sickness are endemic.

Maun is linked to Francistown on the Rhodesian/South African railway system, by a new all-weather gravel road, and there is a second made-up road penetrating 30 miles along the Chobe river in the north east, joining the Rhodesian and Zambian networks to a new road from Ngoma to Katima Mulilo in the eastern Caprivi Zipfel. Other motorways in northeastern Botswana are mostly sandy tracks in the dry season and many are impassable in wet weather, even to lorries or four-wheel-drive vehicles, which are more or less essential for travel in this region.

The only post offices are at Kazungula and Maun, and only Kasane and Kazungula have telephonic communication with the outside world, by means of a party line from Livingstone. There are police radios at Kasane, Kazangula, Panda ma Tenga, Kachikau and Maun, and several of the safari companies are in radio touch with their bases at Maun, Kasane and the Victoria Falls during the hunting season. These companies also maintain a number of bush landing strips during the dry season which augment those at Maun, Serondela, Kasane and Panda ma Tenga. The first two are regular stops on the weekly Botswana National Airways flights between Francistown and Livingstone.

TABLE 1

Revenue collected by the Revenue Officer, Kasane for the financial year 1965/66 and the 1966 Hunting Season (in Rand)

Item	From presence of Reserve	From other Wildlife use	Other Sources
Income Tax			267[1]
Personal Tax			260[2]
Graded Tax			1,063[2]
Ordinary Tax			3,120[2]
Trading Licences etc		20	445
Trophy Dealer Licences	20		
Leases and Rents	2		549[3]
Road and Road Traffic			1,697[4]
School Fees			171
Medical Fees			381
Sale Government Property			190
Judicial			614
Hides		300	53
Forest			92
Agriculture			59
Liquor Excise etc.	2,990[5]		
Arms/Ammo. Licences		160	
Other			12
Game Reserve Entrance	1,324		
Package Licences etc. (Hunting)		12,464[6]	
Safari leases		900[7]	
Total	4,336	13,844	8,973
% Total	16.0	50.4	33.2

1/ Obviously low but Income Tax from District benefits from Reserve.
2/ Benefit to same extent from presence of Reserve.
3/ Some Serondela properties only leased because of presence of game.
4/ Benefits considerably from presence of Reserve.
5/ Hotel built to serve Reserve.
6/ Low as it does not include licences for Bechuanaland Hunters Ltd., which earned government an added ± R 10,000 p.a. from hunting in Chobe District.
7/ Approximately only as does not include Bechuanaland Hunters Ltd., Nunga Area, but includes White Hunters Ltd.'s little used southern area south of parallel 19°S.

TABLE 2

Average Monthly Temperatures for Kasane, Francistown and Maun

Month	Kasane[1]		Francistown[2]		Maun[3]	
	Max°C	Min°C	Max°C	Min°C	Max°C	Min°C
January	30.4	18.8	30.7	18.1	31.5	19.0
February	30.1	18.7	30.1	17.7	31.3	18.7
March	30.3	17.8	29.3	16.0	30.9	17.4
April	30.1	16.0	28.6	13.3	30.6	14.4
May	28.5	12.0	26.1	8.8	28.1	9.5
June	26.0	9.1	23.1	4.8	25.0	5.9
July	26.2	8.4	23.6	5.1	25.2	5.7
August	29.1	10.5	26.1	7.4	28.6	8.6
September	33.0	15.0	29.7	12.0	32.5	13.3
October	35.2	18.5	32.3	16.1	34.9	18.0
November	32.9	19.1	31.7	17.6	33.8	18.9
December	30.8	18.8	30.9	18.0	32.2	19.1
Ave. year	30.2	15.2	28.5	12.9	30.4	14.0

1/ Kasane average based on 24 years.
2/ Francistown average based on 30 years.
3/ Maun average based on 30 years.

There are small trading stores at Kazungula, Kasane, Mucheje, Kavimba, Kachikau, Satau, Panda ma Tenga, Nata and Maun and hotels at Kasane and Maun. The importance of Kachikau as a commercial center has declined greatly since the early fifties, when each of the four trading stores are said to have had a wage bill in excess of the gross turnover of the only survivor in 1966. A similar decline occurred in Panda ma Tenga with the closing down of the Colonial Development Ranch in this area in the early sixties.

A limited amount of fish is exported from the Lake Liambezi area by Zambian fish buyers. This industry boomed in 1963 when approximately 30 tons of fish were exported in the month of May, but has since declined to a mere trickle. The upsurge in the fish population was apparently a response to high floods in 1957 and 1958 and again in 1962 and reports indicate that a large proportion of the fish now exported through Botswana are in fact caught in the Caprivi.

Climate

Summer temperatures are high (table 2) and the mean annual rainfall declines from northeast to southwest from around 27 inches to about 18 inches per annum. Precipitation is almost exclusively during the summer months (November to March) and is somewhat unreliable, as shown by the extremes for Kasane/Kazungula, Francistown and Maun (table 3).

These climatic factors give rise to generally dry marginal country which is interspersed with swamp and seasonally inundated grassland along the Chobe and Okavango rivers, and it is this mixture of contrasting habitats which accounts for the remarkably varied fauna.

Physiography and Drainage

Major Drainages - The Okavango and Chobe river systems rise in the Angolan highlands while the Zambesi, which supplies water to the Chobe, has it source in western Zambia. The Okavango flows in a southerly and then easterly direction from the western slopes of the highlands, before cutting southwards across the Caprivi Zipfel into Botswana. Here the flow slackens and the river divides into the finger-like distributaries of the Okavango swamp, often aptly described as an inland delta (fig. 1).

In the southwest the swamps drain towards the shallow depression giving rise to Lake Ngami, but little water has reached the lake by this route during the last century, as most of it now enters via the Ngabe river. The Thamalakane, which links the fingers of the delta along the southeastern fringe of the swamps, divides south of Maun and one arm, the Ngabe river, augmented by other distributaries, flows west into Lake Ngami, while the Botletle river flows in an easterly and then southerly direction into Lake Dow, en route to the Makarikari pans. These are also fed in the northeast by the Nata river flowing out of Rhodesia.

The Kwando or Mashe river, as the upper reaches of the Chobe are variously known, rises on the eastern slopes of the Angolan highlands and after flowing in a southerly direction across the Caprivi, turns north of east through the Linyanti swamps, to form the border between the Caprivi and Botswana as far as the Chobe-Zambezi confluence. Here the four territories of Botswana, Rhodesia, South West Africa and Zambia have a common meeting point in the river at Kazungula (fig. 1).

The Chobe system is flanked by swamp above Lake Liambezi but, east of here, most of the swamp and swamp grassland is in the Caprivi. A series of molapos, or open grassed drainage lines, feed flood season water from the Zambezi into the Chobe east of Lake Liambezi. These molapos coalesce in the eastern Caprivi to form seasonally

TABLE 3

Annual Rainfall in mm at weather Stations in and around northeastern Botswana

YEAR July - June	Francis-town	Maun	Kasane (Kazungula)	Gweta	Kachikau	Panda ma Tenga
1921/2	349.7					
1922/3	561.1	504.4	721.3			
1923/24	302.5	312.4	444.7			
1924/25	821.1	624.5	1035.8			
1925/26	580.2	299.9	541.5			
1926/27	274.8	273.7	563.6			
1927/28	418.5	402.3	558.0			
1928/29	674.1	338.2	886.8			
1929/30	560.5	346.9	767.9			
1930/31	416.3	439.4	395.8			
1931/32	707.1	802.7	747.0			
1932/33	321.5	191.7	427.9			
1933/34	477.2	501.1	669.2			
1934/35	355.5	274.3	570.2			
1935/36	282.4	641.3	862.0			
1936/37	484.3	379.7	902.2			
1937/38	237.2	312.4	456.6			
1938/39	708.1	574.0	575.3			
1939/40	537.7	539.2	826.2			
1940/41	434.5	294.3	793.7			
1941/42	342.1	414.2	660.2			
1942/43	426.2	372.8	671.8			
1943/44	455.9	705.1	818.7			
1944/45	354.0	310.0	362.9			
1945/46	632.9	623.3	997.7			
1946/47	113.7	286.0	433.8			
1947/48	652.5	795.0	795.5			
1948/49	424.6	334.5	476.9			
1949/50	228.6	534.4	808.2			
1950/51	510.7	678.1	594.6			
1951/52	336.5	441.8	1054.9			
1952/53	910.0	512.2	882.4			
1953/54	250.5	560.5	835.5			
1954/55	779.2	872.6	907.9			
1955/56	331.7	438.6	602.5			
1956/57	486.8	408.0	514.0			
1957/58	436.9	602.4	1395.8			
1958/59	496.2	483.0	600.0			
1959/60	285.7	312.7	631.2	286.2		
1960/61	523.0	618.2	832.0	788.0		
1961/62	351.2	314.9	491.5	462.7	508.2	467.5
1962/63	416.9	551.2	564.0	546.3	670.9	845.7
1963/64	253.3	504.6	510.0	366.4	545.9	483.2
1964/65	225.6	206.0	496.2	280.2	329.3	420.2
Annual average	448.3	463.7	690.3	454.9	513.5	554.1

inundated grassland and swamp, through which the Kasai (Kasaiya) channels feed water into the Chobe throughout the year so that the bulk of the water flowing out of the Chobe at Kazungula originates from the Zambezi overflowing its sourthern bank.

The Linyanti swamp, besides being fed by the Kwando, also receives water in some years from the Okavango, via the Makwegana or Selinda spillway, which descends almost 100 feet over 75 miles according to Mackenzie (1946), making the suggestion of a flow in the opposite direction impossible. This sporadic flow is the only means by which the Okavango loses water to the sea, and normally its whole annual flow of 7½ million acre feet is dissipated in Botswana, chiefly through evaporation and transpiration from the swamps.

The southern edge of the Mababe depression, an ancient lake bed, is fed by the Kwaai, a distributary of the Okavango, while the Savuti channel slopes towards the northern edge from the Chobe system. Although water has flowed into the depression from both sources during the past decade, the minimal gradients have prevented it becoming a lake during historic times.

The inconsistent nature of flooding in areas affected by the Chobe and Okavango systems is likely to have important ecological implications, which need to be taken into consideration in any management program involving wildlife. The effects may be of relatively short duration and may apply for a single season, or they may influence the ecology of an area over much longer periods. For example, the Savuti channel, which can have a marked bearing on the seasonal dispersion of game in the northern Mababe and surrounding areas, held water when Livingstone discovered and named it the Sunta in 1853. The channel was dry by the time Selous visited the Mababe in 1879 and remained thus for almost 100 years, during which time large Acacia giraffae (mean girth of 10 at 3 feet = 66.5 inches, range 43 to 104 inches) grew up in the sandy bed. West of the sand ridge, however, the channel may have held water for longer as Stigand (1923) noted that the bed had been dry since 1888. It was again reported flowing in 1960, and local information from villagers, interpreted against aerial photographs, suggests it broke through in 1957 or 1958 during the exceptionally high floods in the Chobe and Zambezi.

This flow, which killed the large trees in the bed, continued until 1964 and gave rise to swamp conditions in an area of about 10 square miles just south of the Gubatsa hills (fig. 5), but by early 1965 the flow had slackened and by October the channel was dry away from the Linyanti swamp, except for one small elephant-maintained seep near the hills which persisted until October 1966. The game populations, that had built up while water was available, largely collapsed or dispersed, but during 1966 the channel again began to fill. By October the water was seven miles west of the hills, which were reached in February 1967, and water was again spilling into the "swamp" by early April.

Both short and long-term changes occur along the edges of the Okavango swamps. Hundreds of square miles may remain waterless for wildlife in one year, while other areas flood excessively, due to changes in the aquatic vegetation, which regulate the flow of water along some of the important distributaries. This causes concern at the possible effects of the spread of the exotic floating fern Salvinia auriculata. It is already established on the Chobe system where it has spread west to within eight river miles of Lake Liambezi. It was first reported in this region in 1947 and has since colonized many square miles of river and swamp. The possibility of it invading Lake Liambezi and the Linyanti swamp, and then spreading into the Okavango swamp via the Makwegana spillway promoted an informal invitation to Mr. D. Mitchell, of the University College of Rhodesia and Nyasaland, to carry out a preliminary survey of the problem in March 1967. The results and conclusions of

this survey were contained in a report submitted to the Government by Mitchell in 1967.

Topography and Soils

Northeastern Botswana is characterized by heavy Kalahari sand around the northern fringe of the Makarikari basin. The Chobe-Linyanti system is separated from this inland drainage system by an extensive sand ridge. Between Kasane and Ngoma the Chobe flows against the foot of this ridge and there is no swamp on the Botswana side of the river, although there is limited seasonally inundated grassland between the meanders, and centered on Serondela there is an elevated flood plain on limestone.

West of Ngoma the channel of the Chobe is less well defined and there are areas of swamp merging with large areas of grassland, subject to seasonal inundation between Kachikau and Lake Liambezi, a shallow lake at the eastern end of the Linyanti swamp, 15 miles north of the sand ridge (fig. 5). To the west, the grassland narrows into a series of wide winding molapos, which fill from the Chobe only during exceptional floods. These are separated by low sandy ridges, some of which are paved with limestone, and the molapos become less and less conspicuous towards the Savuti.

Limestone comes to the surface along the lower edge of the sand ridge, which is formed by an overburden of Kalahari sand on a basaltic core which breaks the surface from Ngoma, to Kachikau as a low but distinct escarpment. In the east the sand ridge slopes gently in a southerly direction towards the Kakulwani plains and Ngwezumba river, while in the west it forms the watershed between the Chobe flats and its system of molapos, and the Mababe depression, before curving southward across the Savuti to form the Magwigwe sand ridge around the western lip of the depression. A similar but less distinct ridge forms the eastern edge of the Mababe.

The Kakulwani plain is one of several stretches of black "cotton" soil draining in a southwesterly direction into Botswana from the Rhodesian border, from the basalt areas around Panda ma Tenga. It has a series of pans in a weak watercourse along sections of its northern edge and feeds into the Ngwezumba river.

This seasonal river rises in the Chobe Game Reserve and after 42 miles within clearly defined banks spills into the Mababe depression, giving rise to a very sandy plain which, from the air, has all the appearances of an inland estuary losing itself in woodland. There are permanent pools, fed by seeps, at Ngwezumba Bridge and water can be obtained from the riverbed or sandy plain well into the dry season in most years.

South of the Ngwezumba river there is a weak system of drainage lines in a southwesterly and then westerly direction into the Mababe, while the Nunga river, which arises from the Nunga plains in much the same way as the Ngwezumba does from the Kakulwani plain, flows southwest towards Nyai Pan at the northwestern tip of the Makarikari system.

The Savuti channel sloping into the northwestern Mababe from Zibalianja on the Linyanti swamp has already been described, but south of it there is a second molapo known as Tsantsara. It also cuts through the Magwigwe sand ridge from the general direction of Zibalianja but has not been known to flow in historic times.

The sand sheet between the Chobe river and the Kakulwani plain or Ngwezumba river consists of heavy Kalahari sand, but is interspersed with numerous small glades which generally have heavier soils and one or more seasonal pans. In addition, there are several significant molapos, with fairly hard bottoms, which converve on the

Ngwezumba river. South of this river there is generally less sand to the northeast of the Shinamba hills and libalas are more common. These are shallow drainage lines with reasonably compact soils supporting perennial grassland, but unlike molapos, they are less well defined and contain fair numbers of characteristic bushes and trees. They are most common around the southern edge and to the southwest of the black "cotton" soil plains. Mopane veld is often associated with them and there is a broad belt of this veld type on fairly hard ground draining from the libalas, to the southwest of Kakulwani, towards the Shinamba hills.

The floor of the Mababe depression is generally sandier in the north and harder in the middle and south, but this trend is interrupted by a number of sandy "estuaries", similar to that described at the tail of the Ngwezumba river, where molapos enter the depression. There are also a number of low sandy ridges, north of the central open grassland.

Elsewhere, except along the fringes of the Okavango swamp, northeastern Botswana is generally sandy and there are few hills to break the monotony of the landscape. The Shinamba hills which rise about 300 feet above the surrounding country in the southeastern corner of the Chobe Game Reserve have already been mentioned. These are less impressive than the Goha hills which overlook the northern Mababe, rising 600 feet above the floor of the depression. Between these hills and the west bank of the Savuti channel there are seven smaller hills shown in figure 5.

History of Land Use

Past land use has had a marked effect on the habitat of wildlife in northeastern Botswana. The suppression of perennial grasses and bush encroachment are widespread symptoms of past human activity,especially through fires and overgrazing. These, and associated changes in the ecosystem, have led to an imbalance in the delicate animal-plant relationships, which accounts for several existing animal problems in the region.

The general deterioration in conservation values has created conditions which are less suitable for some species while others have prospered in response to conditions which, at least temporarily, suit them better. The pattern is similar over large areas and is not confined to wildlife. It is well documented for tsetse fly, and certain changes leading to an increase in annual grasses, and to a considerable increase of seeds, may have accounted for the eruptions of several species of rodent which started in 1966 and continued into 1967. There are also several areas where quelea habitat has improved over the past two or three decades.

In area after area, old residents described a general decline in the numbers of the most sensitive grazing species of wildlife. Other grazers benefited, or are benefiting, from the particular level to which the sere has descended, while browsing species are generally on the increase. It is therefore useful to develop a syndrome from different aspects of the ecosystem in order to provide a general understanding of the trends in the plant and animal communities, as a background for planning the management of wildlife.

Agriculture and Settlement

Selous (1881) travelled extensively in northeastern Botswana, including much of the present Chobe Game Reserve, in 1874 and 1879. The only people he mentions in Botswana were Masubia living in the southern Mababe, and stray bands of bushmen in this area and near Panda ma Tenga. He made contact with people on the Imparira island, at the eastern tip of the Caprivi, who, according to early writers, were also Masubia,

and with refugees from the Barotse, who had established themselves along the north bank of the Chobe in 1873 or 1874. The latter appear to have been linked with the Mambakush, who now reside near Kabamakuni at the apex of the Okavango delta.

Around the turn of the century, Masubia settled in the north of the district in the Kachikau Enclave. Several reports describe these as the people from the Mababe, but at least some originated from the Caprivi, as a number who made the move are still alive.

The Masubia were followed into the north of the district by a group of Batawana from Ngamiland in about 1912, led by Sekume, who had broken away from the parent tribal authority. The numbers of people built up and with them their herds of livestock. The headquarters of the Batawana element, at least, moved several times but eventually it became necessary to establish cattle posts away from the Chobe flats. Nevertheless, a portion of the Batawana element appears to have emigrated around 1920 to 1921 as old people at Gweta claim they moved from Kavimba to the Botletle river about this time, prior to moving to the Gweta area. These people indicated the move was motivated politically, although the underlying cause was a lack of suitable grazing for their cattle.

Stock posts belonging to the people of the enclave were scattered along the Chobe, in the present game reserve, spread west along the Linyanti swamps, and in the south were centered on large pans and the Ngwezumba river. The last occurred along the edge of Kakulwani to the east of the national park boundary (extension A, fig. 14) and south from here to the Shinamba hills and the Masame area. Many of these outposts were dependent on seasonal pans so that the livestock became concentrated near permanent water during the dry season.

People with stock also settled along the Linyanti in the Savuti area, and down the Magwegana spillway. They appear to have been a mixture of Batawana and Mambakush, but were the first to have had to shift in the face of advancing tsetse. Indications are that they moved many years before the cattle posts were closed along the Ngwezumba for, whereas old cattle kraals and wells are still recognizable near Ngwezumba, they have disappeared near the Linyanti. Lewis and Krog (1962) indicate tsetse recolonized the Zibaliaja area between 1922 and 1942.

There was limited cultivation near some of the cattle posts, most agriculture being on the alluvial flats to the north and east of Kachikau. This cultivation fluctuated according to the flooding of the area and two main systems of planting were employed, involving orthodox dryland cultivation and the so-called "water-gardens" where crops were sown in the damp soil left by the receding floods.

Some spectacular crops were reaped, but the productivity of the area was very dependent on the behaviour of the floods as the average gradient for many miles may be as little as three to six inches per mile. Miller (1945) reports that, until 1925, all the lower-lying areas were regularly submerged by the Chobe and maize was grown on the sandy soils away from the river. "These periodic inundations doubtless improved the moisture content of the soil and by the deposition of silt assisted in the maintenance of fertility, and they would also retard the effects of overgrazing and burning."

By 1945 these sandier areas were used for sorghum, a more drought-resistant crop. Miller attributes the rapid deterioration of the country, after the flood waters receded, to overgrazing by domestic stock. By 1937 wind erosion was such that Miller (1937) requested the assistance of a sand dune stabilization expert from South Africa and recommended the evacuation of the people from parts of the Chobe flats. This recommendation was reinforced by the District Commissioner, Maun, in 1945.

However, during the late forties and early fifties very large herds of cattle were still centered on the enclave and the cattle posts were estimated at over 20,000 head. This period also saw a boom in crop production, but by 1953 tsetse fly was rapidly spreading from the west. The domestic stock and people were compressed into an ever-decreasing area, aggravating the already acutely down-graded veld, and an outbreak of Senkobo, Streptothricosis, among the impoverished cattle, possibly aided by Nagana, killed all but about 600 head and led to the closure of all the cattle posts. The first disease is seldom fatal to livestock and was probably a secondary manifestation of the extremely poor condition of the animals.

The absence of draft oxen coupled with the gradual conversion to permanent swamp of the most fertile soils, which had been available for cultivation since the floods began receding in 1925, was the cause of great hardship to the people. Many found conditions intolerable and moved back to Maun after 50 years in the Chobe district, while others went to Gweta and Nata. Those who remained cultivated by hand and subsisted on very meagre crops.

Gradually, aided by an exchange scheme by which oxen were bartered for cows, the cattle population was built up and now numbers some 1,600 head. Conservation values are, however, already declining again (table 4), mainly as the result of too frequent burning which is held to be necessary to provide palatable grazing for the cattle, many of which were very thin in October 1966 (Child and Hepburn 1967).

Sampling was carried out by means of step-point-transects described by Evans and Love (1957) and elaborated and tested by Riney (1963) in neighbouring parts of Rhodesia, in similar habitats to those found in the Chobe district. The exact procedure adopted follows Child (1965). This method provides a measure of the status of the vegetation, the extent of its use by animals, as gauged by the incidence of their droppings per unit area, effects on the vegetation of fire, and a series of separate individual assessments of the trend in conservation values along a transect. The last, when related to the known land use history of an area, allows an assessment of a series of simple syndromes, where certain combinations of facts can only indicate certain, sometimes very specific, phenomenae. Although the evidence from a single series of observations may not be altogether specific, that from several groups of observations in different localities with slightly different land use histories very often is. This method can therefore obviate the need for elaborate field trials and the laying down of fixed transects which cannot be expected to yield results for a number of years and may be useless unless continuity of observation is assured.

The results of some of these stransects are set out in table 4. Transects 32, 33, 35 and 35a were run in examples of the least disturbed flood plain grassland between Kachikau and Lake Liambezi, while transect 34 was in a similar habitat near a village with fair numbers of livestock. The status of the perennial grasses was generally fairly high, except near the village where they were heavily trampled, but conservation values were not being maintained. This was largely due to the practice of frequent early burning.

The remaining transects were in tsetse country, which had not been grazed by livestock since the early fifties. The first was sited in a molapo, or open grassed drainage line leading from the flood plain grassland on the edge of the tsetse distribution. Cattle are occasionally grazed up this molapo, but the chief cause of veld deterioration was again fire and this applied at numerous other points well within the fly belt, checked along this system of molapos. Line 37 was on a sandy elevation adjacent to the molapo sampled by line 36. Tsetse were present and use by grazing and browsing animals was light. The status of the vegetation was generally low but was not as clearly downgrading as in the molapo, apparently chiefly as the result of the natural protection from fire afforded by the poor grass cover.

Transect 38 was in most healthy grassland located in the enclaves. The area had been very heavily grazed until 1953, and well-grown scrub was in evidence in country which Livingstone (1857) described as open grassland between the sand ridge at Goha and the Chobe river, but it had not been burnt for several seasons when the transect was run. Even here slight differences in slope, near the edge of the poorly defined molapo, reflected in the ecological stability of the area, which was critically balanced between patches that were gradually improving and others which were clearly deteriorating.

The last transect was placed in well-developed mopane woodland near the western extremity of the enclave where reinvasion by tsetse took place about 20 years before. The status of the grasses was low and conservation values were deteriorating. This was attributed to past land use, previous to the reinvasion of the fly, coupled with more recent burning and possibly the fairly heavy use made of the area, within five miles of the Linyanti swamp, by wild ungulates, although the intensity of this use would not have been excessive had the grasses been in a healthy state.

The land use history of the Kachikau enclave is described in some detail as it is fairly well documented and illustrates the type of changes in the vegetation which may result from improper land use. Similar, although less spectacular changes occurred as the result of a Colonial Development Corporation ranching scheme in the Panda ma Tenga area, which operated between 1950 and the early sixties. These alterations of the habitats have led to changing trends in the dependent wildlife populations.

In addition to resident livestock in the Chobe district the number of cattle grazing certain parts of the range is greatly augmented by cattle being exported on foot to the north.

Cattle Export Trade

Cattle exported from Ngamiland to Zambia and Katanga have been trekked along a number of routes converging on Kazungula. The reinvasion of large areas of Ngamiland and the Chobe district by tsetse fly was the primary reason for shifting the route further and further east to its present position. The stock routes may themselves have been partially responsible for this spread of the fly, and the ecological basis for this suggestion is elaborated in the section on tsetse.

The general practice when exporting cattle through Kazungula was for traders, who had purchased and held cattle throughout Ngamiland, to move large herds, numbering several hundreds, towards the Chobe flats just after the rains and while the seasonal pans in the Mababe depression still held water. Initially they were moved fairly quickly, covering the distance of some 180 miles from say Maun to Makwarana in about three weeks, during which time they were walked and grazed on alternative days. They were "drifted" the final 70 miles from Makwarana to Kazungula taking several months, thus allowing time for them to gain weight along the Chobe flats before they were sold.

This method of moving cattle led to heavy grazing along the stock route south of Makwarana by successive mobs of cattle for several months every year, beginning toward the end of the growing season, before most perennial grasses had completed building up root reserves for the dry season. Trampling would have further reduced the vigour of these grasses and so encouraged the scrub invasion now evident along most old stock routes. This invasion can be very rapid on sensitive soils such as those in much of northeastern Botswana, and can transform open grassland into dense thicket. The area around Bushman Pits provides a good example of this phenomenon which has taken place during the past 20 years.

TABLE 4

Results of Vegetation Transects run in the Kachikau Enclave

Transect No.	Date	Status of Vegetation as % Ground Cover								Conservation Trend		Animal Droppings in Milacre Plots											Vegetation Type
		BG	L	C	F	G	A	P	Wood	↑ → ↓	Total	Plots	Cow*	Reedbuck	Hare*	Sprinhare	Duiker	Elephant	Zebra	Eland	Impala	? Antelope	
32	4.10.65	94	25	20	2	6	0	26	0	30	30	30	1	1									
33	4.10.65	85	37	25	0	15	0	40	0	2 18	20	20	3		9	5						1	
34	4.10.65	96	18	2	0	4	0	6	0	10	10	-											Flood plain grassland
35	5.10.65	92	19	8	1	8	0	16	0	25	25	25				Nil							
35a	5.10.65	88	52	32	0	12	0	44	1	10	10	10				Nil							
36	5.10.65	77	41	16	4	20	0	32	0	10	10	10	1		7		1					2	Molapo
37	5.10.65	88	48	21	1	12	14	19	38	1 9	10	10			1				1	1			Sandy area between molapos
38	5.10.65	92	70	49	4	7	1	55	12	10 6 14	30	30								3	1	1 1	Lightly wooded molapo edge
39	6.10.65	99	36	5	0	1	2	4	45	10	10	10								2		1 1	Mopane woodland
Total										10 9 136	145	145	5	1	17	5	1	1	6	1	2	5	
Average		90	38	20	1	9	2	27	11														

BG = bare ground; L = Litter; C = grass canopy; F = forbs or forb canopy; G = rooted grass (i.e. basal grass cover); A = annual grass (canopy or rooted); P = perennial grass (canopy or rooted); wood = wood plant or its canopy; ↑ = conservation values improving, → = conservation values stable or trend not clearly apparent; ↓ = values downgrading. * = pellets of this species, as opposed to complete defecations, present in plot.

The area takes its name from some old shallow wells which had water at a depth of 24 feet and yielded a strong supply when the area was established as a C.D.C. cattle post late in 1949. The stock manager entrusted with opening up the post, describes the country around the old homestead as open grassland similar to that now found on the waterless Kanyu flats, and this is confirmed by others who knew the area two decades ago. The open country stretched south to the riparian fringe along the Botletle river, west 30 miles, and east to Nyai Pan, also a distance of 30 miles.

Wildebeest and springbok, both of which are grazers preferring open grassland, were common around the homestead. The road to Panda ma Tenga skirts the northwestern corner of Nyai Pan, and this stock manager reported that the mile and a quarter of dense bush, now separating the two, did not exist in 1949.

Trade cattle was introduced to the post almost immediately and at times numbered 10,000 head, of which a portion was periodically walked to Panda ma Tenga along the present road via Dodo Crossroads. Initially there were difficulties with the watering of this large number of cattle and many were held along the Botletle, until other wells came into operation. The Botletle had itself been dry for several years before this, when very little water had come down from the swamps.

The wells were sunk by six gangs of well-diggers who were usually able to obtain water within 30 feet, and sometimes at as little as 12 feet.

Today there is dense scrub north of the Botletle river and most of the area, which covered some 500 square miles, shows advanced srub encroachment and the widespread replacement of perennial grasses by annual species. To the west of Nyai Pan the bush forms almost impenetrable thickets about seven feet tall. It is composed chiefly of Dichrostachys cinerea, Commiphora edulis, Grewia flava, G. retinervis, Terminalia sericea, T. prunioides, Mundulea sericea, Combretum spp., Acacia spp. including A. ataxacantha and A. mellifera, with mopane (CM3)* and Catophractes alexandri locally common. Occasional large trees include mopane (CM2)*, T. prunioides, A. gillettiae and on some of the sand ridges Burkea africana while Combretum imberbe is conspicuous on heavier soils, especially towards Kanyu. Grasses are sparse or absent and include mostly annuals.

A gemsbok flushed from the road, and unable to escape more than 15 yards from a vehicle, demonstrated the density of the scrub, through which a path has had to be bulldozed to enable cattle to pass along the stock route which was reopened in 1956, for the exporting of Ngamiland stock, after the route across the eastern Mababe became unusable.

With the exception of some of the largest trees, M. sericea, and Boscia albitrunca, which are evidently relatively fire-resistant, and some of the youngest bushes, most plants have a well-developed fire induced ground-level coppice (see sub-section on Fire). A sample of 63 plants were dug up and the annual rings in the coppice or tap root and in the aerial stems were counted. The results are shown in table 5, which indicates two important thresholds in the process of scrub invasion; it is significant that these were determined before the history of the area was known.

Most of the plants were between 14 and 17 years old judging from the rings in the coppice and roots and the stems of M. sericea. This scrub was therefore established soon after the cattle post at Bushman Pits was opened, although for some years fires were of sufficient intensity to kill the aerial stems, but since about 1958 or 1959

* Describes various growth forms of mopane defined below.

TABLE 5

Age Determinations of the Ground Level Coppice and Stems of the Scrub Invasion west of Nyai Pan

Species	Sample	Ground level coppice or root			Stem		
		Max	Min	Mean	Max	Min	Mean
Grewia retinervis	9	19	12	15	9	7	8
Grewia flava	13	20	11	15	12	7	8
Combretum sp.	10	22	11	15	11	7	8
Commiphora edulis	7	22	14	16	8	7	8
Unidentified species	4	17	16	17	8	6	7
Acacia mellifera	3	19	15	17	7	7	7
Acacia ataxacantha	2	16	16	16	10	8	9
Mundulea sericea	10	16*	9*	12*	16	6	12
Acacia giraffae	2	-	-	-	40	13	28
Boscia albitrunca	3	-	-	-	34	14	25
Total	63						
mean age excluding last 3 spp.				17			8

* Rings in root - no coppice.

this has no longer been possible. That such fires should have become ineffective for a variety of species, spread over three quarters of a mile sampled, would indicate a sudden change in the vegetation inhibiting fires, so that it is pertinent that this threshold follows closely the reopening of the stock route in 1956.

Earlier stages of this type of veld deterioration are evident south of Nyai Pan, where there is a progressive gradation from dense scrub, through scrub whose aerial growth is still controlled by fires to open grassland with mild scrub encroachment among the Kanyu pans. It is to be expected, however, that fire and/or grazing east from the stock route will hasten the process and that thickets will eventually occupy the whole area between the old main road and Nyai Pan, and will eventually spread on to heavier soils nearer the stock route.

The heavy overstocking by resident herds and the seasonal influx of export cattle, along the Chobe flats was at least partly responsible for the crash in the livestock industry based on Kachikau. It also led to bush encroachment on parts of the flats which do not become inundated, as well as in adjacent areas along the sand ridge.

While this method of exporting cattle operates smoothly and would be difficult to replace, it should be recognized that it has, and will continue to have, a harmful effect on the ecological stability of a large area of state land.

Logging

The "Enumeration Report on the Maun Chobe Block" submitted by the Forest Department in May 1966 (Henry, 1966) crystalized the differences which were bound to arise between this Department and the Game Department over the independent responsibilities for interdependent natural resources in overlapping areas. Commercial logging took place in the Chobe district between 1935 and 1938 and again between 1944 and 1955. The first concessionaires exploited the best pockets of woodland in the extreme northeast of the territory, between Kazungula and Kalwizikankanga, in conjunction with similar forest across the Rhodesian border, but withdrew when it was obvious that it was uneconomic to exploit timber further west (Kelly - Edwards, 1960). The second concern, based on a mill at Serondela, also encountered financial difficulties and, despite diversification into crop production and other ventures on the Pookoo and Chobe flats, went into liquidation. This may have been partially due to bad management and over-capitalization, but also resulted from the low yield of timber possible in the local Kalahari woodland, coupled with the distances from the railway line.

The activities of the first concessionaires only just extended into the present Chobe Game Reserve, but those of the second firm were almost wholly within its limits. The resulting modification of the habitat, through interference with the dominant floristic element, was one of three important influences, which include burning and past over-populations of livestock, which have altered the delicate animal/plant relationships in this region. These set the stage for many current wildlife problems and the Game Department was anxious to avoid aggravating the ecological situation by having further logging in the game reserve, as was advocated by the Forest Department.

The Game Department was able to present a strong case against logging in the northeast of the reserve (see for example Hepburn 1966, Child 1966), in view of the relative economic and aesthetic importance of the two industries. It was finally decided at a series of meetings between the two ministries concerned in Gaberones, that logging should not take place in the game reserve east of Ngoma, but would be

allowed south of the existing boundary of the Kachikau enclave (Area F, figure 14). In the meantime the author was asked to comment on proposed forestry legislation which would have effectively placed habitats within the reserve under the jurisdiction of the Forest Department. In view of the disagreement already evident between the two departments in separate ministries, it was recommended that the Forest Act should not apply within established game reserves. In effect this meant only the Chobe Game Reserve, as the proposed Forest Act would have been effective only on state land.

This suggestion met the immediate needs of the Game Department in order to prevent further avoidable modification of the habitats in the Chobe Game Reserve, but was not entirely satisfactory as it is proposed to have additional game reserves for the rational exploitation of wildlife and in such areas multiple land use might be desirable. It was therefore recommended that the Chobe Gambe Reserve, with certain changes to its existing limits, should be elevated national park status, thus automatically precluding logging within its borders. The results of this suggestion are elaborated later in Part II of this report.

Fire

Past and present burning practices have undoubtedly had a very marked and widespread effect on the habitats of northeastern Botswana. Future veld management should take these changes into account, as they have altered the composition of the plant communities and this is reflected by changing trends in animal populations. The harmful effects of improper burning can be accentuated by the changes they induce in wild animal populations and are often reinforced when associated with domestic stock production, but it should be borne in mind that these effects can result solely from an ill-considered burning policy.

Effects of early or improper burning - The doubt expressed by several people and included in the Forest Report, as to the reported effects of annual early burning should not go unchallenged. It has been suggested that it does not favour scrub at the expense of grasses and that there is no evidence of scrub invasion in the Kalahari woodland in the Chobe Game Reserve. The ecological importance of fire and its correct use need not be dealt with in this report, as it is well documented, but the general lack of understanding of the subject makes it necessary to outline very briefly some of the principles which have emerged from years of painstaking research. This general background theory is also relevant to other parts of the present report and frequent reference is made back to this sub-section.

The relative effects of fire on the vegetation vary with climate, soil fertility, other local conditions and the time of year and frequency of burns. Generally fire is most damaging to woody vegetation late in the dry season in areas favouring a luxuriant grass growth and is most effective against grasses early in the season where the rainfall is low or erratic and where soil fertility is low. The latter includes dry marginal areas such as occur away from the river in the Chobe Game Reserve. Here early burning, such as is advocated by the Forest Department (and which was introduced in 1938), destroys the aerial parts of perennial grasses, often before they have had time to translocate essential food reserves to the storage organs in the roots. This places an added burden on the plant at the onset of the critical dry season when there is inadequate soil moisture to allow for the synthesis of nutrients. A further deleterious result of early burning, even somewhat later in the season, is the well-known flush or "green-bite" induced by fires, which stimulate the grasses to produce new leaves, and thus to draw on their food and moisture reserves at a time when true growth is not possible.

TABLE 6

Results of Vegetation Transects in Kalahari Woodland

Transect No.	Date	Status of Vegetation as % Ground Cover								Conservation Trend			Animal Droppings in Milacre Plots					
		GB	L	C	F	G	A	P	Wood	↑	→	↓	Total	Plots	Duiker	Springhare*	Sable	Eland	Zebra
9	10.9.65	93	73	27	0	4	0	31	40	5	2	3	10	10	1	2			
40	20.10.65	97	82	10	1	0	10	0	82			10	10	10			1	2	1
41	20.10.65	96	56	10	0	1	5	6	30			10	10	10	2				
Total										5	2	23	30	30	3	2	1	2	1
Average		95	70	16	-	2	5	12	51										

Symbols as for Table 4.

* Droppings, as opposed to complete defecations, present in milacre plot.

The result of repeated early burning is that the perennial grasses, on which ecological stability is dependent, lose vigour, are at a disadvantage in competition with woody plants and eventually disappear. Early burns are less hot than those later in the season and do little more than singe woody vegetation, so that burning to promote grasses usually takes place as late as possible, when hot fires can be achieved and when woody plants are mobilizing nutrients and are therefore most vulnerable.

The claim in the Forest Report that there is no bush encroachment in the Chobe forest block is difficult to reconcile with the findings from field work in this area. Although sampling in this part of the reserve was curtailed by fire during the 1965 and 1966 dry seasons, results obtained (table 6) give clear indications of bush encroachment, and a general deterioration of perennial grasses (see also section on Kalahari veld).

The status of the perennial grasses was generally low, and along two of three transects the grass cover was deteriorating, while in the third area, which had not been burned for at least four seasons, signs of early recovery were apparent. In addition to the clear signs of bush encroachment along these transects, particularly transect 40, scrub was judged to be invading 59 of 61 glades in the Kalahari woodland. These results are similar to those of Riney (1963) who worked on similar problems in the Gwai and Gwampa forest areas in adjacent parts of Rhodesia. He summarizes the results of his transects in the forest area thus:- "From the transects run in the forest areas (most of which were run in forest experimental areas) it was clear that areas associated with frequent burning were poorer with respect to present status and less satisfactory with respect to trend, than transects protected from frequent burning." He notes that the worst affected areas were the vleis and grassland areas which have counterparts in the Chobe Game Reserve. However, Riney concludes by noting that, "it is only fair to the Forestry Commission to mention that since these observations were made the Commission has discontinued its policy of annual burning and adopted a plan of rotation burning similar to that suggested by Kennan, Staples and West (1955) in which they recommend spelling from burning for a period of three to four years. This may prove to be an important forward step to forest management and especially to any schemes of multiple use within the forests that may develop, using either wild animals or cattle".

Bush encroachment is generally widespread in the Chobe Game Reserve. It probably became established as the result of overgrazing, by cattle in particular, as it is best developed along old stock routes and around old cattle posts, but in other areas with a light game population which have apparently never been heavily grazed by cattle, because of the nature of the veld or the presence of toxic weeds, it can be attributed to fire alone, as Riney found in Kalahari woodland in a tsetse area in Rhodesia. He selected this area, which had never been grazed by cattle and where wild animal numbers were low, because he hoped to gain a measure of really healthy Kalahari woodland for comparison elsewhere. He was careful to select the very best areas so that his results are worth quoting as they illustrate the destructive effects of regular burns.

"The results of this transect series completely nullified the hope that the area could be used as a standard for comparison. For these nine transects the average percentage of bare ground was 90 percent litter plus grass 51 percent and the average height of the grass at the end of the dry season was about 9 inches - seven out of the nine transects were characterized by bush encroachment, - and all but one of the transects were downgrading in condition. Some areas showed active recent gully erosion.

"The one exception was in a moist vlei area under water for several months of the year in which it is possible to get a fire through only late in the season. Only in this one transect - has annual burning apparently not detracted from conservation values and the transect was assessed as stable.

"Since this tsetse area has never been subjected to any type of land use prior to the shooting operations (because the presence of tsetse fly precluded the use of cattle) and because the numbers of animals, judging from the number of droppings left on the ground, were nearly as scarce as those occurring in Livingstone Game Park - the present unsatisfactory status and trend can only be attributed to the policy of annual burning that has taken place for at least the previous twelve years. The reason for the burning was to increase the visibility for tsetse area hunters.

"It is not within the scope of the present paper to discuss pros and cons of tsetse shooting. Since the present transects were deliberately located in the best areas that could be found, it does seem appropriate to emphasize the potential value of this kind of information to administrators dealing with tsetse operations, for the practice of early burning has not only already resulted in a fairly advanced stage of deterioration, including bush encroachment, but the trend at the time the transects were taken was still clearly downgrading. It is suggested that this type of evidence is important to consider particularly if one is concerned about the future use of this country for agriculture, or if there is any reason to be concerned over the ecological implications associated with increasing bush encroachment and a decreasing proportion of perennial grasses. Radical changes in habitat,not only for game animals but also for tsetse flies, have already taken place."

Riney's results are quoted in some detail as there are strikingly similar parallels between the problems of early burning in similar country in the Chobe district. Here too there is the problem of deteriorating grassland for game, and cattle in the Kachikau enclave, and the danger of further spread of the advancing tsetse front, on the control of which large sums have already been spent.

Irrespective of the primary cause of bush establishing itself, too frequent fires of insufficient intensity are encouraging its growth and spread. There appear to be two important thresholds in the deterioration of grassland towards thicket formation. The first was reached in most areas when the vigour of the grasses was reduced enough to allow the bush to establish itself. At this stage the grass growth was, or still is, sufficient to allow a fire hot enough to burn back the branches without killing the roots, which continue to grow and coppice afresh from ground level after each fire. The second threshold is arrived at when the vigour of the grasses is further reduced by fire and competition from the scrub, so that there is no longer sufficient combustible material to allow a hot enough burn to kill the stems. These grow rapidly into uniform stands of multistemmed trees and bushes. The pattern is very evident in mopane, but is also discernible in most of the important species involved in scrub encroachment (see discussion on bush encroachment in the Nyai Pan area).

Three types of mopane are recognizable and are designated as CM1, CM2 and CM3, which include two distinct growth forms. CM1 describes normal single-boled trees and their saplings, but CM2 and CM3 are derived from a ground-level coppice and are multistemmed. CM3 describes this type in the scrub form, when aerial shoots seldom measure over three inches in diameter, over bark at the base, and are rarely over seven feet tall. At this stage the aerial shoots are still very susceptible to fire, but in the case of CM2 this is no longer the case, with the result that the stems are thicker and taller and may exceed 40 feet.

CM2 and CM3 often represent mopane encroachment into areas that were better grassed in the past. Thompson (1962) found that mopane does not establish readily in vigorous grassland, but that once established it tends to suppress grass growth, and Child (1965) describes how the removal of mopane led to very significant improvement in perennial grasses within one season in the Zambezi valley. CM3 apparently results from seedlings establishing when the vigour of the grasses is reduced, but while there is still sufficient combustible material for fires to kill off the aerial shoots at ground level.

