The History of Veld Burning in the Wankie National Park, Rhodesia

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THE Wankie National Park is an area of 5,614 square miles (1,454,534 ha) in the north western portion of Rhodesia. About 75 percent of this is made up of Kalahari sands and is typical sand dune country. The dunes run, roughly, from east to west across the Park in parallel lines. These dunes are covered in Rhodesian teak *(Baikaea plurijuga)* and associated species. The depressions between them carry grassland mixed with scrub vegetation of various types. Permanent natural water is scarce and occurs mainly in the western areas adjacent to the Botswana border in the form of seepage springs. These soils can tolerate considerable abuse by overgrazing and excessive burning without apparent deterioration. On the other hand, the basalt soils, which make up most of the remaining 25 percent, are much more vulnerable to overgrazing and excessive burning, and are prone to both gully and sheet erosion if not treated with care. On this soil type, permanent natural water is fairly common.

The average rainfall of the Wankie National Park is 25 inches (635 mm) per annum and falls between November and March, but there can be considerable variation.

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To understand the influence of fire on this land, it is necessary to investigate the history of human occupation.

There can be no doubt that prehistoric man inhabited portions of the Wankie National Park; the rock carvings at Bumboosi and Detema are proof of this fact. The rock carvings depict wild animal spoors and the archaeologist, the late Neville Jones, believed that the carvings were done by people of the Wilton Age (Davison, 1967). One must assume that, as these people carved the spoors of game, they were mainly hunters, and there can be little doubt that through the ages the area now known as the Wankie National Park has a history of occupation and visits by people whose livelihood was based on hunting. There is evidence to support the fact that in more recent times more settled tribes occupied sections of the Park, and the ruins at Bumboosi and Detema are an indication of this fact.

What is certain is that, at some stage or other, the Bushmen (the Masarwa and Makaukau) people who are normally associated with Botswana used much of the area for their hunting activities. The names of the majority of pans and seepage springs in the Park have Bushman names, and when the first Warden of the Park patrolled the area, soon after it was declared a Game Reserve in 1928, there were still Bushmen parties semi-resident in the Southern Section. To this day there are Bushmen along the Nata River in Botswana who recall the time, when as small children, they accompanied hunting parties into what is now the National Park.

Throughout Africa, hunting tribes have realized the value of fire as a hunting aid, and it must be accepted that the Bushmen burnt areas to assist them in these activities (Burchell, 1822). Burning undertaken in grassland areas, especially where the water table was high, resulted in an early flush of green grass and wildlife concentrated on these areas making the hunters' task more simple.

Whilst there is little evidence to support the fact that Bushmen used dogs for coursing, it is certain that the Matabele and the Bananzwa people, who came later, used this method to kill wildlife, and large burnt areas would certainly have simplified coursing with dogs.

During road construction in the Kapula Vlei near Masuma Dam a section of eroded vlei soil revealed the presence of pieces of pottery, and in discussions with Dr. Oliver West, he expressed the opinion

that areas around Masuma indicated previous cultivation. From this one must assume that at some stage a people who were hunter–cultivators resided in areas of the Park where suitable soils existed.

These early agriculturists would also have used fire as a means of clearing areas for cultivation, and with their casual approach to fire, there is no doubt that they would have made no effort to control it after it had burnt the area intended for crops.

There can be no doubt that when the Matabele who ruled this portion of Rhodesia came into possession of firearms obtained from the early traders, they undertook the hunting of elephant and there are many records of them being in possession of large quantities of ivory prior to permanent settlement by European peoples. These people would certainly have used fire as a hunting aid.

It must be accepted that African tribes do not view the use of fire with such caution as does the present-day European. In fact, tribes believe that unless there are veld fires at the end of the dry season there will be no rain. In other words, both primitive hunters and primitive stockmen accept fire as being an integral part of their existence and burn with impunity.

In the 1870's the famous hunter and naturalist, Frederick Courtney Selous, hunted over much of the area, and in his writings he describes many experiences which he had in this part of the country (Selous, 1908).

