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THE IMPORTANCE OF PANS TO WILDLIFE IN THE KALAHARI AND THE EFFECT OF HUMAN SETTLEMENT ON THESE AREAS

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ABSTRACT

A cross-section of Kalahari pans was studied to determine wildlife use and the effect of human settlement on these areas. The pans without settlement are shown to be important to many wildlife species including the valuable large antelope – blue wildebeest, red hartebeest, gemsbok and springbok. Human settlement has led to a disappearance of most wildlife species, a reduction in perennial grass cover, and an increase in shrubs. It is suggested that these facts should be taken into account by land-use planners in this arid area where the use of wildlife is already a significant factor in the economy.

INTRODUCTION

The south-western half of Botswana is arid Kalahari shrub and tree savanna without perennial surface water. The region supports valuable wildlife populations and is devoted to scattered extensive livestock production, centered on settlements at wells and boreholes. Increasing demands to intensify land-use in this sparsely populated area are resulting in more and more conflicts between the interests of wildlife and domestic animals. The pans and pan-like areas scattered throughout the region are particularly critical in this respect as both groups of animals make use of these areas.

This survey attempted to determine the importance of these pans to wildlife, particularly the large gregarious antelope. It also sought to measure the effects of human activity near the pans on both the wildlife and the vegetation. Field work took place mainly in October and November, at the end of the 1968 dry season. This research is being continued by the senior author.

STUDY AREA

Human densities in south-western Botswana vary from 0 to 1,2 persons per km^2 (Campbell 1965). Most live in settlements and derive their livelihood from hunting and gathering or from primitive pastoralism. The pans sampled in this survey are shown in Fig. 1, which also indicates the mean annual rainfall, which is erratic and falls mainly in summer (Pike 1972). There is no permanent surface water and water in the pans after rain usually persists only for a few weeks. Mean monthly temperatures at Tshabong vary between maxima and minima of 35° and 18°C respectively in December, and 21° and 2°C respectively in June, with wide diurnal fluctuations.

The area consists of flat or undulating sandveld with dune formation increasingly conspicuous towards the south-east. It lies within the huge sandveld area of southern Africa known as the Kalahari System (Mountain 1968). This system covers nearly all of Botswana, the north-eastern part of South West Africa, a large portion of Angola and Zambia, and smaller parts of Rhodesia and the north-western Cape. Scattered throughout the rather homogeneous sandveld of south-western Botswana there are numerous pans which usually have a well developed dune on the leeward side. Surface calcrete is often present on the pans and their soils vary from saline clay soils without vegetation, to hard grey soils capable of supporting a good vegetative cover. The dominant grasses and low bushes on the pans in the study area grow in fairly distinct zones or bands, similar to those described by Leistner (1967) for pans in the dune veld.

The vegetation of southern Botswana has been described in detail by Blair Rains and Yalala (1972) and in the study area it consists of open shrub or tree savanna with *Acacia giraffae, A. uncinata* and *Boscia albitrunca* the dominant trees. There is a well developed herbaceous layer of grasses (particularly *Stipagrostis uniplumis* and *Eragrostis lehmanniana)* and forbs, except where the vegetation has been modified through human settlement, as here grasses are generally suppressed and bush encroachment is evident.

Wildlife is fairly plentiful in the area and mobility is a feature of many species (Parris 1972) including the common gregarious species with which this survey was primarily concerned, i.e. blue wildebeest *Connochaetes taurinus,* red hartebeest *Alcelaphus buselaphus,* gemsbok *Oryx gazella,* and springbok *Antidorcas marsupialis.*

The eight pans studied are all fairly large with diameters ranging from about one to three kilometres. The four pans with permanent settlements were selected as being a fairly representative cross-section of settled pans in the area. Khuis pan is about eight kilometres from the Molopo. The area is subject to fairly intensive grazing by stock from settlements along the Molopo and this has probably been the practice for over 100 years (Clement 1967). The administrative centre and villages at Tshabong are situated around the edge of the pan which has been heavily grazed by stock for at least 50 years, although the intensity has probably increased during recent decades with the advent of the borehole. Some of the oldest residents can