At this stage CM3 may still be susceptible to hot late burns after an interval of several seasons, which would in any case kill young plants where they did succeed in germinating in healthy grassland, but such fires are suppressed by early burns or trampling by livestock. CM3 persists, while fires, possibly aided by frosts which tend to kill the leaves and make them more combustible, are still hot enough to kill the aerial shoots, but are not of sufficient intensity to kill many of the roots. Under these conditions the roots coppice many times while they continue to grow at ground level. One such plant, chosen at random along the edge of the Kakulwani plain had a long axis at ground level of 34½ inches and the greatest width at right angles to this was 24½ inches. In the CM3 stage this does not form a solid platform and some grass may grow between the prostrate "branches". In this plant the tap root was still well developed and had not yet been superseded by the lateral roots, as is usual in older mopane. The tap root had a cross-section of 2 5/8 inches, six inches below ground, and was about 30 years old judging by annual rings visible in the root. There were well over 100 scars, up to 2 3/4 inches in diameter, from burnt off aerial shoots, but many others were masked by subsequent growth. The oldest of the 43 living shoots had five rings, was 44 inches high and had an over-bark diameter of half an inch, 3 inches above ground level.

A CM2 tree 20 yards from this plant,and no longer subjected to effective fire, had a basal diameter of about two feet. There were nine stems of which four were over 25 feet high. The greatest number of visible rings was 46 in a stem 5¼ inches in diameter three feet above ground level, indicating the plant had been protected from damaging fire for about 50 years.

Uniform stands of CM2 often have an abrupt edge, giving way to CM3, and often contain an occasional old CM1. In such cases the encroachment is not evidenced by bushes diminishing in height progressively out into grassland, but by a decline in the density of CM3, which further investigation may show is also correlated with a decline in the age of the coppices (see section on vegetation in the Mababe).

This explanation of the encroachment of grassland by mopane based upon numerous inspections of CM2 and CM3, in all stages of development, is an over-generalization, as local soil factors, including surface drainage, are obviously of great importance in accelerating or depressing the process. It does, however, contradict the conclusions reached in the Moremi Game Reserve by Tinley (1966). He argued that scrub mopane of the CM3 variety results from the destruction of better woodland by fire and that the multistemmed form of CM2 was derived from CM1 damaged by elephant.

Elephant seldom break trees at ground level and their use is characterized by coppicing at an irregularly higher level so that it would be unlikely to result in uniform stands of trees with regrowth from basal coppice. Under exceptional circumstances fires may burn back CM2 stems, but of the hundreds of CM3 examined out in grassland not one has been found to have a scar left by a large stem such as would occur if a CM1 was burnt down. In addition, most CM2 show very old fire scars, but at most only singeing of the bark from later burns. Further, many CM3 have tap roots, which disappear in older plants and their anatomy shows clearly they are a coppice of

distorted horizontal stems with roots, and none of the numerous burnt out adult CM1 stumps investigated showed signs of regrowth. Finally, evidence in the sub-section on elephant shows that this species was uncommon in northeastern Botswana when much of the encroachment took place.

Fire alone, although it has modified the growth of CM2 and CM3, may not always have been responsible for the spread of scrub mopane, which may have resulted from over-use by livestock, or in a few areas to an overabundance of game, although the build up in wildlife has usually been a manifestation of previous changes in the habitats. The importance of livestock in promoting uniform stands of CM2 or CM3 containing an occasional old CM1 tree was evident near Panda ma Tenga. Here the scattered CM1 trees out in otherwise open grassland attracted cattle which had trampled out the grasses beneath them and invasion by CM3 was well advanced, particularly around the trees near the edge of the plain.

Similar growth forms and patterns of encroachment were evident for other species. These thresholds in the deterioration of perennial grasses and the consequent scrub invasion are very important, as a reversal of downgrading trends is generally a relatively simple matter above a threshold, but becomes much more difficult once conservation values have slipped over the threshold. This is best illustrated with a local example. The only practical method of controlling scrub economically in large grazing areas is by the use of hot late burns in a properly planned burning program but, once the bush becomes too dense, there is never enough grass at the end of a season to allow for such a fire. Several fires in the Chobe District in October 1965 were ineffective against bush although they eliminated the grass and generally had an effect on the vegetation similar to that of an early burn. This was due to insufficient combustible material following a series of dry years in areas where previous burning had been too frequent. In several of these places an adequate spell without fire may allow its future use against scrub, but in some areas this will not be possible. Where extensive thickets have developed, the scrub has shaded out the grass to the extent that fires are no longer possible, let alone hot enough to kill the scrub. Here reclamation of the country will probably be very slow and may be expensive.

These examples stress the need for proper control of fire, not only in the Chobe Game Reserve, but throughout most of northeastern Botswana. This does not mean that no fires would be preferable, as fire properly used with clear objectives is a valuable management tool. Much vegetation has been modified through past land use and occasional fires are accepted as an important ecological factor in the evolution of most African habitats. The Game Department is therefore correct in insisting upon its right to use planned burning for management purposes. It was also justified in questioning the Forest Department's right to burn early annually because economics mitigated against proper fire control, and to suggest the need for a clearly defined policy considering all interests where there are overlapping forms of land use.

Tsetse Fly

The history of tsetse fly infestation in eastern Ngamiland and the Chobe District is summarized by Lewis and Krog (1962) and Wilson et al (1963). The only species known to occur in Botswana is Glossina morsitans and until the latter part of the nineteenth century the Botswana fly belts were linked to the Zambezi belts at Kazungula.

It has been suggested that the recession of the fly last century was due to the rinderpest epidemics which swept through this part of Africa between 1894 and 1896 killing many of the vertebrate hosts of the fly. Historical evidence recently

compiled by Summers (in press), however, indicates that the fly belts in Rhodesia and the Kazungula area of Botswana receded before the outbreak of rinderpest, and the trader Westbeech was able to move waggons right up to Kazungula by 1881, whereas before this he had had to leave them first at Panda ma Tenga and later, according to Mohr (1876), at Lesuma.

Summers also found that areas which are known to have been densely settled with Shona people, but which were laid waste by raiding Matabele and allowed to lie fallow, encouraged the reinvasion of tsetse. Similar habitat conditions would have resulted from the movements of large numbers of people and their stock in Botswana during the first few decades of this century, which is circumstantial evidence that this form of land tenure also favoured the spread of fly. Old people, involved in two such moves, affirm thatthe main reason for migrating was the decline in grazing, and grazing of this intensity would certainly promote scrub encroachment leading to improved tsetse habitat.

It is pertinent that Pole Evans (1948) reporting on a survey carried out along the present main road between Maun and Kazungula, remarks upon the spread of scrub generally and particularly mentions that dense thickets of Acacia giraffae and A. litakunensis (?)* were invading the open spaces between the molapos and threatened to overrun much of the country along the Mogogelo river. He attributes this to incorrect land use and to overgrazing by domestic stock in particular.

Lewis et al (Ms) found, as the result of their tsetse fly resting-site studies, that Acacia woodland is especially important to fly in Ngamiland during the latter part of the dry season. Most species of Acacia, including the two mentioned above, grow quickly, so that it is significant that one of the greatest advances in the fly front recorded between 1942 and 1962 took place in the Mogogelo river area. Here a large area of Acacia woodland, including at least some of that described as scrub in 1937 by Pole Evans as it occurs in dense stands on sandy elevations between the molapos, was ring-barked by the Tsetse Fly Control Department in 1965.

Livingstone (1857) provides another example of where modification of the habitat preceded the invasion of fly. Descending the sand ridge north of the Goha hills, he describes the country from there north to the Chobe river as open plains. There are still a few old people in the Kachikau enclave who remember when the whole eastern section was open grassland with occasional large evergreen trees and numerous palms on the sandy ridges which are today well wooded by Acacia and other species.

The area north of Goha was a favoured grazing area for traders from Kachikau, one of whom claims to have had several thousand head near Makwarana at times. These cattle evidently overgrazed the area with the result that bush became established on the more sensitive soils along the edges of the molapos and by 1952 provided suitable habitat for fly. The cattle then had to be moved to an area east of Kachikau and the vacated area now has a very dense fly population.

The recolonization by fly of much of northeastern Botswana has taken place where cattle numbers were high and where the results of the consequent scrub invasion are still apparent. It would thus appear that the reinvasion of fly was made possible by ecological conditions resulting, at least in part, from the mismanagement of livestock. Once begun, the process would have snowballed, as livestock was compressed

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* probably A. tontilis.

from areas threatened by fly into areas which were already overstocked, so accelerating the destruction of perennial grasses and bush encroachment. In addition, this would set the stage for a crash in the cattle population, which from O.B. Miller's evidence, is exactly what happened to the livestock industry centered on Kachikau.

This would also explain the tsetse fly invasions across the stock route from Ngamiland to Kazungula as it was moved further and further east in the Mababe; these are areas with Acacia woodland, which has been modified through the proximity of the stock route.

Vegetation

The vegetation of northeastern Botswana consists typically of tree and bush savannah with woodland on Kalahari sand in the extreme northeast and plains in the Makarikari depression. A well-developed riparian strip occurs along the Chobe east of Ngoma, along the Linyanti swamp west of Lake Liambezi, and lines many of the molapos of the Okavango system. There is open grassland on black "cotton" soils in the east, on areas subject to seasonal inundation along the Chobe river or in molapos, and in the central Mababe.

The vegetation in the state land section of this region has been described by A. Blair Rains, the leader of a team investigating the possibility of opening up parts of the area for the cattle industry, on which the author represented wildlife interests. This author's map was based on groundwork and physiognomic units which could be distinguished on aerial photographs.

The vegetation of the northeastern corner of Ngamiland between the Linyanti and Okavango swamps is not well known. It is described as "Sandbelt wooded with mopane and mosheshe" (Burkea africana), away from the molapos, on Stigands' map of 1921. Smithers (1964) indicates it has areas with an avifauna typical of the central Kalahari, with an intrusion across the Caprivi in the central region of tree and bush savannah. There are also broad belts of Acacia and mopane woodland, which is more typical of northwestern Botswana.

Pole Evans (1948) described deteriorating conservation values in many habitat types in Ngamiland and the Chobe district from his 1937 survey. Many of his statements are still very pertinent, although veld deterioration has continued during the intervening 30 years of continued mismanagement. Specific instances are mentioned elsewhere in this report, but it is important to bear in mind the widespread influence on the vegetation of past land use, particularly of the livestock industry and too frequent burning early in the season. These, and the influence of local seasonal overpopulations of game and past logging activities, have altered the vegetation from its pristine state and need to be taken into account in any management program designed to preserve or restore ecological stability, or to promote the essential habitats of any endangered species of wildlife.

The effects of past land use are discussed in greater detail in the following description of the vegetation of the Chobe Game Reserve.

The Vegetation of the Chobe Game Reserve

Figure 5 is a preliminary generalized vegetation map of the Chobe Game Reserve, summarizing the detailed surveys of Kalahari woodland areas being undertaken by the Forest Department, augmented by similar work in other vegetation types by the author and warden of the reserve. The work has been based on cross-country traverses recorded on 1:50,000 aerial photograph print laydowns, but is not complete due to the lack of even the most primitive motor tracks leading into the more remote areas.

Further investigations are needed south of the Ngwezumba river, between the Shinamba hills and the eastern Mababe, south from these hills, and in the northwestern corner of the reserve, as well as filling in gaps elsewhere.

The Forest Department is presently workin the Shinamba area and it is recommended that the Game Department should continue this work in other areas as it will provide a useful basis for biological research and the management of wild populations of animals and plants in the Chobe district and will facilitate future land use planning.

The Chobe Flood Plain

Most of this area is subject to seasonal inundation and consists of attractive open grassland which provides valuable grazing for resident large mammals and those which concentrate along the river during the dry season. The following grasses and cyperuses have so far been identified, but grazing is so heavy that most had to be matured in seed boxes and several important plants have not yet flowered or still await typing. Acknowledgment is made to the Government Herbarium of Rhodesia for carrying out these identifications: Cyperus digitatus, C. articulatus, C. esculentus, Setaria sphacelata, Hemarthria altissima, Echinochloa stagnina, Panicum manicatum, P. maximum, Dactyloctenium giganteum, Digitaria setivalva, D. adscendens, Digitariella remotigluma, Brachiaria nigropedata, B. deflexa, B. brizantha, Eragrostis rigidior, E. jeffreysii, E. lappula, Eragrostis sp. and Paspalum commersonii. H. altissima, E. stagnina, and S. sphacelata are important species so far identified from moist depressions and P. commersonii, is dominant under similar conditions in a breached rice paddy, while D. setivalva, D. adscendens, E. rigidior, E. jeffreysii, B. deflexa, B. nigropedata, B. brizantha and P. maximum are conspicious on drier sandier elevated portions of the flats. The depleted nature of the grassland on these elevations is very apparent from the air and on two point-line transects there was 91 percent bare ground, only 64.5 percent grass canopy plus litter; these areas, which were selected as having a better grass cover than most, were clearly downgrading.

The grass Cynodon dactylon is spreading on parts of the flats, while the reed beds along the river mentioned by Miller (1939) have been reduced to a few relic patches, but one area, prepared for irrigation by Chobe Concessions Ltd., in 1950/51, is well grassed over, as is a rice paddy constructed by this firm.

The Chobe flats form a habitat type in which perennial grasses are relatively resistant to abuse, but nevertheless large areas are downgrading. Past overgrazing by domestic stock may have initiated this process, and the heavy grazing and trampling to which it is subjected by wildlife may have a bearing on it, but an important factor suppressing the habitat is too frequent burning. These fires are difficult to control as they are mostly started by people crossing from the Caprivi, and are associated with their poaching activities.

Similar fires can be observed in the Caprivi during most of the year. In this type of grassland they lead to very hot burns, particularly toward the end of the dry season. This explains the depletion of the fringe of woody vegetation, composed chiefly of Syzygium guineense along the main channel of the Chobe opposite Kasane which is shown in a photograph published by Mackenzie (1946). There is little doubt that they also tend to suppress woody vegetation in depressions on the flood plain, where soil moisture is particularly favourable for grasses, but on the slight elevations, which tend to be sandy, grasses are more sensitive to fire, and in the absence of bush the ground is bared to wind erosion.

This process is apparent along the Botswana side of the Chobe and in the Caprivi, and is of particular importance to the future of lechwe, an important tourist

attraction in the game reserve and a significant source of protein and skins to the people of the Caprivi. This is dealt with more fully under lechwe, so that here it is adequate to stress the need for the closest possible cooperation between the Botswana and South African authorities over the control of fire along this margin of the Chobe Game Reserve.

The Riparian Strip

There is a narrow riparian strip along the edge of the flood plain. It seldom exceeds seventy yards in breadth and varies from having a closed canopy to fairly scattered evergreen to almost evergreen trees. The most conspicuous of these include Acacia nigrescens, A. albida, A. tortilis, Diospyros mespiliformis, Garcinia livingstonei, Croton megalobotrys, Lonchocarpus capassa, and Trichilia emetica.

This fringe has been badly damaged through the activities of elephant and is discussed at greater length in the subsection on that species.

"Pookoo" Flats

The elevated flood plain around Serondela was christened "Pookoo" Flats by Selous (1881) who described the area as "a flat ..... in some parts over half a mile broad, lying between the steep forest-covered, jungly sand-belt and the bank of the river". He continued that, "this flat might be from six to eight miles long, and lay in the form of a semi-circle, in a bend in the sand-belt, that rose abruptly behind it, and ran down to the water at each extremity". He concluded significantly, that "the greater part of this extensive tract - once no doubt the ancient bed of the river - was open, though here and there patches of bush were scattered over its surface, and nearer the river grew many very fine wide-branching camel-thorn trees (Acacia giraffae)".

To day the most characteristic feature of the vegetation is the dense bush which covers most of this area. It is composed chiefly of Dichrostachys cinerea, with other species such as Acacia tortilis, Ziziphus mucronata and Combretum mossambicense locally common. Scattered through the bush there are large trees such as Acacia tortilis (which, judging from his description of their form, Selous mistook for A. giraffae - a species more typical of sandier soils), A. nigrescens, Phyllogeiton discolor and Croton megalobotrys with, occasionally, other trees of the riparian strip, and west of Serondela a few Boscia. The encroachment of bush was caused by heavy grazing and as in the riparian strip, many of the large trees show extensive recent elephant damage.

There are also open patches supporting the grass Cynodon dactylon which signify old cattle kraals or other human disturbance. The most notable of these are around the old sawmill site at Serondela and in old cultivations opened up by Chobe Concessions (Pvt) Ltd., to the east of the mill, and at Kabulabula, where at various times there has been a police station, a trading store and a veterinary control post, to prevent contact between cattle from Botswana and the Caprivi.

Elsewhere over large areas perennial grasses have been largely replaced by annuals such as Panicum maximum, Dactyloctenium sp. and Urochloa sp. Conservation values are generally low and in many parts still deteriorating, transects 10, 11, 14 and 15, but in the extreme east the status is reasonable and the veld is improving, line 13 (table 7). The area is heavily used by game, but fires which enter the area from outside or are started by residents of Serondela are also an important suppressive element. The grass cover is so poor in most parts that even a late burn has little

TABLE 7

Results of Vegetation Transects on the Pookoo Flats

Transect No.	Date	Status of the Vegetation as % Ground Cover								Conservation Trend				Animal Droppings in Milacre Plots											
		BG	L	C	F	G	A	P	Wood	↑	→	↓	Total	Plots	Elephant*	Buffalo*	Bushbuck	Waterbuck	Baboon	Hog/Pig	Kudu	Wildebeest	Sable	Puku	? Antelope
10	13.9.65	99	52	6	0	0	4	2	40			10	10	10	3	1	3	1	2						
11	13.9.65	78	68	48	0	21	1	68	5		3	7	10	10		7		4		4	2	1			1
13	16.9.65	82	73	42	0	15	1	55	26	5	2	3	10	10	2						1				2
14	16.9.65	93	49	36	0	6	1	41	3	2	3	5	10	10		5		2		1	1		1		
15	16.9.65	95	55	25	0	4	8	19	45	1		9	10	10			1	1	1	4				3	
Total										8	8	34	50	50	5	13	4	8	3	9	4	1	1	3	3
Average		89	59	31	-	9	3	37	24																

Symbols as for table 4.

*Droppings of these species as opposed to complete defecations, present in the plots.

effect on the bush, although it removes all plant litter and annual grasses so holding the vegetation at a low successional stage.

The eastern section near the base of the sand ridge is protected from fire and here perennial grasses such as Cymbopogon sp. and Heteropogon contortus are well represented. Trampling by elephant and other game is considerable, but does not appear to harm the grass unduly and is tending to open up the dense stands of scrub. Dichrostachys cinerea here and elsewhere along the edge of the flood plain is dying in significant quantities, having apparently reached the end of its life span, and a deliberate late burn through a part of the eastern section in 1964 had the beneficial effect of opening up vistas through the bush. Not only did this hot fire remove much of the dead scrub, but it also killed a proportion of the healthy plants, including young regeneration.

Kalahari Sandveld

Selous (1881) describes the vegetation along the northern face of the sand ridge between Sidudu valley and Pookoo flats in June 1874 as dense jungle in which visibility was reduced to a few yards, but indicates that further from the river the country was more open. Although the area may have had good rains that year, as the river was still high, and allowing for some poetic licence, this description nevertheless indicates that the vegetation on the face of the sand ridge has been opened up.

This is borne out by the recollections of older residents one of whom in particular, visited a logging camp at Sidudu between 1936 and 1938. On this occasion his party had to make their way through very dense bush that lined the narrow track, but when he returned to this particular area some 20 years later he found a very noticeable reduction in the density of the bush.

Conspicuous trees in the area include Acacia giraffae, A. nigrescens, Phyllogeiton discolor, Commiphora spp., Lonchocarpus nelsii, Prerocarpus martinii, while the tall bush is made up chiefly of Combretum eleagnoides, C. mossambicense, Baphia obovata, Bauhinia macrantha and Commiphora spp.

Perennial grasses are limited to relic patches and annuals such as Panicum maximum, Urochloa sp. and Dactyloctenium sp. are conspicuous during the rains.

Conservation values are deteriorating (table 8) and high populations of elephant are very important in this respect, masking harmful effects of fire or past livestock activities east of the Pookoo flats, except in the immediate vicinity of old cattle kraals.

Open woodland, tending toward forest in the east between Kasane and Lesuma, stretches south from the crest of the sand ridge to the edge of the Kakulwani plains or Ngwezumba river, but is interrupted by a series of molapos, south of Ngoma to Kachikau, and by the numerous small glades with more compact soils, only a small proportion of which are shown in figure 5. The woody vegetation of this area is described by Miller (1939) and recently in considerable detail based on a two-to-five percent coverage forest enumeration, by Henry (1966). It is therefore only necessary to generalize here.

The woodland has a well-developed shrub story near open water, particularly within four to six miles of the Chobe river and near old cattle posts, but the herbaceous layer of grasses and forbs varies. The most important trees include Baikiaea plurijuga, Pterocarpus angolensis, Burkea africana, Erythrophleum africanum, Ricinodendron rautenii, Guibourtia coleosperma, Entandrophragma caudatum, and in the Mandabuzi area towards the east of the reserve Brachystegia boehmii. The relative

importance of these trees varies with soils, and Colophospermum mopane appears on harder ground near glades, along the northern edge of Kakulwani and along the upper Ngwezumba river and in the west towards the Mababe, while Acacia giraffae, Kirkia acuminata and Sclerocarya caffra are more conspicuous towards the Chobe river.

Dichrostachys cinerea, Combretum eleagnoides, Acacia spp., Diplorhychus condylocarpon, Baphia obovata, Commiphora sp., Combretum mossambicense, Bauhinia macrantha, Popowia obovata, Ochna pulchra, Diospyros batocana, Grewia flavescens and Terminalia sericea, which may grow into small trees, are important elements of the scrub layer, together with seedlings of the larger trees. The distribution and local abundance of this scrub has been influenced to a marked extent by past land use. Miller (1939) advocated a policy of regular early burning in order to suppress grasses and prevent the accumulation of litter necessary for hotter burns later in the season, which would have endangered useful timber trees, then being exploited for the first time near Kazungula. As already noted, this type of burning, not only suppresses perennial grasses, but also promotes bush growth and probably accounts for the widespread encroachment of moderate to low density scrub in Kalahari woodland. Its systematic nature would have made it more detrimental to habitats than the fires caused by wandering groups of bushmen hunters which it sought to prevent. The bushmen's fires would have varied through the season and would not have affected exactly the same areas year after year.

Although Riney's work in tsetse areas, quoted above, shows that fires alone can induce dense bush on Kalahari sand, the densest bush in this type of country in the Chobe Game Reserve is correlated with the main areas of past overgrazing by domestic stock. Dichrostachys cinerea and other species form thickets along old stock routes and the fringe of dense bush along the Chobe was probably caused by stock, as old residents confirm that cattle used to graze out this distance from kraals and water along the edge of the flood plain. Here the species composition varies locally, but often includes D. cinerea, Baphia obovata, Combretum eleagnoides and Bauhinia macrantha while locally other species including Commiphora sp., Terminalia sericea, Acacia spp. and even young Ricinodendron rautenii are dominant. Near old cattle posts around the headwaters of the Ngwezumba D. cinerea, Acacia spp., C. eleagnoides are conspicuous, while scrub mopane and scrub C. imberbe in particular, which occur along the edges and out into Kakulwani plain, probably became established while grazing was heavy in this area.

The grasses vary with local soil differences, the extent of bush encroachment and the interval since an area was burnt, ranging from predominantly annual species to fairly well-developed perennial grasses. Important species include Tristachya superba, Schmidtia bulbosa and Heteropogon melanocarpus.

The glades in Kalahari veld are characterized by open grassland into which scrub is encroaching as the vigour of the perennial grasses continues to be reduced through fire. As already mentioned, scrub was clearly invading 59 of 61 glades inspected. The species vary but often include mopane, while Combretum hereroense and occasional Lonchocarpus capassa bushes or trees are often present and Diospyros mespiliformis trees mark many of the pans.

The Kakulwani Plain

The northern edge of this plain resembles a weak discontinuous drainage line culminating in Kwikampa pan and contains Lonchocarpus capassa, Piliostigma thonningii, Combretum imberbe, Diospyros mespiliformis, near pans, and "strangler" Ficus species, while mopane scrub and trees are also conspicuous along this margin which has a very sensitive grass cover of annuals. Out in the grassland there are occasional L. capassa and mopane, Combretum imberbe and other scrub occurs in clusters, which in the case of mopane may represent well grown trees usually of the CM2 type.

TABLE 8

Results of Vegetation Transects on the Face of the Sand Ridge overlooking the Chobe Flats

Transect No.	Date	Status of Vegetation as % Ground Cover								Conservation Trend				Animal Droppings in Milacre Plots																	
		BG	L	C	F	G	A	P	Wood	↑	→	↓	Total	Plots	Elephant*	Pig/Hog	Sable	Kudu	Buffalo*	Bushbuck	Duiker	Zebra	Eland	Waterbuck	Wildebeest	Baboon	Tsessebe	Impala	? Antelope
3	9.9.65	99	39	6	0	0	6	0	30			10	10	10	6	1	2	1													
4	9.9.65	98	46	7	0	2	7	2	37			10	10	10	7	1	1	1	5	1											
5	9.9.65	98	41	7	0	0	5	2	28			10	10	10	1			2	8	2	1										
6	9.9.65	97	45	5	0	1	4	2	16	1	1	8	10	10	3	1	1	1	5		1	1									
7	10.9.65	100	68	5	1	0	5	0	22			10	10	10			1			1	1		1								
17	21.9.65	99	47	2	0	1	3	0	16			10	10	10	4				7		1		1	1	1						1
18	21.9.65	98	66	3	0	1	4	0	41			10	10	10	3				2			1				1					
19	21.9.65	100	35	1	0	0	1	0	35			10	10	10				2	1			3	1			1					2
20	21.9.65	99	43	0	1	1	0	1	10			10	10	10	2	1					4			1			2	3		1
Total										1	1	88	90	90	26	4	5	7	28	4	8	5	3	2	1	2	2	3		4
Average		99	48	4	-	1	4	1	26																						

Symbols as for table 4.

*Droppings, as opposed to complete defecations, present in milacre plots.

Schmidtia bulbosa, Eragrostis superba and Digitaria sp. are common along the northern edge, but elsewhere the grasses are generally tall except in the clusters of mopane, as here and in certain other areas the significance of which requires further investigation, they are replaced abruptly by sparse short annual grasses and forbs. The tall grasses include Tristachya superba, Heteropogon melanocarpus, Cymbopogon excavatus and Andropogon gayanus. It was interesting that the first of these was more dominant in 1967 than in 1966, following two good rainy seasons and a rainy seasons and a reasonably hot September fire in 1966.

The status of perennial grasses on the Kakulwani plain was generally high at the end of the 1965 dry season (table 9), but conservation values were not always being mantained. Perennial grasses were losing vigour on all but the first two transects and the incidence of woody plants was increasing, particularly near some edges of the plain. Wild animal numbers were not high enough to overgraze the area, neither had livestock favoured the plains previous to the early fifties, according to several witnesses who had manned the old cattle posts. The chief cause of veld deterioration was therefore too frequent burning or burning at the wrong time of the year. Transects 25 and 26 were in a portion of the plain protected from a proportion of these fires and here conservation trends were generally satisfactory.

The mopane bush and trees and the other scrub apparently represent the type of encroachment discussed in the subsection on fire further below, and may have become established while cattle numbers were high as it is best developed near the largest pans. Much of it is, however, susceptible to the hot burns which can be achieved late in the season and,while the process of encroachment is clearly advancing locally, in some areas it has halted, and scrub is receding in others, particularly in those protected from a proportion of the fires, so that the remainder are particularly severe.

Libala Country

Leading from the southwestern corner of the Kakulwani plain toward the Shinamba hills there is a mosaic of libalas interspersed with islands of Kalahari sand supporting Kalahari woodland elements which in this area have mopane as an uncharacteristic species.

The libalas themselves generally support a good perennial grass cover in which Tristachya superba and Schmidtia bulbosa are often conspicuous, although the actual species composition varies considerably. Woody plants include mopane, Lonchocarpus capassa, Combretum hereroense, with Diospyros mespiliformis or C. imberbe at many of the pans, but this vegetation is also very variable. Conservation values range from stable or improving in some libalas to downgrading on most of the Kalahari woodland "islands". Here scrub encroachment by such species as C. eleagnoides is advanced near the Ngwezumba pools, and elephant and fire damage is widespread.

These libalas coalesce towards a broad belt of mopane (CM1) which drains towards the Shinamba hills. Here too, conservation values are better and there is a reasonable cover of perennial grasses, apparently because of the protection this area receives from fire, as the only charred stumps located were from a very old burn, and the area is protected by scrub in adjacent areas.

Vegetation South of the Ngwezumba River

Little attention has been paid to the vegetation in the area between the Shinamba hills and the Mababe depression, and south and southwest from the hills. The area is rather inaccessible and a survey is currently being undertaken by the Forest Department.

TABLE 9

Results of Vegetation Transects in the Kakulwani/Kwikampa Area

Transect No.	Date	Status of Vegetation as % Ground Cover								Conservation Trend			Total	Plots	Animal Droppings in Milacre Plots												
		BG	L	C	F	G	A	P	Wood	↑	→	↓			Elephant*	Sable	Kudu	Giraffe	Eland	Zebra	Hare*	Pig/Hog	Buffalo*	Taessebe	Steenbuck	Oribi	?Antelope
25	28.9.65	87	54	22	3	13	0	35	0	6	4	3	13	10	2	1	2			4	1						1
26	28.9.65	78	36	33	0	22	0	55	6	10			10	10						Nil							
26a	29.9.65	-	-	-	-	-	-	-	-			10	10	0													
26b	29.9.65	-	-	-	-	-	-	-	-		1	9	10	0													
26c	29.9.65	-	-	-	-	-	-	-	-			10	10	0													
27	29.9.65	87	16	20	0	13	0	33	7			10	10	10						Nil							
28	29.9.65	95	54	6	1	4	0	9	12			10	10	10			2		1	12	4	1	1	1	2	2	
29	29.9.65	75	40	25	3	25	0	50	1			10	10	10										1		1	
30	29.9.65	90	54	20	0	10	0	30	21			10	10	10				1									1
Total										16	5	72	93	60	2	1	4	1	1	16	5	1	1	2	2	3	2
Average		90	28	14	1	10	0	24	5																		

Symbols as for Table 4.
*Droppings as opposed to complete defecations present in milacre plots.

South of the river there is a mixture of Kalahari woodland, some mopane and more open country as far south as the Ghautumbi molapo. To the south and east of this there is well developed woodland of a remarkably homogeneous nature in which Pterocarpus angolensis, Ricinodendron rautenii and Burkea africana are conspicuous from the air, while nearer the Shinamba hills there are areas of Kirkia acuminata, presumably on poorly drained soils, and mopane, which lead toward the last vegetation type. Bush encroachment is apparent along some of the sandy molapos.

Mababe Depression

The Mababe depression is an ancient lake bed enclosed by sand ridges, except in the south where the lip is ill defined. The dominant trees on these ridges are usually Acacia spp., often A. giraffae, but in the north and northeast they are superseded by species typical of the Kalahari woodland described above. The scrub layer is variable but often includes Combretum eleagnoides, Dichrostachys cinerea, Grewia spp., Boscia sp., Baphia obovata, Acacia spp., Lonchocarpus nelsii and Croton gratissimus, while the herbaceous layer is chiefly annual grasses and forbs.

The vegetation of the floor of the basin varies from closed woodland to open grassland with very scattered trees. The most common woody vegetation types are Acacia spp., such as A. giraffae, A. gillettiae and A. tortilis, of which the first two, which are usually in looser sands, are often associated with Terminalia sericea. Mopane of the CM1, CM2 and CM3 types are also widespread and abundant, while other important trees are Lonchocarpus capassa and Boscia albitrunca.

There are four major areas of grassland. The moderately heavy sands in the extreme north give rise to open plains country with scattered clumps of trees, chiefly CM2 associated with pans and Acacia/Terminalia woodland on sandier minor elevations. The grasses identified by Rains et al (1967) included Diheteropogon amplectans, Hyperthellia dissoluta, Schizachyrium sanguineum, Andropogon schirensis, Tristachya superba and Aristida spp. Scrub is limited to scattered CM3, Bauhinia macrantha, Acacia sp., Combretum hereroense, C. imberbe and Lonchocarpus capassa, but table 10 indicates conservation values were not being maintained. Many tufts of perennial grasses were dying and these and the small bushes were on distinct pedestals resulting from increasing wind erosion. The first point-line transect (table 10) was situated some three miles west of old stock routes and wildlife use was light, but the area had obviously been burnt repeatedly. This occurred again in 1966.

A number of fingers of this grassland spread southward (figure 5). In the east CM3 is dense near the stock routes and made up all the 31 percent wood canopy on transect 43, while towards the tail of the Ngwezumba river Dichrostachys cinerea is very evident in the grassland which includes Digitaria sp., Eragrostis rigidior, Eragrostis sp., and Schmidtia bulbosa. In thickets along the eastern stock route the grass cover is sparse and restricted to annuals while the scrub includes Acacia spp., D. cinerea, Grewia spp., Lonchocarpus nelsii, Combretum eleagnoides, Boscia albitrunca, Croton sp., and occasional mopane of both CM1 and CM3 types. Acacia gillettiae and D. cinerea form dense patches, while the only large trees are provided by the scattered CM1 in this area which has the appearance of having been markedly downgraded while the eastern stock route was in use. The soils are light and would have been sensitive to trampling and under such conditions bush encroachment tends to proceed rapidly.

West of the Maun-Kasane road there is a large area of Acacia woodland separating the eastern and central southern extensions of the northern plains. Here the main woody species include Acacia spp., Terminalia sericea, Combretum sp., Grewia spp. and Boscia albitrunca, while the herbaceous layer comprises mainly annual grasses with Schmidtia bulbosa conspicuous along some edges. The plains along the central stock route and arms

from it support dense to fairly dense CM3,while the western limits of the northern plains end in Acacia-Terminalia or mopane woodland. These two veld types form a matrix east of the Savuti with large areas of Acacia-Terminalia in which D. cinerea and other scrub is well developed, merging with strips of mopane,between most of which there is well grown CM3.

Around the Savuti channel there is predominantly Acacia woodland with areas of mopane and moderate to dense scrub encroachment. A giraffae trees are conspicuous as are Acacia spp., C. eleagnoides, CM3, L. nelsii, L. capassa and Grewia spp. in the shrub layer, while annual grasses predominate in the herbaceous layer.

In the east of the Mababe, the Ngwezumba "estuary" gives rise to the very sandy Gxlegcauka plain. This plain floods from the Ngwezumba and in exceptional years, like 1966, fairly extensive areas may be covered by a foot or more of water. Scrub is limited chiefly to the saplings of the scattered large trees such as Combretum imberbe, Albizia sp., Burkea africana, Acacia spp., and Lonchocarpus capassa. The perennial grasses are generally tall.

Similar sandy "estuaries" result from other molapos entering the Mababe. For example, the Tsantsara molapo gives rise to such an area some 10 miles south of the Gubatsa hills. Here there is moderate to dense low scrub of Acacia spp., D. cinerea, T. sericea and occasional mopane (CM3), with scattered small trees, chiefly Lonchocarpus nelsii, while the grasses include many annuals and the perennial Schmidtia bulbosa, possibly as the result of the proximity of the old waggon road.

The central Mababe grassland is divisible into two regions shown in figure 5. In the northeast there is very little scrub and only occasional large trees, mainly mopane. There is a good perennial grass cover in which the trend in conservation values varies locally from stable or improving to the early stages of deterioration. Charred stumps of large trees indicate that fire is a factor in limiting the number of trees in this well-grassed area, while dead scrub Acacia had apparently been killed as the result of poor drainage in the heavy soils. It was not possible to visit this area during the wet season to determine the grasses, but most species occurring in the south central region were represented.

The north central Mababe ends abruptly in mopane woodland in the north and east and is enclosed by the south central Mababe scrub savannah to the south and west, which separate it from the Savuti "swamp" to the northwest. The mopane in the north forms a well-developed band of woodland composed largely of the CM1 type. This extends in a narrow belt around the east and is followed by the road from Tsotsoroga to Jovorega, while to the northeast of Tsotsoroga it extends some 10 miles to the base of the sand ridge. Once again it is composed largely of CM1, but the numerous glades in it contain varying densities of CM3, with CM2 well represented in intermediate areas and along the western edge, against the central Mababe grassland.

Southeast from the tail of the Ngwezumba river there is a spur of mixed Kalahari woodland surrounded by open plains country with CM3 and scattered groups and tongues of CM2, with occasional CM1 trees extending north from the better woodland. Similar country occurs between the narrow belt of woodland and the eastern lip of the Mababe further south.

The best woodland contains mostly annual Aristida spp. with perennial grasses limited to slight depressions and around the numerous seasonal pans, many of which are marked by large trees such as L. capassa, C. imberbe or Diospyros mespiliformis. Acacia spp. including A. nigrescens are scattered through the woodland and occur at the pans but most have been killed by elephant and a sample of over 300 showed that 90 percent or more of the trees were dead. Ximenia americana is very noticeable in this country during the dry season when most of the ground is bare or littered with dead mopane leaves.

TABLE 10

Results of Vegetation Transects in the Mababe Depression

(Lines 42 and 43 were in the northern grassland region, and lines 44 and 45 were among the Gubatsa Hills)

Transect No.	Date	Status of Vegetation as % Ground Cover								Conservation Trend		Animal Droppings in Milacre Plots										
		BG	L	C	F	G	A	P	Wood	↑→↓	Total	Plots	Elephant*	Zebra	Hare*	Ostrich	Eland	Wildebeest	Hog	Tsessebe	Springhare	Buffalo
42	27.10.65	83	26	11	2	18	-	28	2	15	15	10	1	1	1	1						
43	27.10.65	84	37	6	1	4	-	10	31	10	10	10			3		2					
44	27.10.65	100	42	-	-	-	-	-	1	10	10	10	3					10	3	1	1	
45	27.10.65	100	33	2	-	-	2	-	7	10	10	10	2				2	5				1
Total										45	45	40	6	1	4	1	4	15	3	1	1	1
Average		91	35	5	1	6	1	10	10													

Symbols as for Table 4.
*Droppings, as opposed to complete defecations, present in milacre plots.

Bush encroachment was investigated briefly in the Mababe depression by comparing the number of annual rings in the ground level coppice and in the oldest surviving stems arising from the coppice. This involved digging up whole plants and, although rot and distorted anatomy tended to minimize age determinations for some of the coppices, it nevertheless provided a useful indication of the age of the plant.

The difference in the ages of the coppices and the aerial branches in different areas gave the approximate time lag between the scrub becoming established and the last effective fire that burnt back the stems to ground level. In some cases adequate fires are no longer possible, while in others they could now only be achieved by protecting an accumulation of litter for a number of years.

In one area, five miles south of the Gubatsa hills on the old waggon road to Maun, 18 CM3 plants had coppices between 15 and 31 years old (mean 22 years) and stems ranging from eight to 15 years (mean 10 years). There was still plentiful grass and much of the latter variation was due to the relative protection from fire of the various plants. The coppices of five Lonchocarpus nelsii ranged from 20 to 38 years (mean 27), but no stems had more than eight or nine rings. This species was more widely spaced and did not afford itself as much protection as some of the mopane. Five Combretum hereroense coppices average 26 rings (range 18 to 35), but with the exception of one heavily charred stem with 12 rings, none had more than 9 or 10.

The grasses had obviously been more sensitive in a neighbouring area due to soil factors. Here 15 CM3 coppices ranged between 22 and 35 rings (mean 29) and the stems varied from 21 to 27 rings (mean 23). The coppices were much smaller and the lower number of vertical stems were much taller.

One and a half miles south of Goha pan on the central stock route (figure 5), 20 CM3 had coppices with between 17 and 34 rings (mean 29). Ten, with less protection from fire, had stems showing 4 to 6 rings (mean 5), while the remaining 10 had stems with 8 to 11 rings (mean 9). The average coppice of four C. hereroense was 19 years (range 15 to 24), but none had stems over five years old, and like the first group of mopane none had much protection from fire.

A sample of 21 CM3 in a glade near Goha pan on the eastern stock route contained three plants 38 or more years old and none under 18 years, the average age being 27. Four had the oldest stems with five rings, one had but three rings and the rest had four. This area was burnt in April 1966, but the fire was not adequate to kill back the coppicing stems. CM3 near the edge of the glade was older. Ten plants ranged from 31 to 34 rings, with one older plant having 43. A fairly well-grown CM2 away from the effects of fire had 20 rings, while a CM1 had 52. Nine other protected CM2 had stems with 26 to 30 rings (mean 29). Young CM1 growing away from grass around the edge of this glade had from 27 rings to over 70 rings, while the largest CM2 with fire-charred ground-level coppices had 58 and 62 rings and were 28 and 31 feet tall, but older portions of the coppice had rotted away.

A fourth station was sited in a glade 1½ miles south of Tsotsoroga pan in the midst of well-developed CM1. Ten CM3 coppices in the centre of the glade had from 15 to 31 rings (mean 23) while the stems had 5 to 7 rings (mean 5.5). Near the edge of the glade five CM3 coppices had 22 to 41 rings (mean 30) with stems with five to eight rings (mean 6). Four large CM2 on the abrupt edge of the glade had ground level coppices with 51 to about 70 rings, but a single large CM1 inside the woodland, selected as being of average age, had 7171 rings in addition to a hollow center. This tree had an overall diameter, three feet above ground level, of 32 cm, of which 2 cm was bark, 12 cm contained the rings (6 cm sapwood, 6 cm heartwood) and the hollow center accounted for the remaining 18 cm.

According to Mr. Tom Kays of Maun, the eastern stock route across the Mababe was pioneered by his father in 1922 or 1923, but the old waggon road along the Magwigwe sand ridge was already in existence, as Stigand (1923) shows. Bushmen drovers working on the new route claim that various operators did not always use precisely the same route, or water and graze their stock at the same pans. This would explain the widespread occurrence of CM3 in the Tsotsoroga - Goha pan area.

Mr. Kays clearly remembers some CM3 when he travelled with his father in 1921, but this was probably less dense as the above observations indicate much of it has established in the glades since then. This suggests that overgrazing, possibly accompanied by early burning, was the primary cause of mopane becoming established under conditions which were less favourable for it. Sufficient grass, however, continued to survive to allow fires of adequate intensity to kill back the aerial shoots and so give rise to CM3. The glades probably have soils less well suited to mopane, while in areas less marginal to the species, around the best woodland, this process has proceeded to the CM2 stage.

Deterioration in the herbaceous layer of the mopane woodland and adjacent areas may have been initiated by the proximity of the eastern stock route,but recovery is being prevented by repeated fires started along the road between Kazungula and Maun. The whole area was burnt out during the 1963 and 1965 dry seasons and, although these fires were late in September, there was insufficient combustible material to affect woody growth so that their only result was to prevent the accumulation of litter which would be necessary to promote trends toward the recovery of perennial grasses.

The southeastern Mababe supports large areas of Cynodon dactylon, Cenchrus ciliaris, Chloris virgata, Urochloa sp. and Bothriochloa sp. which are short grasses occuring between stands of tall Sorghum verticilliflorum. Scattered through it there are bands or thickets of Acacia spp. Proceeding west from Jovorega pan out of mopane woodland (CM1), a belt of CM2 or CM3 is entered where there are more perennial grasses. This ends abruptly in an area of open Cenchrus ciliaris before a band of large dense Acacia tortilis which scrub of the same species is entered, prior to passing into the more open short grassland with the patches of Sorghum and Acacia, mentioned above. Similar zonation is apparent around the west of this area near the Magwigwe sand ridge. It may therefore be significant to quote Pole Evans (1948) who described this country 30 years ago. He crossed from Jovorega to Shaleshanto and notes that "on emerging from the belt of mopane forests on the (Mababe)* flats,open grass country is encountered in which Cenchrus ciliaris is the dominant grass," which is illustrated by a photograph. While this grass still dominates in some areas, a photograph such as this, showing virtually no bush, would be difficult in this part of the Mababe now. He continues, "apart from a belt of dense Acacia litakunensis (?) which protrudes into the grassland, the country becomes more and more open grassland towards the west ... In the obviously lower lying portion tall Cymbopogons flats Cenchrus ciliaris dominate with Chloris gavana, Digitaria spp., and bush extends to the west until it meets the Magwikwe sand ridge. No fringing forest was seen along the eastern or western edge of the flats ..., only in the distance to the extreme south could fringing forest be seen in the neighbourhood of the Mababe (Kwaai) River".

Although Pole Evans' exact route cannot be traced and, although it would be possible to obtain similar photographs to three of his five plates of this area, the other two show conditions much more like the northern central Mababe now. His description of the vegetation indicates that there has been an increase in woody vegetation, mainly Acacia spp. This has apparently transformed the open grassland of the southern and western Mababe into scrub savannah. This encroachment is discussed in relation to tsetse fly and probably results from past mismanagement, as the deterioration process is most marked along the old

* Author's brackets.

waggon road in the west where Acacia scrub with relic patches of C. ciliaris extends to the southern fringe of the Savuti "swamp" (figure 5). Here the chief species are A. tortilis, A. hebeclada and A. mellifera with intrusions of CM3 near stands of CM2 which, with some CM1 woodland forms a mosaic with plains type country, containing CM3 or other scrub, between the central Mababe and the Magwigwe sand ridge. Here the country may not differ significantly from conditions in about 1920, judging from the occasional annotations included on Stigand's (1923) map, butby then tsetse had cut the stock route and had encroached across the southern Mababe.