The early European hunters did a lot of their killing from horseback, and areas with short grass cover would ensure greater efficiency. These hunters carted their supplies in ox-wagons, and it was the generally accepted practice to burn land to ensure green grazing for their trek oxen and horses.

In addition there was European settlement in more recent times. The area around the Headquarters of the Park was known as Petties Farm. Farming operations ceased in this section of the Park just prior to its declaration as a Game Reserve in 1928. The Robins section was occupied by a Mr. H. G. Robins who settled on the land in 1914. On his death in 1939 the farm became a portion of the Wankie National Park (Davison, 1967).

Other areas, such as Nantwich, Mbiza and Sinamatella, were also utilized for farming. The accent in all these farming operations was

on livestock. Over the years these properties have been purchased and added to the National Park.

The Europeans who ranched in this area would certainly have used fire as a means of providing green feed for their stock.

It must be recognized that natural barriers to the spread of fires are virtually non-existent in that there are no major water courses or features which would inhibit the spread of fires at the end of the dry season. Accordingly, it is obvious that large tracts of the country were burnt out on a fairly regular basis prior to it being declared a National Park. The intensity and extent of the burns would, of course, have depended on the time of the year, and the frequency of fires.

It is now generally recognized that lightning fires are of frequent occurrence, and what is now the Wankie National Park would certainly always have been subjected to fires starting in this manner since time immemorial.

From the foregoing it will be realized that fire has had a major influence on the vegetation, and, because of this, has influenced the range of wildlife species which occur.

Typical examples of how fire has created open grasslands which are suitable habitat for animals, such as zebra, are seen in the areas surrounding seepage springs in the Western sector of the Park. The water in these springs is permanently available to certain species in that even at the height of the dry season animals, such as elephant, are able to dig for this water. Large concentrations of elephant at the height of the annual drought resulted in denudation of trees and this in turn caused the grasses to become the predominant vegetation cover. Undoubtedly, these areas burnt fiercely when they were subjected to fire and, this in turn, increased the extent of the grassland and eliminated any tree growth endeavouring to re-establish itself. (Fig. 1).

In 1928 the area was created a Game Reserve and the first Warden, Mr. Ted Davison, was appointed. The Game Reserve was administered by the then Southern Rhodesian Forestry Department.

The Forestry Department adopted a burning policy which had the welfare of commercial timber as its prime object (Fig. 2). As with other Government Departments at that stage in Rhodesia's

development, funds were very limited and the total budget for the Wankie Game Reserve in its first year was £ 500. This meant that there was no finance available for fire protection of any description. The Forestry Department's policy at that time was to burn after the termination of the rainy season. This resulted in a patchy burn over the whole area and the object was to prevent "hot" fires later in the season. This regular early burning was, of course, detrimental to the continued existence of pure grasslands, and resulted in scrub encroachment into many of these areas. The grasses were weakened by the repeated early burning, and this enabled woody growth to intrude. It was thought that little damage was done to Forest lands and this was, of course, the object of this particular policy. However, in view of present day knowledge, there is considerable evidence to support the fact that this type of burning was detrimental to Forest land. West states (pers. comm.) that the Rhodesian Forestry Commission have found that repeated early burning inhibits the regeneration of the very timber they are endeavouring to protect. Atwell and Mitchell (1961) stated that, "The early burning policy, leading to the removal of original dry season forage, causes animals to seek food elsewhere; a likely result being increased destruction of timber trees by elephant". Feeding records from elephant in the Wankie National Park indicate that an elephant's diet is approximately 50 percent browse and 50 percent grass (Rushworth, pers. comm.) This being the case it is obvious that the early burning policy which was practiced in this National Park destroyed a large portion of the elephant's food requirements in the form of grass, and undoubtedly led to increased feeding pressure on woody growth. Mukwa *(Pterocarpus angolensis)* is in a very precarious state in this National Park through ring–barking of the mature trees by elephant and the fact that the roots of immature trees are dug up and also fed upon by them. It is quite feasible that the regular early burning policy contributed towards this virtual elimination of Mukwa.