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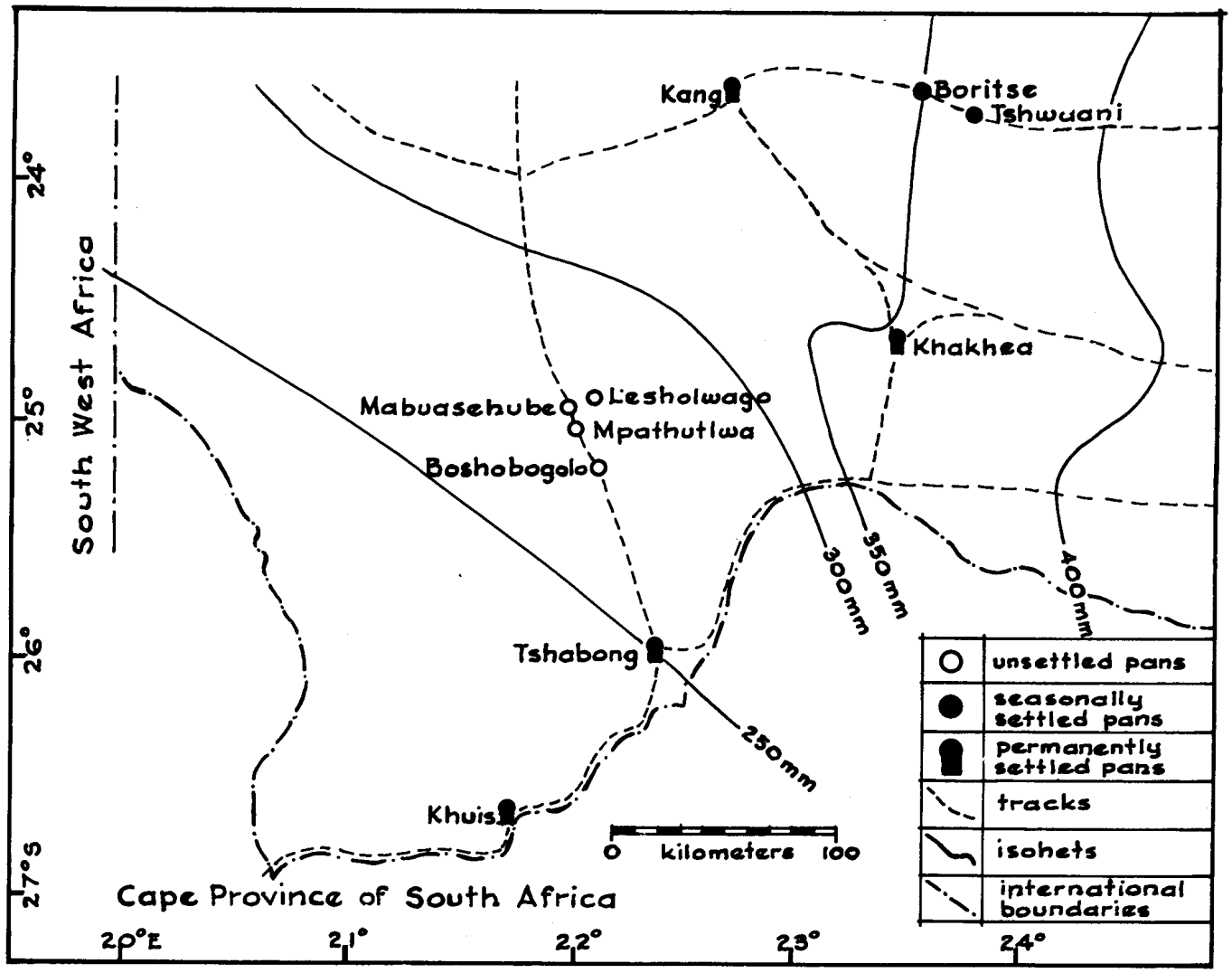

Fig. 1. South-western Botswana, showing pans surveyed.

remember a permanent spring with reed beds on the pan, but these have since disappeared. Khakhea was another settled pan at which the oldest people could recall a permanent spring which dried up around 1920 when the village water supply became dependent on a well. According to these elders, their fathers owned no stock and had lived by hunting and gathering, relying upon "sipping wells" while away from home. This practice was no longer possible as the moist areas in the surrounding sandveld, from which water could be sucked up through a reed, had all dried up. Some 1661 head of cattle plus numerous sheep, goats, donkeys and horses were watered from the borehole on the edge of the pan in 1967 (von Richter 1969). Kang is an old settlement and is on the route along which cattle from the north are walked to markets in the south; von Richter (*op cit.*) lists the resident cattle population as 4553 head in 1967.