The Savuti "swamp" arose as the result of the channel filling in about 1958 to 1960 when swamp conditions prevailed until early 1965. Since then it has reverted to grassland with Cynodon dactylon dominant around the margin of the "swamp". Here the tree Croton megalobotrys is conspicuous with occasional L. capassa on the eastern side on higher ground, while L. capassa is a constituent of the margins of well-developed A. giraffae woodland on the west. The vegetation in the center of the "swamp" is changing rapidly, but still retained relics of aquatic vegetation including Phragmites etc., by the end of 1966 and whether these trends will continue or whether the area will revert to swamp for a further period will depend upon the behaviour of the Savuti.

The habitats near the Savuti (transects 44 and 45, table 10) suffered generally from the concentrations of game including elephant, buffalo, hippo, impala, warthog etc., which built up near water in the channel and swamp. They may not have been in a stable state prior to this radical change in the habitat, however, as old cattle kraals along the waggon road signify past overgrazing by domestic stock. Overbrowsing by giraffe on such species as L.capassa and Boscia albitrunca is marked, but perhaps less so than along the edges of the south central Mababe.

Thus the vegetation of the Mababe depression includes open plains interspersed with areas of woodland. Conservation values are generally deteriorating due mainly to fires, but this process was probably initiated in many cases by mismanagement of livestock, accompanied by incorrect burning. In this respect stock routes between Ngamiland and Kazungula have had a significant effect. Wildlife concentrated around the Savuti while there was water, had a marked depressive effect on the vegetation locally, and there are indications of overgrazing in the south central Mababe.

North Goha Plain

There is a small area of plains country in a depression on the sand ridge immediately to the north of the Goha hills. It is much larger than the usual glades in Kalahari woodland and is encircled by a band of mopane. Common grasses include Schmidtia bulbosa, Cenchrus ciliaris and Aristida spp., while Sorghum versicolor in the central region is indicative of poor drainage. Besides the widespread mopane, which occurs in all its forms, there are also a few Acacia giraffae, Lonchocarpus capassa and an occasional baobab, Adansonia digitata. Patches of Dichrostachys cinerea occur in the CM3 dominated scrub invasion and pans are numerous in the west and east of the area.

A photograph of the area by Pole Evans taken in 1937 indicates this encroachment was well advanced by then.

LARGE MAMMAL FAUNA

The remarkably varied fauna of northeastern Botswana results from the merging of several distinct ecological associations, ranging from the swamp and swamp grassland of the Chobe and Okavango systems, through the general woodland-plains country matrix, to elements similar to the central Kalahari. Not only do these vegetation types provide

strikingly different habitats, due to the variation within them and the ecotones between them, but the varying effects of flooding in this remarkably flat country give rise to further differentiation.

Although all the species of large mammals occurring in the region are not represented in the Chobe Game Reserve, notably springbok and hartebeest, it can still boast 38 species, jackal sized or larger, which makes it the equal of some of the best in the world. Past land use and the modification of the habitats, both in and outside the reserve have, however, influenced the relative abundance of most species, although the only one which has entirely disappeared during historic times is the white rhino and this is being reintroduced.

As the result of the low effective rainfall, most habitats are dry and marginal and therefore sensitive to changes. The easily demonstrated deterioration in conservation values over large areas has led to an imbalance in the animal/habitat relationships, which accounts for several urgent current problems in the reserve and has set certain trends in motion which will have to be carefully watched.

Wildlife populations are very sensitive, and such changes can detonate chain reactions which lead to a decline and eventual disappearance of some species while the same conditions may favour an increase in others. Such a buildup is usually only temporary. It depends upon a given level of habitat deterioration, which is especially favourable for a species. With further change these optimal conditions are not maintained, and in this respect a species, which has become too numerous, may itself hasten the process by overutilization of its essential requirements. The result is an eventual crash in the population, usually to a level below the original carrying capacity of the area, particularly if the downgrading process has proceeded beyond one or more critical thresholds, similar to those described when considering the effects of fire, and this may make reversing the process difficult. Even when an area is stabilized with regard to conservation values this may have been achieved through a deflection in the vegetative sere, so that the resulting habitats may differ from those in the area prior to the disturbance.

These facts need to be taken into account in any wildlife management program in northeastern Botswana, which should comply with clearly stated policies for land use in specific areas. The spectacular die-off among wildebeest in the Makarikari region, discussed more fully in the species account below, was an example of one such eruption followed by a crash in the population. There are several other species in an eruptive phase and some may have reached a point where numbers are declining. These populations threaten their own habitats and those of some associated species, but the answer to the problem will depend upon how an area, and the wildlife populations within it, are to be used.

The following accounts include relevant information on the species' biology obtained during the present survey, as well as suggestions for future research highlighted by this broad investigation. In many cases it has not been possible to follow up these problems to any depth, neither would it have been justified, when the priority was to attempt to recognize and define the broad problems confronting wildlife management in a large area with limited economic and human resources.

The distributions of the following species are described in terms of the one sixteenth degree square grid illustrated in figure 6. The nomenclature and systematic arrangement follows Ellerman et al (1953).

BABOON — Papio ursinus

Baboons were recorded along the Chobe River between Kasane and Ngoma in 1724-D-4 and 1725-C-3 around the headwaters of the Ngwezumba river in 1824-B-4 and 1825-A-3, near Kasinka in 1824-A-2, at Goha hills in 1824-A-3, on the Savuti "swamp" in 1824-C-1, at Tsotsoroga in 1824-C-2, and along the Linyanti swamp in 1824-A-1 and 1823-B-4. They were also noted along the edge of the Okavango system in the Moremi Game Reserve in 1923-B-1, 2 and 3 and along the Thamalakane and Mogogelo rivers in 1923-D-1 to 4, while there were reports that a troop at Nunga in 1825-D-1 had recently established itself in this area.

The species did not occur in numbers in well-developed Kalahari or mopane woodland, or in the mixture of scrub and woodland south of parallel 19°S, except where these bordered other vegetation types, and they were not known along the Botletle river east of about Makalamabedi. Along the Chobe river baboons ranged at least 3.1 miles on to the sand ridge in highly modified Kalahari woodland, making extensive use of fire traces to do so, but generally returned in the late afternoon or early evening to roost in trees along the river, although at the end of the dry season this return was sometimes delayed for up to three hours after dark. After the vegetation flushed at the beginning of the rains there was a tendency for fewer troops to be contacted on routine game counts between Kasane and Ihaha. An average of 16 contacts per count in October and November 1965 declined to 5.3 in December and then gradually rose to about eight in July and over 15 in November before the 1966/67 rains broke and the pattern was repeated.

Baboons occurred in large numbers along the Chobe and Linyanti, but elsewhere were resident only in watered areas and disappeared from much of their range as the pans dried up. This was particularly evident during the severe dry season in 1965 and may have explained the buildup along the Chobe and the subsequent decline when the rains started as vacated range soon became reoccupied, although in the east of the Chobe Game Reserve this would have required a move in either direction of at least 25 to 40 miles. There were, however, three or more troops on the Savuti "swamp" in October 1966, when the only known water within 12 miles was a small seep in the Savuti channel at the foot of one of the Gubatsa hills. This was not visited for at least four days while the baboons made extensive use of the swollen rhizonetous roots of a burnt-off "bullrush" which had survived from when the "swamp" held water.

It was difficult to obtain numerical data on baboons as troops were large and tended to spread out so that when contacted on routine game counts along the Chobe they were simply noted as "troop". There were at least 12 such troops resident for most of the year along the count route and this represented at least 750 to 1,000 individuals along this 20 mile stretch of riparian vegetation as three counts of troops varied from 66 to 92 (mean 75) individuals, and these were by no means the largest troops in the area.

Repeated observation indicated a peak of oestrus females in April through June, with most births around the end of the year in 1965, although there was some breeding in all months in 1966 and the first half of 1967, and there were a great many oestrus females in February to May 1967. A very high proportion of the adult females were in oestrus in April through June 1965, when there were very few carried infants, and of those noted all were adult coloured and therefore probably at least five months old (Prof. R. Hall, pers. comm.). It was not until July 18 that the first small dark infant was recorded, but from then their numbers gradually increased to a peak in November - December. According to Hepburn (pers.comm.), a similar pattern was evident during 1963 and 1964. In 1966 and early 1967 small numbers of newly born infants were noted in all months except November to February when they were numerous, even while a proportion of the females were in oestrus. It was, however, noticeable then that males, including large adults, frequently carried young from the vicinity of danger.

Oestrus females were recorded, at least in small numbers, in every month between June 1965 and June 1967. The absence of small youg during the middle of 1965 was therefore probably due to pre-or post-natal mortality due to severa habitat conditions in the dry season following a series of dry years as Hall(1962) and Child (1965) have observed similar effects elsewhere.

As a result of the more or less seasonal breeding pattern previous to 1967 it was possible to separate juveniles into size classes representing annual age classes, from which it was evident that some females reached sexual maturity in their third year and similar aged males were noted mounting receptive females.

Early maturity of females taken together with high numbers in oestrus indicated a high reproductive potential. This was borne out by an oestrus female, collected during copulation in July 1965, which had just ovulated and had milk indicating that mature females can breed annually, as young over about six months became progressively more independent of the females, and the gestation period in baboons is about six months (Asdell, 1964).

Baboons fed extensively on fruiting trees in the riparian strip including Garcinia livingstonei, Diospyros mespiliformis, Phyllogeiton discolor, Markhamia acuminata, Strychnos stuhlmannii and Capparis tomentosa, and on the flowers and buds of species such as Acacia nigrescens, A. tortilis, Lonchocarpus nelsii and the leaves of Croton megalobotrys and Baphia obovata. Almost all trees of S. stuhlmannii showed extensive scarring of the bark where baboons had scraped it away with their teeth. They made considerable use of the roots, in particular, of swamp and semi-swamp plants, including several grasses and sedges, and entered water to recover the roots of water lilies, an activity which sometimes necessitated their submerging the whole body, although more often the head remained dry. The young leaves of the annual grass Panicum maximum were grazed extensively by groups of baboons, as were the mature heads later in the season, and the small weed Tribulus terrestris was used before the thorny fruits hardened.

Species often associating with baboons included mongoose, warthog, impala and bush-buck. The association with the latter was a positive relationship which is discussed later in the report when considering bushbuck, and this may have been true in the case of the mongoose, although the associations with impala and warthog were probably of a more casual nature, although baboons benefited to some extent from roots loosened by warthog on the Chobe flats and Savuti "swamp".

Although Selous (1881) remarks upon the high population density of baboons along the Chobe in 1874, which was higher than he had encountered anywhere else on his travels in southern Africa, and although old residents of the area all agree that baboons have always been especially common along the Chobe, it appeared that the population was approaching dangerous limits by 1965. They became very thin from July onwards, when they showed a remarkable lethargy in the presence of danger. Large areas of rocky hillsides near Kasane and Ngoma were worked over repeatedly in their quest for food concealed beneath stones, to the extent that up to six inches of soil had been shifted over some 70 percent of an area sampled by means of a point line transect. All grasses and lesser plants were destroyed unless protected by fallen trees and even well-established bushes were endangered when their roots were exposed. Similar but less intense activity was widespread and, although not as marked during the less severe 1966 dry season, it appears safe to conclude that baboons are too numerous for the habitats presently available to them along the Chobe river, especially when, for one reason or another, their food supply is reduced.

Control of the population would, however, require fairly sophisticated management techniques if this valuable tourist amusement is not to become unduly disturbed, and it would appear that under prevailing conditions there is little likelihood of the problem being solved except by the general protection of the habitat from such destructive agencies as fire.

WILD DOG — Lycaon pictus

Wild dog were recorded in 1724-D-4; 1725-C-3; 1824-B-4; C-1,3 and 4; 1923-B-2 and 4; and 2025-A-2 and B-2, in groups of one to 25. They move about a good deal and are probably more widespread than these contacts imply. Fourteen animals killed by wild dog included two young of their own species, four kudu, four impala, two waterbuck, one lechwe and a bushbuck.

The species plays a useful role in wildlife areas where, in addition to its value as a selective agent tending to eliminate weaker individuals, it temporarily disperses browsing and grazing species and so helps achieve more even use of the veld. It is, however, imcopatible with livestock production and for this reason often becomes a problem animal in ranching areas.

BROWN HYAENA — Hyaena brunnea

Brown hyaena have been recorded in parts of Rhodesia bordering northeastern Botswana, and their possible occurrence in adjacent parts of this territory requires investigation.

SPOTTED HYAENA — Crocuta crocuta

Hyaena were noted from 1724-D-4; 1725-C-3; 1824-B-4; C-1,2 and 4; 1825-A-1 and 3; C-1 and 2; 1823-B-1, 2 and 3; 1924-D-4, with a breeding record of three small brown cubs in 1924-A-1 on June 27, 1966. The species is generally rather inconspicuous but judging from spcor is widespread in northeastern Botswana.

LEOPARD — Panthera pardus

Leopard are seldom seen in northeastern Botswana, although their presence has been confirmed in 1724-D-4; 1725-C-3; 1824-A-1; 1825-A-3 and 4; 1823-B-1, 2 and 3; and 2024-B-1. They may occur throughout the Okavango swamps and are probably more widespread than these sparse records suggest.

Thirteen skulls were recovered by the author, members of the Game Department and Game Scouts in the Moremi Game Reserve from leopard kills. These included four adult female duiker, in the youngest of which permanent tooth replacement was almost complete; three big adult male baboons; two adult impala rams; and adult male tsessebe with all permanent teeth; a well-grown bushbuck ram; a very young male roan calf, and a full-grown antbear.

The hunting of leopard, often with the aid of traps, is a very profitable occupation due to high prices paid for skins. The decline in the leopard population suggested by local people, in a number of areas, may be partially due to this, and the Game Department is seeking appropriate control over the exploitation of this valuable species.

LION — Panthera leo

Lion are widespread in northeastern Botswana where they have been recorded from 1724-D-3 and 4; 1725-C-3 and 4; 1824-A-1, 2 and 3; B-2 and 4; C-1, 2 and 4; 1825-A-1 and 3; D-1 and 4; 1923-B-1, 2 and 3; 1924-A-1 and 2; D-4; 1925-B-2; and 1926-A-1 and 3. They are also reported from the Okavango swamps, the edge of the Linyanti swamp and

are troublesome to livestock owners on the stock route and in the Panda ma Tenga area.

Buffalo and wildebeest, with 16 each, headed the list in a smaple of 105 kills. These were followed by lechwe and warthog with 14, eland with 10, waterbuck and zebra with eight, sable seven, kudu six, puku two, tsessebe two and roan and giraffe one each. This method of recording the predatory preferences of lion, while useful for gaining a picture of the main species preyed upon, has limitations in that larger species are easier to find, not only on account of their size but also because more meat remains to attract vultures for longer. Further, many small or hornless skulls are completely eaten.

The species has become more conspicuous along tourist routes in the Chobe Game Reserve during the past two to three years but it is diffucult to obtain a true picture of trends in the population here or elsewhere in the region, as the apparent increase may be due to conditioning to tourist traffic. The species is very important to the safari hunting business and the need to afford it maximum protection commensurate with legitimate defence of livestock is discussed more fully later in the report.

CHEETAH — Acinonyx jubatus

Cheetah are very inconspicuous in the area with which this report deals, and the Game Department's decision to afford them absolute legal protection on a nationwide basis, seems fully justified, especially in view of the high prices offered for their skins.

They have been confirmed in 1724-D-4 and 1725-C-3, where they are occasional visitors to the Chobe flats, and in 1824-C-2; 1825-A; 1923-B and 1924-D-4. Four kills included two adult impala rams with permanent teeth, a male impala calf and a female duiker with exchanging premolars and incisors, while Mr. P. Brown reported their killing an ostrich in the Tsau area.

ELEPHANT — Loxodonta africana

Elephant occur throughout northeastern Botswana, and they, or their signs, were recorded in 1724-D-3 and 4; 1725-C-3 and 4; 1823-B-3 and 4; D-1 and 2; throughout A, B and C and in D-2 and 4 in 1824; throughout A, C and D, with the exception of D-2, in 1825; in 1923-B-1 and 2; D-4; 1924-A-1, 2 and 3; B-4, and D-2; 1925-A-1 and 3, and B-4; 1926-A-1 and 3; 2023-B-2; and 2025-A-2. The species is, however, subject to considerable seasonal movements depending upon the availability of surface water and the seasonal fruiting of trees like morula, Sclerocarya caffra, and mugongo, Ricinodendron rautenii.

The widespread activity and well developed elephant paths, linking up pans, are very conspicuous from the air and on aerial photographs. Many lead southward from the Chobe across the Ngwezumba river where there are many well-developed paths radiating out east and southeast from the Mababe towards the Rhodesian border between Panda ma Tenga and the Sibanini river.

History of Elephant Population

There is general agreement among local people, living as far apart as Gweta, the fringe of the Okavango, Kachikau and in the eastern Caprivi, that the elephant population has increased very rapidly, especially during the last 10 years. In 1966, for example, they were reported for the first time from areas to the eastern Makarikari, where they have not been known for many years.

One man living along the Chobe, after a long absence, noted that in 1933 there was a well-known herd of 20 to 25 head between Kazungula and Kasane, but that otherwise the

species was scarce along the river. In the same area several old people have remarked that it is now no longer safe to walk along the main road. Another man doubted that natural increase alone could have accounted for the rapid buildup in numbers, in spite of the high proportion of juveniles in the breeding herds.

Elephant had been unknown to the bushmen living around the source of the Ngwezumba river for several generations until about 1945. Then within a single year the whole area to the north, as far as the Chobe "filled" with elephant which came from the direction of Masame, moved towards Lesuma and then across to the Chobe west of Kasane.

The warden of the Chobe Game Reserve counted the number of elephant tracks going to and from the Chobe across 19 miles of road, during two 24 hour periods in October 1963. The road was first swept and if animals going to water crossed the road in tight groups, so obliterating each others spoor, the groups were counted on the flats. This problem seldom arose with animals drifting back from water as then they are usually in more open formation. These counts yielded 485 and 508 (mean ± 500), but similar counts in 1965 (table 11) indicated a considerable increase in elephant. These were both years in which all the seasonal pans in the reserve dried up.

Heavy late rains in 1966, augmented by widespread rain amounting to about 50 mm during the first week in June, resulted in many pans retaining water throughout the dry season. In spite of the number of elephant that remained away from the river, a spoor count on October 7 and 8 gave 619 head.

The seasonal pans were dry or almost dry by the end of July 1965 when they were inspected from the air. During the same week the elephant in the 240 square miles of game reserve along the Chobe west of Sidudu were counted from a Cessna-Wren aircraft, with automatic pilot and capable of speeds down to 40 m.p.h. The area was flown in strips parallel to the Chobe, and in addition to the pilot there were three observers, one of whom acted as recorder. Visibility among the leafless trees was good and a height of approximately 500 feet above the ground and a speed of 100 m.p.h. was found most suitable while searching for elephant. Large groups were circled at much lower speeds just above the trees.

Most elephant were contacted within six miles of the river, between 0900 and 1200 hours, and counting was discontinued 9 miles from the Chobe as there were very few elephant thus far from the river. Ground observations indicated a very marked peak in elephant activity on the Chobe flats during the 1965 dry season, between 1400 hours and sundown (1815 hours in July). Some animals may have moved out of the count area at night, although the herds were all very static, with several individuals lying down, when observed during the morning.

An increase in elephant along the Chobe during the past decade was confirmed by evidence from the Caprivi. The Magistrate at Katima Mulilo kindly supplied the following information on the numbers of "garden raiders" which had had to be destroyed, and provided the author with a guide to the eastern Caprivi. Between 1940 and 1945, "very few elephant were shot, perhaps three or four, but certainly not many more". About 12, or an average of one per month, were shot in 1946, and this satisfied the need for crop protection. However, 256 tusks (i.e. ± elephant) were collected, mostly from the eastern Caprivi, in the 21 months between November 1962 and July 1964, giving an average of 12.2 per month, and 94 elephant, or an average of 7.4 per month, were shot in the 13 months between September 30, 1964 and November 8, 1965. This rapid increase was confirmed by careful interrogation, avoiding any leading questions, of more than 60 villagers scattered over the eastern Caprivi.

Seasonal Fluctuations in Numbers

The regular standardized counts between Kasane and Ihaha, show the seasonal influx of elephant along the Chobe toward the end of the dry season (figure 7). It was possible to establish the route followed by a proportion of these elephant which cross into the Caprivi, by carefully questioning the occupants of successive villages.

These animals move into the Caprivi each dry season around June or July and return to Botswana at the onset of the rains in November or December. This movement which involves males, females and juveniles, is differentiated in figure 8 from the dry season, which are mady by males only, which do not apparently remain long or penetrate deep into the Caprivi.

Many of the elephant, including visitors to the Caprivi, disperse away from the Chobe during the rains. This can be very sudden and took place in November 1966 before the rain fell along the Chobe but when thunderstorms were visible to the south of the sand ridges. There are also several records of elephant at small pans, over 20 miles from permanent water, within days of their filling for the first time in the 1965/66 and 1966/67 rainy seasons.

The seasonal distribution of elephant and their signs indicate that many disperse to temporary pools throughout much of northeastern Botswana during the rains and then gradually coalesce towards the larger pans and eventually to permanent water as the dry season progresses. The permanent water at which elephant end up at for the dry season is probably influenced by the sequence in which the pans dry up in any year.

This phenomenon, which was evident for several species that made relatively more use of small pans, so long as they held water, suggests a useful adaptation towards the spreading out of feeding pressure and more efficient use of vegetation.

Cause of Rapid Increase in Elephant Numbers

The pattern of elephant paths and the history of the population along the Chobe river, indicated that the rapid buildup in numbers was partially due to an influx of elephant, possibly augmented by increased successful breeding and greater protection. Similar patterns have been noted in the Savuti- Linyanti area, the Kwai-Moremi area, and toward Nata and Odiakwe, while elephant died in appreciable numbers in the Tamafupi-Jari pan area along the borders of the Wankie National Park during 1965. This die-off was reported to have extended well into the park, and along the border affected mainly young animals.

The elephant were in very poor condition with markedly accentuated spinal ridges, sunken temples and dull grey hides with numerous callous-like lumps on the skin and around the orafice of the mush gland. There were few small post-lactating calves, and most of those observed were alone. Fifteen carcasses were located in a single day in thick bush near pans without the aid of vultures and included one adult tuskless female, another female which was very old with well-worn final molars; one calf carcass measuring 80 inches at the shoulder; eight fresh carcasses of calves with shoulder heights between 60 and 42 inches (mean 50 inches); three older carcasses in this age group, and one that measured 35 inches at the shoulder, had very soft bones and may have represented a stillbirth.

The following account of competition for water between individuals in a small group, was typical of that observed among larger groups in several areas in northeastern Botswana in October 1965, but was particularly noticeable near Tamafupi. Four individuals were slightly removed from the rest of a herd of 16 animals drinking at a small water hole.

TABLE 11

Spoor counts of Elephant crossing the Main Road between the Game Reserve Headquarters and Ihaha in 24 hour periods in 1965

Date	Number of spoor crossing road			
	To River	From River	Mean	Monthly Mean
Sept. 10	481	451	466	
Sept. 22	735	791	763	
Sept. 23	634	676	655	
Sept. 24	890	769	830	679
Oct. 16	681	775	728	728
Nov. 26	95	49	72	72*

*After rains had set in.

These four animals consisted of an adult female, a well-grown female, a male calf of about four feet at the shoulder and the adult's small calf. The first three were drinking from a small hole two feet deep dug by elephant, while the young calf pulled at a fallen tree a few yards away or suckled from its mother.

The animals were observed for 50 minutes while the adult female stood in the best position from which to reach water and attempted to prevent the other two animals from doing so. While she was sucking up water she could do little more than impose her body between the hole and the male and lean against the young female so that it was difficult for them to insert their trunks into the hole, which the young female did by going down on her "wrists". As the cow squirted water down her throat she tried to hook the other animals' trunks out of the hole with her front feet, or pushed them away with her head or shoulders. This led to considerable impact between the tusks of the older animals and for some time discouraged the male who wandered about with a partial erection. The male and young calf left with the adult female, when the herd moved away from water, suggesting they were both her calves.

The biggest individuals were usually best placed when larger herds watered, while the four to five foot age group were seldom able to drink in the most critical areas. They could be seen standing in the shade near most pans, but if they attempted to approach the water they were challenged and chased off by older individuals. On one occasion a herd was chased away from water with difficulty, using a vehicle, whereupon one of these young animals immediately rushed to the water and stood its ground until the vehicle and its shouting and banging occupants were within two yards.

No water and very little wet sand was placed on the body which might have explained the callouslike swellings on the skin of most of the 300 to 400 animals observed in the Tamafupi area.

There were also reports of competition for water between elephant and sable or buffalo. At least two adult sable were charged and killed at water while others were chased from it. This also applied to buffalo on many occasions, although sometimes a herd of buffalo was successful in driving away the elephant.

The vegetation around the pans in the Tamafupi area was heavily used and it was interesting that the elephant droppings did not possess their usual cohesive properties at this time of the year and soon broke down as they dried, apparently partially as the result of containing more woody tissue. It is also possible that the shortage of water impaired digestion.

It is therefore evident that elephant were overpopulated along the border with the Wankie National Park, at least during the unusually severe dry season in 1965. The area in northeastern Botswana where elephant populations have increased all radiate out from here and are linked to the park by well developed paths. Elephant have been very numerous in the park for many years and large-scale culling, with the object of reducing numbers, was started in 1966. There are areas with extensive recent elephant damage between Wankie and the Chobe river. This and reports by bushmen from the intervening areas, of a buildup of elephant during the past three decades, originating from the general direction of Wankie, suggests that the increase in elephant along the Chobe is at least partially attributable to an overflow from the park.

The Role of Elephant in Habitat Destruction along the Chobe

Elephant are the most important factor now suppressing the sensitive habitats along the face of the sand ridge and in adjacent vegetation types. Herds spilling down the ridge toward water or digging for roots destroy much of the poor ground cover every year and

extensive damage is caused to the bush, while several species of large trees in the riparian strip are threatened.

Table 12 summarizes the utilization of woody plants along point line transects within four miles of the Chobe river during September 1965. If a quick but careful inspection did not reveal any use, a plant was classed as IV; if the use did not exceed a season's growth it was put in III; and if more than a season's growth was judged to have been removed, in II, unless the plant was severely mutilated, ring barked or pushed over, when it was classed as I. Some of this use was due to species other than elephant, particularly in the case of Capparis tomentosa, an evergreen creeper highly favoured by kudu and bushbuck but, with the exception of this plant, use seldom exceeded class III.

The effects of elephant on scrub were also measured in two pairs of 100 feet sqare plots in December 1965, after the bush had come into leaf (table 13). The eastern pair was situated in an area of heavy use while the western pair was sited to sample unusually light use. All the bushes were assigned into one of three use classes; if the plants were virtually untouched by elephant they were rated as 'a', those noted as 'b' had the tops browsed off but the rest of the plant healthy, while plants in 'c' ranged from those with tops and lateral branches removed and shooting from the base or main stem, to those coppicing from an established root, from which elephant had removed or destroyed the stem.

The results of these two sampling methods are not strictly comparable as, although the plots were sampled only 10 to 12 weeks after the transects were run, it was necessary to set much more lenient limits to the use classes as there had been heavy elephant activity during the last 6 to 8 weeks of the dry season. Nevertheless, both sampling methods indicated a shift in the species composition of the scrub in favour of less desirable forms such as Dichrostachys cinerea and Combretum mossambicense which are not valuable browse. C. mossambicense has a straggling form and, when in leaf, tends to shade out other plants and restrict visibility, but it is very deciduous and provides poor protection for the soil through the long dry season.

A reduction in the extent of elephant use now would probably lead initially to a thickening up of the bush through coppicing but, if the use continues desirable, species may be eliminated. Trampling is also destroying much of the litter and herbaceous layer and preventing the stabilization of the face of the sand ridge, but it is the damage to the large trees in the riparian fringe which gives greatest cause for concern.

The trees in this strip are generally slow growing and are an attractive element along game-viewing routes on the edge of the Chobe flats. Elephant use was assessed between the warden's house and Serondela. All trees over 5½ inches d.b.h. were considered for the first one mile (table 14), but thereafter a more limited range of species was taken (table 15). Class I contained ring-barked specimens while those in class II had over half the bark around any circumference removed, class III had less than half the bark removed and class IV were untouched or had scars which had healed. A fifth class recorded trees felled by elephant. Each tree was classified for damage caused before 1965 and that caused in 1965, and a number of individuals received two ratings when barking was followed by felling in either the pre-1965 or the 1965 category. The data in table 14 was collected by the author and the warden of the reserve, while that in the second table was gathered by junior staff under the supervision of the warden.

A fair proportion of Acacia nigrescens was badly damaged. Of the 840 trees in the pre-1965 group, 41.7 percent had been more than half ring-barked or pushed over and 13.6 percent of the 619 in the 1965 group (which included 11 trees that had previously been felled but in which one or more branches were still alive) were in these heavy-use classes. This fast growing species is, nevertheless, becoming more conspicuous in the

TABLE 12

The extent to which woody vegetation had been used by game along transects within one mile of the Chobe river

Species	Sample	Use Classes							
		I		II		III		IV	
		No.	%	No.	%	No.	%	No.	%
Dichrostachys cinerea	266	71	26.7	41	15.4	99	37.2	55	20.7
Combretum eleagnoides	259	143	55.2	70	27.0	43	16.6	3	1.1
C. mossambicense	117	35	29.9	28	24.0	46	39.3	8	6.7
Baphia obovata	88	36	41.0	44	50.0	8	9.1	0	0.0
Croton megalobotrys	51	11	21.6	23	45.0	16	31.4	1	2.0
Acacia ataxacantha	40	33	82.5	3	7.5	2	5.0	2	5.0
Securinega virosa	34	21	61.8	9	26.5	3	8.8	1	2.9
Trichilia emetica	25	5	20.0	6	24.0	13	52.0	1	4.0
Capparis tomentosa	20	4	20.0	11	55.0	4	20.0	1	5.0
Markhamia sp.	15	6	40.0	5	33.3	4	26.7	0	0.0
Lonchocarpus capassa	16	10	62.6	2	12.5	4	25.0	0	0.0
Acacia spp.	19	4	21.0	5	26.3	7	36.8	3	15.8
Combretum apiculatum	13	9	69.3	1	7.7	3	23.1	0	0.0
Ziziphus mucronata	12	4	33.3	5	41.6	2	16.7	1	8.3
Popowia obovata	13	0	0.0	7	53.9	4	30.8	2	15.3
Acacia giraffae	10	5	50.0	4	40.0	0	0.0	1	10.0
Other spp. (30 spp.)	107	34	31.8	19	17.8	26	24.3	28	26.2
Total	1 105	431	39.0	283	25.6	284	25.7	107	9.7

TABLE 13

Species composition and its use by elephant in 100 feet square plots on the face of the sand ridge

Species	Eastern Plots						Western Plots							Total	
	Sample	Class a		Class b		Class c		Sample	Class a		Class b		Class c			
		No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%
Combretum eleaegnoides	593	2	0.3	29	4.9	562	94.8	558	118	21.2	440	78.9	0	-	1151	155.1
Baphia obovata	390	0	-	14	4.5	376	96.4	52	9	17.3	25	48.2	18	34.6	442	21.2
C. zeyheri (?)	0							121	82	67.8	39	32.3	0	-	121	5.8
Bauhinia macrontha	194	13	6.6	88	45.4	93	48.0	42	16	38.1	26	61.9	0	-	236	11.3
Dichrostachys cinerea	38	34	89.5	3	7.8	1	2.6	42	41	97.6	1	2.4	0	-	80	3.8
C. mossambicense	21	15	71.5	4	19.0	2	9.5	0							21	1.0
Acacia spp.	5	5	100.0	0	-	0	-	8	7	87.5	1	12.5	0	-	13	0.6
Popowia obovata	2	1	50.0	0	-	1	50.0	6	3	50.0	3	50.0	0	-	8)	
Grewia spp.	0							1	0	-	1	100.0	0	-	1)	
Lonchocarpus capassa	0							1	0	-	1	100.0	0	-	1)	
Phyllogeiton discolor	1	0	-	1	100.0	0	-	0							1)	1.2
A. giraffae	1	0	-	1	100.0	0	-	0							1)	
Markhamia acuminata	9	4	44.5	0	-	5	55.5	0							9)	
Ximenia caffra	4	0	-	4	100.0	0	-	0							4)	
Total	1258	74	5.9	144	11.5	1040	82.7	831	276	33.2	537	64.6	18	2.2	2089	100.0

TABLE 14

Elephant damage to large trees in a sample of the riparian strip one mile long

Species	Pre-1965 Use					1965 Use					Sample
	I	II	III	IV	Felled	I	II	III	IV	Felled	
Kigelia pinnata			2	2					4		4
Acacia nigrescens	19	29	34	45	25	6	19	32	52	18	152
A. albida		1	1				1	1			2
A. giraffae	1		8	8				2	14		17
A. galpinii (?)	6	1						1			7
Ziziphus mucronata			2	1	1			2	1		4
Trichilia emetica			5	9					14		14
Lonchocarpus capassa	3	4	9	17	7		2	7	21		40
Phyllogeiton discolor	1	4	9	12			1	6	18		26
Lannea kirkii		4	6	2	2		2	3	6	1	14
Garcinia livingstoneii		3						2	1		3
Diospyrus mespiliformis	1		1	2				2	1		4
Croton megalobotrys	1			2	2				2		5
Strychnos stuhlmannii	1	2		3	1				5		7
Total	33	48	77	103	38	6	25	58	141	19	299

TABLE 15

Utilization by elephant of some large trees in the riparian strip between Sidudu and Serondela

Species	Sample	Pre-1965 Use					1965 Use*				
		I	II	III	IV	Felled	I	II	III	IV	Felled
Acacia nigrescens	688	65	89	197	214	123	-	40	106	135	1
Acacia giraffae	462	135	15	74	175	63	1	4	36	223	-
Lonchocarpus capassa	180	7	13	49	101	10	-	3	16	124	-
Strychnos stuhlmannii	237	3	12	24	160	38	-	-	10	183	-
Phyllogeiton discolor	529	44	43	181	196	65	-	13	90	315	-
Total	2096	254	172	525	846	299	1	60	258	1190	1

* Lower 1965 sample resulted from trees which died as the result of pre-1965 use, i.e. over 28 percent of the standing trees were already dead, having mostly been killed within the past 2 to 4 years.

riparian strip where there are clusters of saplings affording protection to the innermost ones. Pole Evans (1948) does not even mention the species in his brief description of the riverine vegetation in 1937, although it now provides about half the trees and a higher proportion of the regeneration, under 5½ inches d.b.h.

Fifty of 299 (17 percent) of the trees in the first mile strip were badly damaged during 1965 and over 50 percent had been more than half ring barked or pushed over, mostly within the previous few years. While some of these trees could probably recover, repeated use in successive dry seasons is endangering the structure of the plant community on which several other species are dependent. There are, for example, very few healthy A. albida along the Chobe, 20 percent of the Lonchocarpus capassa were badly damaged by 1965 and another 2.7 percent were mutilated in 1965. Amongst the 555 Phyllogeiton discolor, 19.8 percent were killed by 1965 and another 8.5 percent were in class II.

The warden assessed the damage to A. tortilis in 1963 and 1964 along the main Kasane-Ihaha road. In a sample of 124 trees, 13 (10.5 percent) had been killed before 1963, 55 (44.4 percent) were killed in 1963 and another 12 (9.7 percent) were killed in 1964. Ring-barked trees usually collapsed in two to three seasons, so that approximately 60 percent of this attractive species was eliminated in about four years, although since then the adults have escaped such severe attention.

It was noticeable that in some years elephant tended to concentrate on particular species in given areas, while in others these species were hardly touched. Besides A. tortilis this applied to Kirkia acuminata at Ihaha, Commiphora spp. in the same area and A. nigrescens further west, in 1965, while Pterocarpus angolensis and Ricinodendron raut received very heavy use near Ngwezumba in 1963.

Conclusion

Elephant pose a considerable management problem in several parts of northeastern Botswana, and serious consideration should be given to the need for reducing their impact on the habitat. The most critical areas in the Chobe Game Reserve are in the northeast and northwest, while outside the reserve they appear to be along the borders of the Wankie National Park.

More information in relation to population trends and management practices is needed from Wankie, while the situation in the northwest of the Chobe Reserve is complicated by a lack of numerical data and the erratic behaviour of the Savuti during the past seven years. There is sufficient information from along the Chobe river, east of Ngoma, to confirm the need to reduce the population pressure on the face of the sand ridge and in the narrow riparian fringe.

It is doubtful if the provision of artificial water holes away from the Chobe river will alleviate the problem, as has been suggested, and it is to be expected that elephant numbers will soon build up to dangerous proportions where this is done, especially if the population is being reinforced from outside the reserve. The only practical solution would therefore seem to be to cull a significant proportion of the elephant converging on the Chobe at the end of the dry season. This would be a management measure only, and should not be planned as a sustained yield project.

Difficulties arise from the worst affected area being open to visitors and from the need for expanding tourist amenities along the Chobe in the near future. This may necessitate a delay in reducing the elephant population as any undue disturbance could reduce the attractiveness of the area for investors and visitors alike, at a sensitive period in the reserve's history and when the limited staff are likely to be fully occupied elsewhere.

If it had been possible to remove a portion of the population during 1966 or 1967, then a provisional target of 200 to 250 head (i.e. about 25 percent of the July 1965 population) would have been appropriate if allowances were made for adjustment in the light of experience from the exercise. The figure will probably need revision, however, depending upon changes in the habitat or elephant population which may occur before a reduction in numbers can be achieved.

Fewer elephant watered along the Chobe in 1966 than 1965 and yet dry season photographs show similar extensive damage to the woody vegetation in particular. The second year was especially favourable on account of the amount of water available away from the river throughout the dry season. In spite of this, the already impoverished habitats were further suppressed and it can be predicted that there will be considerably more damage, when next the pans fail early in the year, unless the pressure on the habitats can be relieved.

If numbers are to be reduced through culling, then consideration should be given to the removal of females and juveniles in order to lower the reproductive potential of the population and save the best tourist animals. Depending upon the availability of funds and staff it may be possible to remove the animals from some distance from the tourist routes, when conventional firearms could be tried. Strict attention should, however, be paid to the need to minimize disturbance,and the use of immobilizing drugs would seem preferable, under local circumstances, especially if the animals are to be shot in small numbers over several months so that the carcasses can be utilized and if this has to be done near tourist routes. Experience gained with this method in the Luangwa valley in Zambia, should prove of value for gauging its usefulness along the Chobe. The results of the first full seasons' operations were encouraging and the removal of some 200 elephant in a fairly restricted area did not disturb the survivors unduly.

BLACK RHINOCEROS — *Diceros bicornis*

It is well established that black rhino once had a wide geographical distribution extending over much of northeastern Botswana, and that numbers have been greatly reduced in some areas within the last 20 to 30 years. Bushmen claim an individual has lived for some years along the Rhodesian border between Kakulwani and Panda ma Tenga. Another was seen in the Sidudu valley about 10 years ago, and one was speared but not killed by a bushman near Kasane about this time and is claimed to have been the same animal which was stabbed by a policeman from Kachikau a short while later.

Two game scouts found the spoor of an individual which had descended the sand ridge to water at the Chobe river, between Ngoma and Muchenje in June or July 1963. One of these men had been a cattle drover on the stock route across the eastern Mababe and claimed to have found rhino spoor south of the Goha hills on several occasions in the late forties, although he couldnot remember personally having seen an animal in this area. Two professional hunters reported spoor on the sand ridge between Gohan and the Savuti and between the Savuti and the Linyanti in 1963 and 1964 and the presence of rhino in the former area has been confirmed by staff of the Tsetse Fly Control Department.

Game ranger S. Holmes a Court followed spoor and contacted a rhino on the Magwigwe sand ridge south of the Savuti in 1964, and there are reports of the species in Botswana near the Kwando river and on Chief's island in the Okavango swamps where crocodile hunters under Mr. "Bobby" Wilmot and a W.N.L.A. air crew both reported seeing three animals about six years ago. Wilmot's party also encountered two in mopane woodland between Jovorega and Tsotsoroga in 1963 or 1964, where they were also seen about the same time by another reliable independent observer. The present author's party found and photographed spoor

some eight miles south of the Gubatsa hills in the western Mababe in October 1965 and found droppings about the same distance east of Jovorega on the boundary of the proposed extension 'C' (figure 14) of the Game Reserve, in June 1966. An individual was contacted on the northeastern edge of the Savuti "swamp" in January 1967. Finally there have been two reports of rhino along the Rhodesian border south of Panda ma Tenga which may represent the wanderings of animals released into the Wankie National Park since 1961.

The extent to which rhino numbers have declined during recent years is borne out by the recollections of several old bushmen, one of whom in particular could remember seeing something like 50 different animals around the foot of the Goha hills when he lived there during his youth (probably about 40 years ago). It is, however, possible that rhino are more numerous than the few recent observations suggest, as they are all from remote unpopulated areas, but if the present relic population is to survive then it will require special protection. It will be necessary to determine where the majority of the animals occur and then to ensure that they are not hunted, at least until numbers build up. Rhino can tolerate a wide range of habitat types, but are usually associated with permanent open water, and present habitat conditions, including wide-scale bush encroachment, may be beneficial for the species, which is, however, very susceptible to hunting. Roth and Child (in press) have shown that the recruitment rate to the breeding herd is low and of the order of seven percent per annum, so that the survival of a population is very dependent upon the longevity of the adults.

BURCHELL'S ZEBRA — Equus burchelli

Zebra occur throughout most of northeastern Botswana, where they are subject to considerable movement. They have been recorded in 1725-C-3; 1724-D-4; 1824-A-1, 2, 3 and 4; B-4; C1, 2, 3 and 4; D-2; 1825-A-1 and 3; C-2; D-1; 1823-B-3 and 4; D-1 and 2; 1923-A-2 and 4; B-1, 2 and 3; 1924-D-3; A-1 and 2. Spoor throughout much of 2024-A and B confirm reports of large seasonal concentrations from this and adjacent parts of the Makarikari system.

During the 1965 dry season zebra disappeared from around the headwaters of the Ngwezumba river after the pans dried, except for a few watering at the Ngzezumba pools. They were then numerous in the reserve along the Chobe river, particularly toward Ngoma. On the other hand, the pans retained water throughout the 1966 dry season and zebra which were scarce along the Chobe, remained in the Kwikampa area in large herds. This circumstantial evidence indicates a definite north/south movement in this region governed by the availability of water.

Large concentrations of zebra occurred in the Mababe depression during the 1965/66 and 1966/67 rainy seasons although numbers were very much lower in the 1965 and 1966 dry seasons, even while many of the pans held water during the second of these years. These observations and a comparison of wet and dry season signs indicate the importance to zebra of parts of the south and central Mababe during the wet season, but a large proportion of these animals leave the area during the dry months. Smaller concentrations in the northwest of the depression in May 1966 indicated some were moving toward the Linyanti swamp, while others may have shifted towards the Okavango system.

The tendency for zebra numbers to increase near permanent water during the dry season and for the species to disperse during the rains indicates that the availability of surface water is one of perhaps several factors governing their seasonal movements.

There was considerable disagreement among old residents of northeastern Botswana as to whether they considered the zebra populations had increased, decreased or remained unchanged since they had known a particular area. Several, including a number of residents

around the Makarikari, where the game officer estimated over 15,000 head from the air in 1965, indicated an increase while others, particularly those from further north, reported the opposite.

The species is a popular tourist attraction in game reserves, is sought after by Safari hunters and has assumed considerable value during the past few years, due to the international demand for hides, which fetch up to R15 in Botswana. It would therefore seem advisable to keep a careful check on changing trends in population numbers and to restrict exploitation where this threatens towards overutilization.

BUSHPIG — Potamochoerus porcus

Bushpig have been recorded along the Chobe river only in 1724-D-4 and 1725-C-3, but Lugard (1909) notes that the species was common along the Linyanti in 1824-A-1, where their presence requires confirmation. It apparently does not occur in the Okavango swamps and has not been recorded in the hunting returns from tsetse fly control operations on the Maun Front.

WARTHOG — Phacochoerus aethiopicus

Warthog are not common away from the major rivers in northeastern Botswana. They have been noted along the Chobe in 1724-D-4; and 1725-C-3 along the Linyanti and Savuti, or in molapos in 1823-B-3 and 4; D-1 and 2; 1824-A-1 and 2; C-1 and around the headwaters of the Ngwezumba in 1824-B-4 and D-2; and in 1825-A-1 and 3. There are also records from 1824-C-2 and 3; and 1924-A-1 and the species is very numerous along the molapos in the Moremi Game Reserve in 1923-B-1, 2 and 3. It has been shot in large numbers on the Maun Front tsetse advance in 1923-C-3 and 4; 2022-B-3; 2023-A-1 and 2, and occurs in small numbers on the Makarikari where it has been noted in 2024-B-4 and near Nyai Pan in 1924-D-4.