This system of burning continued until 1961 when there was a change in policy. It was decided that there was overwhelming evidence to support the fact that regular early burning was detrimental to the continued existence of grassland and that, if burning had to be undertaken at all, the late burn would be preferable. Therefore,

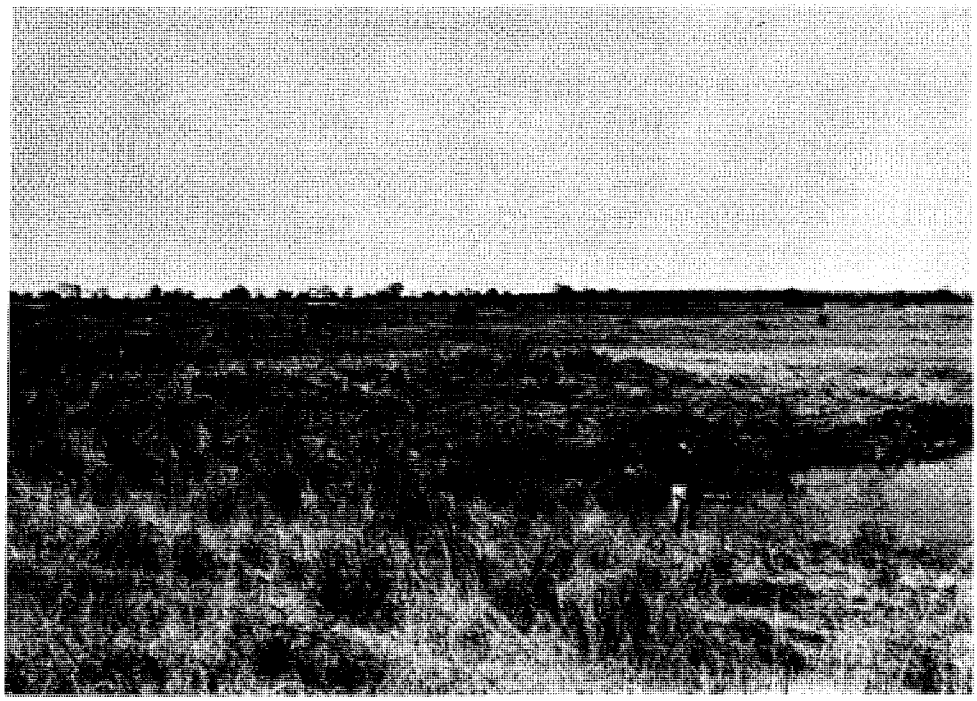

FIG. 1. Nehimba Pan, Wankie National Park. Permanent natural water supply where the action of elephant has destroyed tree growth with resultant change to grassland and which is maintained by fire.

within the limits of the funds and personnel available, every effort was made to fight fires which occurred within the National Park. Normally these efforts were successful until late in the year, between September and October, when due to the dry nature of the vegetation it became impossible to control fires with the limited resources available.

At this stage there was almost a complete lack of firebreaks; vehicle tracks which were limited in length and width were the only features available from which to burn back. Dependent on the success of the policy in previous years was the intensity with which fires burnt. In other words, if late season fires did not occur for, say 3 years, when they did occur they could be described as "hot" burns, and in a fashion simulated the natural fires which had occurred in the

FIG. 2. Natural seasonal pan in the Wankie National Park. Due to the fact that water is only present for a few months of the year elephant have had virtually no effect on tree growth and scrub surrounding the waterhole. Limited grassland maintained because of seasonal flooding which is detrimental to tree growth.

past. To a certain degree this policy was detrimental to forest land and evidence of this can still be seen.