The four unoccupied pans were selected because they were all more than 80 kilometres from the nearest village. Therefore, apart from occasional hunting or burning, the activities of the wild animals are not greatly influenced by human disturbance. The four pans include both highly saline and only slightly saline pans.

Mabuasehube was inhabited for a considerable period, about 40 to 60 years, until 1948, when the large stock post at the pan was abandoned (Kgothi, personal communication). Livestock use since then has been limited to occasional groups of animals on their way between Tshabong and Tshani. The former inhabitants burnt the veld regularly and these fires may have spread to the other unoccupied pan areas. The stock were sometimes walked the eight kilometres to Mpathutlwa and Lesholwago pans but few would have moved the 32 kilometres to Boshobogolo pan.

METHODS

Sampling of vegetation and animal-use was done as far as possible on similar vegetation types so that meaningful comparisons could be made. The sandveld was considered to be fairly uniform and measurements were taken at 0,8 kilometre or 1,6 kilometre intervals. On the pans the following vegetation zones were sampled. *Sporobolus spp.* zone, *Eragrostis truncata - Stipagrostis obtusa* zone, *Stipagrostis obtusa* zone and *Rhygozum trichotomum - Stipagrostis obtusa* zone. Not all the pans had all these zones so comparisons were made only between similar zones on different pans. On settled pans the zones were sometimes modified by overgrazing but were still recognizable as such.

The status of the vegetation, trends and the relative use made of areas by animals were measured by means of composite transects similar to those suggested by Riney (1963), and as used by Child et al (1971). Each transect consisted of 100 step points at two metre intervals to describe the status of the

vegetation, 10 equidistant assessments of trend and 10 or 20 pellet plots, each 3,8 m^2 in area and 20 m apart. Supplementary pellet plots were also measured in some areas. Measurements of status recorded the incidence of bare ground, plant litter, rooted plants, and plant canopy. Grass and grass canopy were separated into annual and perennial species.

Assessments of trends were based chiefly on clear trends in perennial grasses. The overall trend in an area was determined as either stable, improving or deteriorating from a summation of the 10 separate assessments on the transect sampling the area. Where the status of the vegetation was too low for such assessments the trends are designated by a question mark in the tables.

Determination of the incidence of animal droppings in pellet plots along the transects or on supplementary pellet plot lines followed the methods suggested by Child et al (1971). For all species except hare and springhare complete defaecations were enumerated if over half the pellets were judged to fall within the plot. A group was also counted if an animal had defaecated while walking and two or more of the pellets were in the plot. Hare and springhare pellets were recorded simply as present or absent.

In addition to the pellet plot counts, eight counts of animals were made from a vehicle by two observers while travelling from Tshabong to Mabuasehube, between April 1968 and February 1969. This was a distance of 137 km of which about six kilometres was in the neighbourhood of pans.

Shrubs in the Mabuasehube area were aged by counting the number of growth rings in the oldest subsurface part (root or stem). The method followed Child (1968) and was necessitated by the growth form of the species involved, as all had well developed ground level coppices. There was some difficulty in distinguishing a number of the rings in the oldest specimens and their ages may have been underestimated, particularly when sections had rotted away. Nevertheless, the method allowed a good approximation of the age structure of three shrub populations near this pan.

RESULTS

Animal distribution in relation to pans.

General observation and preliminary counts indicated that many Kalahari animals tended to concentrate at or near pans, while others were seldom seen anywhere else. Other evidence of the importance of the pans and pan-like areas for browsing and grazing animals comes from the fact that local stock owners often walk their stock 16 km or more to the nearest pan. On fenced ranches, pan-like areas are often more heavily grazed than the surrounding sandveld. Pans provide suitable habitats for many small animals (Smithers 1971).

The results of the eight road counts between Tshabong and Mabuasehube are summarised in Table 1 and are in general agreement with these

TABLE 1. Distribution of game animals in relation to pans on eight road counts between Tshabong and Mabuasehube in the Kalahari, south-western Botswana.