The recent expansion of the vigorous warthog population along the Chobe river has been described elsewhere (Child et al, Ms). Here the species is resident (figure 9) and appears to have benefited from disturbances to the habitats set in motion by past land use; in particular to the spread of the grass Cynodon dactylon, which is much favoured.

Warthog numbers declined along the Savuti when the channel dried up early in 1965. Sixty skulls were located in October 1966 and January 1967 from different parts of the "swamp" and included three sucklings, seven yearlings, five two-year-olds, 14 three-year-olds and 31 older animals which were predominantly males, aged according to Child et al (1965). Warthog were no longer numerous near the "swamp" when the skulls were collected and a total of 52 were classified into sex and/or age classes after considerable searching. These included 42 adults of which 20 were females, 10 males and 12 which were not sexed; three yearlings, born about the time the "swamp" dried, and seven sucklings. Several of the last were very weak and could hardly run, and only one litter contained as many as two sucklings. Only two 1966/67 sucklings were noted in January, and these were very small compared with those along the Chobe, although the physical condition of the adults had improved since October.

The warthog population around the Savuti "swamp" increased rapidly while there was water, but then declined when this dried up. The low number of juvenile and the high proportion of old adult skulls among the last survivors suggested a mortality pattern which favoured the oldest animals in the population, similar to that observed on islands cut off during the formation of Lake Kariba (Child, 1965). The main difference was the high proportion (± 80 percent) of old males' skulls, as no differential mortality between the sexes was detected at Kariba.

This population will probably expand again, while the channel continues to feed water into the "swamp". The previous buildup appears to have resulted from the availability of surface water raising the carrying capacity of the habitat and through changes in the habitat which favoured warthog. These included greater soil moisture, allowing the proliferation of several plants sought after by warthog, as well as the spread of grasses such as Cynodon dactylon in heavily trampled areas.

Reports indicate warthog have increased along the Kwaai during the past decade, and they are very numerous along the northern boundary of the Moremi Game Reserve, where one observer counted over 100 leaving a small water hole less than four yards long. Hunting returns from the Maun Front indicate a considerable increase in the population along the southern fringe of the Okavango swamp (Child et al, Ms).

Warthog are of little value as trophy animals, but breed rapidly and provide highly palatable protein, so that it would seem appropriate to encourage their controlled exploitation, where numbers are high and where the local people rely largely on hunting for their meat requirements.

HIPPOPOTAMUS — Hippopotamus amphibius

Hippo occur in most permanent waters in northeastern Botswana and were noted in 1724 -C-4; D-3 and 4; 1725-C-3 and 4; 1823-B-3 and 4; D-1 and 2; 1824-A-1; B-1; C-1; and 1924-B-1 and 2. They are also widespread in the Okavango swamp and have been reported from the Botletle river. They wander between seasonal pans during the rains when they have been confirmed in 1824-B-4; C-2; along the stock route in 1825-C-1 or 3 and in the Nunga river in 1825-D-1 or 3.

Old people in the Lake Laimbezi area have noticed no significant change in the population, although crop raiding has intensified during recent years (see sub-section on Enclave), but numbers are said to be greatly reduced in the Okavango swamps,and the Game Department is seeking more rigid control over hunting. Although hippo come into conflict with river-bank cultivation, they are an important factor influencing the pattern of flooding in swamps and should not be destroyed unnecessarily.

GIRAFFE — Giraffa camelopardalis

Giraffe are infrequent visitors to the Chobe flats east of Kachikau, but elsewhere in northeastern Botswana they are one of the more conspicuous species. They have been recorded in 1724-D-4; 1725-C-3; 1823-B-3 and 4; 1824-A-1, 2, 3 and 4; B-2, 3 and 4; C-1, 2, 3 and 4; D-2 and 4; 1825-A-1, 2 and 3; C-1, 2 and 4; 1923-B-1, 2 and 3; 1924-A-1 and 2; D-2 and 4; 1925-A-1 and B-2; 1923-A-1 and 3, and there are reports of giraffe from the west of the Maun Front tsetse area in approximately 2022-B-4.

The species was encountered with similar frequency in the same areas at all seasons and does not appear to be subject to any significant periodic movement patterns. A sample of 360 was classified according to sex and age and, as far as could be determined, included animals in complete groups, although some may have been overlooked when groups spread out to feed. These included 84 full-grown males, 173 full-grown females, 55 juveniles, 43 calves, with the top of the head reaching the crest of the hump on the females' necks, and five unclassified individuals.

This indicated a satisfactory proportion of immature animals although most of the adults were thin and in several areas favoured trees had clearly defined giraffe browse lines at 16 to 18 feet above the ground. Nine giraffe were collected on the Savuti in April 1967, when physical condition was expected to be at its seasonal peak. The animal

in best condition was a female with adult dentition, with 18 mm of subcutaneous fat at the base of the tail, a kidney fat index of 53 and healthy coloured femur marrow (see Child, 1965). The marrow was good in two others and fair in a fourth, but was poor in two adults and in three well-grown juveniles cutting their third lower molars.

Distinct browse lines, characterized by broken stems up to about two inches in diameter were noted on Boscia albitrunca and other species along the Linyanti, and on Timunjelenjele (?) in the Tamafupi/Garufu pan area, where there was also widespread evidence of the use of Terminalia sericea. Heavy use was made of B. albitrunca, Lonchocarpus capassa and Phyllogeiton discolor near the Savuti and in a sample of 131 B. albitrunca in the southwestern Mababe 127 had very distinct browse lines and only one tree showed little use. In the southeastern Mababe L.capassa was very heavily browsed in some areas but hardly touched in others. In a sample of 478 trees, along 6.6 miles of road, soon after the road south from Jovorega to Mababe village enters the Acacia belt, all but 20 (4.2 percent) showed extensive use. A sample of 100 trees three miles further south contained only seven which were heavily browsed. In the first sample most of the trees under 18 feet had been stripped of all branches and many were dead, those above this height showed distinct browse lines with the smaller branches broken by giraffe.

They were also recorded eating Acacia spp. (including A. giraffae, A. tortilis and A. hebeclada), mopane, Combretum spp., (including C. hereroense, C. imberbe, C. mossambicense), Zizyphus mucronata, Baphia obovata, Burkea africana and Dichrostachys cinerea, some of which were quite heavily browsed, locally.

The heavy localized use of several important browse plants and the generally poor condition of adults suggested giraffe populations are over-taxing the habitats in a number of areas. The meat is very popular with the local people and the species is easily hunted, so that it would be unwise to relax the stringent legislation protecting it, but a proper investigation of its biology should be encouraged. This is the type of prescribed topic which might appeal to visiting research workers.

DUIKER — Sylvicapra grimmia

Duiker may occur throughout the Chobe Game Reserve, but were not encountered in well-developed mopane south of the Ngwezumba river or in the Mababe depression, and numbers were generally low. The species is probably more common around parts of the Okavango swamps, however, as increasingly large numbers have been shot on tsetse control on the Maun Front during the past 25 years.

It has been recorded in small numbers along the Chobe river in 1724-D-4 and 1725-C-3, where it is largely a nocturnal visitor to the Chobe flats, although relatively more common in Kalahari woodland. It has also been noted in 1824-A-2 and 3; B-2 and 4 and C-1 (a single specimen); 1825-A-1 and 3; C-2, 3 and 4; D-1; 1923-B-3; 1924-A-3 and south from Nyai pan to the Botletle river in 1924-D-3 and 4; 2023-B-2; 2024-A-1; B-3; and D-1.

Duiker are notably resistent to hunting, and many of the changing trends in the habitats in northeastern Botswana should favour this species.

STEENBUCK — Raphicerus campestris

Steenbuck were never recorded on the Chobe flats between Kasane and Kasinka, but one was noted near the base of the sand ridge in 1824-A-2 and there are reports of occasional observations to the north of this. Several were seen along molapos in 1824-A-1, but

numbers are generally higher toward the south of the region. Besides these records, steenbuck were observed on the sand ridge in 1724-D-4 and in 1725-C-3; 1824-A-3 and 4; B-2 and 4; C-1, 2 and 4; 1825-A-1 and 3; C-2; D-1 and 4; 1924-D-2 and 4; 1925-A-1 and 3; B-2; 1926-A-1; 2024-A-1 and 2; B-1, 2, 3 and 4; D-3, and they have been shot in large numbers on the Maun Front in 2023-A-1, 2 and 3.

Of the 52 sexed and aged, 23 were adult males, 25 adult females and 4 were juveniles. This small solitary browsing antelope is resistant to hunting and may have benefited by the general bush encroachment in northeastern Botswana.

SHARP'S GRYSBUCK — Raphicerus sharpei

Shortridge (1934) quotes a report of this grysbuck occurring along the sand ridge between Kasane and Kavimba but recent records indicate that its range up the Chobe river extends only 1½ miles into the Chobe Game Reserve where it is apparently confined to 1725-C-3. Most contacts have been along the river although occasional individuals have been reported on the sand ridge.

Numbers are in any case very low, and it would seem advisable to afford the species absolute protection in northeastern Botswana.

ORIBI — Ourebia ourebia

Oribi have a restricted distribution in Botswana, where they are apparently limited to the extreme north as they are not known to the local people elsewhere. They seem to have disappeared from the limited plains country immediately north of the Goha hills in 1824-A-3 during the past 15 to 20 years, but reports indicate small numbers survive on the Chobe flats in or about 1824-A-2, and Hepburn observed them in 1966 in neighbouring parts of the Caprivi in 1724-C-4 and D-3. Their status along the Magwegana spillway needs checking, as several indirect reports suggest their presence in this little-known region, and Shortridge (1934) indicates their presence in neighbouring parts of the Caprivi.

This population is separate, south of the Zambezi, from the population along the Rhodesian border, which is itself isolated from the populations in the east of that territory (Child and Savory, 1964). In Botswana they are known from 1824-B-4; 1825-A-1, 2, 3 and 4; and B-3, where numbers are still reasonably high, although all old bushmen interviewed in this area agreed that they had declined appreciably during the past 20 to 30 years. This was substantiated by the fact that all the adults whose physical condition was assessed during the present survey were very thin and a lactating adult female collected in September 1966 had very depleted fat reserves, including the femur-bone marrow which was poor.

The species' range only just extends within the limits of the game reserve, although more suitable habitat will be added by the proposed eastern extension of the national park. This sensitive grazing species is in danger of extinction over much of its range in southern Africa and the decline in numbers in northeastern Botswana is in accordance with the general deterioration of perennial grasses. Incorrect burning appears to be the primary agent in this respect in oribi habitats within the game reserve, so that the control of fires along the edges of the Kakulwani plains is a high priority for preventing the disappearance of the species.

REEDBUCK — Redunca aurundinum

Reedbuck are not common in the Chobe Game Reserve, although numbers are higher in the Kachikau Enclave and the species is well represented around the Okavango swamps and around Panda ma Tenga. Up to five were recorded in a small area on the Chobe flats in 1725-C-3, and up to seven near the Ngwezumba pools in 1824-B-4, in the 1965 dry season, although they have not been seen since. The only area in the game reserve where reedbuck are at all plentiful is on the Savuti "swamp" in 1824-C-1. Outside the reserve they are known from 1824-A-2; 1923-B-3, and according to Tinley (1966), can be expected in 1923-A-2 and B-1; they have been shot in increasing numbers on the Maun Front; and are said to be plentiful around Panda ma Tenga in 1925-D-1. In the last area they are reasonably common on the Nunga plain, but according to bushmen living there, this is a recent extension of their range from further north, as they were unknown in this area six years ago.

The species can stand considerable hunting, as the hunting returns from the Maun Front demostrate, but is often sensitive to deterioration of its perennial grassland habitat. It would be desirable to have more of this species range within the proposed national park.

THE KOBS — Genus Kobus

Three members of this genus occur on the Chobe and Pookoo flats where they may be seen together. Lechwe and puku were recognized as species requiring special investigation, while Professor W. Elder, a Fulbright Scholar, guest of the Botswana Government, undertook an intensive study of waterbuck. Puku and lechwe were therefore studied in some detail by the author and Dr. von Richter. This project, to be published separately, had a theoretical background, comparing the ecology of the three congeneric grazing species, but was designed to yield information of practical value toward their better management.

It is therefore necessary to indicate the general conclusions reached along the Chobe river, only briefly.

Waterbuck — Kobus elipsiprymnus

Waterbuck have been recorded within four miles of the Chobe in 1724-D-3 and 4, and in 1725-C-3 and 4. They occur along the Savuti and Linyanti in 1823-B-3; D-1 and 2 and 1824-C-1, and a single male was recorded at Tsotsoroga pan in 1824-C-2 in June 1966. Small numbers have been noted near Ngwezumba pools or Kwikampa pan in 1824-B-4 and it is reported from the Panda ma Tenga area in about 1825-D-1. Two males were noted near Nunga in the south of this square in the five years ending 1965 by members of a bushmen community. There are waterbuck in the Moremi Game Reserve, at least in 1923-B-1 and 2, but the species is generally scarce around the southern and western fringes of the Okavango swamp. A single specimen is recorded in the hunting returns from tsetse operations on the Maun Front and there is a recent report of a young male a little to the north of this.

Waterbuck do not appear to be subject to any seasonal movements along the Chobe (figure 10), where they became more conspicuous on the flats during the dry season. One recognizable male was observed repeatedly over a 24 month period in an area not exceeding 27 acres, and several groups were noted on a number of occasions in the same areas for from three to nine months.

Waterbuck appear to calve throughout the year with a peak in midwinter. Juveniles were plentiful, but social segregation from an early age made it difficult to obtain an accurate calf to female ratio. Nevertheless, the species is reported to be expanding

along the Chobe, where their distribution on the Pookoo flats is similar to that of warthog and appears to be related to the grass Cynodon dactylon, which is also spreading in disturbed areas and is eaten extensively by waterbuck. The physical condition of 21 adult males and 24 adult females was assessed during the 1965 dry season and, although many were very thin, some, particularly east of Serondela, were in better shape than the majority of game concentrated along the river; in 1966 waterbuck were among the animals in best condition at the end of the dry season.

The present status of the vegetation along the Chobe appears to suit waterbuck, but elsewhere in northeastern Botswana numbers are low. Hunting of the species should probably be limited to the shooting of a restricted number of males by holders of expensive licenses.

Puku — Kobus vardoni

There is a small relic population of puku on the Chobe and Pookoo flats near Serondela in 1724-D-4 and 1725-C-3. Within historic times this represented the southern limit of a bulge in the species range across the Caprivi. Puku have disappeared from the north bank of the Chobe within the last 40 years. The last stronghold was Imparira island, at the eastern tip of the Caprivi, where they were reported plentiful in 1947. The island was settled for the first time for many years in 1958 and by 1963 the species had disappeared. A small herd on the opposite bank of the Chobe has not been seen since about this time either.

Selous (1881) describes the species as numerous on the Pookoo flats in 1874 when he saw groups of up to 50 and notes that puku extended west along the south bank of the Chobe for about 70 miles from the Chobe/Zambezi confluence. In 1965 four men on foot twice counted the population between Kasane and Simwanza, by working back and forth across this resident species' narrow range. The counts yielded 81 and 83 indicating the entire population in Botswana was under 100 individuals of all ages. These are mostly resident within five miles of Serondela, with occasional individuals as far west as Simwanza and as far east as Kasane.

Table 16 summarizes puku classified into sex and age classes in June through January. The significance of these classifications is to be discussed elsewhere, but it is pertinent to note the high proportion of immature animals which represented 76 per 100 adult-sized females. The physical condition of adults was also generally better than that of other ungulates along the river, and 18 of 36 males and 10 of 33 females were classed as fair.

Numbers have obviously declined since Selous' time, but the population appears to be fairly healthy, although much of the area they once occupied in Botswana is now no longer suitable habitat and poaching from the Caprivi may be significant. Management for the Pookoo flats and close cooperation with the South African authorities in law enforcement suggested later in the report, should favour puku. Numbers are very low, however, and a careful check should be kept of the welfare of this species.

Lechwe — Kobus leche

There are two distinct populations of lechwe represented in Botswana. The species occurs along the Linyanti-Chobe system and in the Okavango swamps. It converges on the Chobe when the river is low, in 1724-D-3 and 4 and 1725-C-3, from higher parts of its habitat in the Caprivi, and large herds graze the Chobe flats in Botswana for six or seven months of the year (figure 10). There are also lechwe along the Linyanti where they have been recorded in 1823-B-3 and 4, and 1824-A-1. Their occurrence along the Savuti in 1823-D-1 and 2, and 1824-C-1 is dependent upon the presence of water in the channel.

These two areas are united by suitable habitat, where the species has virtually disappeared during the last generation from areas where Selous found them plentiful in 1874.

The Okavango population is said to be numerically strong, and the species is plentiful in the Moremi Game Reserve in 1923-B-1, 2 and 3.

While the lechwe from the eastern Caprivi are in Botswana, they provide a very valuable attraction to visitors to the Chobe Game Reserve, but numbers have declined rapidly during the past few years. In 1962 Hepburn estimated over two and a half thousand on the flats west from Kabulabula to Ihaha, but the highest count from Ihaha to Kasane in 1965 was 1,414 and in 1966 it was only 778 and some 20 to 25 percent of these were east of Kabulabula. This trend is substantiated by unanimous reports from all over the eastern Caprivi and by the low numbers observed by Hepburn, from a helicopter flight between Kasane and Lake Liambezi, while searching for locusts in 1966.

Very young calves have been recorded between July and January while lechwe were plentiful in Botswana, but most calves born in 1965 and 1966 were dropped from the second week in September with a peak in December. Here there was a definite crest in rutting activity from late October well into December. Lechwe were classified into sex and age classes according to standards developed on the Kafue flats by Robinette and Child (1964). These results, based on a sample of 4,461, gave a calf to full grown female ration of 43 per 100, but this was reduced to approximately 18 per 100 by the time the calves were about 11 months old.

The physical condition of 192 adult males and 940 full-grown females was assessed and, with the exception of a male with damaged testicles, all were classed as poor and the majority were in the extreme. Von Richter examined lechwe near Kabe in the Caprivi in May 1967 and found they were in better condition than they had been along the Chobe during the previous October to January period. This was probably not caused directly by the season of the year when the observations were made, but to differences in the conservation values of the habitats. Those along the Chobe were badly downgraded, while a point line transect done in the Kabe area in 1965 showed that, although the small sandy elevations were severely downgraded, the extensive molapos between had a healthy perennial grass cover.

Many lechwe are hunted by the people of the Caprivi who also poach considerable numbers from the flats on the Botswana side of the Chobe when the species in concentrated along the river. Whether or not this uncontrolled hunting is significant in reducing the lechwe population requires further investigation. In any event the hunting along the north bank of the Chobe with dogs may be responsible for many crossing to the Botswana side to graze during the day, only to return to the Caprivi shortly before sundown. Proximity to the river at this time of the year affords the animals a measure of protection, but on the south bank the grassland is heavily grazed by a range of species, has been downgraded by past land use and is further suppressed by fires associated with the poaching activities. Many of the grasses most favoured by lechwe were so short that they had to be transplanted into boxes and allowed to grow before they could be identified.

The control of the rapid decline in the lechwe population across the Botswana/Caprivi boundary calls for greater protection of their habitats along the Chobe and on the sandy elevations on both sides of the border. This, and the control of hunting, will only be possible through close cooperation between the game reserve authorities and the South African Administration in the Caprivi. Failure to halt the declining trends can be expected to lead to the loss of a valuable tourist attraction in the reserve, and of a useful source of meat and skins for the people of the Caprivi. The only year-round lechwe habitat on the Botswana side of the Chobe is outside the reserve in the north of the Kachikau Enclave.

TABLE 16

Sex and age breakdown of puku along the Chobe river, by months

Month	Adults ♂♂	Adults oo ++	Juveniles	Calves	Juveniles + calves 100 females
June	32	38	29	13	111
July	14	-	13	-	-
August	14	7	3	1	57
September	29	34	29	18	138.2
October	14	7	3	1	57
November	33	69	35	12	68
December	27	58	22	8	52
January	44	105	41	11	50
Total	207	318	175	64	Average 76

The desirability of incorporating this into the sanctuary is discussed in Part II of this report.

The lechwe pastures along the molapos in the Moremi Game Reserve are mostly heavily grazed and show considerable deterioration of conservation values. A sample of 289 lechwe contained 30 calves and 131 adult-sized females, giving a ratio of 23 calves per 100 females, and the majority were in very poor condition with a number of deaths reported during the 1965/66 rains. This would suggest that the population is approaching a critical stage, but more investigation is needed on the lechwe in the Okavango swamps, before appropriate remedial action can be decided.

IMPALA — Aepyceros melampus

Impala have a patchy distribution in northeastern Botswana which is closely associated with that of mopane veld. A herd is said to have disappeared from Nungwe valley between Kasane and Kazungula, in 1725-C-3, during the past four or five years. The only records of the species in this one sixteenth degree square during the present survey was of five, nine to 18 month old dispersing individuals. Three 12 to 14 month old rams were noted near Serondela in 1965 and 1966, and a nine to 10 month male and female were noted at Sidudu in August 1966.

The species is fairly numerous in a narrow band parallel to the Chobe between Kabulabula and Ngoma, in 1724-D-4. This population, centered around Simwanza, is isolated from other impala in Botswana. There are also records from along the Linyanti in 1823-B-3 and 4 and 1824-A-1 and 2, and there is a strong resident population around the Gubatsa hills in 1824-C-1 which extends south into C-3 to link up with the population in the southern Mababe and along the Kwaai in 1923-B-1 and 2; 1924-A-1, 2 and 3. Impala have also been observed in all seasons in the southeastern Mababe in 1824-C-2 and 3, but here numbers seen were highest in the wet season.

There is a small population around the headwaters of the Ngwezumba river and in the mopane along the northern edge of Kakulwani, in 1824-B-4 and 1825-A-3, and the species has been encountered in 1824-D-2. Impala have been seen or reported along the stock route in 1825-C-2 and 3, from mopane near the northern fringe of Nyai Pan in 1924-D-2 and 4, Nata ranch in 1925-D-3, and warden Holmes a Court saw an adult male and female and a young male 15 miles north of Jari pan in January 1966, in 1926-A-3. They are also said to occur west of Gweta in 1824-A-2.

Impala are common in and around the Okavango swamps which occupy most of 1922 and 1923 and have been shot in large numbers on tsetse fly control in 2023-A-1, 2 and 3, and occur in the northern half of 2022. They also occur in a narrow band along the east bank of the Botletle river between Makalamabedi and some miles south of Tsoi in 2023-B-4; 2024-A-1-2 and 3 and B-3. This population may now be isolated from those around the swamp and those to the north east of Lake Dow, and it does not occur in mopane, but in fairly thickly wooded vegetation along the river. The river here appears to form the limit of their geographical distribution as, although the species is plentiful on the north and east bank, it is unknown to the local people on the south and west bank.

Very little is known of the status or trends of the Botletle or central populations, although numbers are reported to have declined markedly around the Ngwezumba source during the past 15 to 20 years since bushmen manned cattle posts in this area.

The population along the Chobe is said to have expanded rapidly over the past four years and this is borne out by the results of the present survey. River counts sampled

the eastern fringe of this population, which is resident along the river, and recorded impala some two miles further east than they were known for the previous four years. None were recorded on counts in June 1965 but,since then fair numbers have been noted on all counts (figure 9). A downward deflection is discernible in both years around October when females become more secretive while calving.

The first calves were noted on November 12 in 1965, when they were about a week old, and on November 3, 1966, when the oldest calves were less than three days old and when most females were still pregnant. Calving was very seasonal and most young are born within two to three weeks although, judging from size, a small proportion may have been dropped four to six weeks after the peak. Rutting activity was noted during the second week in April 1967.

Table 17 summarizes the sex and age class breakdown by months of 409 impala classified from whole groups along the Chobe in 1965 and 1966. As is usual with this species, year round classifications gave a very high calf to adult female ratio as a result of social segregation with calves forming large conspicuous bands during the dry season before a proportion disperse away from the parental home range. Calves, however, remained with the females for at least three months and the December-January figures indicate a high survival rate through early life. The reproductive potential of impala approaches 100 calves per 100 females over one year old and the January figure indicates 84 calves per 100 females survived to an age of two to three months when losses are usually high.

The apparent yearling ratio is lower than in the population, as from about January yearling females, which reach sexual maturity at 17 to 19 months, could not be separated from older females. Further, a proportion of this age class had dispersed from the adult range. Child (1965) found this dispersal took place at about 11 to 12 months of age, but it may start earlier along the Chobe, when the calves are nine to 10 months old as several of this age class were noted outside the species' usual range.

Although this population is increasing and spreading, individuals were mostly classed as in poor condition, as gauged by standards determined by Riney (1960). The physical condition was assessed for 114 adults of which all 23 males were grouped as poor as were 87 of the 91 females, the four exceptions being individuals that were in fair condition during the rains.

The population around the Savuti channel and "swamp" evidently built up while there was water between 1959 and early 1965, but then experienced a considerable die-off. By October the animals were all very thin and there were very few calves. In the following October the animals were again thin and not one in more than 100 was found to be better than poor condition; the calves, although more numerous than the previous year and representing 20 to 25 per 100 females, were noticeably small compared with those along the Chobe. This may have been related to a later calving season, although rutting was also evident in this area during the second week in April 1966.

There were reports of impala having increased in and around the southern and eastern fringe of the Okavango swamps, during the 10 years before this assignment began. This was evident from the analysis of tsetse hunting records from near Maun (Child et al, 1967) and was reported from Chief's Island, the Moremi Game Reserve and down the Kwaai river into the southern Mababe. Over 1,000 impala were observed at close quarters along the Kwaai in August 1965, and all were in very poor condition. The situation was even more critical by October when the majority of adults had staring coats and drooping ears. A ram shot at random had no fat deposits, the bone marrow was red and watery, and the utilization of protein tissue was obviously well advanced.

The animals were still very thin in February 1966, at the height of the rains and not one in over 100 adults was in anything but very poor condition. Calving took place around the second half of December which was later than usual and later than the season on the Chobe. Many calves died before they were six months old, and in June there were 26 calves in a sample with 97 adult females, when on account of the harsh conditions a large proportion of the yearling females were still visibly smaller than adults.

It is evident that the populations in and around the Okavango swamps are approaching the crest of an eruptive phase, but that the depression of their essential requirements as the result of several dry years had a marked effect on the herds in a number of areas. These, and the impala along the Chobe, appear to be increasing as the result of the general deterioration of habitats, which at this stage are favouring the species, which in turn is further suppressing the vegetation. Experience in 1965 and 1966, however, suggests that the populations around the swamps will soon decline, unless appropriate measures can be taken. These should include the controlled removal of a significant proportion of the animals.

SPRINGBOK — *Antidorcas marsupialis*

The geographical range of springbok includes the Makarikari plains in the south of the area covered by this survey, but ends very abruptly with no records north of about 19° 45' S.

Springbok have suffered a reduction in habitat due to the bush encroachment in large areas on these plains and recent increase in the prices offered for their skins has intensified hunting pressure against them. This should be rigidly controlled. The species has been incorporated into the farming program on many farms and ranches in South Africa, and the possibility of its being similarly used in Botswana should be considered when planning development of areas within its range.

GEMSBOK — *Oryx gazella*

Child and Savory (1964) received one report of gemsbok in 1725-C-4 in Rhodesia, although this species does not normally penetrate north of the 19th parallel in that territory. In Botswana it is regularly hunted on the Kakulwani plain in 1825-A-2, 3 and 4, but elsewhere is not common north of 20°S in the northeast. There are records and/or reports of two individuals north of the sand ridge in 1824-A-2 and another on the ridge in 1824-A-4. Several have been noted in mopane woodland in 1924-A-1 and 3, in Kalahari woodland in 1925-A-1, and the species is common south from Nyai pan in 1924-D-4.

ROAN — *Hippotragus equinus*

Roan were recorded in numbers in 1724-D-4 and 1725-C-3 and in small numbers in 1824-A-1, 2 and 3; B-2 and 4; C-1, 2 and 4 and 1825-A-1 and 3. They were also reported from 1923-D-1 and 2; are said to be plentiful in the western Makarikari, and to have survived in fair numbers around the southwestern fringe of the Okavango, although few were shot in the last 10 years of tsetse control hunting on the southern fringe.

In the northeast of the Chobe Game Reserve they are subject to seasonal movement with numbers building up along the river during the dry season (figure 11). As with several other species this appears to be influenced by the availability of surface water away from the river, which would explain the difference between the 1965 and 1966 peaks.

TABLE 17

Sex and age class breakdown of Impala on eastern fringe of Chobe population

Month	Adults		Yearling	Calves	Total
	♂♂	♀♀ ++			
May		8		5	13
June	1	1	7	14	23
July	5	8	1	25	39
August	3	5		23	31
September	9	18	4	42	73
October	9	11		8	28
November	6	20	11	13	50
December	4	27	3	23	57
January	8	43	8	36	95
Total	45	141	34	189	409

Roan are sensitive grazers, favouring open grassland or plains in northeastern Botswana. Reports from old people point to a very marked decline in numbers in the past 10 to 40 years throughout the region, with the possible exception of the western . . Makarikari. Residents of Kasane claim that even during the last five years there has been a significant drop in the dry season concentrations along the Chobe.

Much of the Makarikari is waterless and it includes some of the healthiest multi-species grassland found on the present assignment. Further west, however, the species has declined drastically in the area between Kanyu and Maun.

Roan favour open country, but remarkably few were contacted during the present assignment, considering some 30,000 miles were driven in the study area. All 30 adults whose physical condition was assessed were classed as poor, and most were in the extreme, even during the most favourable months of the year.

The species should be considered as in danger of disappearing from much of its range and should receive special protection. This is probably mainly due to habitat deterioration, but in several areas numbers are now approaching a critical level so that any hunting of the species should be very strictly controlled. It might even be limited to holders of the package licences issued to the clients of the safari companies, except where careful investigation shows that more general hunting can be allowed. It is also most desirable that surviving areas of good roan habitat should be conserved and that the management of such areas in the Chobe Game Reserve should be given a high priority.

SABLE — Hippotragus niger

Sable are widespread in the northeast of Botswana, where they are subject to some seasonal movement. The species has been recorded along the Linyanti and Chobe in 1823-B-3 and 4; 1824-A-1 and 2; 1724-D-3 and 4 and 1725-C-3, and in the Mababe depression in 1824-C-1, 2 and 4 and 1924-A-2. Elsewhere in the Chobe Game Reserve they were noted in 1824-B-4 and D-2; and in 1825-A-1 and 3 and this range extends outside the Reserve in 1825-A-2, B-3 and D-1; C-2 and 4; 1823-D-1; 1923-B-1 and 3; 1925-B-2 and 1926-A-1.

The species is now reported to be rare on the western side of the Okavango swamps, where a generation ago it was still fairly plentiful, and very few have been shot on tsetse control on the Maun Front on the southern fringe of the swamps. The species' effective range is therefore the eastern fringe of these swamps and adjacent parts of the Mababe, the Chobe/Linyanti area and Kalahari woodland in the northeast and east of the region.

The regular counts along the Chobe river indicated the seasonal nature of sable usage of the Chobe flats (figure 11). Numbers were high around Kwikampa pan and the Ngwezumba pools in June 1965 and circumstantial evidence indicated most moved north to the Chobe when the pan dried. There was little water away from the river during 1965 and sable numbers were higher there during the dry season than in 1966, when many pans held water throughout the year.

Sable were strictly seasonal breeders which dropped their calves early in the year. The first calves in 1966 were noted on 5 February, 20 miles south of Dodo Crossroads, but they were not seen on the Chobe flats until the 26th of the month. The first record in 1967 was in the first week in April, but these were fairly well grown and were estimated to be two to three months of age. These dates comply with the observations of bushmen in the Ngwezumba-Nunga area, who gave the peak in calving as January or early February.

In several parts of northeastern Botswana old residents volunteered that there had been a noticeable decline in sable numbers during the last 20 or more years, and in some of these areas, notably around Tamafupi and Nunga, several skulls were found in the veld. These included seven adult males with moderately to well-worn permanent teeth, one adult female with heavily worn teeth and a juvenile just cutting its third lower molars. In addition Hepburn located six adult males which had recently died along the Chobe in 1962. Four of these had all permanent moderately worn teeth, but the other two skulls could not be located in 1965.

A total of 278 head were classified between September and November along the Chobe River. These included 69 adult males, 114 adult females, 30 yearlings and 65 calves. The proportion of males may be high as bulls tended to space themselves singly along the edge of the flats, where they were more or less resident during the dry season. The females and juveniles on the other hand, spent much of the day in woodland away from the river and tended to water in the late morning or early afternoon.

The survival rate of 57, eight to 10 month old calves per 100 adult females indicated by the above figures, was fairly satisfactory as was the number of 20 to 22 month old yearlings. But the physical condition of 71 adults along the Chobe river was judged as poor for 42 females and 27 males. Only two males, which remained on the flats after the 1965/66 rains had set in, were classed as fair.

The animals along the Chobe were generally in much better condition than those observed near Tamafupi in October 1965, and in or near the Moremi Game Reserve in August 1965 through June 1966.

Sable are fairly sensitive grazers, which appear to be entirely dependent on the availability of open water, as they have not been observed in waterless areas. The deterioration of the perennial grasses near permanent water through trampling or grazing by other species may therefore affect the species adversely. Together with the general decline in perennial grasses, this suggests that the range of sable will continue to decrease, unless adequate protection can be provided for its habitat.

The species is popular in national parks and game reserves, and is prized as a trophy so that, although numbers are still reasonably high in some areas, it should receive as much protection as possible from other forms of hunting.

TSESSEBE — Damaliscus lunatus

Special attention was paid to this little known species during the present survey, and the following discussion is based on the results of this work which is to be published elsewhere (Child and Hepburn, Ms).

There are records of tsessebe from 1724-D-4; 1725-C-3; 1823-A-4; C-2 and D-1; 1824-A-2 and 3; B-4; C-;, 2, 3 and 4; 1825-A-1 and 3; C-1 and D-1; 1923-B-1, 2 and 3, and from the Maun Front tsetse area, where it has been shot in decreasing numbers over the past 24 years (Child et al, Ms).

The species is subject to some seasonal movement, particularly in the north where numbers build up along the Chobe in years when the pans dry up (figure 12). There is also some dispersal away from permanent water in the southwest of the Chobe Game Reserve, although a proportion remained in the dry season range and tsessebe can apparently do without surface water for several months at a time.

Tsessebe are plentiful in some areas, but old people report a definite decline in numbers. Tsessebe are exclusively grazers and physical condition and the proportion of juveniles showed a close parallel with the status of perennial grasses, so that this decline was probably at least partially due to deteriorating habitats. The species is, however, also very susceptible to hunting. Skins now fetch reasonably high prices and it would appear advisable to control hunting and to limit the off-take from much of its range.

RED HARTEBEEST — Alcelaphus buselaphus

Hartebeest occur in the Makarikari area in the south of northeastern Botswana and have been seen or reported from 1925-D-2; 2026-A-1; 2024-B-3; D-1 and 3. They probably never enter the Chobe Game Reserve, as has been suggested, as none of these areas are within 70 miles of its borders and there does not appear to be suitable intervening habitat.

WILDEBEEST — Connochaetes taurinus

Wildebeest are subject to considerable movement in central Botswana and this extends into the northeast of the territory where they have been noted in 1724-D-4; 1725-C-3; 1823-B-3 and 4; D-1 and 2; 1824-A-1, 2 and 3; B-4; C-1, 3 and 4; 1825-A-3; B-3 and D-1; 1923-B-1, 2 and 3; 1924-A-1 and 3; D-4; 1925-A-3; 1926-A-3, and they have been shot in declining numbers on the Maun Front during the past 24 years (Child et al, Ms). The species also occurs, at least seasonally, throughout most of the Makarikari.

The decline in the Makarikari population between about 1960 and the spectacular crash in 1964 is being traced in the above manuscript. This appears to have been a classical example of a population eruption, followed by the expected heavy mortality as the species exceeds its habitat resources. Early writers do not mention herds of wildebeest "numbering thousands", or "blacking out the horizon" and the first such accounts appear to be from about 1920 to 1930. From then until 1962 most visitors to the area were impressed with the numbers of wildebeest they saw and Riney and Hill (1963) describe driving for over an hour without outflanking a herd.

The heavy mortality coincided with several dry years which followed a number of wet years. Survivors in the southwestern Makarikari appeared to favour a band of grassland with light to moderate bush encroachment, but still supporting a reasonable cover of Cenchrus ciliaris and Schmidtia bulbosa which together with Odyssea paucinervis were grazed in April, 1966.

Perennial grasses had virtually disappeared between this area and the Botletle river and this was a recent phenomenon as charred stumps and tufts were found in sandy soils where wildebeest and cattle were numerous until 1964. The collapse in the grasses was probably fairly sudden, judging from the uniform stands of scrub. On the other hand there was healthy stable multi-species grassland away from water between Kamaga and Gweta.

This evidence led to the hypothesis that wildebeest had increased as the result of land-use practices which had changed the species' composition of grasses near water, favouring such species as C. ciliaris and S. bulbosa, which are obviously palatable. Once the trend was in motion the increasing numbers of wildebeest would have accentuated it until this species alone or in combination with livestock, which were also numerous, overtaxed the simplified grassland and promoted bush encroachment, or, in areas unsuitable for bush, sand-dune formation. The wildebeest died in large numbers in 1964 and the cattle a year later.

This hypothesis suggests that the decline in wildebeest was due to some extent to changes in the habitat and not solely to the construction of veterinary disease control fences, as has been claimed. There is no denying that many animals died on these fences, but many also died in severely impoverished habitat many miles from them, and there is no evidence to hand to suggest that this resulted from the fences cutting a migration route.

Wildebeest appear to move into the southern Mababe from the edge of the Okavango swamps during the wet season as they are then more common in the depression than during the dry months. There is also a buildup along the Chobe in most years, (figure 12), apparently associated with the drying up of the pans in the Ngwezumba/Kakulwani area, but this has been very much less significant in recent years. Large herds have not been seen in the Kasane area for some years and old residents agree that wildebeest have become much less plentiful in the Kasane/Panda ma Tenga area during the last decade.

Wildebeest have a high reproductive potential and numbers can recover rapidly, although it seems unlikely that this will happen where the habitats have been seriously modified, as they are reported to have virtually disappeared from the Bushman Pits area before the general die-off in the rest of the Makarikari.

The species requires careful conservation and the protection of its habitats, so that moves to create a sanctuary in the Nyai Pan area should be encouraged. The disease control fences have killed many wildebeest and may have restricted their geographical range in Botswana so that the closest possible cooperation should be sought between the Game and Veterinary Departments over the siting of any future fences, and in the general management of the species where it occurs together with livestock.

BUSHBUCK — Tragelaphus scriptus

Bushbuck are common along the Chobe and Botletle rivers and, according to reports, this applies along the edge of the Linyanti, although the species appears to be less common in the Okavango delta. It has been recorded or reported in reasonable numbers from 1724-D-4; 1725-C-3; 1823-B-3 (?) and 4; 1824-A-1; 2023-B-2 and 4; 2024-A-1 (?) and 4; B-3 and a single juvenile was observed in 1824-A-2 at Kasinka, well away from the Linyanti. Tinley (1966) reports them from riparian vegetation in the Moremi and they have been shot in small numbers on the Maun Front, particularly toward the lower end of the Nxaragha valley near the western limit of 2023-A-3.

Bushbuck have not been recorded over three miles from the Chobe river, but within this narrow band there is a seasonal difference in the intensity of use. During the dry season they are closely confined to the riparian fringe with individuals feeding a short distance out on the Chobe flats. The most important browse is then Capparis tomentosa, Gardenia spathulifolia and Acacia sp., and the first two bear very distinct bushbuck browse lines by the end of the season. Bushbuck become less conspicuous in the riparian fringe and a portion of the population moves further from the river as soon as the vegetation begins to come into leaf just before the rains. Species particularly favoured at this time include Baphia obovata and Acacia nigrescens. These movements, and decreasing visibility from about January, account for the low numbers recorded on the standardized counts described in detail later in the report (figure 13).

During the 1965 dry season bushbuck were active in the early mornings, but activity declined during the morning before building up to a peak just before sunset. After sundown most were observed lying down in thickets in the riparian fringe and relatively few were observed on night counts, using a powerful spot lamp, until about 23.00 hours, after

which they became more active and could be found in fair numbers in areas where a few hours before none were seen. This activity continued until about 01.30 hrs, but whether it extended until dawn was not determined.

Bushbuck were frequently associated with baboons and derived some food from fragments of plants dropped from the trees by the baboons, but were also recorded eating baboon droppings which may provide a significant element in their diet, particularly during the dry season when this association is most pronounced.

Small calves were observed throughout the year even when there was rutting behaviour in this more or less solitary species. The sex and ages were determined in a sample of 622, between June and January 1965/66 and 1966/67 (table 18). The social structure of these groups is summarized in table 19, which indicates that lone adults or a female and her calf were the most usual social units, amounting to 55.9 percent of the observations, followed by single or, occasionally, pairs of juveniles, which made up another 23.4 percent of the contacts.

Old residents of Kasane are agreed that bushbuck are now more common along the river than 10 years ago, and this is borne out by the high proportion of juveniles in table 18. These animals were estimated to be 18 months old or younger as judged against a known aged 19 month old female reported by Wilson and Child (1964). The population may, however, be approaching the crest of an eruptive peak judging from the heavy use of the most favoured dry season browse plants and the poor physical condition of most adults. In a sample of 60 adult males and 75 full-grown females, all but three males and five females were classed as in poor condition and many noted during the dry season were very thin. Six of the eight exceptions were in the vicinity of the Game Reserve headquarters, where they are sheltered from competition from other species, and even at the height of the dry season a male and two females were noted as fair.

It is therefore probable that environmental resistance to the expanding population has been intensified through the general increase of game along the Chobe, particularly during the dry months. An important factor may be the increase in elephant, although they have not been noted using either C. tomentosa or G. spathulifolia. The former grows rapidly, and at this stage the control of bushbuck numbers is probably a fairly low priority, although it would be prudent to maintain a close check on population trends.

SITATUNGA — Tragelaphus spekei

Sitatunga are limited to swamp habitats and occur in the Okavango delta and on the Botswana side of the Linyanti swamps as far east as Lake Liambezi in 1923-B and 1824-A-1. There are reports of occasional members of the species along the Chobe river east of this limit, within the Kachikau Enclave, and von Richter found an old skull at Kabulabula in 1724-D-4 in early 1967. They also occur in the eastern Caprivi in permanent swamps near Kasane.

Suitable habitat stretches in a belt averaging about two miles wide for over 50 miles west of Lake Liambezi, on the Botswana side of the border, but the best available maps indicate that less than three square miles is within the Chobe Game Reserve, whose north-western corner does not quite reach to the main channel of the Linyanti. Little is known of the species' biology, but it is an important trophy animal and can readily be viewed from prominent trees along the edge of the swamp.

It is therefore recommended that consideration should be given to protecting more of this species' specialized habitat. This is related to the question of changing the status of land tenure of some parts of this region, discussed later. It would also be

TABLE 18

Sex and age of bushbuck along the Chobe river by months

Month	Total	Adults		Juveniles	Juveniles: 100 adult ♀♀
		♂♂	♀♀		
June	51	17	14	20	143
July	51	20	19	12	63
August	52	7	20	25	125
September	166	38	74	54	73
October	115	35	42	38	90
November	129	23	37	69	187
December	28	5	9	14	155
January	30	8	11	11	100
Total	622	153	226	243	
Average					107.5

TABLE 19

Group structure of Bushbuck

Group Structure	Frequency of occurrence	
	No. of observations (%)	No. of individuals (%)
Single ad. ♂	95 (22.7)	95 (15.2)
Single ad. ♀	90 (21.6)	90 (14.4)
ad. ♂♂	10 (2.4)	21 (3.3)
ad. ♀♀	12 (2.9)	25 (4.0)
Single ad. ♂ and Single ad. ♀	12 (2.9)	24 (3.8)
Ad. ♂♂ + ad. ♀♀	2 (0.5)	6 (0.9)
Ad. ♂ + Juvenile(s)	11 (2.6)	23 (3.6)
Ad. ♂ + ad. ♀ + Juveniles	14 (3.4)	49 (7.8)
Ad. ♂ + Juvenile	49 (11.7)	98 (15.7)
Ad. ♀♀ + Juvenile(s)	21 (5.0)	54 (8.6)
Juvenile(s)	102 (24.4)	137 (22.0)
Total	418	622
Average No./group		1.49

advisable to discourage large-scale burning of the swamp until the effects of these frequent fires on sitatunga habitat can be gauged.