During the period in which the area had received the status of firstly, a Game Reserve, and subsequently a National Park, a system of developing water supplies was carried out and at the present day there are some 80 boreholes plus a number of dams. The changes which have taken place to the vegetation around these artificial water supplies is the same as that which occurred around the natural permanent water supplies previously described, i.e. elephant concentrations knocked out the tree growth which resulted in grassland taking over, and these grasslands have been extended and maintained by fire. A classic example of this is at Guvalala Pan (Fig. 3) where acacia and

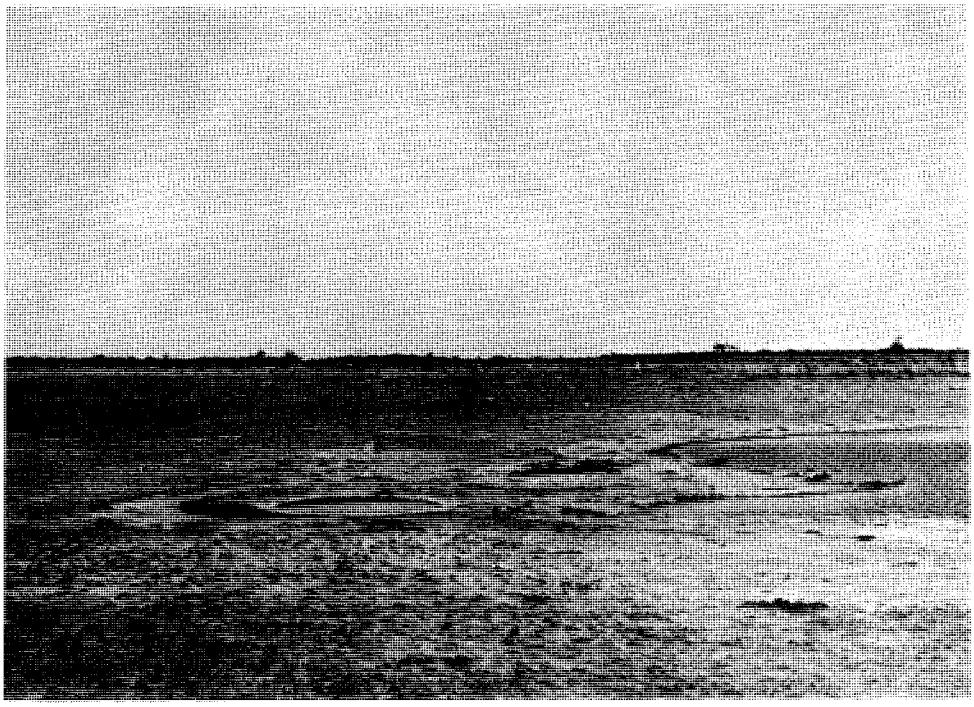

FIG. 3. Guvalala Pan, Wankie National Park. Artificial water supply derived from a borehole. Concrete trough can be seen in the centre of the photograph. Because this is a permanent water supply elephant are eliminating woody growth and the country is tending towards grassland. Fire would maintain and extend the grassland.

scrub terminalia have given way to grass and there are now resident zebra.

Some interesting changes in animal behaviour took place as a result of the changes in burning policy. There are indications that early burning tended to be attractive to both eland (*Taurotragus oryx*) and tsessebe (*Damaliscus lunatus*) in that they concentrated on areas which had been burnt early as soon as there was a flush of green growth. The same, of course, applied to a much wider variety of animals, but the long term effect of burning seems to be pronounced in so far as these two species are concerned.

When early burning was stopped within the National Park it was found that eland tended to move into forest areas where the early burning policy was still being carried out. Farmers with land adjacent

to the National Park used this type of burning to good effect in attracting eland onto their property. There was one such landowner who deliberately attracted eland onto his property by this means, and because they sometimes damaged fencing, he exercised his right by law to destroy them.

At one stage the necessity for carrying out early burning within the National Park in order to stop the movement of eland to adjacent land was seriously considered.