Species	At Pans			In Sandveld		
	Minimum No. per count	Maximum No. per count	Average No. per count	Minimum No. per count	Maximum No. per count	Average No. per count
Springbok	6	430	166,4	0	200	36,4
Hartebeest	0	49	10,5	0	0	0,0
Wildebeest	0	24	3,2	0	0	0,0
Gemsbok	0	75	27,2	0	0	0,0
Eland	0	29	3,6	0	0	0,0
Kudu	0	0	0,0	0	20	2,5
Ostrich	3	32	16,1	0	20	3,2

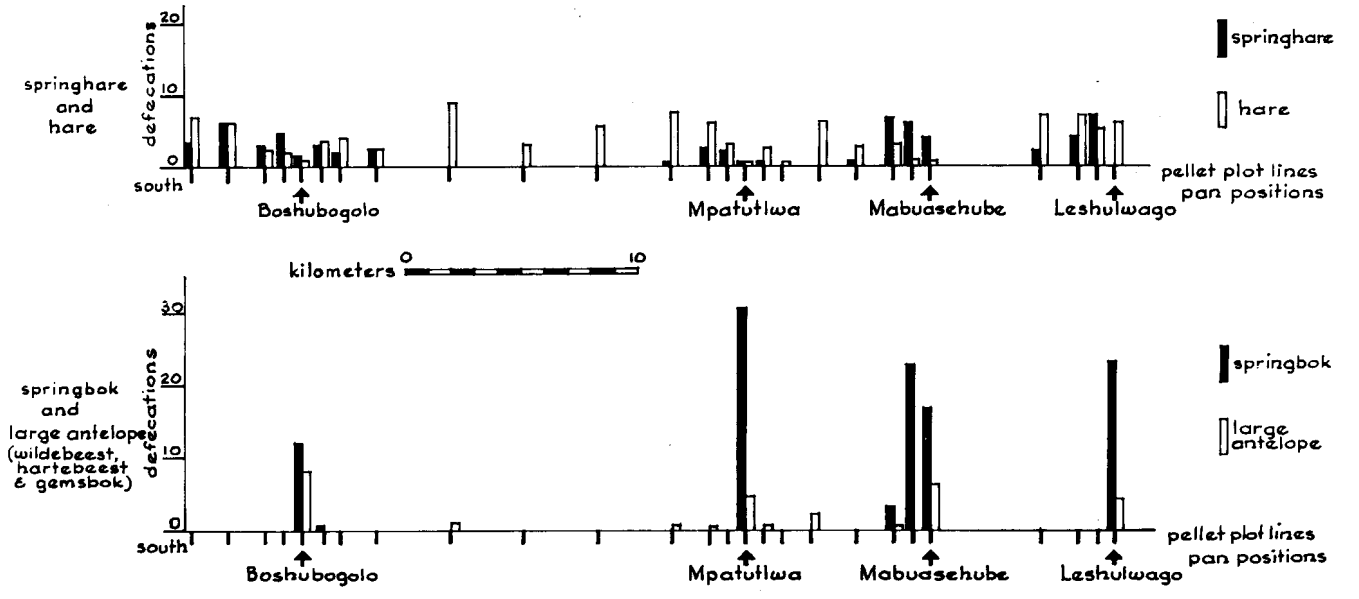

Fig. 2. Distribution of animal defaecations in relation to four unsettled pans in the Kalahari, south-western Botswana; defaecations shown as mean number of pellet groups per ten sample plots.

TABLE 2. Incidence of wildlife and domestic stock defaecations within 0,8 kilometres of settled and unsettled pans in the Kalahari, south-western Botswana.

Pans	Average number of defaecations per 10 plots*												
	Domestic stock				Wildlife								
	Sheep & Goat	Cattle	Donkey & Horse	Camel	Springbok	Hartebeest	Wildebeest	Gemsbok	Eland	Unidentified antelope	Ostrich	Springhare	Hare
Settled	6,6	5,0	1,8	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,1
Unsettled	0,0	0,0	0,0	0,0	10,6	1,7	2,7	0,6	0,6	0,1	1,3	3,5	2,2

*Data from 20 pellet-plots given as average per 10 plots for ease of comparison.

observations. Visibility is better on pans than in sandveld but as only six kilometres of the road was along pans and 131 km was in sandveld, the area of pan sampled was less than the area of sandveld sampled. However, with nearly all species considerably more animals were seen on the pans than in the sandveld. The only exception was kudu, but in this case only one sighting of 20 individuels was made.