KUDU — Tragelaphus strepsiceros

Kudu were recorded in 1724-D-4 and 1725-C-3 where numbers were high, and in smaller numbers in 1823-B-1 and 2; 1824-A-1; B-2 and 4; C-2 and D-2; 1825-A-3; and near Tsoi on the east bank of the Botletle at about the center point of 2024. They have also been shot in numbers on the Maun Front during tsetse control operations along the southern fringe of the Okavango swamps.

Although kudu occur away from the Chobe in the northeast of the game reserve, most are found within a short distance of the river. Here, like bushbuck, there is a local seasonal shift in the intensity of use. More activity near the river during the dry months leads to a virtual absence of kudu from the riparian strip and surrounding vegetation, as soon as browse on the sand ridge begins to come into leaf in November (figure 13). This is not related to visibility along the count route, as the drop occurs while it is good and numbers showed a clear increase while many bushes were still in leaf in 1966.

Juvenile skulls from the Maun Front and observations along the Chobe river support Simpson (1966) who describes a marked peak in calving early in the year in Rhodesia and Zambia. Animals were classified into sex and age classes according to ageing criteria developed by this author (tables 20 and 21). Entire groups of kudu were difficult to classify because of their preference for dense bush and only those where it was reasonably certain that the whole group could be observed are included in the tables.

The first table gives an indication of the composition of these groups and demonstrates the obvious prevalence of groups of females and juveniles, or of smaller groups of adult males. There is a general concensus of opinion that kudu have increased along the Chobe and this is substantiated by the high numbers of immature animals in the second table. The ratios should, however, be used with considerable caution as there is obvious social segregation between different classes and adult females appear to be more secretive than groups containing juveniles.

The kudu population is beginning to encounter considerable environmental resistance and without exception 41 adult males and 80 full-grown females were classed as in poor physical condition, and during the 1965 and 1966 dry seasons many were very thin. In 1965, in particular, the adults became very lethargic in the presence of danger and several had rough coats and drooping ears. These assessments of physical condition were confirmed by the poorly developed fat deposits in five specimens with fully adult dentition.

Kudu also made extensive use of Capparis tomentosa and Gardenia spathulifolia during the 1965 dry season, but generally fed at a higher level than bushbuck, thus avoiding undue competition with them.

The species is reported to be declining in the Okavango delta area and this is supported by lower kills over recent years in the Maun Front tsetse control hunting area, as the species is usually resilient to this type of hunting (Child et al, Ms). It is not common away from the Chobe or Linyanti and, as a valuable trophy animal, should be protected against undue persecution. A careful check should be maintained of population trends near the Chobe and more information is needed of its general biology in this area. Together with a study of bushbuck this could provide an attractive project for a visiting research worker and thus lead to a better understanding for the management of these two important tourist species.

TABLE 20

Sex and age class breakdown by months of Kudu along the Chobe river

Month	Total	Adults		Yearlings	Calves	Calves: 100 ad. ♀♀
		♂♂	♀♀			
June	19	12	1	4	2	-
July	51	6	15	17	13	87
August	67	10	26	24	7	27
September	137	35	29	47	26	90
October	26	1	6	14	5	83
November	31	3	13	8	7	54
December	2	2				-
January	8		4		4	100
Total	341	69	94	114	64	
Average						68.1

TABLE 21

Group structure of Kudu along the Chobe river

Group Structure	Frequency of occurrence	
	No. of observations (%)	No. of individuals (%)
Ad ♂ (♂)	29 (33.3)	52 (15.2)
Ad ♀ (♀)	4 (4.6)	6 (1.7)
Single Ad ♂ and Ad ♀	1 (1.1)	2 (0.5)
Ad ♂ (♂) and ad ♀ (♀) with calves and/or Sub-ad	8 (9.2)	52 (15.2)
Ad ♀ (♀) with calves and/or yearlings of both sexes	30 (34.5)	181 (53.0)
Ad ♂ (♂) + Juvenile(s) of one or both sex	4 (4.6)	15 (4.3)
Juvenile(s)	11 (12.5)	33 (9.7)
Total	87	341
Average size of all groups		3.9

ELAND — Taurotragus oryx

Eland are widely distributed in northeastern Botswana where they are subject to considerable movement, but they are only occasional visitors to the Chobe flats east of Kachikau. They have been recorded from 1724-D-4; 1725-C-3 and 4; 1824-A-1, 2 and 3; B-2 and 4; C-1 and 2; D-2; 1825-A-1 and 3; D-1 and 3; 1924-D-4; 1925-C-2 and 1926-C-2.

Eland are of special significance to the bushmen and the following account of their behaviour is based on these people's intimate knowledge of the species, augmented and confirmed by field observations during the present assignment.

The female herds which usually number 10 to 30 individuals break up temporarily to calve from July to September, but then reunite and several such groups coalesce and are joined by males which gives rise to large herds. Rutting begins while some calves are still being born and reaches a peak around October. The large herds persist into the rains but break up between January and May and from then on the males remain in small groups of from one to six or eight individuals. The calves leave the female herds about June and run in herds on their own, which may remain together until the animals reach adulthood, although young animals are sometimes associated with the large herds during the rains.

Fairly small calves were recorded from September, although Hepburn (Pers. comm.) noted young calves in July in both 1962 and 1963, and calves were generally well represented. No animals were classified as in poor condition and most adults which could be approached close enough were rated as "good". A male with all permanent teeth, killed by a lion at Ngwezumba pools late in August 1965, had over 23 mm of subcutaneous fat on the back, a kidney fat index of 329 and good fat reserves in the femur bone marrow.

Eland are not numerous in and around the Chobe Game Reserve but, the population appears to be healthy and may be expanding, as modifications to the habitat probably favour this browsing species and several old people considered numbers higher now than twenty years ago, although others had noticed no change. No particular management is recommended at this stage, although hunting should be regulated to ensure a safe off-take.

BUFFALO — Syncerus caffer

Buffalo are locally very numerous in parts of northeastern Botswana where they are subject to considerable dispersal away from permanent water during the wet season. They have been recorded in 1724-D-3 and 4; 1725-C-3 and 4; 1823-B-2, 3 and 4; D-1 and 2; 1824-A-1 and 3; B-1, 2, 3 and 4; C-1, 2, 3 and 4; D-2; 1825-A-1 and 3; C-1, 2 and 3; D-1, 3 and 4; 1923-B-1, 2 and 3; 1924-A-1 and 2; 1925-B-2 and 1926-A-1 and 3. Buffalo are reported plentiful throughout the Okavango swamps and were one of the more numerous species shot on tsetse control on the Maun Front. They also move in a southerly direction toward the Botletle east of the Makalamabedi fence from the general direction of the southern Mababe.

The movements of buffalo require further investigation, on account of the species' possible implication in the spread of foot and mouth disease. The veterinary authorities in Botswana seem generally agreed that it is the only wild ungulate which is likely to transmit the disease over long distances, the significance of other species being in the local dissemination of the virus in an outbreak area.

The species is very nocturnal and secretive along the Chobe river, but becomes more conspicuous during the dry season (figure 7), possibly as the result of an influx of animals from waterless areas. Groups that had grazed on the flats during the night were followed and led two observers over 14 miles in an easterly direction one day and more than 10 miles in a southwesterly direction, from approximately the same starting point, two days later, without either group of cows and calves being seen. Similar tracking of bachelor herds was more rewarding as these moved only three to six miles from the flats.

History of Buffalo Population

Buffalo appear to have been reasonably common along the Chobe in 1874 when Selous (1881) shot several. They were unknown to the bushmen of the Ngwezumba area for several generations until about 1944 to 1946 when they began to be seen in small numbers over a fairly wide area, but are now common in this region. The bushmen at Nunga reported a similar sequence of events, although it was not possible to date the reappearance of the species there. A buildup in numbers is also reported along the Chobe. Stigand (1923) gives a brief account of the game in the Okavango swamps and on a journey from Toten, along the Thamalakane, across the western Mababe and up to the Linyanti near the present Ngamiland border but, significantly, does not even mention buffalo.

These and other reports indicate buffalo were fairly widespread but not especially common during the latter half of the 19th century, and that numbers were low and their range restricted for the first three or four decades of this century. By the early forties buffalo were being shot in large numbers on tsetse control on the Maun Front along the southern fringe of the Okavango swamps but, in spite of some reduction in the area hunted, the number shot per year showed a steady upward trend until 1965, when the pattern of hunting was changed (Child et al, Ms).

There was a marked die-off of buffalo in the Savuti area after the channel ceased flowing early in 1965. The skulls of 39 of the first to die around the swamp included 20 adult females with moderately to well worn permanent teeth; 2 unsexed adults with moderately worn teeth; nine adult males with moderately worn teeth; three young adults with the premolars exchanging, and four juveniles with the first or second molar erupting. The second wave of deaths was represented by 11 skulls of which 10 were adult males with moderately or heavily worn teeth and one was a female with lightly worn permanent teeth. Mr. Eric Rungren also observed the early stages of this die-off among animals along the Linyanti and of 11 carcasses, nine were old females. These samples suggest a mortality pattern, affecting first juveniles, then old females, old males and finally young adult females, similar to that observed by Child (1965) during the die-off of a herd of over 200 buffalo compressed onto an island during the formation of Lake Kariba.

Hepburn (pers. comm.) reports many thin and dying buffalo in the Enclave and south to the Ngwezumba river in 1962 when a number shot by local villagers were abandoned as too thin to eat.

The author inspected 16 lower jaws of buffalo collected in the Jari pan area on behalf of Riney and Hill (1963). Three had a complete set of teeth but the remainder were well grown juveniles. Some 2,000 buffalo were estimated to have died in this area of 48 square miles in 1962. There was a further heavy die-off in 1965 and considerable numbers are reported to have died during the intervening two years. The dentition and femur bone marrow were examined from 42 carcasses in October 1965, as well as the extent to which each carcass had been eaten by predators or scavangers. These included 21 adult males of which four had well worn permanent teeth, 13 moderately worn teeth and four lightly worn teeth. The only carcass in this group which had been extensively eaten was one with lightly worn teeth, although several of the others were known to have been killed by lion, which had abandoned the meat after very little feeding. It was also noticeable

that very few of the adult males had oily femur bones. On the other hand most of the 12 females with moderately or lightly worn permanent teeth had oily femur bones and had been extensively eaten. Two males with exchanging incisors 2 and 3, and a female with erupting adult canines were intermediate in the oiliness of their bones and the amount of meat removed, between the adult females and males, but a slightly younger male with the third molar erupting was hardly touched. Three small calves with the first molar erupting or in,were, however, extensively eaten, but these carcasses were older than most others.

A herd of 70 to 75 buffalo observed at Jari pan contained no small calves, and only five individuals which were not almost full grown. All the animals in this herd were very thin.

Here the pattern of mortality appeared to have proceeded further than near the Savuti. Adult males, after three years of generally heavy die-offs, were dying in greater numbers than the females, most of which were probably killed by lion, as their carcasses had better fat reserves than those of the males and they were generally more extensively eaten.

Trends in Buffalo Populations

As already noted, the population sampled by tsetse hunting on the southern fringe of the Okavango swamps is still apparently expanding. Reports indicate the same from several other areas around the swamps. The population along the borders of the Wankie National Park, near Jari pan, received a severe setback between 1962 and 1965, and habitat conditions are such as to suggest that animals will continue to die in this area in dry years unless appropriate action can be taken.

The die-off around the Savuti was probably precipitated by the exceptional habitat changes associated with the drying up of the channel. Buffalo are, however, very numerous seasonally along the Linyanti where several died in 1965. This population may be reaching a peak in an eruptive phase as conservation values in the area are generally low.

The buffalo along the Chobe near Kasane are still apparently increasing and juveniles are numerous. Many were in poor condition in October 1965, but some of these may have been animals which moved to the river from elsewhere as fat reserves were generally satisfactory in 15 buffalo shot for rations, between October 1965 and October 1966, and in four juveniles which drowned in the Chobe during a stampede in August 1966. With the exception of the juveniles,most had some subcutaneous fat at the base of the tail, and this reached 25 mm in depth in a female shot in October 1966. Most adults had reasonable kidney fat indicies (see Child, 1965), ranging between 14 in a November female to 51 in the above October female. Only one of the young calves and an adult female shot in August 1966 had poor fat reserves in the femur marrow.

The perennial grasses on the Chobe flats were heavily grazed by buffalo at night, particularly during the dry season, and most of those shot had stomach contents with a significant proportion of this grass. The stomachs of the four juveniles drowned in August 1966 were full of green grass from the flats. The species also make extensive use of browse such as Baphia obovata, Dichrostachys cinerea, Pterocarpus stevensonii and Combretum spp.

Conclusion

There has been a marked increase in the number of buffalo in most of northeastern Botswana since the turn of the century, when numbers were low, possibly due to the great rinderpest which swept through this part of Africa between 1896 and 1898. The recovery

was assisted by changes in the habitats, including an increase in browse plants and cover, but in several areas the species is becoming overpopulated and a number of populations are at, or approaching, the crest of an eruptive peak, and can therefore be expected to begin to decline. Their activities are also damaging to the habitats of other species.

The species is much sought after as meat by many of the local people and the controlled hunting of buffalo should be encouraged, as a source of local protein and as a distraction from the hunting of several other species. An investigation into the possibilities for harvesting buffalo on a commercial scale in one or more of the concentration areas would also be desirable. Little is, however, known of the biology of this species, and every opportunity should be taken to accumulate basic information on its movements, habitat requirements, breeding, growth patterns, etc.

DISCUSSION

The changing trends in many wild populations, in which the sensitive grazers are declining numerically and the species favoured by bush are increasing, coupled with the widespread bush encroachment and general deterioration of perennial grasses, especially on sensitive soils or where there has been the most intensive detrimental land use, causes concern for the future productivity of the region. The pattern of deteriorating conservation values occurs throughout much of Africa, but is particularly critical where the vegetation is sensitive to abuse, as the result of climatic factors or the geology or geomorphology of an area. The habitats in northeastern Botswana are subject to a low erratic effective rainfall and are mostly on unstable sandy soils.

Veld management, whether for wild or domestic species, should aim at achieving the long-term stability of the habitats and at halting the distressing decline in conservation values over large areas. At the same time it is necessary to seek to increase yields from these marginal lands and it is suggested that the controlled utilization of wildlife, in its varied forms, should receive full consideration in this respect. This does not imply that wildlife should replace existing forms of land use, but that it should be integrated with them on a carefully planned basis.

The remainder of this report is devoted primarily to suggestions for the management of the wildlife industry in northeastern Botswana. These suggestions include what appear to be appropriate measures for the control of the industry under prevailing circumstances and at the present level of understanding of the various species' biology and the utilization of wildlife in Botswana. A strong plea is made for incorporating the accumulation of useful information in any biological management or administrative control program, as this will provide a basis for more efficient coordination of the industry in the future.

AVIFAUNA OF THE CHOBE GAME RESERVE

The varied birdlife of the Chobe Game Reserve is already a popular attraction with many visitors, and its significance as an added tourist attraction should increase. This prompted a survey of the species known in the reserve, which is included as appendix A of this report.

PART II

SANCTUARIES AND GENERAL TOURISM BASED ON WILDLIFE

CHOBE GAME RESERVE

History

The Chobe Game Reserve came into existence under the Bechuanaland Government Proclamation No.22 of 1961, better known as the Fauna Conservation Proclamation, after an alternative area along the Rhodesian border and adjacent to the Wankie National Park had been considered and rejected. The original description of the game reserve included a larger area, extending further south and east, but the boundaries were altered several times until in 1965 they were as shown in the figure 14.

Previous to the setting aside of the game reserve, various government officials in authority had enacted local regulations for the protection of several species, in addition to royal game, in this area, and in particular had attempted to restrict hunting along the Chobe river. In April 1962, a warden was appointed to the reserve and was stationed at Kasane and from then onwards policing activities were intensified, within the limits imposed by a meagre staff of from two to seven game scouts. These activities were further restricted during 1963 and 1964 when for 18 months the warden was required to act as district administrative officer, in the absence of a district commissioner.

The 27 miles of main road along the Chobe river from Kasane to Simwanza was built in 1962 with a R20,000 Colonial Welfare and Development grant to the game reserve. At the same time, a series of game-viewing tracks providing loops from this road onto the Chobe flood plain were opened up for tourist traffic, giving a total of some 60 miles of game-view routes.

The Chobe River Hotel was built in 1961, by private enterprise, to serve the game reserve. This company installed a pontoon across the Zambezi river at Kazungula in order to allow the area access from the Zambian road network, as at this stage there was only a primitive track to the Victoria Falls along the south bank of the river.

The Chobe Game Reserve was officially opened to the public on August 1, 1964, and the numbers of visitors making use of the amenity are summarized in table 23. A satisfactory growth in the volume of tourism was evident in the first year, but by 1966 tourist accommodation was saturated at peak periods, particularly during long holiday weekends in Rhodesia and Zambia in July, and during Rhodesian and South African school holidays.

Changes in the Status and Limits of the Reserve

The regulations governing the Chobe Game Reserve were similar to those applying in national parks in several neighbouring states and clearly indicated the Government's

intention that the area should be managed as a national park. The official status as a game reserve tended, however, to result in recommendations for conflicting forms of land use within the reserve and a division of the responsibility for game and its habitats between two Government Departments with diverging interests. Further it denied the area the prestige of a fully proclaimed national park.

It was therefore recommended to the Government that the status of the reserve should be elevated to that of a national park, to be run on established internationally accepted principles, and the necessary legislation is now before Parliament where it has been read for the first time. It was also evident that the prevailing arbitrary map-line limits of the reserve needed revision. They cut across ecological units and are difficult to administer as they ignore existing physical features. The author was requested to investigate possible changes.

The six areas considered are indicated as A to F in figure 14. Definite recommendations have been made for four of the areas while, in the remainder, suggestions in this report may require modification in the light of future developments.

Area A - Eastern Extension

The Kakulwani plains and adjacent libalas are attractive game-viewing country which only just penetrated the eastern border of the reserve. This was the only protected oribi habitat in Botswana and, as already noted, the area is probably important alternative habitat for the dry season concentrations along the Chobe river of such species as sable, roan, tsessebe, wildebeest and zebra. Further there was only a restricted area suitable for tourist development in conjunction with the pilot water-manipulation project situated around the head waters of the Ngwezumba river.

According to old people who used to live in the area, the plains were not much used by cattle, even when livestock was plentiful, as the coarse grasses are unpalatable in the dry season and the black "cotton" soils too adhesive during the wet season. A further disadvantage was the presence in neighbouring sandveld of "mohau" Dichapetalum cymosum, a toxic weed dangerous to livestock. No objections were raised by the Directors of Agriculture or Veterinary Services to an extension of the eastern limits of the game reserve, and the latter went so far as to agree that a slight deflection of the stock route between bore holes No. 2 and 3 could be justified. In fact the nearest point on the proposed boundary, drawn up in consultation with the Forest Department so as to exclude as much saleable timber as possible, was about $3\frac{1}{2}$ miles from the stock route.

This extension of an additional 100 square miles of unoccupied state land has been incorporated into the schedules defining the national park.

Area B - Southeastern Corner of Reserve

The Forest Department is presently surveying the extent of timber resources in this area. Should they be worth exploiting,then consideration should be given to excluding some of the better wooded areas to the south of the Shinamba Hills and east of the Mababe Depression from the national park, retaining them as game reserve. It would then be desirable to compensate this loss by the addition of more of the libala country to the northeast of the hills and to ensure that the hills are well within the park. According to the surveyors carrying out the ground checks for the preparation of the maps of Botswana by the Directorate of Overseas Surveys, these hills are just within the present eastern boundary of the reserve.

TABLE 23

Visitors to the Chobe Game Reserve since it was opened to the Public in August 1964 expressed as daily, weekly and annual tickets purchased

Month	1964/65			1965/66			1966/67		
	Daily	Week	Ann.	Daily	Week	Ann.	Daily	Week.	Ann.
August	210	19	-	427	52	3	407	86	2
September	202	64	-	259	25	-	267	38	1
October	136	11	-	191	18	-	188	13	-
November	133	62	-	117	17	-	72	2	-
December	91	7	-	117	25	-	277	17	1
January	79	17	-	122	-	-	212	9	-
February	65	-	-	63	2	-	107	-	-
March	127	-	-	97	4	-	255	20	-
April	337	19	-	262	23	-	282	21	-
May	237	16	-	325	17	-	347	103	-
June	176	-	-	166	7	1			
July	514	46	-	551	43	1			
Total	2 307	261	-	2 757	233	5	2 414	309	4
							Total to May		

Under no circumstances should areas north of an east-west line some five miles south of the Ghautumbi molapo be excised from the park, as has been requested by the Forest Department.

Area C - Southern Extension

The Mababe depression is a natural ecological unit bisected by the southern boundary of the reserve which is arbitrarily sited along the 19th parallel. It was therefore suggested that the southern part of the Mababe should be added to the reserve, as the area was unoccupied state land in which the hunting rights were divided between two safari companies. The area was also hunted over by the 80 odd residents of Mababe Village, who moved north to this area from Mokoba in 1954.

The proposed line would have been as follows: south along the Magwikwe sand ridge from the 19th parallel to a point due east of the southern limit of the Kwaai airfield of Ker, Downey and Selby Ltd; thence by the shortest distance to the Kwaai river; east along this river to where it divides in the southern Mababe, just north of Mababe village; thence along the eastern watercourse, until it is no longer clearly defined; thence in a straight line south of east to the sixth pan south of the mopane limit, going south along Riley's road from Jovorega to Rakuku (i.e. about 17½ miles south of Jovorega on this road); then north along the road, including the pans in the game reserve, to the first pan south of the mopane limit; thence due east eight or ten miles to a track running more or less parallel to Riley's road; thence north along this road to the 19th parallel.

This additional area has large wet season concentrations of game, such as wildebeest and zebra, as well as large more or less resident populations of impala, kudu, tsessebe and giraffe, and would appear to be of considerable importance to game moving from the vicinity of the Moremi Game Reserve, during the rains. The country varies from open grassland to open bush or tree savannah with occasional closed forest. The ground is hard so that, providing there is underground water, the area could easily be opened up for tourism.

There is tsetse fly; an attempt to introduce large scale agriculture in the south was a costly failure, and neither the Directors of Agriculture nor Veterinary Services could visualize any objections to its inclusion in the game reserve. This was in fact recommended in general terms in "A Land Use Survey of the Northern Statelands Botswana" by Blair Rains et al (1967).

It is, however, a long way from Kasane so that it would be some years before it could be developed, while in the meantime it is earning valuable revenue from safari hunting. For these reasons it has not been included in the national park. Nevertheless, the area should be declared a game reserve (or controlled hunting area) until such time as it is required in the park, as this would allow the management of the habitats and wildlife populations in the Mababe as a whole and would facilitate better control of tribal hunting.

Area D

The southwestern corner of the game reserve is not to be included in the national park, the limits of which follow the Magwikwe sand ridge south of the Tsantsara molapo. The area will, however, retain the status of game reserve in which safari hunting will be permitted.

Area E

The Linyanti swamps and their environs provide an interesting contrast with the Chobe river east of Ngoma. The area has plentiful game, at least during the dry season,

and should be sampled by a tourist circuit. At present there is, however, very little of it within the game reserve for, as already noted when discussing sitatunga, the reserve includes only 2½–3 square miles of swamp and, according to the best available maps, does not impinge on the international boundary, along the main channel of the Linyanti.

It would therefore seem highly desirable that more of this habitat should be brought within the park. The only way this can be achieved at present is by including part of the west of the Kachikau Enclave within the reserve, as this is unoccupied state land, but any serious inroads on the enclave would prejudice its usefulness as a hunting concession. A more desirable alternative would be the incorporation of the triangle between the Savuti and Linyanti, but this would require the consent of the North-West-District Council, as being in Ngamiland, it is Batawana Tribal Territory.

Area F

An area of particularly good Kalahari woodland adjacent to the southern border of the Kachikau Enclave has been excluded from the definition of the national park in order to allow the exploitation of the timber. It retains its status as game reserve and in addition will become, in terms of new forestry legislation, part of the forest reserve including most of the present Kachikau Enclave south of the Chobe flats.

For obvious practical reasons it is seldom possible to achieve the ideal within a national park, so that it contains only complete ecosystems, all the year round natural habitat requirements of the species recorded in it, and is therefore independent of surrounding areas. This is especially difficult where mobile populations, subject to more or less extensive movements of a seasonal nature, are involved in an area which is not geographically isolated in any way. The suggested changes in the game reserve or national park boundaries seek to alleviate some of these difficulties, but it is nevertheless desirable, wherever possible, that a national park for the protection of wildlife should be surrounded by a buffer zone in which the exploitation of the wildlife is strictly controlled.

In effect this is the case in the hunting concessions around the Chobe Game Reserve. Generally these areas are sparsely if at all populated, and hunting is mostly limited to the activities of the safari companies. There are, however, indications that the status quo is not always being maintained and the situation can be expected to deteriorate further, unless there are adequate safeguards, particularly as the commercial value of wildlife products becomes more generally known. Immediate steps should include a severe limitation on the issue of pot licences in the Chobe district and adjacent parts of the northern state lands, especially along the cattle export route, and the strict control of all hunting by residents of the Kasane-Kazungula-Lesuma area, the Kachikau Enclave and the southern Mababe.

If possible, the zone around the national park, or any other sanctuaries, should receive the designation of game reserve or controlled hunting area, which would not preclude other forms of extensive land use, with which wildlife management should be coordinated. It is particularly desirable that productive forest reserves and game reserves (as opposed to national parks) should be combined in order to obtain most effective utilization of the wild populations.

Kachikau Enclave

This enclave, which has already been mentioned on several occasions in this report, separates most of the game reserve from the Chobe - Linyanti river system, and is itself isolated from the rest of Botswana by the reserve (figure 14). It has already been agreed

that the rational use for this land would be to have it in the game reserve - national park system, but approximately 110 square miles are occupied by some 3,000 people. The area primarily under consideration is roughly that portion of the Chobe flats east of a line passing through Kachikau and Parakarungu which is free of tsetse fly, and is not to be incorporated in a forest reserve.

This area is scenically attractive and could be developed easily and cheaply for tourism. Its inclusion in the national park would increase the tourist-holding potential by over 60 percent and it provides essential habitats for several species, which may otherwise disappear from the Chobe District. The only year-round lechwe habitat is in this region, to the north of Kachikau and, as already stressed, the species is in a precarious position within the game reserve. Sitatunga do not occur in the reserve east of Ngoma, the enclave contains some of the limited oribi habitat which could be protected in Botswana and reedbuck are plentiful, although virtually absent from the present reserve.

These species are associated with attractive vegetation types which are disappearing and which would be worthy of protection, in their own right, if this were not also ensuring that Botswana would continue to have a game sanctuary with a record number of large mammal species. This argument could be countered as purely idealistic, but for the fact that the tourist industry has already proved its value and, with encouragement, could expand rapidly.

The area was first occupied by the present inhabitants around the turn of the century. These people belong to two tribes, the Masubia, which is the tribe of the eastern Caprivi, and an offshoot of the Batawana from Ngamiland. As already noted, their agricultural history has not been a happy one and the area has been subjected to periodic flooding. The first suggestion that people should be moved from parts of the area was made by the Forest Department in 1937. The District Administration reinforced this request in 1945, as by then large areas were completely denuded of all vegetation and wind erosion was widespread. By the early fifties, tsetse was advancing and reached Kasinka in 1952. At about the same time the best croplands in the east began to be submerged and the heavy die-off of cattle precipitated a voluntary exodus of some of the people. For those who remain in this remote part of Botswana expansion is now limited to a relatively small area surrounded by forest and game reserves and by tsetse fly, while there is no shortage of land for human occupation in the east of the Chobe District. Here there appear to be better prospects for crop and livestock production, nearer the District Headquarters and with better communications.

The enclave certainly has some potential for crop production, although it is doubtful if the cliché describing it as the "granary of the north" is applicable in view of the fact that almost 15 percent of the population received famine relief through the World Food Program in 1965. Livestock are estimated to number 1,600 head, but most were in poor condition in 1965 and 1966, judging from a sample of 109 allocated a grading. While the status of the grasses is generally fairly high, conservation values are not being maintained even at this low stocking rate, due to the necessity for early burning in order to render most of the grasses edible.

The restrictions on expansion imposed on these people are bound to come into increasing conflict with forestry and wildlife interests. Fire control and policing operations will remain more difficult and expensive, and the conflict between wildlife and agricultural pursuits will intensify. It is especially pertinent to consider the role of hippo in the regulation of the flow of the Chobe system and their effects on flooding, against their incompatibility with crops and the seasonal demand for their destruction by river bank cultivators. Three very old men, interviewed separately, mentioned an interesting phenomenon in this respect. They could detect no change in the numerical strength of the hippo population over the past 40-60 years, although garden raiding has

increased. Whereas in their youth the hippo used to walk right through their crops growing along the river bank, without causing damage, to graze beyond, this is no longer the case. This suggests that the hippo have only recently learnt to eat cultivated crops or that the grassland has been modified so as to be less attractive to them.

Few nations are better placed than Botswana to plan the long-term development of an area as large as the Chobe District along sound lines, and the Government is aware of this.

A technical meeting was called between members of the Agriculture, Veterinary, Forest, Tsetse and Game Departments and the District Administration to discuss this question. It was generally agreed that good areas for agricultural development appeared to exist in the east of the District, where communications are better, and that these should be further investigated with a view to development, which it was hoped, would attract people from the enclave.

The implied intention toward rational land use planning on a regional basis is to be commended. It is hoped that the necessary preliminary survey work can be implemented in the not too distant future, as continued uncertainty is bound to retard development or to channel it along less productive lines.

Policy

The administration of a national park is greatly facilitated if there is a clearly defined policy setting out the aims and objectives for its management and development. Such a policy should be within the framework of the internationally accepted principles embodied in the "Draft African Convention for the Conservation and Management of Wildlife", taking into account local conditions. It must also bridge the gap between the need to conserve the natural beauty of, in this case, the wildlife populations and their habitats, and the need to exploit these resources for the maximum long-term benefit of the people of Botswana. Above all it must be realistic.

Once a policy has been drawn up and accepted, then it allows the delegation of authority to Field Staff without the danger of ad hoc decisions or individual preferences, which might be temporary, distorting the long-term objectives. In other words, it ensures continuity as and when there are changes in staff and obviates the need for the park warden constantly to have to refer back to his superiors.

This has obvious advantages in reducing time spent on purely administrative functions, but can be equally useful when dealing with biological problems. Management cannot begin until the end product required of such management is known, as this will determine the techniques which may be tried. If, for example, it were policy to have as many elephant in the park as possible, irrespective of the numbers of other species, this would require a different approach than if it were policy to have as many animals from as wide a variety of species as possible. It also focuses the attention of research toward specific problems and so avoids lengthy studies which, although interesting in themselves, may be of very low priority to the overall well-being of the park. This may be important where trained manpower is limited.

The need for a carefully laid out plan for coordinating the development of the amenities within a national park is fairly obvious, but what is perhaps less often realized is the need to integrate this development within an overall policy. A striking example of this need occurs in the drier parts of the Chobe Game Reserve where tourist facilities have to be developed in conjunction with water manipulation projects. The several factors which must then be taken into account include: the availability of underground water habitats which are not over sensitive to trampling by the animals which will use the water; the availability of sufficient sites the right distance apart to allow a system of rotation

in the use of the bore holes so that habitats have time to recover between successive seasons in which the holes are used; there must be reasonably attractive country for game viewing and the siting of accommodation; the presence of hard ground reduces the costs of roads and tracks and, last but not least, there must be adequate game of a sufficient variety to attract and hold tourists at the seasons in which the area is open to the public.

The definition of policy is obviously the prerogative of the Government and the following tentative suggestions are included purely as a framework for the management and development plans outlined below.

Suggested Policy for the Chobe National Park

The Chobe National Park is set aside for posterity for the enjoyment of mankind, in particular for the enjoyment and benefit of the people of Botswana, and for the protection of the animals, plants and natural features within its limits. Recognizing that the aesthetic justifications for the park will be fortified if it is as economically self-sufficient as possible, it is the intention that certain areas of the park should be developed in order to attract and hold visitors, provided this does not conflict unduly with the maintenance of the essential natural beauty of the area. Recognizing also that the area has been modified from its pristine state by past land use and is influenced by current land use in neighbouring areas, it is the intention that the park should be managed in such a way as to safeguard the conservation values of the habitats and the future existence of the fauna native to the area.

The park will be administered in terms of the National Park Proclamation of 1967, by Central Government, through a park warden and subsidiary staff, who will be responsible for: 1) ensuring its proper administration, management and development, in accordance with the principles and the spirit of the "Draft African Convention for the Conservation and Management of Wildlife" of 1967, and 2) for keeping such records of these activities as may be necessary to ensure continuity and facilitate future planning.

The biological management program will be based on a management plan and will aim at providing the greatest number of animals, particularly large mammals, of the widest possible variety commensurate with ecological stability. Where habitat manipulation is necessary, it will be done in such a way as to appear as natural as possible. Scientific research by bona fide research workers will be encouraged, but unless granted written permission to the contrary, it is the responsibility of such workers to obey all park regulations. Buildings, roads and other constructions should be harmonized with the landscape and will be sited only after detailed planning within an overall general development plan. Tourist amenities will aim to attract and hold as many visitors as possible without destroying the essential wilderness qualities of the park. Accommodation should range from primitive camp sites to high-class hotel-type accommodation and private enterprise, under strict government control, will be invited to participate in its development and management.

Biological Management

The Chobe Game Reserve is a large area of some four and a half thousand square miles of dry marginal country which has been considerably modified by past land use. The changes in the habitats are reflected by changing trends in the wildlife populations, some of which are expanding while others recede. The knowledge of the area and the mechanisms affecting these changes is still far from complete, in points of detail, and any management toward countering them will have to be carried out by a small staff, with many other duties, and with limited funds.

It therefore seemed advisable to try to define the priorities for stabilising the habitats and then gradually reclaiming those which are essential to endangered species, although additional desirable measures are mentioned in the discussion on individual species in Part I of this report. The priorities appeared to include the recording of the history of land use, area by area by area; the detailed exploration of these areas with a view to describing the fauna and flora and determining conservation trends, and the establishment of a system of routine recording for measuring the changing trends in wildlife populations. This work should continue, together with the evaluation and, if possible, rectification of possible overpopulations of game, and water manipulation.

Exploration

The exploration of the reserve, using aerial photograph print laydowns as a basis, should continue as opportunity affords. In addition to mapping the vegetation and recording the seasonal abundance of game, gaps in the detailed history of the area should be filled by the careful questioning of old people whenever possible, and repeated checks should be made of conservation trends. The latter should be based on step-point transects and photography and should include a critical assessment of the physical condition of individual adult animals.

The information thus assembled should be filed in an accessible form and should be compiled into area reports, with appropriate maps etc., at periodic intervals. These reports may seldom be complete but would ensure that valuable information is not lost.

Fire Control

The proper control of fire is probably the greatest single challenge to the management of large areas of the Chobe Game Reserve. There are considerable practical difficulties in the controlling of unwanted burns as fires enter from outside or are started by careless travellers within the reserve, and early burning is official Forest Department policy.

The theoretical basis for needing to control fires and for using burning as a management tool, and the effects of different burning regimes on the type of vegetation occurring in the reserve have been outlined briefly in Part I. It is evident that unless the present burning pattern can be altered and unless the trends induced by it can be halted or reversed, certain species, whose essential habitat requirements are declining, will continue to diminish in numbers and may disappear.

Fire control is a difficult and expensive operation so that severe penalties for negligent burning are desirable. These will not prevent all fires, but they will deter a portion of the wrong-doers and so reduce the incidence of fires. It is also necessary to control the movements of people using the main roads through the reserve and to designate limited areas where they may camp and light fires, so that these areas can be specially protected.

Negotiation is called for between the Game and Forest Departments in order to arrive at a policy which is less damaging to the natural resources of the country than one dependent on regular early burns. This is especially pertinent to areas which are both forest and game reserves and around the perimeter of the national park, as obviously the question will not arise within the park.

It should be the Game Department's policy to prevent all unwanted fires in the national park, although it will be some years before this is possible. In the meantime through traffic should be controlled and all available effort should be concentrated in a few critical areas, which could be expanded as opportunity afforded.

The first of these areas should be the strip of highly modified Kalahari woodland backing up the Chobe flats between Kasane and Ngoma (figure 5). The area is already enclosed by fire traces, which should be widened and graded early each season. It might also be necessary to cut a second fireguard parallel to this, particularly along the eastern border of the park. The proposed diversion of the main road through the park to Ngoma bisects this block lengthwise and would be a useful second break if maintained as such, and this would also apply for the transverse road cutting across the area from Kalwizikankanga or Serondellas to Mandabuzi and Ngwezumba.

If built with this purpose in mind, the road could be made effective against fires from the east penetrating deep into the northern arm of the park. It should be noted, however, that where tourist roads are to act as firebreaks this precludes the early burning of an adjacent strip, to increase their effectiveness, as such fires will promote bush encroachment and so reduce visibility for tourists.

The second area which requires special attention is that around the head waters of the Ngwezumba river where the pilot water-manipulation project is situated. The proposed network of game-viewing tracks should be graded annually and their effectiveness against fires increased by moving the verges to a depth of some 20 yards. This would, incidentally facilitate game viewing. This system of tracks will not enclose the area entirely so that to be effective it would need to be supplemented by a series of fire-breaks, particularly along the eastern border of the park.

This area will be linked to the strip along the Chobe by the aforementioned road and, consequently, about half the eastern border of the park would be protected in the direction from which most fires originate. It would, however, be an advantage to have an additional break linking the two areas along the eastern boundary.

The system would be of real benefit to the Forest Department's interests in the forest and forest game reserve to the west and fire prevention here would protect the northern arm of the park from fires from the west. This protection would be increased if the two systems were linked along the 13 miles of road from Ngwezumba toward Kachikau.

The third area deserving special consideration is the Mababe depression, most of which was burned out in 1963, 1965 and 1966 by fires started along the main road between Kachikau and Maun. It might be some time before this area is developed for tourism and until then, the cutting of firebreaks would be unduly expensive. However, the area is protected from settlement in the north by the forest reserve and there is only light settlement to the south, by non stock-owning people, so that the most economic way of limiting fires in the whole Mababe would be through the policing of the southern settlements and through restricting the use of the roads through it to permit holders.

A high priority, which does not fall strictly within the terms of management, is the prevention of the frequent damaging fires on the Chobe flats, started by people crossing over the river in dugouts from the Caprivi. The terrain renders policing extremely difficult, as these people can easily recross the river, which in many places is narrow, while a law enforcement officer has to negotiate several hundred yards of open grassland. The apprehension of poachers becomes virtually impossible when this grass is short after a burn. Poaching is blatant and is carried on in full view of tourists and Game Department staff alike, and is directed mainly against lechwe. Dogs are landed on the Botswana side to chase the lechwe towards the river, where they are dispatched on the bank or in the water.

This is the only serious poaching in the Chobe Game Reserve and calls for close collaboration with the South African authorities in the Caprivi. Not only is the poaching

to be deplored, but the fires started to facilitate it are causing considerable harm to the pastures along the Chobe river in the main game viewing area in the reserve.

Erosion Control

There is very little accelerated erosion in the Chobe Game Reserve which could not be counteracted by the protection of the perennial grasses from the harmful effects of fire. An important exception is the face of the sand ridge overlooking the Chobe flats between Kasane and Ngoma.

Perennial grasses have almost disappeared and recovery from past land use is prevented by the seasonal concentration of game. Large herds of ungulates, including elephant, pour down the sand ridge towards water, shifting considerable quantities of soil and destroying most of the herbaceous layer early in the dry season. This is accentuated by the grubbing activities of baboons, especially in stony areas which might otherwise receive more protection.

Some attempt to stabilize this sensitive portion of the habitat is called for. Fallen trees, of which there are many due to elephant damage, could be laid along the contour in an attempt to deflect the downward rush of animals from the most affected areas. These would also tend to hold soil washed during the rains and could be arranged so as to enhance their protection of patches of grass from undue use.

Habitat Manipulation

It will be necessary to manipulate habitats to some extent, in order to offset some of the harmful effects resulting from past land use. This should be directed toward improving the habitats of endangered species, the diversification of the already highly modified habitats adjacent to the Chobe flats and, to a limited extent, to improving visibility along important game-viewing tracks.

These objectives may often be catered for simultaneously and an opportunistic approach would ensure the most economic use of labour, or the most efficient use of fire. A simple example would be where habitats consisting of uniform thickets were to be diversified by hand clearing. This could be expensive if undertaken as a special operation, but costs would be reduced if it were done when a road maintenance gang were in the area and, by promoting grassy glades where there were none before, it would favour grazers and improve visibility.

Burning, carried out correctly, is a useful management tool and can be used to promote either woody species at the expense of grass, or vice versa, or to improve the nature of grassland. In the Chobe Game Reserve its use should probably be restricted for some years to combating the scrub which is invading grassland areas thus impoverishing the habitats of several grazing species whose numbers are declining. In most areas burning should be limited to fires late in the dry season, preferably after the grass has dried out after an early shower of rain. Neither should such fires take place at too frequent intervals for, as already discussed, this can induce results similar to early burning, if there is not sufficient combustible material.

The correct interval between burns in the dry marginal habitats of the Chobe Game Reserve could be determined from experiment, but this would necessitate a long delay until such trials yielded results. It would seem preferable to limit burning, where it is desirable, to a frequency of not more than one late burn every five years. Even then, this regime should not be strictly adhered to, and an area should be burnt only if there is a good accumulation of combustible material. This might necessitate delaying the burn one or more years until the dry season following a particularly favourable growing season.

The Forest Department currently map all fires in areas of potentially marketable timber and these most valuable records should be augmented and extended to include the whole Chobe Game Reserve. It is especially important that all deliberate burns associated with management should be accurately mapped, and that the conditions before the fire and in the following dry season should be recorded with the aid of step-point transects and a series of fixed-point photographs.

Habitat manipulation should be concentrated along the strip adjacent to the Chobe flats in the northeast of the reserve and in one or two areas in the Mababe depression. In the first area the object would be to break up the thickets which have become established along the main road between Kasane and Ngoma. This will require the hand clearing of patches of bush where grasses are insufficiently developed to enable a hot burn, while judicious burning should be sufficient to thin out the bush at the eastern end of the Pookoo flats. Where hand clearing is necessary, felled scrub should be windrowed at the edge of the clearing to provide material for a hot fire in a later year. Chemical treatment of the stumps may also be needed in order to prevent coppicing.

One or more areas of grassland with moderate to light bush encroachment should be selected in the Mababe depression in order to establish the usefulness of burning for the elimination of such bush. These areas would, however, require absolute protection from fire for at least four years before the trials are started.

It may be necessary to burn small patches of the tall grassland of the Kakulwani plains adjacent to game-viewing tracks in order that tourists may see game. Such fires would have to be early to be of use and should not cause undue damage in this relatively resilient grassland, provided the areas involved are limited to a few acres away from water holes and are not burnt again for a number of years. This will necessitate the keeping of very detailed records.

Water Manipulation

There are a great many seasonal pans in the Chobe Game Reserve, several of which may hold water throughout the year, but there is very little truly permanent surface water. In dry years, such as 1965, it is limited to the Chobe river in the northeast, the Linyanti swamp in the northwest, the pools in the Ngwezumba river at Ngwezumba bridge and, in recent years, to water in the Savuti, although even this was limited to a small seep at the foot of the Gubatsa Hills, during the 1965 and 1966 dry seasons.

The augmentation of natural surface water is therefore one of several management techniques which can be used to raise the year-round holding capacity for several species of game in large areas of the reserve. These species disperse through the reserve during the rains and tend to coalesce towards larger and larger pans and eventually to permanent water, as the dry season progresses. The sequence in which pans dry up varies to some extent according to the local distribution of rain in a given season and this, in turn, influences the movements of the animals so that a secondary aim of water manipulation is to attempt to regulate these movements.

There are, however, several dangers inherent in any management program which alters but one aspect of an integrated ecosystem. It was, therefore, recommended that a pilot project should be tried in order to evaluate the uses and limitations of this type of management under local conditions in the Chobe Game Reserve and that the results of these trials, which should be carefully documented, should form a basis for the consideration of further schemes. Six bore holes have been sunk around the headwaters of the Ngwezumba river and are to be used in a rotational system.

Several factors were taken into account in the planning of this pilot scheme. The development of tourist amenities in this area is a logical step following expansion along the Chobe. Underground water was generally available and the Kakulwani plains and surrounding libala country was relatively stable grassland. The trampling effects of game using the Ngwezumba pools diminished rapidly away from the water and were insignificant a mile from it, in spite of the general deterioration in conservation values due to too frequent burning around the pools. Consequently the bore holes were sited approximately three miles apart. Nevertheless, populations of elephant and buffalo, at least, may require to be controlled in this area for, as already noted, they have built up rapidly from nothing, since the early forties, and damage is widespread.