Tsessebe appear to need burnt areas, and in the Wankie National Park there is concern over the survival of this particular animal. It may well be that the virtual elimination of early burning is detrimental to their existence. Their numbers have declined over the years but early hunters in the Robins Area particularly can produce photographic evidence and describe the large numbers of tsessebe which concentrated on early burns in that portion of the Park.

In 1969 considerable funds were made available for the creation of a proper firebreak system, and these funds will be of a recurrent nature. (Fig. 4).

The greatest danger of fires was from the railway line which forms a portion of the north east boundary of the Park. Generally speaking the prevailing wind is from this railway line. The trains are coal burning, and fires originated regularly from this source. Accordingly, a firebreak was constructed to run parallel to the railway line and 100 yards (94 m) from it. The firebreak is 10 yards (9 m) wide and is completely cleared of all vegetation. The area between the firebreak and the railway line is burnt as early in the season as possible and this provides a very effective barrier. This particular section of the firebreak system is well advanced and some 150 miles (240 km) have been completed. Thought is now being given to a grid system of firebreaks within the remainder of the area. As much use as possible will be made of existing roads, and in the long term it will be feasible to isolate fires within a comparatively small block.

Rushworth has supplied the following summary of the fireguard system which will be constructed:—

1) *Developed Area of Wankie National Park* (developed by firebreaks, water supplies and tourism: 56 percent of Park or 3,119 square miles (180,000 ha).

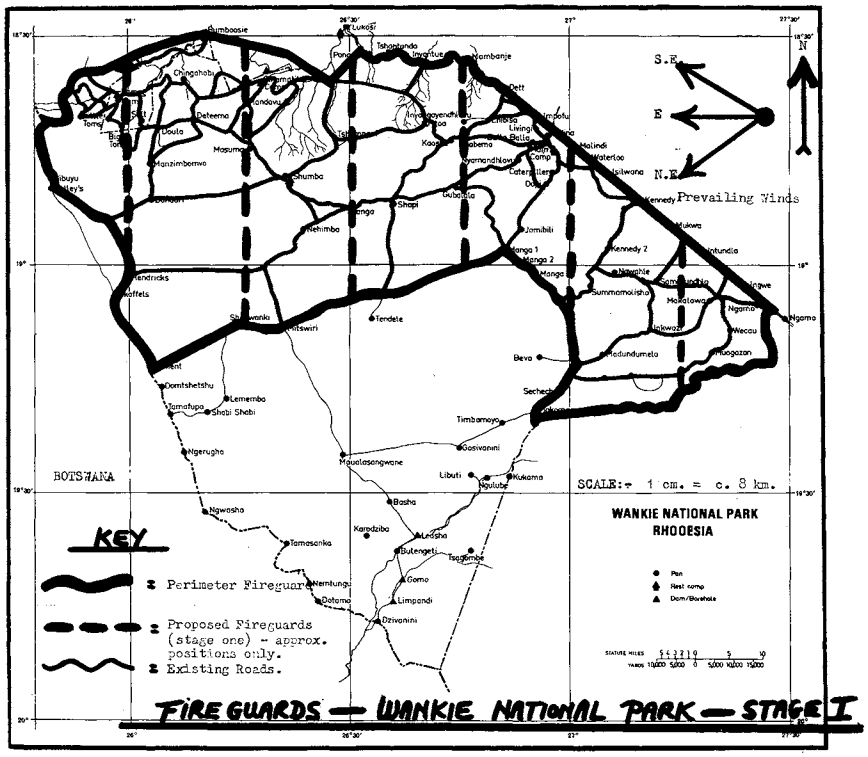

FIG. 4. Prepared by J. E. Rushworth the Botanist in the Wankie National Park indicates Stage One of the proposed fire guards in this Park.

2) *Wilderness Area* (no development of water supplies or tourism and minimum interference): 44 percent of Park or 2,495 square miles (645,000 ha).

3) All fireguards put in will be aligned, as far as is practically possible, in such a way that different vegetation types will be separated and not cut in half. This will greatly facilitate the application of different treatments to different vegetation types.