Figure 2 illustrates the distribution of animal defaecations in relation to four unsettled pans. Springbok showed a marked preference for pans, although at Mabuasehube this extended for about 1,6 km south of the pan into an area of sandveld in which the vegetation was atypical, having apparently been modified by past settlement at the pan. The combined totals for gemsbok, hartebeest and wildebeest were also considerably higher on pans than in the sandveld. Eland and ostrich defaecations although not shown in Fig. 2 were also recorded mainly on pans. Child et al (1971) found a similar relationship between the distribution of the pellets of most large antelope and the dry bed of the Nossob river, which has many pan-like characteristics. Springhare and hare defaecations were not markeldy higher on pans than on sandveld.

Comparison of wildlife and vegetation at settled and unsettled pans.

An evaluation of the transects made in similar vegetation types at settled and unsettled pans shows that permanent settlements have had a very marked influence on the native fauna and flora. Although it is beyond the scope of this survey to consider the rate at which such effects can occur, evidence from other parts of the Kalahari indicates that change may be very rapid, particularly where settlements develop around a reliable borehole (Martens 1972).

Table 2 indicates that the presence of a large permanent village results in the disappearance of most common species of wildlife from the area. It is difficult to distinguish between springbok and small domestic livestock pellets in the field, and when these species occur in the same area caution must be exercised in using the results of pellet counts. However, general observation and information supplied by residents of the villages confirms that springbok are seldom if ever seen on the settled pans. At pans with small temporary villages, such as Boritse and Tshwaani in the Kweneng District, both domestic and wild animals make use of the same pan. Springbok were observed grazing amongst the cattle near Tshwaani pan and in ten pellet plots at Boritse pan six cow, one donkey and 28 antelope defaecations were recorded.

Measurements of the status of the vegetation and trends at or near the two groups of pans (Tables 3, 4 and 5) indicated more perennial grass, more litter and better trends at the unsettled pans. There were very few records of annual grasses, and the data relating to forbs are inconclusive. Assessment of trend is important in demonstrating degeneration of the perennial grass cover, but when the perennial grasses have already been virtually eliminated by overgrazing, as found close to settlements, trend assessments are less meaningful. A low perennial grass cover was recorded in the vicinity of all settled pans, but the extent of this overgrazing varied. In the case of Kang pan the perennial grass cover was poor for at least eleven kilometres from the pan.

Bush encroachment is often pronounced around settlements in the Kalahari and there was generally more bush recorded near settlements in this survey (Tables 3, 4 and 5). However, there is evidence that past settlement at Mabuasehube led to a thickening of woody plants, so that if this pan is excluded and the other three unsettled pans are compared with the settled pans the differences in woody plant cover are more marked.

Effects of Past Settlement at Mabuasehube Pan.

There was a large stock post at Mabuasehube until 1948, when it was abandoned, allowing 19 growing seasons before the area was sampled by this survey. The effects of settlement were still apparent in the highly modified appearance of the surrounding vegetation and Table 4 indicates that the amount of perennial grass and litter was generally lower at 0,8 kilometres than at the other unsettled pans.

The age structures of three populations of bush around Mabuasehube were investigated where woody plants appeared to have increased in density during the recent past. The results of these age determinations are shown in Fig. 3, which suggests similar, but unusual age structures that approach a normal distribution with a small standard deviation (s = 3,2 to 3,6 yrs) centred on mean ages of from 17,0 to 19,4 years, with few young plants with less than 15 growth rings. In each case the maximum age frequency represented plants that became established soon after the stock post was abandoned. A similar frequency distribution was also found in smaller samples of other bush species.

Similar results were obtained near an old stock post on the northern fringe of the Makgadikgadi pan system in central Botswana from which the stock were removed in 1953 and where the owner could give a fairly detailed account of changes that had taken place in the vegetation since depleted grazing forced his departure. The post had been situated in open

TABLE 3. Summary of the status and trend in different vegetation zones on settled and unsettled pans in the Kalahari, south-western Botswana.