There are two methods of rotating the use of the six bore holes. Each hole could be pumped in succession for one dry season, so that the vegetation around it would be spelled from intensified use for five years. After several cycles it should be possible to judge whether this degree of use was safe. However, as this is a pilot project, it is desirable that the results of the trials should become available as soon as possible in order to facilitate the planning of water development elsewhere in the reserve, or in other game management areas. It is therefore suggested that the holes should be spelled for differing periods. The initial cost of equipping the holes would be increased, but should be justified by the greater efficiency of the trials and the difference in cost would be reduced by staggering the years in which the holes were used initially. This would, in any case, be necessary to ensure that there was at least one hole in the system in use for the first 26 years.

A schematic program for the use of each of the six holes is given in table 24, taking into account the relative stability of the habitats surrounding the holes and the need to limit the number of pumps required in any given year. There is a danger that a rest of only one or two years between successive pumpings will prove inadequate to allow the vegetation to recover around bore holes No. 1 and 2. As soon as this becomes obvious, pumping should be suspended at these holes and, if possible, others added to the system. If this cannot be done, then these holes should be used only in those years where they are the sole supply, as indicated at the base of the table. The same argument could be applied for bore hole No. 3, but if it is also true for No. 4, then the whole question of the economics of water manipulation will require to be reviewed.

Once safe limits have been determined for the use of each hole, say, after 20 years, then the pumping program should be revised on this basis, taking into consideration those areas which have been most recently used and those which may have deteriorated through too frequent use.

When the scheme is in operation it will be important to ensure that pumping begins early in the year, before most small pans dry up, and that any mechanical failures are attended to promptly. It might therefore be prudent to budget for a complete set of standby equipment. This would mean starting with three sets in 1968 and increasing this to four by 1972.

The importance of adequate records from which to judge the optimum rest period between successive pumpings and to safeguard against extensive damage to the habitats around the bore holes cannot be stressed too strongly. It should be a routine duty for the warden to undertake the following standard recordings at the end of every dry season at each water hole and in at least one control area with permanent natural surface water and one without. The minimum requirements at each site should include three point-line transects from fixed points at distances of 50,100 and 500 yards from the water hole or control point. Ideally these should be in similar habitat and must proceed along a fixed

TABLE 24

Proposed program for trials with the spelled use of six bore holes in a water manipulation scheme in the proposed Chobe National Park

	Bore hole No.	Name	Bore holes pumped in any given year.*																							
			1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Regular Program	1	Tambico Pan		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	2	Sarigho		x		x		x		x		x		x		x		x		x		x		x		x		x
	3	Tjinga Pan	x			x		x		x		x		x		x		x		x		x		x		x		
	4	Poha				x		x				x				x				x		x				x		
	5	Namuchira Pan	x						x					x							x						x	
	6	Noghatsau Pan			x							x							x							x		
	Total holes in use	-	2	2	1	1	3	1	1	2	1	3	1	1	2	2	1	1	3	1	1	3	1	1	1	2	3	2
Revised program for 3 bore holes	1	Tambico Pan				x		x						x				x		x				x				
	2	Sarigho											x												x			
	3	Tjinga Pan									x												x					

*If pumping cannot begin in 1968, the program should begin in 1968 and each bore hole will be used a year later than is shown in the table.

bearing, recording the status of the vegetation, the trend in the conservation values of the habitat and the relative use made of the area by game. This data should be supplemented by a series of panoramic photographs and pictures of the ground cover at the start of each line and at fixed points in different vegetation types within one mile of each water hole. In addition, there should be a detailed account of any management undertaken in the area over the past year and of any other points relative to water manipulation and its influence on wildlife or its habitats. Finally, this information should be compiled into an annual report.

This recording should have commenced prior to any pumping but sampling undertaken during the 1966 dry season was curtailed by an extensive fire and was, in any case, unsatisfactory as the sites of the bore holes had not then been finalized. The routine recording should, therefore, commence in 1967 when the fixed points for the photographs and transects should be chosen and marked in such a way that they can be located in subsequent years with certainty. The experience in 1966 demonstrated the desirability of adequate fire protection in this area as soon as possible.

Similar routine measurements should be planned for future water manipulation projects. The pilot scheme will act as a guide, but it should be borne in mind that habitats elsewhere in the reserve may be more sensitive than those around the headwaters of the Ngwezumba river.

The planning of development in parts of the reserve, which would depend upon the use of underground water, is hampered by the lack of knowledge of the quality and availability of such water, or of the use made of saline waters by most species of game. The former requires a proper geophysical survey in areas such as the Mababe depression, which are otherwise suitable for tourist development, and the latter an assessment of the drinking habits of game with access to saline waters. Work, which could be useful in this respect, is in progress in the Wankie National Park and highly mineralized water is used by game in the Kalahari Gemsbok National Park.

There are a number of artificial water holes in the Gemsbok Park in which the degree of mineralization varies, both as regards total dissolved salts and the constituentions (table 25). All appear to be used fairly extensively by wildlife, including wildebeest, gemsbok and springbok. A detailed survey of the actual extent of this use in relation to varying salinities and the status and trends in the vegetation around the water holes would be valuable. The information would be of use in the Chobe Game Reserve, as well as elsewhere in Botswana where it is necessary to provide water for wildlife.

When in flood the Savuti channel and swamp provide water for large herds of game in easily developed country in the western Mababe, but the erratic behaviour of this watercourse makes it inadvisable to base long-term development on its availability. It would be of considerable value to tourism in in the reserve if the channel could be kept open permanently or if water were available in sufficient quantities from its bed, and both possibilities justify investigation. However, the habitats in the vicinity of this water have already been seriously downgraded,and this fact should be taken into account for any management of water in this region.

Thus water manipulation is necessary in order to try and hold animals in the drier parts of the reserve during the dry season, which is the only time of the year when visitors will be able to penetrate these areas. Provision should be made for these artificial water holes to be in clusters so that water can be provided on a rotational basis without destroying the habitat. Regular observations on the effects of water manipulation on animals and their habitats, augmented by information from elsewhere, should provide the basis for greater efficiency in the use of water as a management tool on a long-term basis.

Overpopulations of wildlife

Several examples of wild populations endangering their habitats and those of other species through overpopulation are mentioned in the discussions of individual species. These include more or less resident species, as well as those subject to seasonal movements and the effects are generally most pronounced near permanent water at the end of the dry season. In years of poor rainfall, when pans dry early and the vegetation near the permanent water is least able to sustain the heavy concentrations of game, the damage to habitats can be extensive. The provision of artificial water holes is not likely greatly to reduce the effect and it could actually accentuate it by raising the overall carrying capacity of the region, with the net result of a tendency for overpopulation in the additional areas in which water is provided.

The disturbance of the delicate relationships between animals and their environment, with the possible exception of elephant along the Chobe is mainly attributable to trends induced through past land use or the effects of harmful burning. It would seem preferable, at this stage, to try to stabilize the habitats and, where possible, to reverse the undesirable trends through their protection or management. Where this fails, and the failure is due to the depressive effects of overpopulation, some control of numbers may be necessary in order to assist in reversing the trend beyond a critical threshold.

Such decisions should be based upon adequate information which can usually be obtained easily enough if the problem is acute. A simple syndrome, with evidence from different aspects of the ecosystem, will often specify the basic causes of a problem and so indicate the most appropriate remedial action.

There are three areas in the reserve where overpopulation should be carefully watched. These are: (1) the strip along the edge of the Chobe flats between Kasane and Ngoma, (2) as already indicated, the area in which artificial water holes are to be provided around the headwaters of the Ngwezumba river, including the vicinity of the existing permanent pools,and (3) the western Mababe around the Savuti.

Routine game counts should continue along the Chobe river between June and November, when there should be at least six counts in each month. The standard procedure already in use should be strictly adhered to. Counts should begin from the warden's house at 14.30 hrs. and should follow the following route: west along the main road to Ihaha, then east along the loop roads to where these rejoin the main road at Msikili, counting should then be suspended until the western entrance to the rice paddy field loop. Any game visible on this loop should be included until the main road is reached at Kalwizikankanga. From there counting is again suspended as far as the entrance to the Water-Cart road, but animals along this loop to Sidudu should be noted. Enumeration should be carried out by two observers in the cab of a land rover or a similar vehicle. Game scouts have been trained to undertake this recording on the standard forms illustrated in table 26.

The information gathered in two years was useful for drawing attention to problems needing further investigation and illustrated the seasonal nature of the concentrations of several species along the river. Even within this short period, important differences in the dry-season use of the area emerged and the rapid decline in the number of lechwe was confirmed.

The vegetation along the main road should be photographed periodically to illustrate any marked changes. Fixed-point photographs were taken of the vegetation on each side of the road every half mile for 12 miles, and then every mile for a further seven miles west from the warden's house during the last week in September and first week in October 1965 and 1966. This information should be augmented with step-point transects in critical areas.

TABLE 25

The Chemical Characteristics of Bore Holes used by Game along the Nossob riverbed, Kalahari Gemsbok National Park*

	Bore Holes					
	Rooikop	Kaspers-draai	Dikbaards-kolk	Kijkij	Kameel-sleep	Sekwats
pH.	8.45	8.19	8.40	8.50	8.70	8.80
CO_3^{--}	123	123	184	123	123	215
HCO_3^-	2059	998	811	811	1123	998
Cl^-	1292	3300	4296	4428	10652	14599
SO_4^{--}	1094	1872	2016	2064	4608	7008
F^-	4	5	6	4	7	10
NO_3^-	-	-	-	-	-	-
Total Anions	4572	6298	7313	7430	16513	22830
$K^+ + Na^+$	2205	3350	4135	4175	9595	13344
Ca^{++}	-	33	16	27	-	-
Mg^{++}	17	66	27	31	24	16
Fe^{+++}	-	-	-	-	-	-
Total Cations	2222	3449	4178	4233	9619	13360
TOTAL	6794	9747	11491	11663	26132	36190

*Data kindly supplied by Department Geophysical Surveys, Botswana.

The large increase in elephant in this part of the reserve over the past few years requires urgent attention as already indicated in the discussion on this species.

Wildlife populations built up to a spectacular level when the Savuti channel filled and gave rise to swamp conditions in the west of the Mababe between 1958 and early 1965. Elephant caused extensive damage to woody vegetation and the effects of trampling and overgrazing were widespread in an area which may have been sensitive, due to past use by livestock, as there are several old kraal sites and areas of well grown scrub.

Much of the game died after the water dried up, but numbers are already increasing now that the channel has filled again. Appropriate management will depend upon the future behaviour of the channel, but neighbouring habitats should be checked with the aid of step-point transects at the end of each dry season while there is water. If conditions continue to deteriorate, some form of control might become necessary.

Conclusion

The habitats in the Chobe Game Reserve are still in a fairly healthy state, although signs of early deterioration are widespread, and several game species are already declining numerically. In suggesting a management program the limitations of manpower and funds are recognized. However, unless some action is taken to stabilize the habitats (and to improve those where this can be achieved easily), conditions will continue to deteriorate accentuating the problems and the cost of remedial action.

Considerable emphasis has been placed on recording changes in the ecosystem with the aid of rapid techniques, as this allows trouble to be detected at an early stage when correction is least difficult. It is, for example, a simple matter to extend the intervals between pumpings from a bore hole, when the habitat begins to show signs of deterioration, but much more difficult to reclaim habitats that are seriously downgraded. A decline in conservation values may not always be obvious to begin with, unless the appropriate signs are sought, but vegetation may then collapse suddenly as the deterioration accelerates past critical thresholds, after which it is difficult to reverse the processes.

Fire is undoubtedly an important factor retarding the recovery of the veld from the effects of past land use, and the early protection of the primary tourist areas is suggested along with the modification and management of habitats in these areas. As more staff and funds become available, management should be intensified and spread into other parts of the reserve, by which time the results of observation and management techniques already tested, should provide a basis for ever-improving efficiency.

THE MOREMI GAME RESERVE

This tribal game reserve is a credit to the people of Ngamiland. It is a triangular-shaped area situated in attractive country along the edge of the Okavango swamps between two of the major distributaries of the Okavango delta and has been described in some detail by Tinley (1966). The vegetation ranges from dry deciduous woodland through grassland, subject to seasonal inundation, to true swamp.

The reserve is administered by the Fauna Conservation Society of Ngamiland whose policy is to retain the area in as natural a state as possible, with no buildings inside the proclaimed 700 square miles or so, where development is to be limited to a few crude tracks. It is planned that these should consist of a road following the Kwaai and Mogogelo rivers, above high water, and linked across the base of the triangle by the road

TABLE 26

RIVER ROAD - COUNT FORM

Date _____ Observers _____ Number of Counters __

Time Start _____ Speedo: Start _____ Weather _____

Finish _____ Finish _____

Miles _____

Species	Locality	Habitat	Numbers						Notes
			No	M	F	Yr	C		

along the eastern boundary of the reserve. Loop roads will lead from these on to molapos, which are not currently flooded in any given year, and to places of interest in the drier woodland in the center of the reserve. Development of the reserve may be complicated by the inconvenience and possible dangers associated with the tsetse fly.

Tourists are allowed to drive, walk or camp where they please, but each party is obliged to hire an armed game scout, so that this reserve has much in common with the wilderness concept, in so far as it can be applied under local conditions.

The reserve is gaining in popularity, in spite of its remoteness and the density of tsetse fly in some parts, and is much more accessible now that there is a good all-weather gravel road from Francistown to Maun. The day-to-day administration of the reserve and the control of visitors is undertaken by the members of the Fauna Conservation Society, who have in addition done some useful development work in their spare time. The increase in tourism will place an ever-increasing burden on these public-spirited people and their resignation from the society, which could be necessitated for reasons beyond their control, would lead to a disruption in the supervision of the small staff of paid game scouts. The recent moves to entrust the day-to-day supervision of these scouts to the Game Department is therefore to be welcomed, especially as the Game Department plan to build accommodation and to station an assistant warden on the border of the reserve.

Tinley (1966) confirmed Riney and Hill's (1963) warning that the area now forming the Moremi Game Reserve might need careful management. The area was used for livestock production prior to the reinvasion of tsetse fly and until 1963 was frequently burnt. Two point-line transects run at random along the edge of the Mogogelo molapo in August 1965 demonstrated the low level of the vegetation and the deterioration of conservation values in some parts of the area. This is especially noticeable along the Kwaai river in the northeast of the reserve. Over 2,000 lechwe and 1,000 impala were examined and not one animal was classed as in other than poor condition. This also applied in smaller groups of kudu, waterbuck and wildebeest and in subsequent more detailed assessments of the condition of the adults of several species the majority were very thin, even during the growing season.

Impala, lechwe, warthog and, to a lesser extent, tsessebe and wildebeest, are very numerous and there is extensive elephant damage in some areas. Impala calves were notably small and numbers of these, lechwe and tsessebe young were lower than to be expected in a healthy population.

It is clear that more detailed surveys are needed in this and surrounding areas to examine the apparent overpopulation and the various alternative management techniques which could be tried in order to stabilize the reserve ecologically. Research into tsetse fly suggested by the Tsetse Fly Control Department should be welcomed provided it does not conflict with the objectives for the reserve.

NYAI PAN

Nyai or Paradise pan is situated in the northwestern corner of the Makarikari system. It is about six miles long and four miles wide and is apparently the flat bed of an extinct lake, separated by a series of sand ridges, around the southern perimeter, from the more typically Makarikari element of the Kanyu flats.

The ground is hard and supports open parkland with scattered groups of Terminalia prunioides and occasional baobabs around the western margin and groups of stunted Acacia

tortilis near many of the very temporary seasonal water holes on the surface of the pan. The grasses are generally short perennials such as Panicum repens, Sporobolus sp. and Cenchrus ciliaris, with taller species such as Cymbopogon sp. more conspicuous toward the northeast and Tragus sp. very evident in overgrazed areas near the stock route from bushman pits to Kazungula. As already noted, there is dense bush encroachment along this route dating back to 1949-50. It is most developed along the southwestern and western sides of the pan on lighter soils, and early stages in the development of thickets are clearly visible on the sand dunes to the south.

The pan is an important concentration area for game during the rains when large numbers of springbok, eland, zebra, wildebeest and gemsbok and smaller numbers of giraffe, lion, cheetah, elephant and hyaena focus on it. On one occasion in March 1966 over 2,000 head of game was estimated from a single point. There were some 1,400 springbok, 250-300 eland and over 200 zebra, together with 150-200 wildebeest, over 60 gemsbok and one black-backed jackal.

There have been suggestions from several quarters that this unofficial sanctuary should receive formal status, the latest of which is made by Blair Rains (1967) in "A Land Use Survey of the Northern State Lands, Botswana".

This advisor to Government on the potential for expanding the cattle industry in the northern state lands notes the exceptional opportunities for viewing game in this area and suggests its protection for this purpose. The proposed limits of the sanctuary would be as near the stock route in the west as the veterinary authorities could permit, latitude 19° 45' in the north, longitude 25° 00' in the east and the 20° 00' parallel or the old Maun - Francistown road in the south. An eight-mile wide corridor would link the area with the Botletle from the southwestern corner.

This suggestion forms a very useful basis for negotiation with representatives of other types of land use. It would also be desirable to consider including part of the Kanyu flats, as this is one of the last remaining portions of relatively undisturbed typical Makarikari country. Experience in the Bushman Pits area has demonstrated how very sensitive this type of country is to rapid deterioration through the mismanagement of livestock, and already there are clear signs of accelerating bush encroachment. One cattleman volunteered that this bush had started to become established in one particular part of the Kanyu flats during the past two or three years, since cattle from the stock route began to graze this far from water. The early stages of thicket formation around the northern rim of the salt-pan system, occurs in part of the 80 square miles referred to as 'F' by Blair Rains, in which he suggests a maximum stocking rate of 25 acres per animal unit, subject to the availability of water and to mineral deficiencies, not precluding livestock production. Even this stocking rate may be too high and it would seem advisable to maintain a very close watch for further deterioration in this grassland, irrespective of the primary form of land use to which it is to be devoted.

If the Nyai pan and some of the surrounding country is to become a game sanctuary, and this suggestion is fully supported by the present author, careful attention should be paid to its proper management. The results of the research now being carried out by a Fulbright scholar, into the biology of certain of the large mammals, should be of considerable value in determining this management and the precise limits of the sanctuary. The underground water in most of the area is highly mineralized, and if the management program adopted is to include the provision of artificial water holes, particular attention should be paid to the experience in providing saline water for several of the same species in the Kalahari Gemsbok National Park.

TOURIST DEVELOPMENT IN NORTHEASTERN BOTSWANA

Botswana is well placed to benefit from the rapid growth taking place in international tourism which has doubled to East and Central Africa during the last decade, and is expected to do so again in Central Africa by 1985. It is also in a good position to participate in the rapidly expanding Southern African tourist industry (table 27).

A positive and progressive policy recognizing wildlife as the basis of most tourism to Africa will assure Botswana of an increasing share of this valuable source of foreign exchange. More and more established resorts are becoming saturated, so that there is a very good opportunity for rapid growth in places like the Chobe and Moremi Game Reserves, as the demand for international tours continues to grow. This is well illustrated by recent increases in tourism to Rhodesia, where the value of foreign earnings has increased by 36 percent in two years to R11.2 million in 1965. The Wankie National Park is in a less attractive area than the Chobe Game Reserve, although the two have much in common, especially with regard to their proximity to the world-famous Victoria Falls, so that it is pertinent to note that the number of visitors to Wankie has increased by about 500 percent in 12 years. The value of the revenue now earned by Wankie (R54,452 in 1965) is almost half (49.5 percent) of the entire budget of the northwestern District Council, responsible for Ngamiland and the Chobe District.

Tourism should be coordinated throughout northeastern Botswana in order to make full use of local assets and to attract more visitors for longer periods. The Chobe and Moremi Game Reserves, the Okavango swamp and the proposed sanctuary incorporating the Nyai pan, are complementary in the remarkable diversity of their country and the variety of their wildlife and together offer an attractive combination on a circular tour.

There should also be the closest possible liaison between the Botswana tourist industry and that in neighbouring countries, in order to promote and coordinate tourism on a regional basis.

The following suggestions for development within the Chobe Game Reserve were made with this perspective in mind, particularly with the desirability of linking the Chobe Game Reserve with other tourist attractions in northeastern Botswana through the Moremi Game Reserve. The limited resources upon which a Government can depend for such development were recognized in the staged nature of the program which can be geared to the availability of capital. Considerable participation by private enterprise is envisaged in order to relieve the Government of much of the day-to-day administration of the tourist trade, although it is essential that it should retain very strict control over all private operations. Strict terms and conditions should be written into all agreements which should be prescribed to allow future expansion and avoid stagnating monopolies. If private enterprise is to erect tourist accommodation, agreements should provide for the proper supervision of the siting of all buildings, as well as their construction and maintenance. Minimum standards of service should be prescribed and prices regulated to within reasonable limits. Agreements must also contain an indisputable "wind up" clause and should provide for prompt retribution for any transgression of game reserve regulations.

Development in the Chobe Game Reserve

Present facilities for the public, centered on Kasane, are inadequate and many visitors are satisfied with a short stay in Botswana. There is therefore a pressing need for further development and an improvement in the amenities along the Chobe river, between Kasane and Ngoma.

TABLE 27

The growth in tourism in selected game sanctuaries in Rhodesia, South Africa, South West Africa, Zambia and Botswana

(Figures supplied by: (1) Rhodesian Department National Parks & Wildlife Management; (2) South African National Parks Board; (3) South West African Administration and, (4) Zambian Game and Fisheries Department)

Year	Annual visitors to sanctuaries											
	(1) Rhodesia		(2) South Africa						(3) S.W.A.	(4) Zambia		Botswana
	Wankie National Park	Victoria Falls National Park	Kruger National Park	Gemsbok National Park	Golden Gate National Park	Mt. Zebra National Park	Bontebok National Park	Addo Elephant National Park	Etosha Pan National Park	Kafue National Park	Luangwa National Park	Chobe Game Reserve	Moremi Game Reserve
1934			19.740										
1935			25.807										
1936			29.334										
1937			33.849										
1938			38.014										
1939			32.603										
1940			22.525										
1941			34.168										
-			-										
1946			37.166										
1947			45.465										
1948			58.739										
1949			66.080										
1950			71.279										
1951			82.761										
1952			89.393										
1953	c5.000		85.723						4180				
1954	-		91.106						4340				
1955	-		101.058	3.683			785		6210		549		
1956	11.500		105.183	4.145			805		7268		915		
1957	-		117.187	6.448			737		7141		938		

(continued..)

TABLE 27 (continued)

Year	Annual visitors to sanctuaries												
	(1) Rhodesia		(2) South Africa						(3) S.W.A.	(4) Zambia		Botswana	
	Wankie National Park	Victoria Falls National Park	Kruger National Park	Gemsbok National Park	Golden Gate National Park	Mt. Zebra National Park	Bontebok National Park	Addo Elephant National Park	Etosha Pan National Park	Katue National Park	Luangwa National Park	Chobe Game Reserve	Moremi Game Reserve
1958	15.500	10.975	116.849	6.548			1057		9598		1170		
1959	19.298	15.874	135.740	4.133			927		9872		1347		
1960	15.913	18.638	137.113	4.769			-		12690		1252		
1961	12.280	13.226	152.465	5.114			-		10729		2292		
1962	14.393	c35600	153.871	4.620		1.707	-		12118	2055	2022		
1963	20.244	c 35.200	180.044	5.562		1.521	8.562		23478	2053	2795		
1964	22.559	35.216	220.579	5913	12.844	2933	9.996		32537	2053	1999		340
1965	25.351	35.134	255.398	5.924	15.887	5120	12.140	38.382	33346	-	-	2578	780
1966	-	-	264.596	-	-	6338	12.645	34.105	36584	-	-	2995	1560
% increase last 2 years	12.4	-*	3.5	-	23.6	23.7	4.1	-	9.7	-	-	15.0	** 50.0
% increase last 4 years	76.3	-*	46.9	28.2	-	31.66	32.2	-	55.8	-	-	-	-
% increase last 8 years	63.5	220.1	94.9	-	-	-	1470.8	-	270.5	-	113.1	-	-

*Expansion limited by accommodation

**Approximately calculated from entrance fees.

Kasane should be looked upon mainly as a family holiday resort offering good hotel accommodation and residential plots, with the emphasis on fishing, and game viewing, and also water sports on the Chobe river between the game reserve and the Chobe rapids. The construction of a nine-hole golf course, between Kasane and Kazungula, would do much to attract and hold guests to the Chobe River Hotel. The efforts of this establishment to provide more accommodation and proper housing for its staff, should be encouraged. Attention should also be paid to the aesthetic appeal of the area around the hotel and approaching the northern entrance of the game reserve.

High-class accommodation and a camping site are needed at Serondela. The Government's intention to attract private enterprise to construct and operate the former and its plans to build the latter during 1967 should be of immediate benefit. It will also be necessary to demolish most of the existing shacks as soon as their leases expire. These developments will more or less saturate the area along the Chobe, and no further building should be permitted, except along the ridge between the game warden's house and Kasane, and west of Ihaha, where there is scope for two small tourist camps, together totalling not more than 40 beds.

Highway A72 needs to be rerouted further from the Chobe river between Kasane and Ngoma. This road was gazetted as a public road by Government Notice No.5 of 1960. At the time it was a primitive track, but with the establishment of the game reserve it was brought up to a standard suitable for use by saloon cars, by means of a R20,000 Colonial Development and Welfare grant to the game reserve.

The amount of traffic along the road has increased from a trickle in 1960 to over 8,000 vehicles a year, of which over two thirds are commercial vehicles, including heavy lorries, and only 27 percent of the vehicles belong to tourists visiting the reserve. The road is now the main access route to the eastern Caprivi from the south, and much of the traffic is fast moving.

The question of rerouting the road has been considered by several economic missions, and has generally received a fairly low priority, owing to the considerable cost of building an alternative road of similar standard. Nevertheless the present use of the road is incompatible with the interests of the national park. Through traffic is often noisy, impatient and disturbing to game and game viewers; it uses the road at all times of day and night, there has been an increase in road kills (including an elephant calf, bushbuck and smaller species), and is disfiguring the verges for a distance of over 50 yards with a heavy mantle of dust. A land rover travelling at less than 15 miles an hour produces very little dust, but at 20 miles an hour visibility is impaired for several minutes after the vehicle has passed. This is especially noticeable toward the end of the dry season. The road is already deteriorating as heavy transport breaks through the nine foot wide gravel strip, or destroys its edges, and as the road becomes progressively more corrugated it forces all traffic to speed up in order to ride these corrugations.

An alternative route from four to eight miles from the river has been selected and should be opened up as soon as possible. As a purely interim measure consideration could be given to making speeds in excess of 20 m.p.h. along the present road difficult, through the construction of artificial "hazards". All through traffic could be required to carry permits stating the time of entry at Ngoma or Kasane and should be penalized if it reaches the other end of the reserve in under a specified time. Finally, the road approaching Ngoma should not be improved until an alternative route is open.

There is also scope for an additional 50 miles of game-viewing tracks in this area, to further reduce the pressure of traffic on the roads in this, the most attractive part of the Chobe Game Reserve.

An early start is needed with development in other parts of the reserve as even with the improved amenities indicated above, it can be expected that the river front will become saturated within two to four years, particularly if a full-scale advertising program is mounted to publicize the reserve. It should be noted that until now the Game Department has been reluctant to advertise for fear of attracting more visitors than could be catered for, as this would be undesirable at this stage in the reserve's history.

Development away from the Chobe will depend largely upon the management of artificial water holes and should begin around the headwaters of the Ngwezumba river where the six bore holes are already being drilled. This area is some 40 miles south of Serondela and could support a fair sized rest camp and camping site along the northern edge of the Kakulwani plain near the Gokora pan. About 150 miles of inexpensive dry season game-viewing tracks could take advantage of hard ground in this attractive country, and in the eastern extension to the national park, where there is a mosaic of open plains, mopane veld, libalas and mixed Kalahari woodland. Game is already reasonably plentiful and should soon become conditioned to tourists, and the provision of inexpensive game-viewing blinds on the high banks overlooking the Ngwezumba pools would provide an added individualistic attraction.

From Ngwezumba bridge the main arterial road should follow hard ground along the river to link up with the present Kasane - Maun track near Tsotsoroga pan, and then follow this track on hard ground, through the proposed southern extension of the game reserve to the vicinity of Mababe village. Here it would turn west, through some sand, to the Moremi Game Reserve, a total distance of about 150 miles. A second road could go west from Tsotsoroga to the Savuti, but would have to traverse some soft sand in order to reach the Linyanti swamp. About 250 miles of game-viewing tracks could be laid, mostly on hard ground, in and around the Mababe depression.

There is room for three camps, two large and one small, in the Mababe but, although attractive sites could be suggested, the siting of camps will depend upon the occurrence of underground water, including potable domestic supplies. A preliminary survey undertaken near Tsotsoroga indicated only highly saline underground water, although there were indications of fresh water about five miles up the Ngwezumba valley away from the lip of the Mababe. Fresh water can be obtained from the sands in the Gxlegcauka plains, well into the dry season in most years and there is of course a good supply of fresh water at the Savuti when the channel is in flood. Bore holes sunk in the past near Jovorega suffered from fine silt which harmed the pumps, and all but one were brackish. This exception, thought to have been near the pan, yielded a weak supply of sweet water.

Administration

Any plans for tourist development should make provision for advertising and for the safety of visitors in the reserve. Meticulous care is needed with the signposting of all roads with elephant-proof signs, and all tourist movements, whether by road or air, will have to be coordinated and controlled to avoid visitors being stranded in remote and waterless areas. This will eventually mean a network of check points in radio communication with headquarters and staff and vehicles to assist people in difficulty.

Summary of Priorities for Development

Administration (offices, staff accommodation etc.), communications (roads, tracks, radios and airstrips) and water manipulation (bore holes etc.) would be the responsibility of the Government, which might then lease sites for tourist accommodation or, if funds allow, erect such accommodation and lease these buildings, camp sites, etc.

The following was the order of priorities suggested:

1. To provide for: (a) improved amenities in Kasane, (b) a high-class rest camp or lodge and a camp site at Serondela, and (c) additional game-viewing tracks in this area. At the same time work should begin on: (d) the road to Ngwezumba, (e) the rest camp to Gokora pan, (f) 150 miles of game-viewing tracks in this area, and (g) inexpensive blinds at the water holes in the river.

2. (a) To construct between 80 and 120 miles of road down the Ngwezumba river and into the Mababe depression, (b) to allow for water manipulation in the Mababe, (c) to allow for one camp and 100 to 150 miles of tracks in this area.

3. (a) To continue the main road through the Mababe to the Moremi Game Reserve and, depending on 2 (b), to construct two additional camps and further game-viewing tracks in the depression.

Note: Landing strips should be provided at tourist centers and administrative facilities should develop with roads, water manipulation and tourist areas.

MOREMI GAME RESERVE

The Fauna Conservation Society's aim to prohibit building within the Moremi Game Reserve is a worthwhile objective, but consideration should be given to allowing tourist accommodation just beyond its borders on the Kwaai and/or Mogogelo rivers.

This reserve would form an impressive link between the Chobe Game Reserve and the Okavango swamps, where early indications suggest there is a valuable potential for a unique type of safari. Operators pioneering this aspect of the tourist industry are worthy of continued government encouragement.

There is some heavy sand on the unmaintained track between Moremi and Maun, but the distance is only 50 miles. It is possible that a separate track for the exclusive use of light traffic would bridge this gap in a circular tourist route through northeastern Botswana, as there is a good all-weather road from Maun to Francistown.

This road passes through attractive plains country with scattered palms around the northern fringe of the Makarikari depression and the overall itinerary would be enhanced if the journey could be broken in a sanctuary at the Nyai pan. The country is very different from that so far discussed and a visitor would be introduced to springbok and gemsbok for the first time.

NYAI PAN SANCTUARY

Development in this area will depend upon the outcome of decisions relating to the future status of the area but, if retained for game viewing, it could support a reasonably large rest camp.

CONCLUSION

The popularity already enjoyed by the Chobe and Moremi Game Reserves, which have hardly been advertised, is testimony for the potential value of tourism, based on wildlife in northeastern Botswana, suggested by the rapid recent development of the industry in neighbouring states.

The Chobe Game Reserve in particular, and the region as a whole, are well placed and have the necessary attractions to share in this local manifestation of the world-wide increase in tourism. The Chobe Game Reserve is close to the Victoria Falls, has attractive country along the Chobe river, as well as in the east of the reserve, and in the Mababe depression, and has a wider range of large mammal species than any other sanctuary in southern Africa. If integrated with the Moremi Reserve on the edge of the Okavango swamps and the Nyai pan area in the Makarikari system, it would provide a valuable attraction for overseas visitors and the increasing flow of holidaymakers resulting from South Africa's rising prosperity.

PART III

SAFARI HUNTING

Organization

Safari hunting, based on the provision of expensive exclusive hunting tours organized by private companies, was introduced into Botswana in 1962. Even in the short time that has elapsed since then, this industry has developed into a valuable source of foreign exchange and direct revenue. The total direct revenue earned from hunting licences and hunting concession area fees amounted to approximately R80,000 of which R54,600 was derived through the safari companies. This included some R10,000 collected by district councils and R70,200 taken in concession fees and package licences, and compares with a total Central Government expenditure on the Game Department of R60,221.

Hunting is based on a system of concession areas in which the exclusive hunting rights for non-residents are leased to the companies operating the safaris (figure 3), on a pro rata cost basis, depending upon the maximum number of clients who may hunt in the area at any one time. There were seven companies registered in 1966.

The system has several advantages in that it is easy to administer and, by granting concessions for a number of years, encourages the companies to undertake certain types of development in their areas, required in terms of their agreements. This has resulted in the clearing of several airstrips and the opening up of dry season tracks. There are, however, weaknesses as not all operators have equally attractive hunting areas or ready access to the full complement of species on offer. Further, it threatens to restrict the number of firms which can be accommodated and so reduces competition.

These difficulties are only partially alleviated by the provision of "free areas" in which any non-residents, including the clients of safari companies may obtain permission to hunt, and the creation of three forms of package licences, which are designed to cater for the various regions in the country. In spite of the free areas, several firms are experiencing difficulty in obtaining the full range of species they require, while in other concessions there is an abundance of these same animals. Package licences tend to limit the numbers of any species which may be shot to the permissable off-take in the area, for which the licence is applicable, to the species which is least plentiful. The number of licences which can be sold is consequently limited by the maximum crop that can be taken from the most critical species on the licence. While the provision for supplementary licences, to increase the maximum bag for some species, does allow some flexibility, this does not permit an increase in the number of clients allowed in the area.

If concession areas were sub-divided into smaller units and tenders were invited for these units, it would overcome most of these difficulties, especially if the maximum off-take to be allowed from each area were set in advance. It would also assure the Government of a fair rental. The objection that this might curtail development by the companies could be answered by making allowance for such development when awarding the tenders for the subsequent period.

Control

The permissible crop from any wild population is governed by two factors. The first is the rate at which the population can replace the segment or segments being culled. This is obviously usually much lower for acceptable trophies than the actual recruitment rate for the sex and age class providing these trophies, as many individuals will be substandard in the eyes of the sportsman. The second limiting factor governing the off-take is the degree of control which can be exercised.

I would be beneficial to the Government and the safari companies, and to the long-term survival of the industry in the face of competition from conflicting forms of land use, including other types of hunting, if the throughput of clients could be raised. This requires more biological and administrative supervision, as wildlife is a sensitive national asset, the control and management of which should not be entrusted to private concerns which are bound to be motivated by relatively short-term prospects. It would be unrealistic to expect anything else from efficient business organizations operating under more or less restricted leases.

One of the major drawbacks to the present system, excluding those already discussed, is that it is difficult for the Game Department to guage accurately the game situation in the concessions without the close cooperation of the concessionaires. In particular it is important that the companies should supply regular standardized information on their hunting successes on an area by area basis.

It was therefore suggested that the Government should request or, if necessary, require the companies to comply with the following recommendations:

1. Professional hunters should complete the return illustrated in table 28, following each separate visit to a specific area. This is little enough to expect, especially if the forms are supplied in a convenient sized tear-out book. At most a hunter might have to complete one return at the end of a day's hunting, although generally only one would be needed after several days' sojourn in a given area.

2. The hunter should complete the return before leaving the area, and this should be a condition of his licence. In any case the forwarding of the returns should be the responsibility of the concessionaire, and a factor influencing the renewal of concessions.

3. Such a recording system, which is designed to place least burden on the Game Department and to cause the minimum inconvenience to hunters, requires that the limits of the recording areas remain completely unaltered. It would, therefore, seem advisable to subdivide the present large concessions into sub-units for this purpose at least, in order to allow maximum flexibility. Whole sub-units could then be changed from one concession to another, or reserved for some other form of land use, without invalidating all past records from an area or areas. These subdivisions should be based, as far as possible, on natural features and the use of arbitrary lines on maps avoided. Not only will this make location on the ground simpler, but a division along ecological lines is more likely to fit in with changes in land use.

The Game Department would naturally be responsible for ensuring that accurate records are kept and as much checking as possible should be done in the field. The system is designed to detect changing trends which may require further investigation and will not, therefore, yield results until it has been in operation for a number of seasons.

In conclusion, it should be noted that, although fuller information would be desirable, this rather crude system is designed to supply the Game Department's minimum needs for perpetuating the industry on a coordinated basis. The data should provide for improved efficiency and will supply factual evidence to bolster the case for this type of hunting, as and when conflicts arise over land-use policies. This point was emphasized during the recent survey into the expansion of the cattle industry in the Northern State Lands on which the author was requested to represent wildlife interests. These facts might be stressed while attempting to solicit the willing cooperation of the safari firms.

Hunting by Tribesmen in Concessions

Hunting by tribesmen in the concession areas is of concern to several of the companies and should be controlled especially where it involves non-residents of the particular area. New legislation recognizing the importance of subsistence hunting to many of the rural people, but seeking to control commercialized hunting or hunting by people with other adequate means of support, is a very progressive move in this respect.

Further Surveys of Concessions

It was not possible during the present assignment to survey the concession areas in northeastern Botswana adequately, and more work is needed to determine the status and trends in the wildlife populations and their habitats, particularly in areas away from the Chobe Game Reserve. In those areas which have been sampled, safari hunting is not a threat to the survival of most species, although in several cases deterioration of the habitat is. The usual pattern is a decline in the selective grazers accompanied by an increase in some of the browsing species, a number of which reached a peak in an eruptive phase and died in large numbers during the dry season following poor rains in 1965/66.

Such factors are important for determining the relative crop permissable in an area from a given species. It is unlikely that intensive management will be possible in the concessions for many years to come, but it is in the interests of the safari companies to limit burning, particularly early in the season. There are, however, certain circumstances in which restricted fires may be allowed under the strict control of the Game Department. These include the burning of small patches of swamp for the hunting of sitatunga, and of very limited areas of tall grassland, but in all cases particular attention should be paid to the need to rotate such burning. Similarly, where companies wish to provide artificial water holes, this should be encouraged only where there is adequate provision to ensure that the surrounding habitats are not decimated.

Lion - a Valuable Problem Animal

The existence of the safari hunting industry is largely dependant upon the availability of adequate lion to enable a reasonable proportion of the clients to obtain a satisfactory trophy. On the other hand, the species is in conflict with livestock production and stock owners have the right to protect their property. The problem is emphasized on the fringes of important ranching areas and along stock routes through some of the major concessions, and there is no question that certain people delight in the opportunity to shoot as many lion as possible on the pretext of defending livestock.

The species has disappeared from much of its former range in southern Africa, and needs adequate protection in the concession areas, but, more especially it needs protection from unnecessary persecution in marginal ranching areas. Where it is necessary to kill troublesome individuals, the extent of the hunting should be tempered with the knowledge of the species value to the national economy.

TABLE 28

AREA REPORT - SAFARI HUNTING

(GAME RETURN)

Professional hunter's name _____ Company _____
Date _____ Concession Area _____ Number of guns _____
Length of time in area _____ days hunting. Number in party _____ (1)
_____ days not hunting.
_____ total
Reason for days spent not hunting: moving camp, illness, licence full, photographing, resting, (2)
Rounds of rifle ammunition expended _____

Species	Number on licence (3)	Number required by client (4)	Number shot or wounded	Number shot at and missed	Size (5)	Remarks
Elephant Lion Buffalo Sitatunga Kudu Bushbuck Roan Sable Impala Gemsbok etc. etc.						
Total						

(1) Number of guns under the guidance of the individual hunter.

(2) Delete whichever not appropriate.

(3) Number covered by original licence(s) including supplementary licences taken out while in the area, should be indicated in brackets adjacent to the original number.

(4) Indicate client's aspirations when entering the area, even if more game is shot, and any trophies subsequently shot on supplementary licence should again be included in brackets.

(5) Size. Given horn length in the case of antelope, the total weight of both tusks in the case of an elephant (note if single tusker), tusk length for pigs and total length for other trophies. All measurements to be done according to the standards laid down in Rowl and Ward, except that all measurements will be done on fresh material.

Conclusion

There is a considerable potential in Botswana for earning valuable foreign exchange from recreational hunting, but this requires adequate protection of the sensitive, renewable, natural resource on which it is based. One of the best ways of realising this potential is by fostering the safari hunting industry, which should be encouraged to expand within the limitations imposed by the biological productivity of the species providing trophies and the Game Department's ability to supervise such hunting. This requires certain essential basic data and greater flexibility than can readily be achieved with large corporate concessions, and a limited range of package licences, which preclude an optimum off-take from the majority of species.

PART IV

GAME RANCHING

Introduction

Recent moves to organize game ranching, or the culling of wild populations for the production of protein and other useful animal products on a sustained yield basis in southern Africa, have often been mistaken as advocating a revolutionary form of land use. In fact, they are an attempt to rationalize the oldest type of land use known to man in the light of modern knowledge and developments, and in the face of increasing human populations.

The importance of hunting by the residents of Botswana to the general economy of the country, and in particular its importance in some of the poorer rural areas, should not be underestimated, nor should the continued productivity of the extensive large mammal populations be taken for granted. In some parts subsistence hunting provides the major source of protein in the diet of the people, and a recent FAO report (Amaral, 1965) estimated that about a quarter of the animal protein consumed in Botswana was derived from wild animals. Their skins and hides provide almost the only source of income to the peasants in some parts, while the collecting of bones found in the veld is also important in others.

It is difficult to place a monetary value on this industry as there is hardly any separate record for the sale of game products, and those figures which are available are scattered. Further, it is difficult to judge its true significance to sectors of the community which have not as yet developed a cash economy. There are, however, several indications, such as the results of surveys undertaken on the feeding habitats of bushmen (see for example Silberbauer, 1964), the growing importance of sales of hides and skins, the obvious profitability of the sales of dried meat in settlements such as Maun, and the importance of wild animals as a source of food especially in dry years in many areas. It would be well worth attempting to evaluate the gross annual value of these activities in Botswana.

Game ranching, under prevailing circumstances, can be divided into two aspects: the production of saleable protein and the production of saleable by-products, particularly the trade in hides and skins.

Hide and Skin Trade

This trade has been important in large parts of Botswana for many years and could provide the basis for an increasingly valuable secondary industry. This will require the proper supervision of the business, for which it is essential to have adequate information upon which to base administrative and biological control.

There is legal provision for traders to submit regular returns of their dealings, but this does not appear to have been enforced. There is also a fair amount of useful information scattered about the country in the records of trading companies and Government Departments. For this reason the Government has sought assistance with a survey to collect

and collate this information, with a view to determining its usefulness and, if necessary, suggesting modifications of the form in which it should be regularly submitted in the future. This study is at present being carried out by Dr. von Richter.

The information required of dealers should be designed to facilitate strict legal control and to provide an indication of changing trends in the most important populations harvested for their skins, so that safe yields can be set. The first calls for the closest possible cooperation between the game authorities and the Veterinary Department, which is responsible for regulating the movement of animal products, both within the territory and for export.

The determination of safe yields also requires a better understanding of the species' biology, so that appropriate investigations along these lines would form a logical second phase to the suggested survey. In several instances it would be a matter of relating the existing knowledge of a species' biology to local circumstances, while for other species there is a need for original research into their habitat requirements, productivity, growth rates, etc. Appropriate means of hunting or trapping should also be investigated and, if possible, the best methods of curing and storing skins should be tested and demonstrated to the local people, as current wastage through the improper treatment of hides and skins is high.

A rapid increase in the prices offered for many skins during the past 12 months, makes such a survey and the proper organization of the industry rather urgent. While the prices indicated in table 29 are to be welcomed, for the greatly increased amounts paid to the primary producer who in many cases are villagers in remote areas, they do constitute a double-edged weapon. For perhaps the first time, the large-scale hunting of animals for their skins alone is now possible on a commercial basis.

The above remarks apply to the hide and skin trade in general. It is equally important that the history and continued exploitation of crocodiles in the Okavango swamps should be documented.