4) The areas of the *initial* blocks on the map range from about 1,000 ha (4 square miles) to 50,000 ha (190 square miles); most being in the range 10,000–30,000 ha. This represents Stage One only. In Stage Two it is aimed to subdivide the blocks further till the largest block is no bigger than 25,000 ha (100 square miles); the optimum sizes being between 5,000 ha (20 square miles) and 10,000 ha (40 square miles).

5) When the seven main north-south fireguards have been established, they will, together with the existing (widened) roads, form between 65-70 blocks (Stage I). When Stage II has been completed there will be over 100 smaller blocks. This will enable very adequate control of wildfires and controlled burns.

The policy statement on the Wankie National Park states, "Maintained to preserve objects of geological, ethnological and historical interest and the wide spectrum of wildlife and habitat formerly naturally occurring in the western areas of Rhodesia, the interests of wildlife and habitat to remain paramount"; and therefore, the burning policy which will be developed is to have these objects as it overruling consideration.

Burning plots have been established in various sections of the Park and Research staff are carrying out investigations into the effect of various types of burning on different vegetation. One of the major problems on the Kalahari sand section of the Park is the prevalence of scrub terminalia and in these areas work is being undertaken to determine the effect of late burning. The evidence available at the moment indicates that this type of vegetation can certainly be retarded by late burns. The interests of visitors are also included in this work as the large tracts of scrub terminalia are not particularly attractive to wildlife and visibility is restricted. This means that game viewing roads which traverse these areas are unproductive wildlife-wise for the visitor.

Rushworth's findings on the work which has been carried out are as follows:

1) The DOPI controlled burn trial plots about 16 km (10 miles) South of Main Camp, Wankie National Park, have been in existence for only 2.5 years. Work has been concentrated on the effects of different fire treatments on terminalia–burkea–erythrophleum–combretum low mixed scrub on Kalahari Sands (see Appendix–Wankie National Park–Fire Management under AREA 2).

The aims of these burning trials are:

(a) To establish if fire can be used successfully to reduce the height and density of the woody scrub species (for better visibility) and possibly increase grass cover.

(b) To find out which fire treatment (e.g. annual late (hot) burn; late burn once every two years, etc.) is the most successful in achieving Aim (a) above.

Preliminary indications are that late, hot fires, mainly in October (peak dry season, just before the rains), when the scrub species are showing new flush of leaves and there is a good quantity of dry grass fuel, will give very good results. The burns should be carried out every two-three years, although always maintaining flexibility, depending on the quantity of grass fuel available for the hot fires required. The exact timing of the burns will differ every year, depending on weather conditions suitable for a hot, fierce fire, i.e. hot days and strong, constant winds to drive the flames (mostly easterly in Wankie National Park).

2) Larger-scale burning trials near the tourist route in the Guvalala Pan area (about 24 km W.S.W. of Main Camp) in scrub similar to that at DOPI (above) have furnished convincing evidence that controlled late, hot fires can be a useful tool in helping reduce the height of unwanted scrub in various Kalahari Sand areas of the Park.

This particular area (to the North of the main tourist route) about 405 ha (1000 acres), was subjected to a late, hot fire in the latter part of September, 1969 and again in mid-October 1970. The area of similar scrub immediately South of the tourist route was left unburnt acting as a Control. This unburnt side has mixed scrub up to 12 feet tall whereas that on the burnt side averages three-4 feet in height; the contrast is very striking indeed.

Consideration is being given to using elephant to destroy this scrub and with this in mind plans are well advanced to establish artificial watering points in these areas. If the elephants are able to knock back scrub vegetation, as they have done in other areas where there is permanent water, it will be possible to make use of fire to create and maintain grassland from which will develop suitable habitat for grazing animals, and which will be in keeping with the policy to "maintain the wide spectrum of wildlife and habitat". The burning policy cannot, of course, be uniform for the whole Park. The following factors are recognized:

1) Fire is an invaluable management tool if used wisely.