Vegetation type[1]	Pan		Vegetation status[2]								Vegetation trend[3]	
	Settled	Unsettled	BG %	L %	C %	G %	A %	P %	F %	W %	Stable or up	Down
Pan Zone A	Tshabong		100	2	0	0	0	0	0	11		X
	Tshabong		100	2	0	0	0	0	0	15		?
		Boshobogolo	83	10	12	17	0	29	0	0	X	
		Boshobogolo	92	4	3	8	0	11	0	6		X
Pan Zone B	Khuis		99	16	2	1	0	3	3	0		X
	Kakhea		95	7	3	5	0	3	0	0	X	
	Kang		98	2	2	0	0	2	0	2		X
		Mpathutlwa	67	7	9	33	0	42	0	0	X	
		Lesholwago	87	31	18	13	0	31	0	1	X	
		Mabuasehube	94	19	14	6	0	20	0	0	X	
Pan Zone C	Khuis		98	1	3	2	0	5	9	0		X
	Kang		100	0	0	0	0	0	0	3		X
		Mabuasehube	91	19	22	9	0	31	0	1	X	
Pan Zone D	Tshabong		100	7	0	0	0	0	0	22	X	
	Khuis		100	3	0	0	0	0	0	22		X
		Boshobogolo	99	15	10	1	0	11	0	30	X	
Mean	settled		98,9	4,4	1,1	0,9	0,0	2,3	1,3	8,3		
		unsettled	87,5	15,0	12,5	12,4	0,0	25,0	0,0	5,4		

[1] Pan Vegetation zones
A — *Eragrostis truncata* — *Stipagrostis obtusa*
B — *Sporobolus spp*
C — *Stipagrostis obtusa*
D — *Rhygozum trichotomum* — *Stipagrostis obtusa*

[2] Vegetation status
BG — Bare ground
L — Litter
C — Grass canopy
G — Rooted grass
A — Annual grass
P — Perennial grass
F — Forb
W — Woody plant, rooted and canopy

[3] Vegetation trend
? — Perennial grass cover too low to assess trend

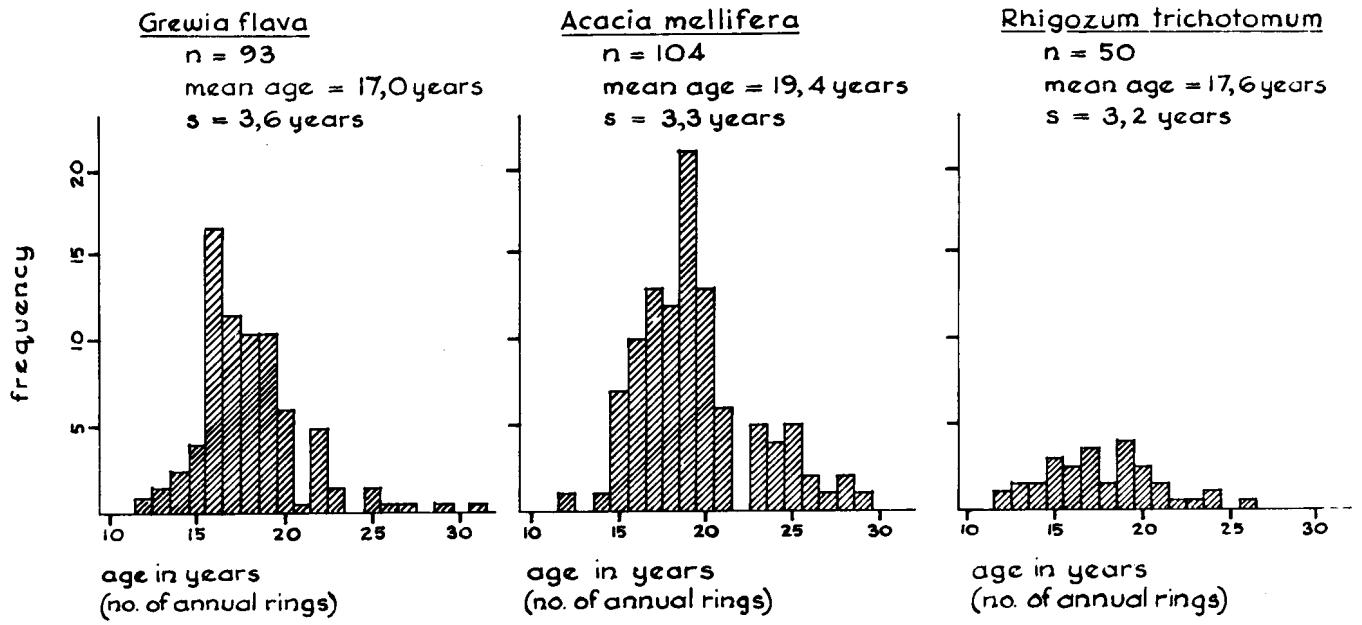

Fig. 3. The age structures (numbers of annual rings) of three populations of bush around Mabuasehube Pan which was abandoned as a settlement 20 years previously.