Commercial Protein Production

Wild populations of large mammals can be made to yield valuable quantities of highly palatable protein on a sustained-yield basis, in much the same way as fish populations for example. In theory, a spectrum of wild animals, that have evolved under native conditions, is more efficient in the production of meat and less destructive to its habitats than one or more introduced species. In fact this is the case in many marginal lands, such as extend over much of Botswana and where current livestock production is leading to serious veld deterioration.

There are, however, several difficulties to putting this meat into the cooking pot on a commercial scale. Neither should the following brief discussion be construed as suggesting that the valuable cattle industry should be replaced by wildlife. Rather, it is intended to draw attention to the possibilities for integrating the use of wild animals into the production of saleable protein. This might take the form of using one or more species, along with livestock, in order to diversify the harvest from an area, so as to raise profits, or so as to reduce the primary crop in order to allow the area to heal from past malpractices; or certain species of wildlife, particularly browsing forms, may be allowed to replace livestock, at least temporarily, while areas that have been seriously downgraded are allowed to recover; or wildlife may provide the primary crop in areas which are unsuited to livestock through being too sensitive to trampling etc., lacking suitable water or through the presence of tsetse fly. In any case the systematic elimination of game, as has also been suggested, would be a retrogressive move in the wise exploitation of the nation's natural resources.

TABLE 29

Prices offered for top-quality hides and skins in Botswana*

Species	Price
Zebra	R15.00
Lion	R30.00
Lioness	R15.00
Leopard	R70.00
Cheetah	R20.00
Serval	R 2.00
Otter	R 1.50
Springbok	.70c
Impala	.70c
Kudu	R 1.50
Wildebeest	R 1.50
Hartebeest	R 1.50
Tsessebe	R 1.50
Wild cat	.25c
Red cat	.50c
Genet	.25c
Jackal	.50c
Silver fox	.50c
Bat eared fox	.25c
Zorilla	.25c
Ostrich skin	R 1.50
Ostrich eggs	.15c
Ostrich feathers	.50c per lb.
Elephant tusks (ivory)	R 1.15 per lb.
Elephant ears	R 3.00
Elephant feet	R 6.00
Elephant tail hairs	.02½ each

* Kindly supplied by Botswana Game Industries (Pvt) Ltd.

Hunting associated with the control of tsetse fly in one small area around the fringe of the Okavango swamps led to the destruction of 60,638 head of game in 23 years without endangering most of the parent populations (Child et al, Ms). This hunting produced 4,702 animals from over a dozen species in 1964 alone. While the hunting did not only cull populations resident in the primary hunting area of about 220 square miles, it did demonstrate the high productivity which can be expected around the fringe of the swamps. At current prices in neighbouring Rhodesia (Roth, 1966) the meat and skins, if properly processed, would have been worth over R95,000 (table 30). A lower productivity could naturally be expected from drier areas, but here there are also species such as springhares, which have proved very saleable in Rhodesia, and other smaller species, whose pelts are valuable and which were not included in the above calculation.

Problems which will probably be encountered by any large-scale operations include the transportation from remote areas over poor roads, of fresh or processed meat, for which a market would have to be found. There would also be questions of health inspection and the possible spread of livestock disease, and the need for developing harvesting techniques applicable to local conditions. Some of these problems would be answered by converting the wild animals into a powdered form of stock feed, as has been suggested, but this would seem a highly inefficient method of transforming herbage into saleable protein.

Recommendations

Every encouragement should be given to the controlled commercial exploitation of wildlife populations, especially to the production of hides and skins. Schemes for the production of protein might begin on a small scale, with the object of developing local markets in order to release more beef for export, although in so doing they would have to compete with the very low prices of meat from livestock. Elaborate schemes should receive support only where there is every indication that they will succeed, as expensive failures may further seriously retard the development of the industry.

Very close cooperation should be sought, at an early stage, with the health and/or veterinary authorities, in order to coordinate and control the industry along sound lines. The possibilities for integrating wildlife utilization with other forms of land use should be fully explored and, in this context, it is important to educate people into recognizing the significance of individual species, instead of the whole range of wild animals under the composite title of "game", as some species may create problems while others, including some of the smaller ones, may provide the opportunity for increasing the value of farming ventures.

TABLE 30

Value of meat and skins of animals shot on Tsetse Control on the Maun Front in 1964 according to the lowest ruling prices in Rhodesia (after Roth (1966))

Species	No. shot	Mean dressed carcase weight in lbs.	Weight of dressed carcases in lb.	Prices (in sh)	Value of shot game £ s.d.	Price per skin (in sh)	Value of skins £ s.d.
Buffalo	618	650	401,700	1/3	25,106.5.0	40	1,236.0.0
Kudu	385	250	96,250	1/3	6,015.12.6	25	481.5.0
Wildebeest	50	263	13,150	1/3	821.17.6	25	62.10.0
Tsessebe	40	190	7,600	1/3	475.0.0	25	50.0.0
Impala	617	60	37,020	1/3	2,313.15.0	7	215.19.0
Reedbuck	531	85	45,135	1/3	2,795.18.9	7	185.17.0
Warthog	916	70	64,120	1/3	4,007.10.0	4	183.4.0
Duiker	1067	21	22,407	1/3	1,400.8.9	2/6	133.0.9
Steenbuck	376	115	4,324	1/3	270.5.0	2/6	47.0.0
Lechwe	28	109	3,052	1/3	190.15.0	7/6*	10.10.0
Zebra	38	418	15,884	0/9	595.13.0	440	836.0.0
Other large antelopes**	13	230	2,990	1/3	186.17.6	25*	16.5.0
Total	4679	-	713,632	-	44,180.18.0		3,457.10.9
Total value of meat and skins						47,638.8.9 R95,276.88	

* estimated value

** includes sable, etc.

PART V

GENERAL

In terms of the request of the Honourable Mr. A.M. Dambe, Minister responsible for Wildlife, in August 1965, and subsequent requests from the Ministry, mention is made of several wildlife matters which,although not directly concerned with the present survey, were pertinent to it.

Reorganisation of Game Department

The strengthening of the Game Department at all levels was one of the major recommendations suggested by Riney and Hill (1963). This led to the appointment in 1965 of a Game Advisor, by the Ministry of Overseas Development, London, to advise Government on the organization of the Game Department. It has not been possible to effect all the recommendations proposed by Kinloch (1965 a and b), for financial reasons, but there has been a very welcome improvement in the staffing and equipping of the Department, culminating in the appointment of a Chief Game Warden, under the OPEX Scheme.

The Department consisted of one Senior Game Warden, three Wardens or their equivalent, one Assistant Warden and 31 junior members of the permanent staff in 1965, all of whom were poorly equipped, especially with regard to transport. The establishment was strengthened by the appointment of the Chief Game Warden, one additional warden and 5 junior officers in the first half of 1967, and the whole Department had better equipment.

The Department is still very small for the many and varied duties it must perform in a large area, but the amount of growth which has taken place is encouraging evidence of the Government's real desire to foster the wildlife industry. This is also borne out by recent legislation which will make the task of administering the resource much easier.

Inservice Training

This report places considerable emphasis on the need for more knowledge as a basis for defining biological or other problems pertaining to wildlife and its relationship with other forms of land use, and for promoting better supervision of the various aspects of the industry. Much valuable information can be obtained by all ranks of field staff, if they are made aware of this need and if standardized methods of reporting are devised. Several of the wardens have undertaken extensive surveys and have detailed knowledge of remote parts but, unless this information can be made readily available, it is of little benefit to the Department. It is, therefore, strongly suggested that a system of regular in-service training should be instituted.

Such training should cover, by stages, all aspects of an officer's duties and should introduce him to the overall objectives of the Department and of wildlife conservation. The possibility of obtaining help with this training from such institutions as the United Nations Development Program sponsored College for African Wildlife Management at Mweka, Tanzania, should be explored.

Research

Some excellent research work has been concluded or is in progress on various aspects of the biology of Botswana. This includes faunal and floral surveys as well as more detailed work on the life histories and the behaviour of several important species. Studies worthy of particular mention include those of the Fulbright Scholar, presently working on large and small mammals in the Botletle river - Nyai pan area, and the Botswana Mammal Survey being done under the auspices of the National Museums of Rhodesia.

The latter is partially financed from Botswana and is being undertaken in cooperation with the Game Department, the Smithsonian Institute in the United States, and several other individuals and organizations. The present assignment, for instance, has been instrumental in contributing some 3,000 specimens of large and small mammals. The mammal survey is now approaching completion and is a good example of the usefulness to Botswana of this type of cooperation. Not only will it provide a good indication of the distribution of mammals and of certain aspects of their biology, but it has acted as a focus for other valuable information. It has also provided an organization to which two Fulbright Research Scholars could be assigned.

It is the Game Department's policy to continue to encourage biological research, although it will only be able to give active assistance to a limited number of workers investigating problems of particular interest to the Department. It is, however, important that all such research should be coordinated and that the Department should be fully aware of its aims, progress and results.

The author was honoured by the Minister, the Hon. Mr. J. Haskins, with a request for ideas as to the conduct that could be expected of visiting wildlife research workers. It was suggested that they would naturally be expected to comply with all regulations applying in their study areas, or where special exceptions were made on their behalf, to adhere rigidly to the provisions of such exceptions. The onus should rest with them for obtaining approval for any actions which are not normally permitted to ordinary members of the public.

A proper system by which workers notified the Department of their intentions and then periodically reported on their activities was advocated. People intending pure research or entering the country without specific terms of reference agreed to by the Government, should be required to submit detailed work plans within a reasonable time after arrival. These would naturally be flexible, but would specify the proposed study and would serve to inform the authorities and others interested in the field of work planned or in progress, so minimizing unnecessary duplication.

These plans should describe the objectives of the investigation, its value (which may be purely theoretical), the methods to be tried, and the personnel to be employed or whose assistance and cooperation is to be sought. The opportunity is then provided for the Government to assess which projects merit assistance and which it might be inadvisable to attempt. This can be beneficial to the worker as it frequently prompts suggestions from people familiar with local conditions.

It is also very desirable that researchers should report their progress periodically, in relation to their work plans, by a method appropriate to the type and duration of their investigation. The plans may be modified or new ones suggested and there should be an indication of the worker's program for the next period in the field.

All investigation should culminate with a report or reports the form of which will vary from reports to the Government to technical papers appearing in scientific journals.

It would be natural to expect several copies of such reports or papers to be lodged with the Game Department and in the case of results the publication of which will be delayed, a somewhat detailed account should be supplied in advance. The last could take the form of an elaborated final progress report.

Two points have arisen since these recommendations were made. The first is the need for retaining in an accessible form useful observations, which a research worker may not wish to publish himself, but which may be valuable to others. The Botswana Game Survey cards, on which selected members of the public have contributed to the knowledge of the fauna, could readily be adapted for this purpose.

The second and greatest need is for a small organization cataloguing the documented results of past surveys and investigations, in order to save duplication. A great deal of valuable work has been undertaken by people in a variety of disciplines from time to time, since the first missionaries entered what is now Botswana, but their writings are difficult to trace, even when they are known. This disadvantage has been expressed by members of at least two Government Departments and it is to be hoped that the recently established Government Archives,or some similar organization, will be able to cater for this need.

LITERATURE

The following list includes literature cited in the present report and in addition, some of the most useful works consulted during the survey, including papers describing techniques.

Allee, W.C., A.E. Emerson, O. Park and K.P. Schmidt: Principles of animal ecology.
1961 W.B. Saunders & Co., Philadelphia. 837 pp.

Amaral, C.J.: Report to the Government of Bechuanaland on the food supply situation.
1965 FAO report No. 1972.

Anderson, C.J.: Lake Ngami. London.
1856

Anonym Utilization of wildlife in developing countries. Cyclostyled Proc.
1964 International Conf., Bad Godesberg. 172 pp.

Anonym The conservation of natural resources. UNESCO Chronicle 2 (8).
1965

Anonym Report of the Technical Commission VIII (of World Forestry Congress
1966 Madrid 6-18 June, 1966). Cyclostyled 3 pp.

Anonym Budget 1966/67 estimates of revenue and expenditure for the year 1966-67.
1966 Cyclostyled Bechuanaland Govt. 98 pp.

Anonym Estimates for development fund 1966/67. Government Printer,
1966 Gaberones. 62 pp.

Ansell, W.F.H. Mammals of Northern Rhodesia. Government Printer,
1960 a Lusaka. 155 pp.

_____ The breeding of some larger mammlas in northern Rhodesia Proc.
1960 b Zool. Soc. Lond. 134 (2): 251-274.

_____ Additional breeding data on northern Rhodesian mammals. Puku
1963 (Occ. Pap. Dept. Game and Fish. N. Rhod.) I: 9-28.

Asdell, S.A. Patterns of mammalian reproduction. 2nd edition.
1964 Constable & Co. London. 670 pp.

Baines, T. Exploration in Southwest Africa. London.
1864

Bi Gourdan, J. Le Phacochère et les suides dans l'ouest Africain. Bul. Inst.
1948 Fr. Afr. Noir, Dakar. 10: 285-360.

Boughey, A.S. A check list of the trees of southern Rhodesia. J.S. Afr. Bot.
1964 30 (4) : 151-176.

Brand, D.J. 1963 Records of mammals bred in the National Zoological Gardens of South Africa during the period 1908-1960. Proc. Zool. Soc. Lond. 140 (4): 617-659.

Campbell, A.C. 1965 Report on the census of the Bechuanaland Protectorate 1964. Bechuanaland Govt., Gaberones.

Child, G. 1964 Growth and ageing criteria of impala (Aepyceros melampus) Occ. Papers Nat. Mus. S. Rhod. 27B: 128-135.

_____ 1965 Behaviour of large mammals during the formation of Lake Kariba. Ph.D. Thesis U. of Cape Town.

_____ 1966 An interim evaluation of the conflict between the Forest and Game Department's interests in the Chobe District. Cyclostyled report to Botswana Govt. 13 pp.

Child, G. and C.R. Savory. 1964 The distribution of large mammal species in southern Rhodesia. Arnoldia (Rhod.) I (14): 1-15.

_____ 1964 and V. Wilson. Observations on ecology and behaviour of roan and sable in three tsetse control areas. Arnoldia (Rhod.) I (16): 1-8.

_____ 1965 L. Sowls and B.L. Mitchell. Variations in the dentition, ageing criteria and growth patterns in wart hog. Arnoldia (Rhod.) I (38): 1-23.

_____ H.H. Roth and M. Kerr (Ms). Patterns of reproduction in wart hog.

_____ P. Smith and W. von Richter (Ms). The effectiveness of tsetse control hunting in the elimination of game from an area in Botswana.

_____ and C.P. Hepburn (Ms). Notes on the biology of tsessebe in northeastern Botswana.

_____ 1967 and C.P. Hepburn. Memorandum submitted to a meeting of Departmental representatives on the desirability of including the Kachikau Enclave into the Chobe Game Reserve/National Park complex typed.

Curson, H.H. 1932 Notes on the flora of Ngamiland and Chobe. 18th report Dir. S. Afr. Vet. Serv. and An. Ind. 1041-1052.

Dasmann, R.F. and A.S. Mossmann. 1961 Commercial utilization of game animals on a Rhodesian ranch. Wildlife 3: 7-14.

_____ 1962 Population studies of impala in southern Rhodesia. J. Mamm. 43 (3): 375-395.

Du Toit, A.L. 1926 Report of the Kalahari reconnaissance of 1925. Pretoria

Economic Planning Unit, Botswana. 1966 Transitional plan for social and economic development. Govt. Printer, Gaberones.

Ellerman, J.R., T.C.R. Morrison-Scott and R.W. Hayman. Southern African mammals.
1953 Brit. Mus. London. 363 pp.

Eloff, F.C. Observations on the migration and habits of the antelopes of the
1959 a Kalahari Gemsbok Park. Part 1. Koedoe 2: 1-29.

_____ Dto. Part II. Koedoe 2: 30-51.
1959 b

_____ Dto. Part IV. Koedoe 5: 128-136.
1962

Evans, R.A. and R.M. Love. The step-point method of sampling - a practical tool
1957 in range research. J. Range Mgmt. 10 (5): 208-212.

Gibbons, A. St. Hill. Africa from south to north through
1904 Marotseland.

Hall, K.R.L. Numerical data, maintenance activities and locomotion of the wild
1962 chacma baboon, Papio ursinus. Proc. Zool. Soc. Lond. 139 (2): 181-220.

Henry, P.W.T. Enumeration report on the Chobe Main Forest. Min. of Agriculture,
1966 Gaberones (mimeo).

Hepburn, C.P. Proposed logging in the Chobe Game Reserve. Cyclostyled report on
1966 the "Enumeration Report of the Main Chobe Forest Block". 12 pp.

Holum, E. Seven years in South Africa: travels, researches and hunting adventures
1881 between the diamond fields and the Zambezi (1872-79). Sampson Low & Co.
London. Vol. II. 479 pp.

Keay, R.W.J. and A. Aubreville. Vegetation map of Africa. L'Association pour
1959 l'Etude Taxonomique de la Flore d'Afrique Tropicale, Oxford Univ. Press.

Keet, J.D.M. Forests of the Okavango native territory. J.S. Afr. For. Assoc.
19? ? : 77-88.

Kelly'-Edward. A review of certain aspects of the indigenous forests of the
1960 Chobe District. Typed.

Kennan, T.C.D., R.R. Staples and O. West. Veld management in southern Rhodesia.
1955 Rhod. Agric. J. 52 (I): 4-21.

Kenneth, J.H. and C.R. Ritchie. Gestation periods. A table and bibliography.
1953 Commonwealth Agric. Bureaux. 39 pp.

Kettlitz, W.K. The distribution of some of the larger game mammals in the Transvaal
1962 (excluding the Kruger National Park). Ann. Cape Prov. Mus. 2: 118-137.

Kinloch, B.G. Preliminary report to the Game Department of Bechuanaland. Min. of
1965 a Mines, Commerce and Industry, Gaberones. (Mimeo).

_____ Report to the Game Department of Bechuanaland. Min. of Mines,
1965 b Commerce and Industry, Gaberones (Mimeo).

Klingel, H. 1965 Notes on the biology of the plains zebra, Equus quagga boehmi, Matschie. E. Afr. Wildlife J. 3: 86-88.

Langdale-Brown, I. and R.J. Spooner. 1963 Land use prospects in northern Botswana. Tolworth, Directorate of Overseas Surveys. 40 pp.

Lewis, I. and E. Krog. 1962 Trypanosomiasis control in relation to agriculture, forestry and other activities in Bechuanaland W.H.O.

Livingstone, D. 1857 Missionary travels and researches in South Africa. London.

Lugard, E.J. 1909 The flora of Ngamiland. Kew bull. 3. London.

Mackenzie, L.A. 1946 Report on the Kalahari expedition 1945. Govt. Printer, Pretoria. 35 pp.

Miller, O.B. 1939 The Mukusi forests of Bechuanaland. Emp. FOR. J. 18: 193-201.

_____ 1945 Soil erosion: Chobe flats, Kachikau. Typed memorandum, 3 pp.

_____ 1948 Check list of forest trees and shrubs of the British Empire. No. 6. The Bechuanaland Protectorate. Oxford, Scrivener Press.

_____ 1952 The woody plants of the Bechuanaland Protectorate. J.S. Afr. Bot. 18: 1-99.

Mitchell, B.L., J.B. Shenton and J.M.C. Uys (in press). Predation on large mammals in Kafue National Park, northern Rhodesia.

Mitchell, D. 1967 A typed report on the Salvinia auriculata problem on the Chobe system.

Mohr, E. 1876 To the Victoria Falls of the Zambezi. Translated. Simpson Low & Co. London. 462 pp.

Morse, C. 1960 Basutoland, Bechuanaland Protectorate and Swaziland report on an economic mission. H.M.S.O., London.

Pertrides, G.A. 1963 Ecological research as a basis for wildlife management in Africa. I.U.C.N. Publ. New Series I: 284-293.

Piennar, E. de V. 1963 The large mammals of the Kruger National Park - their distribution and present day status. Koedoe 6: 1-37.

Pole Evans, I.B. 1948 An expedition to Ngamiland - June-July 1937. Bot. Surv. S. Afr. Mem. 21: 75-203. Govt. Printer, Pretoria.

_____ 1948 A reconnaissance trip through the eastern portion of Bechuanaland Protectorate 1931. Bot. Surv. Mem. 21: 7-73. Govt. Printer, Pretoria.

Purnell, G.R. and W.S. Clayton. Report to the Government of the Bechuanaland
1963 Protectorate on the beef, cattle and meat industry. Cyclostyled
FAO Report. 60 pp.

Rains, A. A land use survey of the northern Statelands of Botswana.
Directorate of Overseas Surveys, Surrey. (Draft report).

Rattray, J.M. The grasses and grass associations of southern Rhodesia.
1957 Rhod. Agric. J. 54: 3-40.

Riney, T. Evaluating condition of free ranging red deer (Cervus elaphus)
1954 with special reference to New Zealand. N.Z.J. Sci. and Tech.
36: 429-463.

_____ A field technique for assessing physical condition of some
1960 ungulates. J. Wildl. Mgmt. 24: 92-94.

_____ The impact of man on the tropical environment. 9th Tech.
1963 Meeting, Nairobi.

_____ A rapid field technique and its application in describing conservation
status and trends in semi-arid pastoral areas. African Soil 8: 159-258.

_____ Utilization of wildlife in the Transvaal. I.U.C.N. Publ.
1963 New Series I: 303-305.

_____ and P. Hill. Interim report on Bechuanaland Protectorate. Rome,
1963 FAO/I.U.C.N., Africa Special Project. Cyclostyled, 39 pp.

_____ and W.K. Kettlitz. Management of large mammals in the Transvaal.
1964 Mammalia 28: 189-248.

Robinette, W.L. and G. Child. Notes on biology of lechwe (Kobus leche). Puku
1964 (Occ. Pap. Dept. Game and Fish., N. Rhod.) 2: 84-117.

Roth, H.H. Game utilization in Rhodesia in 1964. Mammalia 30 (3): 397-423.
1966

_____ and G. Child. (In press). Distribution and population structure
of the black rhinocerus. (Diceros bicornis).

Sclater, W.L. The mammals of South Africa. R.H. Porter, London. 2 vol.
1900

elous, F.C. A hunters wanderings in Africa. London. 400 pp.
1881

hortridge, G.C. The mammals of Southwest Africa. William Heinemann Ltd.
1934 London. 2 vol.

Silberbauer, G.B. Bushman survey. Govt. Printer, Gaberones. 138 pp.
1965

Simpson, C.D. 1966 Tooth eruption, growth and ageing criteria in greater kudu. (Tragelaphus strepciceros Pallas).

Skinner, J.D. 1966 An appraisal of the eland (Taurotragus oryx) for diversifying and improving animal production in southern Africa. Afr. Wildlife 20: 29-40.

Smithers, R.H.N. 1964 A check list of the birds of the Bechuanaland Protectorate and the Caprivi strip. National Museum Trustees, Rhodesia. 188 pp.

_____ 1966 Animals of Rhodesia. Rhod. Tourist Board. 12 pp.

_____ 1966 The mammals of Rhodesia, Zambia and Malawi. A handbook. Collins, London. 159 pp.

Stevenson-Hamilton, J. 1947 Wildlife in South Africa. London, 400 pp.

Stigand, A.G. 1912 Notes on Ngamiland. Geogr. J., April.

_____ 1923 Ngamiland. Georg. J. 62: 401-419.

Summers, R. (in press). Archaelogical distributions and a tentative history of tsetse infestation in Rhodesia and the northern Transvaal.

Talbot, L.M., W.J.A. Payne, H.P. Ledger, L.D. Verdcourt and M.H. Talbot. 1963 The wildebeest in western Masailand. E. Afr. Wildl. Monogr. 12: 88 pp.

Thomsen, J.G. 1962 A description of the growth habits of mopane in relation to soil and climatic conditions. Proc. 1st Fed. Sci. Cong. (Salisbury) 181-186.

Tinley, K.L. 1966 An ecological reconnaissance of the Moremi Wildlife Reserve, Botswana. Okavango Wildlife Soc., Johannesburg. 146 pp.

Weir, J.S. 1960 A possible course of evolution of animal drinking holes (pans) and reflected changes in their biology. Proc. 1st Fed. Sci. Cong. (Salisbury): 301-305.

Weir, J.S. and E. Davidson. Daily occurrence of African game animals at water holes during dry weather. Zoologica Africana I: 353-368.

West, O. 1958 Bush encroachment, veld burning and grazing management. Rhod. Agric. J. 55: 407-425.

Wild, H. 1952 A southern Rhodesian botanical dictionary of Native and English plant names. Govt. Printer, Salisbury. 139 pp.

Wilhelm, J.H. Das Wild des Okawangogebietes und des Caprivizipfels. J.S.W. Afr. Sci. Soc. 6: 51-74.

Wilson, V.J. (In press) Observations on the greater kudu (Tragelaphus strepsiceros Pallas). from a tsetse control hunting scheme in northern Rhodesia. E. Afr. Wildl. J.

_____ 964 and G. Child. Notes on bushbuck (Tragelaphus scriptus) from a tsetse fly control area in northern Rhodesia. Puku, (Occ. Pap. Dept. Game and Fish., No. Rhod.) 2: 118-128.

Wilson, S.G., 963 K.R.S. Morris, I.J. Lewis and E. Krog. The effects of Trypanosomiasis on rural economy. Bull. W.H.O. 28: 595-613.

APPENDIX 'A'

A PRELIMINARY CHECK LIST OF THE BIRDS OF THE CHOBE GAME RESERVE

BY

Graham Child
C. Patrick Hepburn, and
Wolfgang von Richter

The obvious need for a working check list of the birds of the Chobe Game Reserve prompted the compilation of this list. It is based on Smithers (1964), "A Check List of the Birds of the Bechuanaland Protectorate and the Caprivi Strip" (Published by the Trustees of the National Museums of Rhodesia, 186 pp.), augmented by over 340 specimens collected between June 1965 and May 1967. These specimens are indicated in the list, which contains notes on significant extensions of a species range in Botswana, or additional breeding data which has become available. There are five species not so far recorded in Botswana, of which two were represented by collected material. The other three are conspicuous forms, but in accordance with accepted practice, specimens should be collected in support of the visual records. Further collecting of a general nature is also desirable in the drier parts of the reserve away from the Chobe river.

The list does not contain a number of passage migrants which have not so far been taken in this part of Botswana, although they are likely to cross it. It nevertheless shows over two thirds of the species known to occur in the entire country.

Mr. Jali Makawa, a collector of many years' experience and now based on the National Museum of Zambia, Livingstone, collected most of the specimens of which Mr. M.P. Stuart Irwin of the National Museum of Rhodesia, Bulawayo, confirmed our field identifications and undertook subspecific determinations. Mr. A.N.B. Masterson and Dr. C.R. Saunders contributed much of the breeding data. We are grateful to these individuals and organizations for facilitating the survey.

ANNOTATED LIST

Numbers follow Smithers (1964); f= female; m= male; c = clutch size; ‡ = new record for Botswana.

1. Struthio camelus — Ostrich

   7 one third grown chicks Nyai pan; 7 chicks 18 ins. tall; 8, 12 ins. tall; 5, 18 ins. tall, Makalamabedi Gate, Feb., 1966. (All records from outside Chobe Game Reserve).

2. Podiceps rufficolis — Dabchick

   One third grown chicks, Goha pan, April 7, 1966.

4. Pelecanus onocrotalis — White Pelican

5. P. Rufescens — Pink-backed Pelican

6. Phalocrocorax carbo — White-breasted Cormorant

7. P. africanus — Reed Cormorant

8. Anhinga anhinga — Darter

Two colonies, one of over 60 nests with C/3, C/2, C/1 eggs and young, Kasane and Zambezi river, July 1966.

‡. Ixobrychus minutus — Little Bittern

Visually recorded Kasane (C.P. Hepburn, W. von Richter).

11. I. sturmii — Dwarf Bittern

1 m. coll. Kwikampa pan, March 1967; 1 m. coll. Savuti "swamp", April 1967. Both give considerable extension of species range in Botswana.

12. Nycticorax nycticorax — Night Heron

13. N. leuconotus — White-backed Night Heron

14. Ardeola ralloides — Squacco Heron

15. A. ibis — Cattle Egret

16. Butorides striatus — Green-backed Heron

1 m. coll. Kasane, May 1967; 2 nests C/3 Chobe rapids and Zambezi river, July 7, 1966.

17. B. rufiventris — Rufus-bellied Heron

18. Egretta ardesiaca — Black Heron

19. E. alba — Great White Heron

20. E. intermedia — Yellow-billed Egret

22. Ardea cinerea — Grey Heron

23. A. melanocephala — Black-headed Heron

Visually recorded Chobe river, giving marked extension of range, by C.P. Hepburn.

24. A. goliath — Goliath Heron

25. A. purpurea — Purple Heron

26. Scopus umbretta — Hamerkop

Nest C/6, July 9, 1966.

27. Ciconia ciconia — White Stork

29. C. abdimii — Abdim's Stork

30. C. episcopus — Wolly-necked Stork

One specimen coll. Savuti from over 300 on Jan. 12, 1967; 2 visually recorded Nunga, outside Chobe Game Reserve by G. Child, Oct. 1965. Both give marked extension of species known range.

31. Ephippiorhynchus senegalensis — Saddlebill Stork

Nest used for several years near Serondela; 2 chicks 18 ins. high on "knees" June 17, 1966; had just left nest Aug. 1966.

32. Anastomus lamelligerus — Openbill Stork

33. Leptoptilos crumeniferus — Marabou Stork

One specimen coll. Kasane July 9, 1965; nesting colony Linyanti swamp July to September 1966.

34. Ibis ibis — Wood Ibis

35. Threskiornis aethiopicus — Sacred Ibis

36. Bostrychia hagedash — Hadada

37. Plegadis falcinellus — Glossy Ibis

38. Platalea alba — Spoonbill

39/40. Phoenicopterus sp. — Flamingo sp?

Visually recorded Kasane (G. Child et al).

42. Dendrocygna viduata — White-faced Duck

1 m. coll. Gokora pan, March 20, 1967.

43. Alopochen aegypticus — Egyptian Goose

45. Plectopterus gambiensis — Spur-wing Goose

Young on pans in the Mababe March and April 1966. 3/4 grown young Nanyanga April 9, 1967. One third to 1/2 grown young on pans in the Mababe, May 1967.

46. Sarkidiornis melanotos — Knob-billed Goose

1 m., 2 f. coll. Savuti, April 12, 1967; 1 m., 1 f. coll. Goha pan, April 12, 1967.

47. Nettapus auritus — Pygmy Goose

1 m. coll. Kasane, April 27, 1967.

49. Anas undulata — Yellow-billed Duck

50. A. erythrorhyncha — Red-billed Teal

1 m. coll. Goha pan, April 16 1967; 1 f. coll. Gokora pan, March 20, 1967. ½ grown chicks Jovorega pan, April 6, 1967.

51. A. hottentota — Hottentot Teal

55. Thalassaornis leuconotus — White-backed Duck

56. Neophron monachus — Hooded Vulture

57. Aegypius tracheliotus — Lappet-faced Vulture

59. Gyps bengalensis — White-backed Vulture

Nest C/1 egg, Kabulabula, July 6, 1966.

60. Aegypius occipitalis — White-headed Vulture

61. Gypohierax angolensis — Palm-nut Vulture

65. Circus aeruginosus — Marsh Harrier

66. Polyboroides ratiatus — Gymnogene

‡ Pandion halietus — Osprey

Visually recorded several times along the Chobe river (C.P. Hepburn).

67. Terathopius ecaudatus — Bateleur

68. Circaëtus gallicus — Black-breasted Harrier-Eagle

69. C. cinereus — Brown Harrier-Eagle

70. Accipter badius — Little-banded Goshawk

1 m. coll. Kwikampa pan, March 19, 1967; 1 m., 2 f. coll. Kasane, April/May 1967.

‡ Machairamphus alcinus — Bat Hawk

Visually recorded Kasane (C.P. Hepburn).

73. Melierax metabates — Dark Chanting Goshawk

75. M. gabar — Gabar Goshawk

76. Kaupifalco monogrammicus — Lizard Buzzard

1 f. coll. Kasane, April 21, 1967.

‡ Lophaëtus occipitalis — Long-crested Eagle

Visually recorded at Kasane (C.W. Benson, May 1965; G. Child, Jan. and Aug. 1966) and at the Savuti (C.P. Hepburn and W. von Richter, April 1967).

81. Aquila rapax — Tawny Eagle

82. A. wahlbergi — Wahlberg's Eagle

83. Haliaëtus vocifer — Fish Eagle

Nine nests checked July 6 to 9, 1966. 2 had one egg; one had two chicks; 4 had one egg and one chick; 2 had one chick. All the eggs were well set and all the chicks were very small indicating a very restricted breeding season, possibly related to seasonal floods of the Chobe river. A total of at least 18 nests were occupied along 25 miles of river at this time in the Chobe Game Reserve. Young leaving from several nests tended to band together in about September when up to 12 young birds were seen together.

84. Milvus migrans — Yellow-billed Kite

85. Elanus caeruleus — Black-shouldered Kite

1 m. coll. Kwikampa pan, March 18, 1967.

88. Falco biarmicus — Lanner Falcon

90. F. dickinsoni — Grey Kestrel

96. Sagittarius serpentarius — Secretary-bird

97. Francolinus coqui — Coqui Francolin

1 m. coll. Kwikampa, March 19, 1967; 5½ grown chicks Ngwezumba Bridge, April 14, 1966.

98. F. sephaena — Crested Francolin

1 f. coll. Kasane, April 28, 1967; 1 f. coll. Nanyanga, May 31, 1967. 2-6 day old chicks Kasane, Jan. 22, 1967.

100. F. adspersus — Red-billed Francolin

2 f. coll. Kasane and Serondela, March 1967; Eggs found Moremi and Kwai R., Mid-end April (P. Smith); Many small chicks 1/4 to 3/4 grown June to Oct., S. Mababe and Kasane/Simwanza area.

102. F. swainsoni — Swainson's Francolin

1 m. 2 f. coll. Kwikampa/Gokora pans March 1967; 1 f. coll. Kasane May 5, 1967; Many 1/4 to 3/4 grown chicks Mababe and Kasane/Ilhaha area June to Sept.

104. Coturnix delegorguei — Harlequin Quail

105. Humida meleagris — Crowned Guineafowl

108. Crex egregia — African Crake

110. Porzana porzana — Spotted Crake

111. Limnocorax flavirostra — Black Crake

1 f. coll. Kasane, Dec. 12, 1965; 1 f. 2 m. coll. Kasane April/May 1967.

113. Gallinula angulata — Lesser Moorhen

2 m. 2 f. coll. Kasane April/May 1967; Very common on small pans in mopane on stock route to E. of Game Reserve and near Jovorega pan in early April 1967 when many had ½ grown chicks.

114. G. chloropus — Moorhen

1 f. coll. Goha pan, April 16, 1967.

115. Porphyrio porphyrio — Purple Gallinule

1 f. coll. Kasane, April 25, 1967; gives considerable extension of range in Botswana.

116. P. alleni — Lesser Gallinule

1 f. coll. Kasane, April 1967; gives considerable extension of range in Botswana.

118. Podica senegalensis — Finfoot

Visually recorded at Kasane (C.P. Hepburn)

119. Grus carunculatus — Wattled Crane

120. Balearica pavonina — Crowned Crane

121. Otis Kori — Kori Bustard

122. Eupodotis rufierista — Red-crested Korhaan

125. Lissotis melanogaster — Black-bellied Korhaan

126. Actophilornis africanus — African Jacana

2 f. 1 m. coll. Kasane April/May 1967; c/4 fresh eggs Kasane, April 12, 1967.

127. Microparra capensis — Lesser Jacana

128. Burhinus capenses — Dikkop

1 m. coll. Kasane, May 24, 1967.

129. B. vermiculatus — Water Dikkop

2 f. coll. Kasane, Jan. 6, 1966 and March 6, 1967.

130. Hemiparra crassirostris — Long-toed Plover

1 m. 1 f. coll. Kasane April 27 and 26, 1967; gives expected extension of range in Botswana.

131. Hoplopterus armatus — Blacksmith Plover

1 m. coll. Kasane April 21, 1967; 1 f. coll. Nanyanga May 31, 1967.

132. Stephanibyx coronatus — Crowned Plover

1 m. 1 f. coll. Nanyanga, May 30 and 31, 1967.

133. Lobivanellus senegallus — Wattled Plover

1 f. coll. Satau (Kachikau Enclave), April 13, 1967.

135. Charadrius pecuarius — Kittlitz Sandplover

1 m. 1 f. coll. Savuti, April 13, 1967; gives marked extension of range in Botswana.

136. C. tricollaris — Trebel-banded Sandplover

1 m. coll. Savuti, April 15, 1967.

137. C. alexandrinus — White-fronted Sandplover

142. Tringa glareola — Wood Sandpiper

1 m. coll. Savuti, April 13, 1967.

143. T. Hypoleucas — Common Sandpiper

144. Gallinago nigirpennis — Ethiopian Snipe

1 f. coll. Kwikampa pan, March 20, 1967.

† Gallinago media — Double Snipe

1 m. coll. Kwikampa pan, March 20, 1967.

149. Himantopus himantopus — Stilt

151. Rostratula benghalensis — Painted Snipe

1 f. coll. Savuti, April 15, 1967; 1 m. 1 f. coll. Goha pan, April 18, 1967.

155. Rhinoptilus cinotus — Seebohm's Courser

157. Glareola pratencola — Pratincole

1 f. coll. Savuti, April 12, 1967; gives marked extension of range in Botswana.

158. G. nuchalis — White-collared Pratincole

159. Larus cirrocephalus — Grey-headed Gull

160. L. fuscus — Lesser Black-backed Gull

161. Rynchops flavirostris — African Skimmer

165. Chlidonias leucoptera — White-winged Black Turn
1 f. coll. Kasane, May 22, 1967.

166. Pterocles namaqua — Namaqua Sandgrouse

167. P. burchelli — Spotted Sandgrouse

168. P. gutturalis — Yellow-throated Sandgrouse

169. P. bicinctus — Double-banded Sandgrouse

170. Turnix sylvatica — Button Quail
1 m. 1 f. coll. Kasane, March/May, 1967.

172. Streptopelia semitorquata — Red-eyed Turtle Dove

173. S. dicipiens — Mourning Dove

174. S. capicola — Ring-necked Dove
2 f. coll. Kwikampa pan, March 18, 1967.

175. S. senegalensis — Laughing Dove
1 f. coll. Kasane, April 27, 1967.

176. Oena capensis — Namaqua Dove

177. Turtur chalcospilos — Emerald-spotted Wood Dove
2 m. 1 f. coll. Kasane, March and May, 1967.

178. Treron Australis — Green Pigeon
1 f. coll. Kasane, May 20, 1967.

179. Poicephalus meyeri — Meyer's Parrot
1 m. coll. Kasane, May 9, 1967.

181. Tauraco corythaix — Green Lourie

182. Crinifer concolor — Go-away Bird
2 m. coll. Kasane, March 4 and 22, 1967. Occupied nest Kasane, July 1966.

184. Clamator jacobinus — Jacobin Cuckoo

185. C. levaillantii — Levaillant's Cuckoo

1 specimen coll. Kasane, Jan. 5, 1966; 1 m. 1 f. coll. Kasane, March 6 and April 28, 1967.

187. Cuculus clamosus — Black Cuckoo

189. Chrysococcyx caprius — Diederic Cuckoo

191. Centropus cupricandus — Coppery-tailed Coucal

2 f. coll. Lake Liambezi (Kachikau Enclave), March 8, 1967; 1 m. coll. Kasane, May 1, 1967.

192. C. Senegalensis — Fleck's Coucal

1 m. coll. Kasane, Dec. 12, 1965.

193. C. superciliosus — White-browed Coucal

1 f. coll. Kasane, May 10, 1967.

194. Tyto alba — Barn Owl

1 m. coll. Kasane, Feb. 18, 1967. Nesting in Hamekop's nest c/7 eggs, July 9, 1967.

195. Asio capensis — Marsh Owl

Common Central Mababe grassland where 35 flushed in 150 yards in October 1966.

196. Otus scopus — Scopus Owl

1 m. coll. Kwikampa Area in mopane in tall grassland, March 19, 1967. Also common in mopane along stock route, April 1, 1967.

198. Bubo africanus — Spotted Eagle-Owl

199. B. lacteus — Verreaux's Eagle-Owl

5 occupied nests along Chobe between Kasane and Simwanza (all old Fish Eagle nests) 3 had chicks up to about 2 weeks old; July 6 to 9, 1966. 6th nest with young Sept. 30, 1966.

200. Scotopelia peli — Fishing Owl

Visually recorded near Kasane.

201. Glaucidium perlatum — Pearl-spotted Owlet

202. G. capense

1 m. coll. Kwikampa area, March 16, 1967.

203. Ciccaba woodfordii — Wood Owl

205. Caprimulgus pectoralis — Fiery-necked Nightjar

1 m. coll. Kasane, Dec. 2, 1965; 1 f. coll. Kasane, May 26, 1967.

206. C. rufigena — Rufus-cheeked Nightjar

1 m. coll. Kwikampa pan, March 16, 1967; 1 m. 1 f. coll. Goha pan, April 18 and 27, 1967. Gives marked extension of range in Botswana.

207. C. natalensis — Natal Nightjar

209. C. fossii — Mocambique Nightjar

210. Cosmetornis vexillarius — Pennant-wing Nightjar

1 f. coll. Kasane, Dec. 1965.

213. Apus horus — Horus Swift

214. Cypsiurus parvus — Palm Swift

465. Chaetura boehmi — Boehm's Spinetail

216. Colius indicus — Red-faced Mousebird

217. Apaloderma narina — Narina Trogon

1 m. coll. Kasane, March 2, 1967.

218. Ceryle maxima — Giant Kingfisher

Excavating nests holes Kasane, July 9, 1966.

219. C. rudis — Pied Kingfisher

2 m. coll. Kasane, April 25 and May 11, 1967; 3 nests c/6 2 nests c/5, 1 nest 5½-grown chicks, 1 nest 4½-grown chicks, Kasane, July 7, 1967; one nest c/6 and c/5 and two with fully fledged chicks in colony at Serondela, July 8, 1967.

220. Alcedo althis — Half-collared Kingfisher

221. Alcedo cristata — Malachite Kingfisher

2 m. 1 f. coll. Kasane, May 22 and 23, 1967. 3 nests with one fresh egg, 4 very small chicks, 4 larger chicks and other nests being excavated early July 1966.

222. Halcyon cyanoleuca — Red- and Black-billed Kingfisher

1 f. coll. Savuti, April 11, 1967. Gives extension of range into area made suitable by flooding of Savuti Channel.

223. H. chelicuti — Striped Kingfisher

1 m. coll. Kwikampa pan, March 20, 1967; 2 m. coll. Kasane, May 9 and 11; 1 m. 1 f. coll. Nanyanga, May 31.

224. H. albiventris — Brown-hooded Kingfisher

1 specimen, sex undetermined, coll. Kasane, May 3, 1966; 1 m. 1 f. coll. Kasane, April 28 and May 11, 1967.

225. H. leucocephala — Grey-hooded Kingfisher

1 f. 1 m. coll. Kwikampa pan, March 16 and 20, 1967; giving considerable eastern extension of species range in Botswana.

226. Merops apiaster — European Bee-eater

1 f. coll. Kasane, Dec. 30, 1965; 1 m. coll. Kwikampa area, March 17, 1967; later record of this migrant than those mentioned by Smithers (1964).

228. M. nubicus — Carmine Bee-eater

229. M. pusillus — Little Bee-eater

2 m. coll. Kwikampa area, March 16, 1967; 1 m. 1 f. coll. Kasane, May 1, 1967.

230. M. bulocki — White-fronted Bee-eater

1 specimen, sex undetermined, from Kasane, Dec. 1965; 2 m. coll. Kasane, May 4, 1967; excavating nests Kasane, July 9, 1966.

231. Diorocerus hirundineus — Swallow-tailed Bee-eater

1 f. coll. Kasane, May 1, 1967.

232. Coracias garrulus — European Roller

233. C. candatus — Mzilikazi Roller

1 f. coll. Savuti, April 15, 1967; 2 m. coll. Kasane, May 23 and 26, 1967.

‡ C. spatulata — Spatulate Roller

1 f. coll. Kasane, March 29, 1967.

235. Eurystomus glaucurus — Broad-billed Roller

Common along Chobe R. Dec. to Feb.

236. Upupa epops — Hoopoe

237. Phoeniculus purpureus — Red-billed Wood-Hoopoe

2 m. coll. Kasane, April 28, 1967.

238. Rhinopomastus cyanomelas — Scimitar-bill

1 m. coll. Kasane, April 21, 1967.

239. Tockus nasutus — Grey Hornbill

1 m. coll. Kwikampa area, March 20, 1967; 2 f. coll. Kasane, May 5 and 24, 1967.