2) Different soil and vegetation types require different treatment fire-wise, and in some cases fire must be excluded altogether.

3) The needs of certain wildlife species, such as tsessebe and eland require special consideration, and it is possible that the burning of selected areas early in the season will be in the best interests of their survival (it has been observed for example, that there is a high mortality rate amongst tsessebe calves due to predation: if burnt areas are available to them during the calving period, it may well be that their prime defense against predators, which is sight and speed, would effectively reduce calf loss).

4) Bearing in mind the policy statement for the Park, the needs of all species must be considered and, for example, while elephant will require shade and browse the giant bustard will disappear if open grassland is not available.

5) The combination of burning and water manipulation may well be the answer to the problem caused by species such as wildebeest which tend to remain permanently in selected areas to the detriment of the range. Such species could be made to move on by the provision of succulent grazing on burnt areas elsewhere, in conjunction with water supplies. Manipulation of this nature may well remove the necessity for population reduction.

Attached as Appendix A and Appendix B are detailed Fire Management Plans prepared by Research staff of the Department of National Parks and Wildlife Management, Rhodesia.

CONCLUSION

The area now known as the Wankie National Park has been subjected to fires throughout the ages and fire has been an important factor in creating and maintaining habitats.

Further investigation into the effect of burning on different vegetation and soil types is essential.

The value of controlled fire as a management tool will increase as its effects become more fully understood.

ACKNOWLEDGEMENTS

I appreciate Dr. E. V. Komarek's kind invitation to prepare this paper and attend the Tall Timbers Fire Ecology Conference. I am most grateful to Mr. R. I. G. Attwell, Chief Research Officer, Depart-

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Mr. J. E. Rushworth, Research Officer, Wankie National Park, Rhodesia prepared the map on the Wankie National Park fire-break system together with other relevant information, and I am grateful for this help and for useful discussions I have had with him.

APPENDIX A

WANKIE NATIONAL PARK—FIRE MANAGEMENT PLAN

A. Objective:—To perpetuate, by correct management, adequate:

1. Grasslands for the grazers;
2. Woodlands and thickets of various types, for the browsers;
3. Samples of forests for their own sake.

B. Recognised Principles affecting the Management Plan:—

1. Excessive frequency of uncontrolled fire is one of the most serious threats to wildlife, both directly and indirectly;

2. Relatively stable (climax?) communities under protection from fire probably perpetuate themselves indefinitely;

3. Other vegetation communities probably require manipulation in order to preserve their characteristics, especially in view of the compression of normal animal migratory patterns;

4. *Good forest policy (early burning) is not good wildlife policy.* Early burning is a major cause of the deterioration of the quality of herbage available to grazers ("unnatural", interference with seeding, food translocation), increases vulnerability to predation in certain species, causes stress in grazers, encourages bush encroachment, increases tree destruction by elephant;

5. Arising from (4), there is a case for using early burning *only* for making fire-breaks in areas where there would otherwise be a severe risk of uncontrollable man-made, later fires; and, under special circumstances, in certain limited areas under a strict rotation, of one

burn in four years, where tourist requirements may call for better visibility and display of game.

6. Grass should either be eaten, mowed, or burnt.

7. Less game pressure on grassland increases fire hazard.

8. It is unrealistic to consider protection of the whole of the National Park, even if it were possible.

9. Research on fire treatments is necessary in some of the specialised habitats. The degree to which this will be necessary depends on research results available from Research and Specialist Services.

C. Management Plan:—

1. A grid fire-break system will be devised to protect, on an overall basis, the main developed area. Such area to include the Ngamo pans and will run in a generally northwest direction to Robins. The fire-breaks will run generally in an east-west direction on the prevailing wind, and existing roads should be used where their alignment is suitable.

2. Early-burning outwards from the perimeters of the area (in which fire control will be exercised) will be practised, in an attempt to prevent uncontrolled fire entering the area outlined in (1).