TABLE 4. Summary of the status and trend of the sandveld vegetation 0,8; 1,6 and 3,2 kilometres from settled and unsettled pans in the Kalahari, south-western Botswana.

Distance from pan	Pan: settled	Pan: unsettled	Vegetation status*: BG %	L %	C %	G %	A %	P %	F %	W %	Vegetation trend: Stable or up	Vegetation trend: Down
0,8 km	Tshabong		100	6	4	0	0	4	4	9	X	
	Kang		100	12	0	0	0	0	0	19		X
	Khuis		100	3	0	0	0	0	0	5		?
	Khakhea		100	13	9	0	0	9	0	17		X
		Boshobogolo	94	34	17	6	0	23	0	3	X	
		Lesholwago	96	29	11	4	0	15	1	15	X	
		Mpathutlwa	95	38	17	5	0	22	1	15	X	
		Mabuasehube	100	8	1	0	1	0	1	8		X
Mean	settled		100	8,5	3,3	0,0	—	3,3	3,0	12,5	1	3
		unsettled	96,3	27,3	11,5	3,8	—	15,0	0,8	10,5	3	1
1,6 km	Tshabong		100	8	1	0	0	1	1	7	X	
	Kang		100	2	0	0	0	0	0	26		X
	Khuis		100	7	0	0	0	0	7	4		?
	Khakhea		98	27	6	2	0	8	1	28		X
		Boshobogolo	96	27	17	4	0	21	2	3	X	
		Lesholwago	97	23	6	3	0	9	3	11	X	
		Mpathutlwa	98	36	18	2	0	20	4	9	X	
		Mabuasehube	99	31	7	1	0	8	7	12	X	
Mean	settled		99,5	11,0	1,8	0,5	—	2,3	2,3	16,3	1	3
		unsettled	97,5	29,3	12,0	2,5	—	14,5	4,0	8,8	4	0
3,2 km	Tshabong		100	17	1	0	0	1	2	24	X	
	Kang		100	3	0	0	0	0	0	11		X
	Khuis		100	7	0	0	0	0	0	16		X
	Khakhea		96	46	14	4	0	18	0	21	X	
		Boshobogolo	94	26	18	6	0	24	2	5	X	
		Lesholwago	99	27	10	1	0	11	4	6	X	
		Mpathutlwa	94	35	14	6	0	20	5	4	X	
		Mabuasehube	99	51	11	1	2	10	11	20	X	
Mean	settled		99,0	18,3	3,8	1,0	—	4,8	0,5	18,0	2	2
		unsettled	96,5	34,8	13,3	3,5	—	16,3	5,5	8,7	4	0

*See footnote, Table 3.

TABLE 5. A comparison of the status of important components of the vegetation on and around settled and unsettled pans in the Kalahari, south-western Botswana.

Vegetation type*	Average status of main components of vegetation: % perennial grass rooted and canopy		% litter		% woody plants rooted and canopy	
	settled	unsettled	settled	unsettled	settled	unsettled
Pan zone A	0,0	20,0	2,0	7,0	13,0	3,0
Pan zone B	3,4	31,0	8,3	19,0	0,7	0,3
Pan zone C	2,5	31,0	0,5	19,0	1,5	1,0
Pan zone D	0,0	11,0	5,0	15,0	22,0	30,0
Sandveld 0,8 km	3,3	15,0	8,5	27,3	12,5	10,5
Sandveld 1,6 km	2,3	14,5	11,0	29,3	16,3	8,8
Sandveld 3,2 km	4,8	16,3	18,3	34,8	17,8	9,0
Mean	2,5	20,0	7,6	21,6	12,0	8,9

*See footnote, Table 3.

mopane *Colophospermum mopane* parkland, but by the time this was sampled in mid-1968 the area between the large trees had been invaded by young mopane bushes. These consisted of two size classes – a few young seedlings up to 4 cm. diameter, and numerous saplings some 8 to 15 cm. in diameter. A sample of 16 of the latter had from 11 to 17 (mean = 14; s = 1,3)growth rings, indicating remarkable uniformity of age, considering the difference in girth. As at Mabuasehube, the increased density of the woody plants followed immediately after the closing of the stock post. Old residents of the Nata river area volunteered that a similar sequence of events, but on a much larger scale, had occurred when the big village at Naketi was abandoned.