240. T. erythrorhynchus — Red-billed Hornbill

1 m. coll. Kwikampa area, March 19, 1967; 2 m. coll. Kasane, March 29 and April 28, 1967.

241. T. flavirostris — Yellow-billed Hornbill

242. T. bradfieldi — Bradfield's Hornbill

243. Bycanistes bucinator — Trumpeter Hornbill

244. Bucorvus leadbeateri — Ground Hornbill

245. Lybius torquatus — Black-collared Barbet

1 m. 1 f. coll. Kasane, March 7, 1967.

246. L. leucomelas — Pied Barbet

247. Pogoniulus chrysoconus — Yellow-fronted Tinkerbird

1 f. coll. Kasane, March 24, 1967.

248. Trachyphonus vaillantii — Crested Barbet

1 f. and 1 unsexed specimen coll. Kasane, March 28 and 30, 1967. Confirms Smithers' (1964) suggestion that this species would be found in N.E. Botswana.

249. Indicator indicator — Greater Honeyguide

1 specimen, sex undetermined, from Kasane, Nov. 27, 1966; 2 f. coll. Kasane, May 22 and 25, 1967.

250. I. minor — Lesser Honeyguide

2 f. coll. Kasane, March 30 and April 24, 1967.

251. Prodotiscus regulus — Wahlberg's Honeyguide

252. Thripias namaquus — Bearded Woodpecker

2 f. 1 m. coll. Kasane, March and May, 1967.

253. Dendropicos fuscescens — Cardinal Woodpecker

1 m. coll. Kwikampa pan March 16, 1967; 1 f. coll. Kasane April 29, 1967. Identified by Irwin as D. f. capriviensis

255. Campethera abingoni — Golden-tailed Woodpecker

The presence of this widespread species within the Chobe Game Reserve, needs confirmation.

256. Mirafra javanica — White-tailed Bush-Lark

1 f. coll. Kasane, May 9, 1967. Gives marked extension of species range in Botswana.

258. M. africana — Rufus-necked Lark

2 m. coll. Satau and Lake Liambezi (Kachikau Enclave) March 9 and 10, 1967; 1 f. from Goha pan, April 17, and 1 m. from Kasane, April 25, 1967.

261. M. rufeeinnamomea — Flappet Lark

1 m. coll. Kwikampa area, March 20, 1967 with 1 f. from Kasane, May 2, 1967. Identified by Irwin as M.R. mababiensis Gives marked N.E. extension of species range and confirms Smithers' (1964) suggestion that this race would be found in far N.E. corner of Botswana.

262. M. africanoides — Fawn-coloured Lark

This species may occur in the Chobe Game Reserve, but its presence needs confirmation.

266. Calandrella cinerea — Red-capped Lark

1 f. coll. Savuti, April 14, 1967. Identified as c.c. anderssoni by Irwin and although Smithers (1964) is not quite clear on the distribution of the species in Botswana, this appears to represent a marked extension of its range.

273. Riparia paludicola — African Sand Martin

1 m. coll. Kasane, May 24. Several nests at Kasane on July 7, 1966 ranged from new excavations to one with c/4 fresh eggs and 3 with c/3 well incubated eggs.

274. Hirundo rustica — European Swallow

1 specimen from Kasane, Dec. 1965.

275. H. smithii — Wire-tailed Swallow

280/1. H. cucullata and H. abyssinica — Larger Striped Swallow and Lesser Striped Swallow

The possible occurrence of both these species in the Chobe Game Reserve needs checking.

282. H. griseopyga — Grey-rumped Swallow

Pair collecting nesting materials Serondela, July 8, 1966.

288. Motacilla capensis — Cape Wagtail

1 m. 1 f. coll. Serondela, May 27, 1967.

289. Motacilla alba — Pied Wagtail

290. Anthus novaeseelandiae — Richards' Pipit

1 m. coll. Satau (Kachikau Enclave) March 10, 1967; 1 m. 1 f. coll. Savuti, April 13 and 14, 1967. Race given as A.n. rufuloides by Irwin.

291. A. leucophrys — Plain-backed Pipit

1 f. coll. Satau (Kachikau Enclave), March 10, 1967.

292. A. vaalensis — Pale Plain-backed Pipit

297. Macronyx ameliae — Pink-throated Longclaw

1 m. coll. Satau (Kachikau Enclave), March 10, 1967.

298. Eurocephalus anguitimens — White-crowned Wood Shrike

1 m. 1 f. coll. in mopane woodland Kwikampa area, March 19, 1967.

299. Prionops plumata — Helmet Shrike

1 f. 2 m. coll. Kasane, May 5 to 20, 1967.

300. P. retzii — Red-billed Helmet Shrike

1 m. 1 f. coll. Kasane, April 21, 1967.

301. Hilaus afer — Brubru

1 m. coll. Kasane, May 26, 1967.

302. Dryoscopus cubla — Puff-back Shrike

1 m. coll. Kasane, March 6, 1967, and 1 m. from Kwikampa March 17, 1967.

303. Tchagra australis — Three-streaked Redwing-Shrike

2 m. 1 f. coll. Kasane, April 21 and May 26, 1967.

304. T. senegala — Black-crowned Tchagra

1 m. 1 f. coll. Kwikampa area, March 19, 1967.

305. Laniarius aethiopicus — Boubou Shrike

2 m. coll. Kasane, March 2 and 3, 1967.

306. L. bicolor — Swamp Boubou Shrike

307. L. atro-coccineus — Crimson breasted Shrike

308. Malaconotus sulphureopectus — Sulphur-breasted Bush Shrike

2 m. coll. Kasane, March 3 and 6, 1967.

309. M. blanchoti — Grey-headed Bush Shrike

2 m. coll. Kasane, March 28 and 29, 1967. Confirms extension of range expected by Smithers (1964).

310. Lanius melanoleucus — Magpie-Shrike

1 m. coll. Savuti, April 15, 1967.

311. L. cristatus — Red-backed Shrike

315. Oriolus auratus — African golden oriol

1 f. 1 m. coll. Kwikampa, March 17 and 18; 1967; 1 m. from Goha pan, April 16, 1967, gives extension of known range.

316. O. lavatus — Black-headed Oriol

317. Dicrurus adsimilis — Fork-tailed Drongo

2 m. coll. Kasane, April 27 and May 1, 1967.

319. Lamprotornis chalybaeus — Greater Blue-eared Glossy Starling

3 m. coll. Kasane/Serondela, May 22 and 27, 1967.

321. L. australis — Greater Glossy Starling

1 m. coll. Goha pan, April 17, 1967.

322. L. mevesii — Long-tailed Starling

323. Cinnyricinclus leucogaster — Violet-backed Starling

324. Creatophora cinerea — Wattled Starling

325. Buphagus africanus — Yellow-billed Oxpecker

326. B. erythrorhynchus — Red-billed Oxpecker

329. Coracina pectoralis — White-breasted Cuckoo-Shrike

330. Campephaga phoenicea — Black Cuckoo-Shrike

1 m. coll. Kwikampa pan, March 17, 1967; and 1 m. from Kasane, March 28, 1967.

331. Pycnonotus barbatus — Layard's Bulbul

1 m. 1 f. coll. Kasane, March 2, 1967.

332. P. nigricans — Red-eyed Bulbul

Status in Chobe Game Reserve requires checking.

333. Chlorocichla flaviventris — Yellow-bellied Bulbul

2 m. coll. Kasane, April 21 and 28, 1967.

334. Phyllastrephus terrestris — Terrestrial Bulbul

1 f. coll. Kasane, Aug. 5, 1966; 1 m. 1 f. coll. Kasane March 2, 1967.

335. Saxicola torquata — Stone chat

2 m. coll. Lake Liambezi/Satau (Kachikau Enclave), March 9 and 10, 1967; 2 m. from Kasane, May 1, 1967.

336. Oenanthe pileata — Capped Wheatear

Possible occurrence in Chobe Game Reserve need confirmation.

339. Thamnolaea arnotti — Arnott's Chat

1 m. 1 specimen, sex undetermined, coll. Ngwezumba bridge, March 18, 1967.

345. Erythropygia leucophrys — Scrub Robin

2 m. coll. Kasane, April 24 and May 22, 1967.

347. E. quadrivirgata — Bearded Scrub Robin

1 m. 1 f. coll. Kasane, March 28 and 4, 1967.

348. Cossypha heuglini — Heuglin's Robin

2 f. coll. Kasane, March 3, 1967.

349. Luscinia luscinia — Thrush Nightingale

2 m. coll. Kasane, March 5, 1967, gives marked extension of known range in Botswana of this Palaearctic migrant.

350. Turdus libonyanus — Kurrichane Thrush

1 f. coll. Kasane, April 26, 1966; 1 m. coll. Kasane, May 26, 1967.

351. T. litsitsirupa — Ground-scraper Thrush

352. Turdoides jardinei — Jardine's Babbler

1 m. coll. Kasane, March 3, 1967.

354. T. bicolor — Pied Babbler

2 m. coll. Savuti, April 12, 1967. Gives marked extension of range in Botswana.

355. T. leucopygia

2 m. 1 f. coll. Lake Liambezi/Satau (Kachikau Enclave) March 8 and 10, 1967.

357. Muscicapa cinerea — Blue-grey Flycatcher

3 m. coll. Kasane, March 6 to 23, 1967.

358. Myioparus plumbeus — Grey Tit-Babbler

1 f. coll. Kasane, May 4, 1967.

359. Melaenornis pammelaina — Black Flycatcher

2 f. coll. Kasane, April 27 and May 1, 1967.

363. Bradornis pallidus — Mouse-coloured Flycatcher

365. Batis molitor — White-flanked Batis

1 m. 2 f. coll. Kwikampa area, March 16 and 19, 1967.

367. Terrsiphone viridis — Paradise Flycatcher

2 f. coll. Kasane, March 3 and 7, 1967.

368. Bradypterus baboecala — Little Rush Warbler

369. Acrocephalus schoenobaenus — Sedge Warbler

1 m. 1 f. Lake Liambezi (Kachikau Enclave), March 8, 1967.
1 m. 1 f. from Savuti, April 14 and 3, 1967.

370. A. arundinaceus — Great Reed Warbler

2 m. 1 f. coll. Kasane, March 5 to 13, 1967. Gives extension of range in Botswana and later records of this Palaearctic migrant than those of Smithers (1964).

371. A. baeticatus — African Reed Warbler

1 f. coll. Savuti, April 14, 1967.

373. A. gracilirostris — African Swamp Warbler

1 f. coll. Lake Liambezi (Kachikau Enclave) March 9, 1967;
3 m. coll. Savuti, April 13 and 14, 1967. Gives marked extension of range in Botswana.

374. Hippolais icterina — Icterine Warbler

2 m. coll. Kwikampa area, March 15, 1967.

376. Sylvia borin — Garden Warbler

1 f. coll. Kasane, March 14, 1967. Gives marked extension of the range in Botswana of this Palaeartic migrant.

377. S. communis — Whitethroat

1 m. 1 f. coll. Ngwezumba bridge, March 18, 1967; 1 f. from Kasane, March 30, 1967. Like 376,a marked extension of range in Botswana of a Palaeartic migrant.

378. Phylloscopus trochilus — Willow Warbler

1 m. 1 f. coll. Kwikampa pan, March 15 and 17, 1967. Identified as P.t. acredula by Irwin, which gives a marked extension of range for this subspecies of Palaearctic migrant.

379. Cisticola erythrops — Red-faced Cisticola

381. C. chiniana — Rattling Cisticola

1 m. coll. Serondela, May 27, 1967.

382. C. rufilata — Tinkling Cisticola

1 m. 1 f. coll. Goha pan, April 17, 1967.

383. C. galectotes — Winding Cisticola

1 m. 1 f. coll. Lake Liambezi (Kachikau Enclave) March 9, 1967; 3 m. from Kasane and 2 f. from Serondela, April 25, to May 27, 1967.

384. C. pipiens — Chirping Cisticola

385. C. natalensis — Croaking Cisticola

Recorded near Panda-ma-Tenga (Smithers, 1964) and should be sought in similar long-grassland habitat on the Kakulwani plain in the east of the Chobe Game Reserve.

386. C. fulvicapilla — Neddicky Cisticola

387. C. juncidis — Fan-tailed Cisticola

1 f. coll. Satau (Kachikau Enclave), March 10, 1967.

391. Prinia subflava — Tawny-flanked Prinia

1 m. coll. Lake Liambezi (Kachikau Enclave), March 8, 1967; 1 m. from Goha pan, April 18, 1967.

393. Apalis flavida — Black-breasted Apalis

394. Camaroptera brevicandata — Grey-backed Camaroptera

2 m. coll. Kasane, March 22 and 30, 1967. Nest with 3 freshly hatched young 12 miles s. of Jovorega, April 6, 1967.

396. C. stierlingi — Stierling's Barred Warbler

397. Eremomela icteropygialis — Yellow-bellied Eremomela

1 m. 1 f. coll. Kasane, May 26, 1967, and identified by Irwin as E.i. viriditincta

399. E. usticollis — Burnt-necked Eremomela

400. Sylvietta rufescens — Long-billed Crombec

1 f. coll. Kwikampa area, March 15, 1967; 1 m. coll. Kasane, May 26, 1967.

401. Parisoma subcaeruleum — Tit-Babbler

403. Parus niger — Black Tit

2 f. coll. Kasane, March 6 and 7, 1967.

405. Anthoscopus caroli — Penduline Tit

Unoccupied nest W. Mababe.

406. Anthreptes collaris — Collared Sunbird

407. Nectarinia amethystina — Black Sunbird

1 m. 1 f. coll. Kasane, March 24 and May 3, 1967; 1 m. from Kwikampa pan March 20, 1967; 1 f. from Lake Liambezi (Kachikau Enclave), March 24, 1967; 1 f. from Savuti, April 12, 1967. Gives marked extension of range and shows general distribution of this species in northeastern Botswana.

408. N. senegalensis — Scarlet-chested Sunbird

1 m. coll. Kwikampa pan, March 17, 1967.

409. N. talatala — White-bellied Sunbird

1 m. 1 f. coll. Kasane, March 28 and May 9, 1967; 1 f. from Savuti, April 12, 1967.

412. Nectarinia mariquensis — Marico Sunbird

2 m. coll. Kasane, April 24 and May 3, 1967; 1 m. from Savuti, April 12, 1967.

414. Zosterops senegalensis — Yellow White-eye

2 f. coll. Kasane, May 24, 1967.

416. Amblyospiza albifrons — Thick-billed Weaver

417. Ploceus xanthopus — Holub's Golden Weaver

2 m. coll. Kasane, Dec. 14, 1965, and March 13, 1967.

418. P. xanthopterus — Brown-throated Golden Weaver

1 f. coll. Kasane, Sept. 1, 1966; 1 f. coll. Kasane, March 13, 1967; 1 m. from Goha pan, April 17, 1967. Latter = extension of range into dry part of Game Reserve where reed beds are absent, cf. Smithers(1964) who describes the species habitat as Phragmites reed beds in swamp or along rivers.

419. P. intermedius — Lesser Masked Weaver

The presence of this species in the Chobe Game Reserve needs further investigation.

420. P. velatus — Masked Weaver

1 f. 1 m. coll. Kasane, April 21 and May 26, 1967.

421. P. cuculatus — Black-headed Weaver

1 m. coll. Lake Liambezi (Kachikau Enclave), March 9, 1967. The habitat here is open grassland, subject to seasonal inundation, with scattered big trees on termitaria and not woodland as Smithers (1964) suggests as this species habitat.

422. P. ocularis — Spectacled Weaver

423. Anaplectes melanotis — Red-headed Weaver

424. Quelea quelea — Red-billed Quelea

1 m. coll. Kwikampa pan, March 16, 1967; 1 m. 1 f. Kasane, March 28 and May 1, 1967.

425. Euplectes orix — Red Bishop

428. E. axillaris — Red-shouldered Widow Bird

429. Anomalospiza imberbis — Cuckoo-Weaver

Recorded on Gazuma pan by Smithers (1964) and may therefore extend into the Chobe Game Reserve in similar habitat along the Kakulwani plain.

430. Bubalornis albirostris — Buffalo Weaver

1 m. 1 f. coll. Savuti, April 12 and 11, 1967; 1 f. from Kasane, May 26, 1967.

436. Passer diffusus — Grey-headed Sparrow

437. Petronia superciliaris — Yellow-throated Sparrow

1 m. 1 f. coll. Kasane, March 29, 1967; 1 m. coll. Savuti, April 14, 1967.

438. Sporopipes squamifrons — Scaly Weaver

The presence of this species in the Chobe Game Reserve needs confirmation.

439. Vidua macroura — Pin-tailed Whydah

1 m. coll. Lake Liambezi (Kachikau Enclave), March 9, 1967.

440. V. regia — Shaft-tailed Whydah

441. V. paradisea — Paradise Whydah

1 m. coll. Kasane, Dec. 14, 1965.

442. V. funerea — Dusky Indigo-Bird

1 m. coll. Kasane, March 28, 1967. This gives significant extension of species range in Botswana.

445. Pytilia melba — Melba Finch

2 m. coll. Kasane, March 13 and 29, 1967; 1 m. Nanyanga, May 31, 1967.

446. Estrilda astrild — Common Waxbill

1 m. 1 f. coll. Kasane, May 20, 1967.

447. E. erythronotos — Black-cheeked Waxbill

Presence of this species in Chobe Game Reserve needs confirmation.

448. Granatina granatina — Violet-eared Waxbill

1 f. coll. Kasane, May 5, 1967; 1 m. coll. Ngwezumba bridge, March 18, 1967.

449. Uraeginthus angolensis — Blue Waxbill

1 f. coll. Nanyanga, May 31, 1967.

450. Lagonosticta senegala — Red-billed Fire-Finch

1 f. 1 m. coll. Kasane, March 28 and May 9, 1967.

452. L. jamesoni — Jameson's Fire-Finch

1 f. coll. Kasane, May 4, 1967.

454. Ortygospiza atricollis — Quail-Finch

455. Emberiza flaviventris — Golden-breasted Bunting

1 f. coll. Goha pan, April 17, 1967; 2 f. coll Kasane, May 1 and 26, 1967.

456. Fringillaria tahapisi

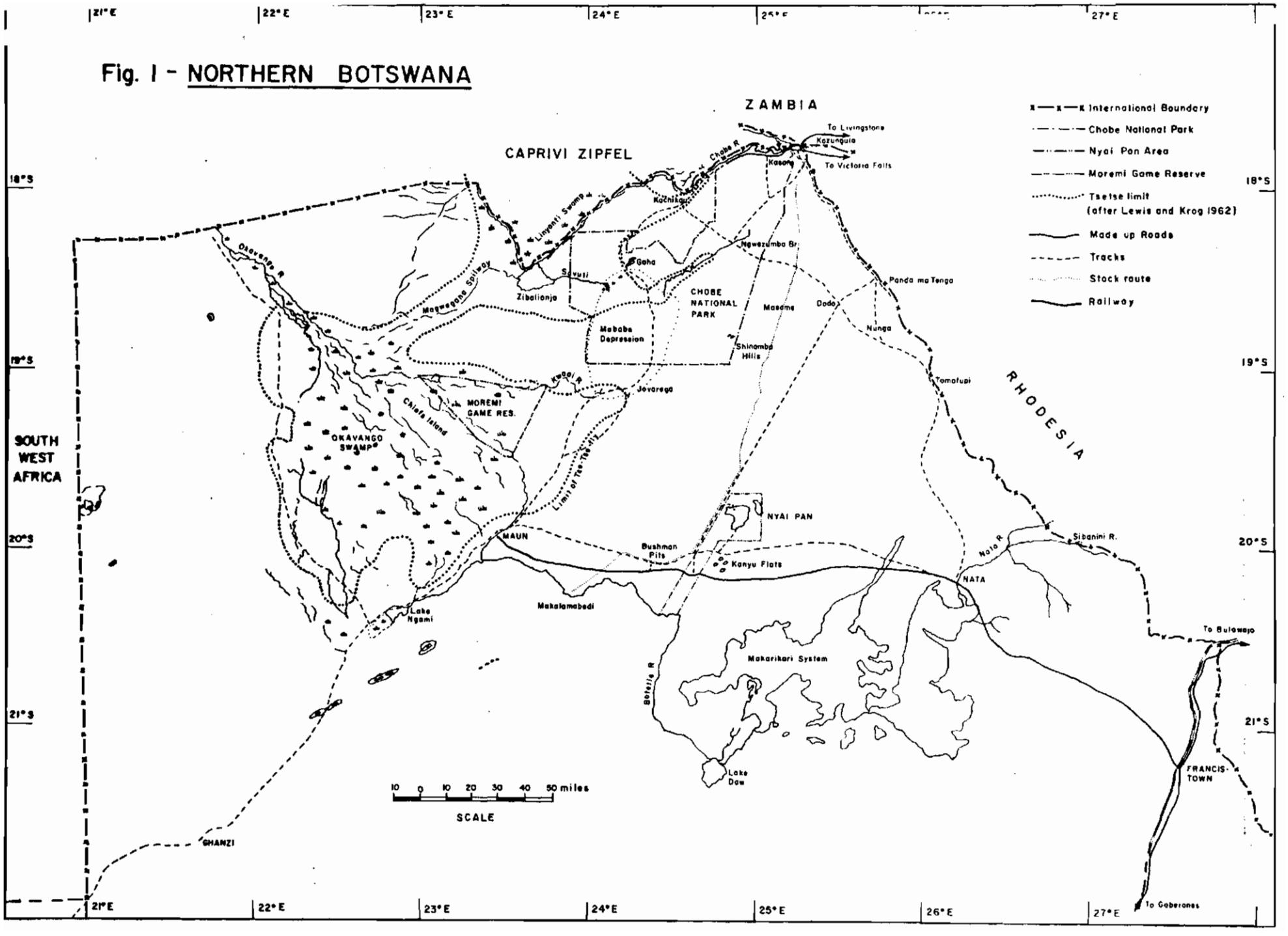
2 f. coll. Kasane, April 21, 1967; gives marked extension of range in Botswana.

459. Serinus mazambicus — Mocambique Canary

1 m. coll. Kasane, March 4, 1967.

460. S. atrogularis — Black-throated Canary

1 m. coll. Kasane, March 30, 1967.



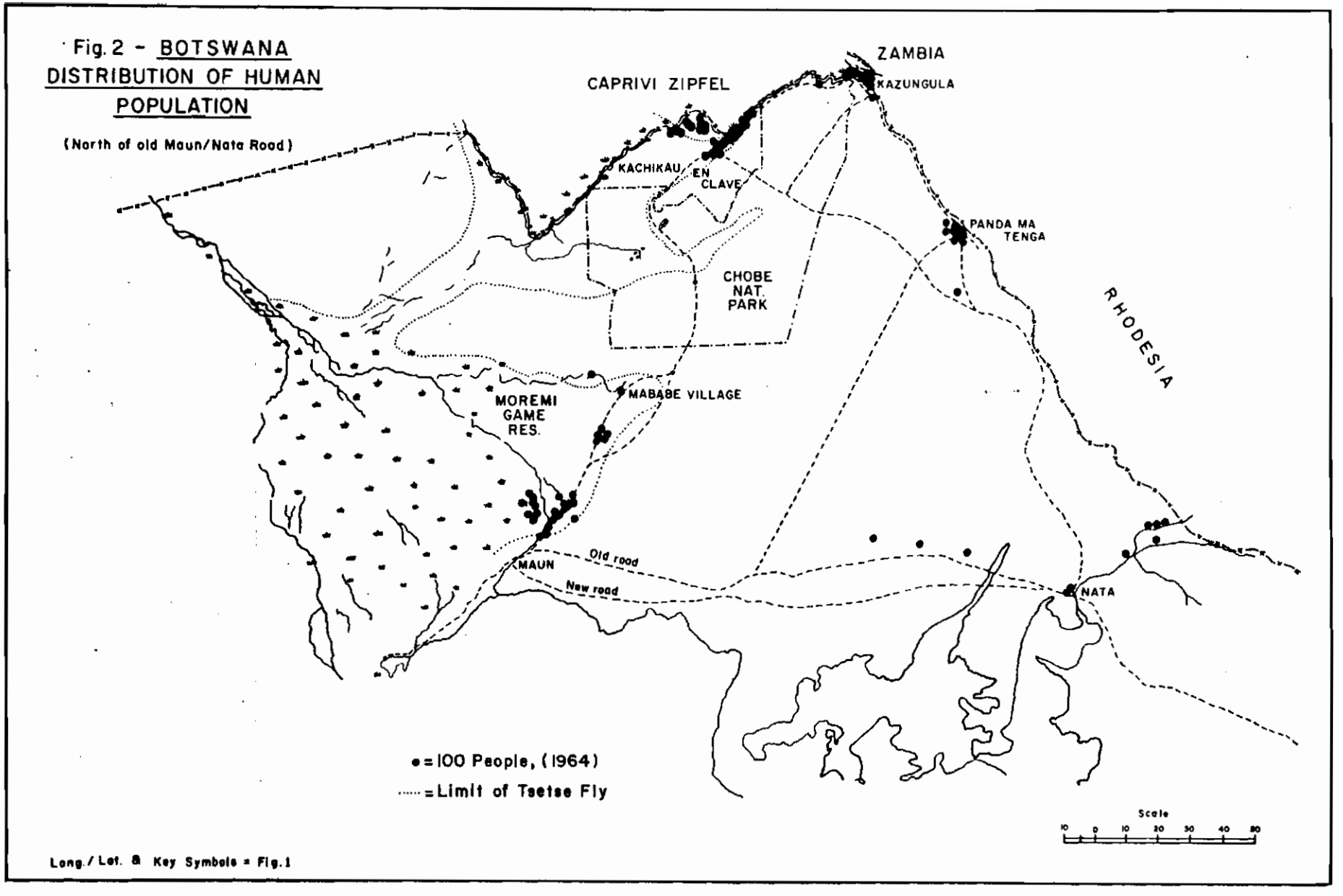


Fig. 3 - WILDLIFE AREAS IN NORTHERN BOTSWANA

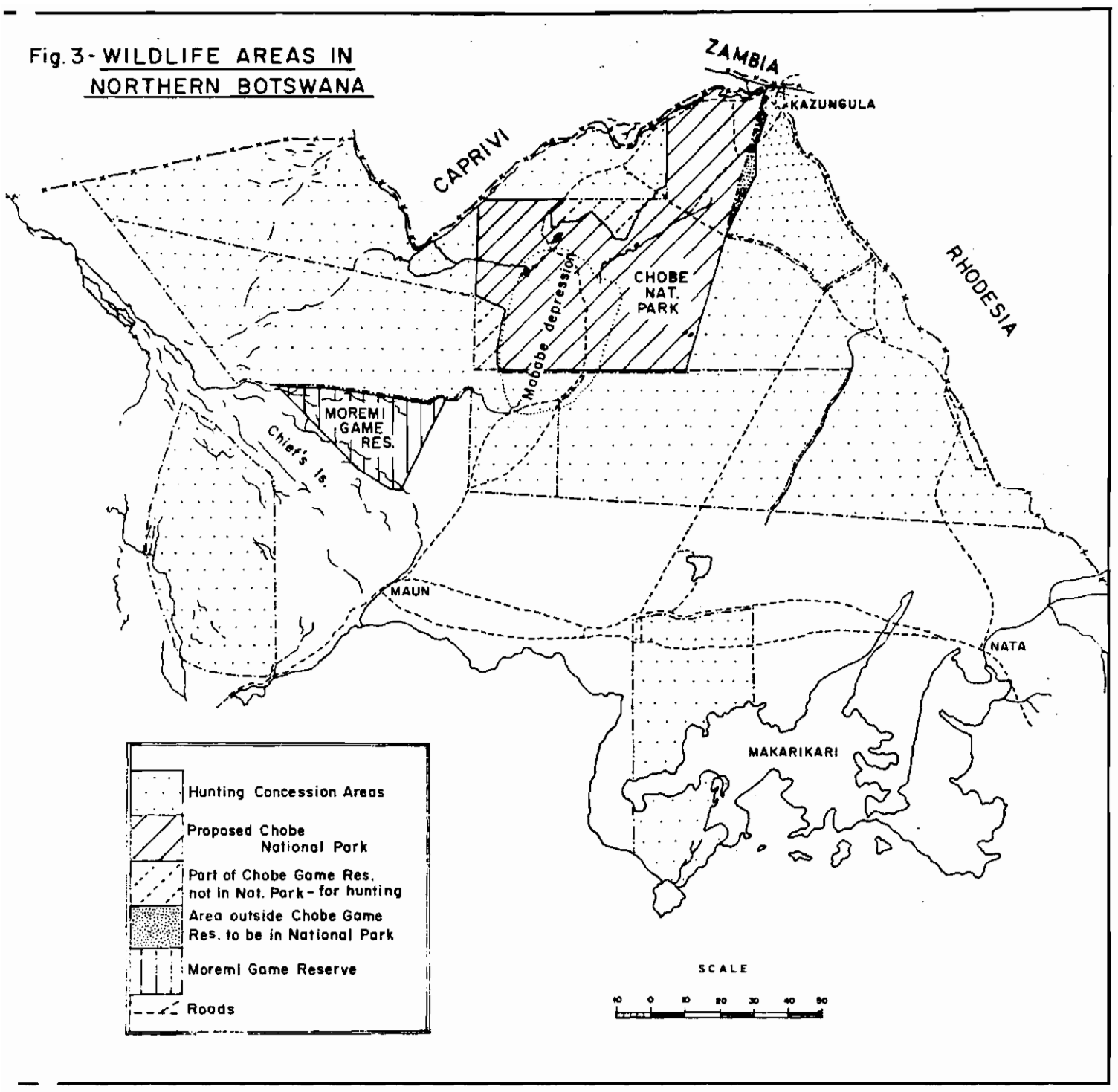
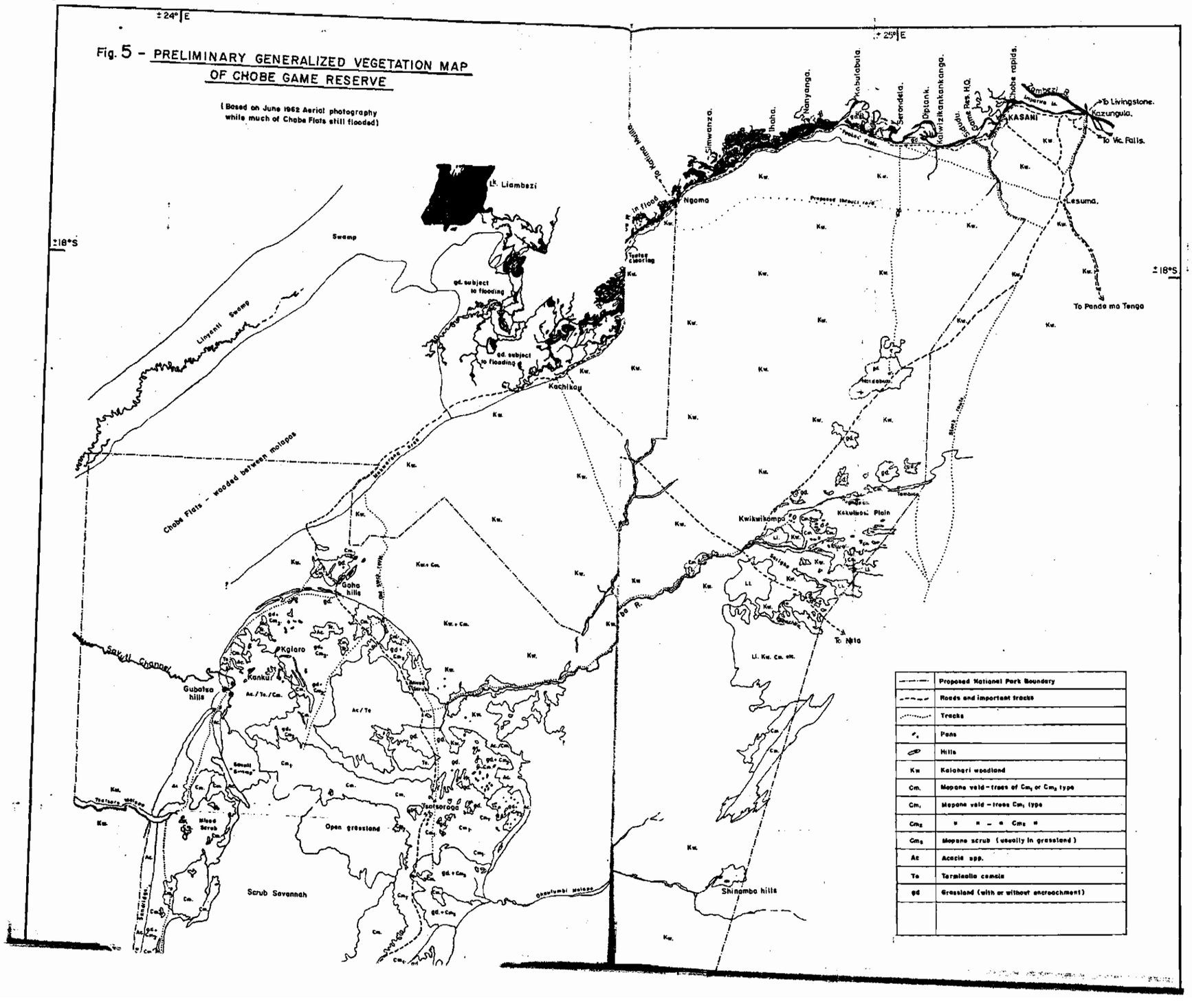


Fig. 5 - PRELIMINARY GENERALIZED VEGETATION MAP OF CHOBE GAME RESERVE

(Based on June 1962 Aerial photography while much of Chobe Flats still flooded)



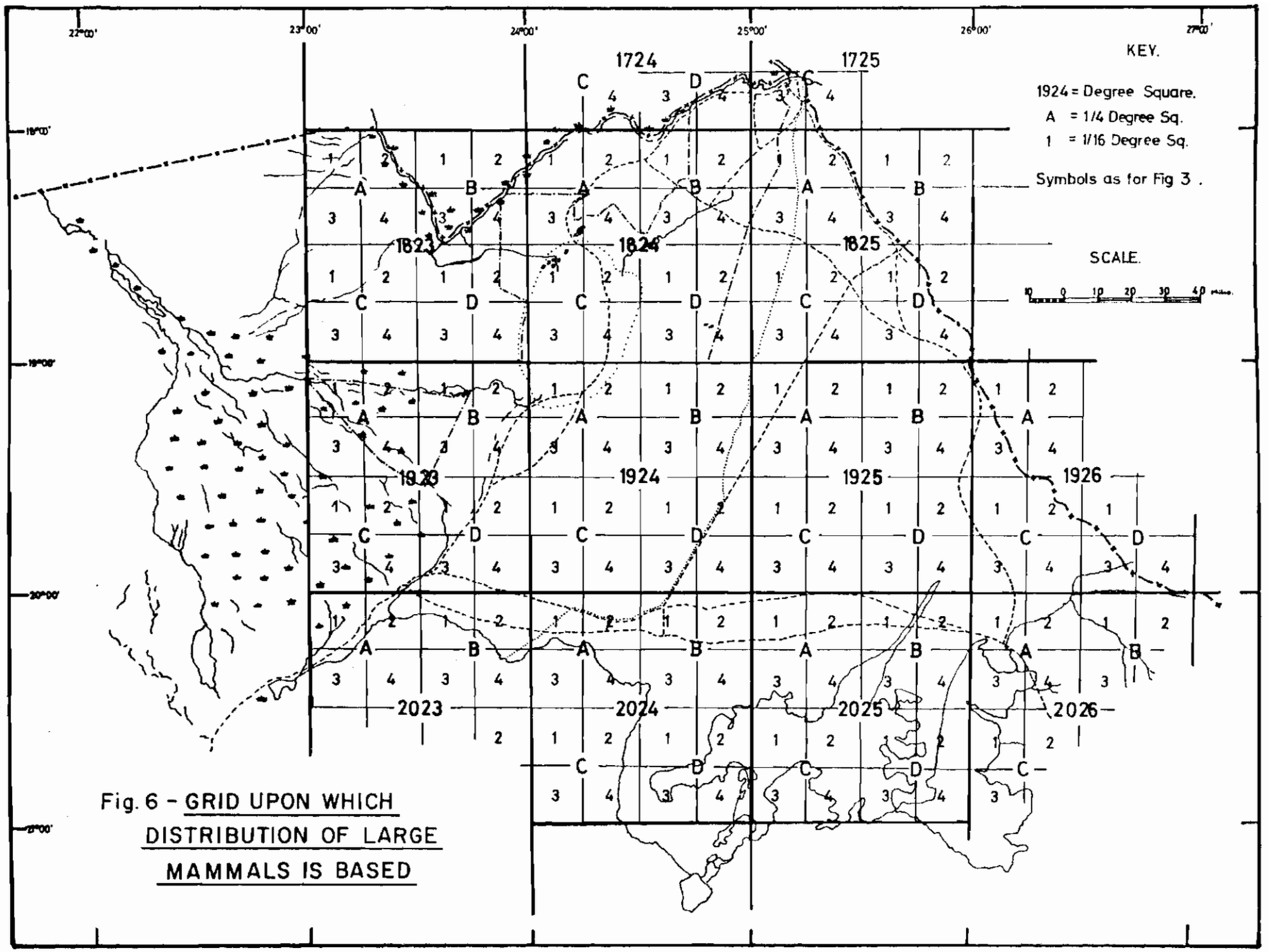


Fig. 6 - GRID UPON WHICH DISTRIBUTION OF LARGE MAMMALS IS BASED

FIG. 7 - ELEPHANT AND BUFFALO ALONG THE CHOBE RIVER

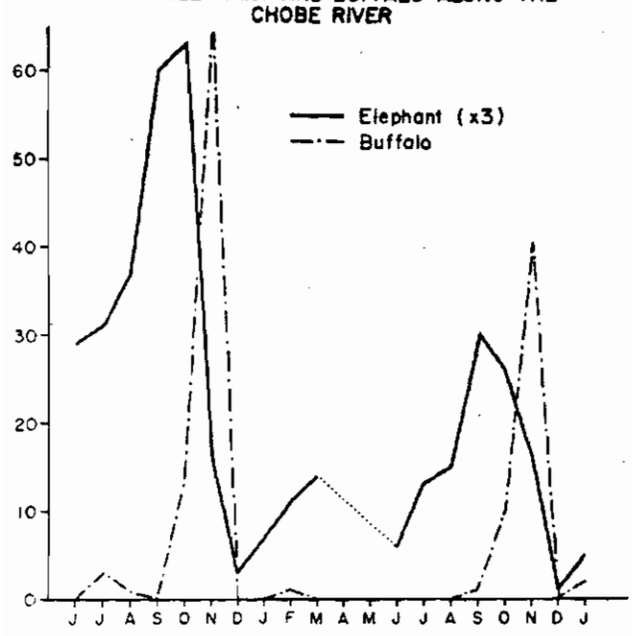


FIG. 9 - WARTHOG AND IMPALA ALONG THE CHOBE RIVER

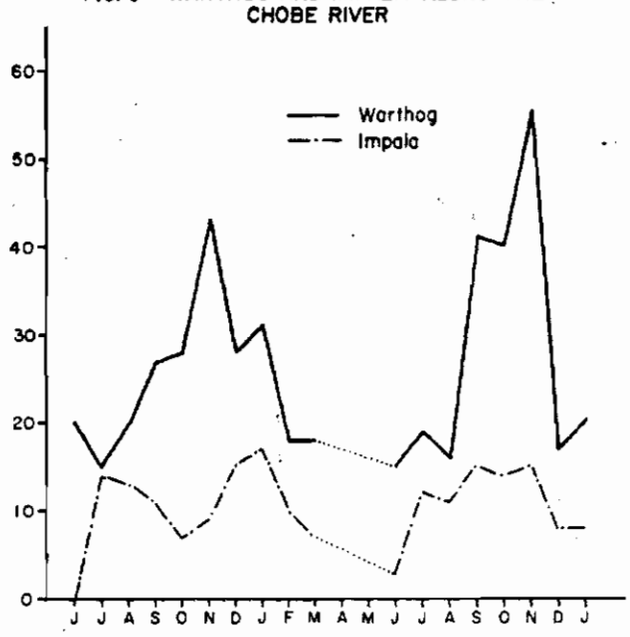


FIG. 10 - LECHWE PUKU AND WATERBUCK ALONG THE CHOBE RIVER

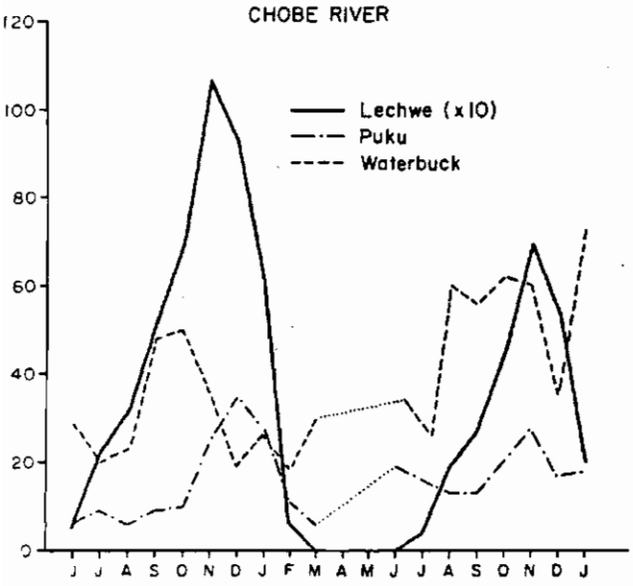


FIG. 11 - SABLE AND ROAN ANTELOPE ALONG THE CHOBE RIVER

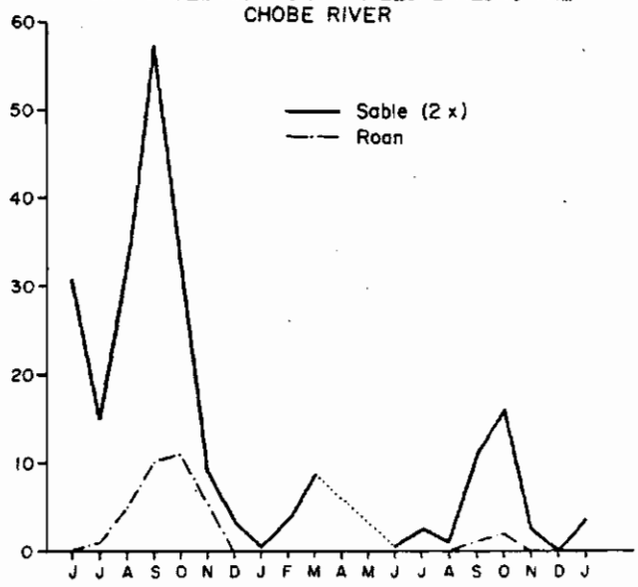


FIG 12 - WILDEBEEST AND TSESSEBE ALONG THE CHOBE RIVER

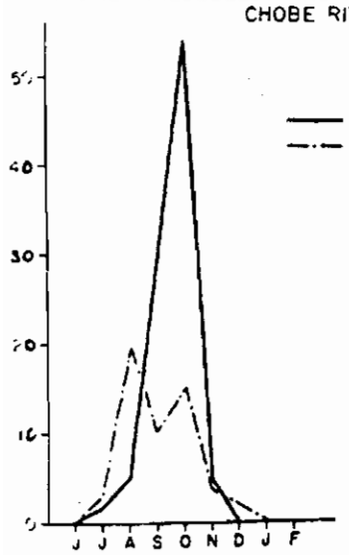


FIG. 13 - KUDU AND BUSHBUCK ALONG THE CHOBE RIVER

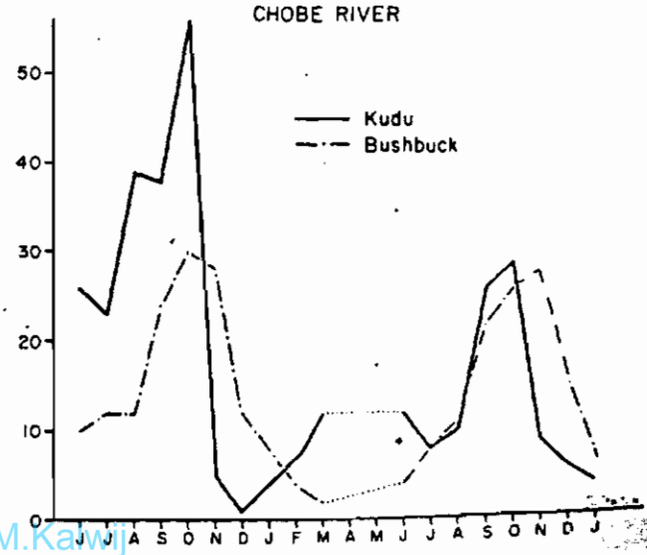


Fig. 8 – MOVEMENTS OF ELEPHANTS FROM BOTSWANA INTO THE EASTERN CAPRIVI