DISCUSSION

This survey confirmed the general observation that many species of wildlife make extensive use of pans, when these pans are not occupied by large permanent villages. The study was mainly concerned with the common large gregarious antelope i.e. blue wildebeest, red hartebeest, gemsbok and springbok as these form the bulk of the antelope population, and all four species showed a distinct preference for pan areas.

Pan soils are characterized by a relatively high mineral content and pans have one or more well used 'salt licks' where antelope eat the mineralized soil. Weir (1969) found high concentrations of sodium to be an important factor in elephant *Loxodonta africana* 'salt licks' on Kalahari sand in Wankie National Park in western Rhodesia. Aphosphorosis is known to occur in domestic stock in the Kalahari sandveld areas of southern Africa. Cattle in this area will often eat old bones and this behaviour has been reported in hartebeest. Child (1968) reports an eland which choked to death on a bone in Kalahari sandveld in north-eastern Botswana. A bonemeal-salt lick is recommended for domestic stock in these areas to overcome mineral deficiencies. For more intensive management of Kalahari antelope the mineral requirements of the different species needs to be determined, together with a measure of the minerals available in the vegetation and at the natural pan 'licks'.

Although all species of wildlife in the study area are adapted to surviving long periods without drinking water (Parris 1972), many species drink water when it collects in depressions on the pans after rain. This water is only available for a relatively short period, and since animals are regularly seen on pans in the dry season the presence of water on the pan is only one of the factors which attracts animals to the pan. Research is being continued to try to establish all the factors underlying the importance of pans to various species.

This study also demonstrates the detrimental effect of permanent settlements on the perennial grass cover on and around the pans. Severe reduction in the perennial grass cover around watering points affected large areas and around Kang borehole involved an area of over 380 km^2.

Child et al (1971) found that the depressive effects of past human occupation were still detectable after 25 and 38 years respectively in two areas in the Kalahari Gemsbok National Park. The sandveld vegetation in the vicinity of Mabuasehube pan also showed signs of past misuse 20 years after the domestic stock had been removed. However in all three cases wild animals utilized the areas after the removal of the domestic stock so that recovery of these areas was slowed down.

The presence of permanent villages also resulted in an increase in the number of woody plant species. The Interim Report of the Commission of Enquiry into Agriculture (1968) notes that one of the side effects of overgrazing in the northern Cape, (i.e. Kalahari sandveld) is the severe problem of bush encroachment, particularly by *Acacia mellifera*. About 2 million hectares have already been seriously infested and unless something is done to combat this problem large parts of the region could become completely useless for farming. The age structure of bush thickets at abandoned villages in two widely seperated areas with different plant species, climate and soil, indicated that most plants became established just after a stock post was closed. Overgrazing while the livestock were present would have favoured bush encroachment from an early stage, but this was apparently kept in check to a certain extent by such factors as trampling, browsing by goats and the cutting of bushes for domestic purposes. However, once the village was abandoned and the stock were removed the bush was able to become firmly established. This shows that the removal of stock from an overgrazed area in the Kalahari is unlikely to result in a rapid improvement in the grass-bush ratio, but is more likely to favour the bush initially. These bushes will have to complete their life cycles before the grasses can fully recover. Thus once the bush has become established it is a long and costly process to restore the perennial grass cover to its former state.

Fig. 4. General view of area near Boshobogolo Pan showing typical vegetation of an unsettled pan.

Fig. 5. General view five kilometres from floor of Tshabong Pan showing typical vegetation of a settled pan.

The presence of a large permanent village seriously reduced the number of wild animals using the pan. This disturbance is caused by a number of factors such as hunting with the aid of dogs and horses, competition from domestic stock and general noise from the village. Von Richter (1969) demonstrated the importance of wildlife to the welfare of the local people and the general economy of the region, so that these permanent settlements are adversely affecting both the natural vegetation and the valuable wildlife populations. It is difficult to express this detrimental effect in terms of rands and cents, but this should be taken into account when calculating the value of livestock produced in these villages.

In the conference on sustained production from semi-arid areas held in Gaborone, Botswana during October 1971, the problems of livestock production in this marginal region were discussed, and many speakers felt that wildlife could play a greater role in the economy of this and similar semi-arid regions. Although it is difficult to move villages that have been occupied for many decades, it is possible to expand both the livestock and game industries in the southwestern parts of Botswana provided that the requirements of both industries are taken into account.

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