3. Certain sample vegetation associations, or individual species, will be selected for special protection from fire. For practical purposes, these should be limited in size and will include:

a) Teak stands of good quality;
b) *Acacia giraffae* consociation;
c) *Acacia* sp. thickets;
d) Riparian forest;
e) Swamp and vlei areas;
f) Part of the shumba grassland (palm area);
g) *Pterocarpus angolensis* stands.

The number and siting of each type will be decided by the local authority (Wardens and Research staff) as will the width of the firebreaks surrounding such areas.

4. Within the blocks created by (1) above, late burning will be effected on a rotational basis (under the guidance of the Chief Pasture Research Officer), from the graded traces which will act as base lines. (Should fires get away within the area as outlined in (1), the presence of the blocks will allow for control).

5. The remaining areas of the Park will take their chance in respect of fire, but uncontrolled fires will be prevented, as far as possible, from entering the area outlined in (1) above.

APPENDIX B

WANKIE NATIONAL PARK

A. Fire and Veld Management Plans:—

1. Document No. 84 (reference (1) below) outlines broad objectives and principles, as formerly agreed. It has been filled out by the detailed fire management plan appended hereto (reference (2) below). There is no doubt that past fires have had a profound influence on the vegetation.

2. Methods of fire-breaking, and of suitable block sizes for burning (when different population densities of animals are involved) are given in references (5), (6), below.

3. Manipulation of fire treatments requires co-ordination with the water management plan.

4. Veld management, which clearly largely overlaps with fire management, will be developed later as findings become available.

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Wankie National Park—Fire Management

GENERAL:—It is important to use fire only when it is really necessary to perform a definite task, when no other method is feasible. There must be complete flexibility and each situation must be carefully assessed at the time the burn is contemplated.

If more balanced grazing (or mowing) is possible, then this is far preferable to fire (much less destructive to a wide spectrum of plants, litter and animals). Where it is required to control very dense woody scrub, lack of sufficient grass (fuel) may necessitate the use of methods other than fire. Fire is, nevertheless, an economic measure.

The natural, undisturbed succession is probably towards woody vegetation types over most of the Kalahari sand areas of the Park, (i.e. woody growth at the expense of the grasses). This applies also to areas with shallower, gritter soils (*Commiphora mollis*, *Combretum* sp., *Terminalia* spp. areas). There are certainly some edaphic grasslands (woody growth excluded due to soil water-logging etc.), e.g black basalt vlei areas (self-churning of soils a factor here also), some Kalahari sandy-loam depression areas, and perhaps some areas where limestone is found close to the soil and surface.

There is not as much danger of water, erosion of soils and other harmful after-effects of burning on Kalahari sands as there is on the other more skeletal lithosol soils or on the heavier "basaltic" loamy clays. In extreme cases there exists a slight danger of wind erosion in Kalahari sand areas. Fire can be harmful to litter development on Kalahari sands.

The following tentative outline of possible burning and protection practices, applicable to the various areas of Wankie National Park, is based on research findings taken from throughout Southern Africa and on personal qualitative assessments only. At the present time, until more quantitative information is available, it must be looked on as no more than a basic guide. Modifications will be necessary from time to time.

NOTE:—Before any controlled burning schemes are implemented, the use of water, salt-licks and other attractions *must* be considered to promote grazing (as opposed to burning) of grassland areas not utilized. This will greatly minimise the need to use fire in such areas.

Areas	Treatments
1. *Baikaea, Pterocarpus, Guibortia,* etc. woodlands and savanna woodlands.	1. Protect*.
Baphia, Croton spp., *Popowia, Combretum, Grewia* understory.	2. Early burn (very light, singe), if necessary (as soon as grass will burn April–May, etc.) to remove excessive accumulation of dead grass and herb top hamper. Possibly every fourth-fifth year, NOT annually. (Should very rarely be required.) * Kalahari Sands
2. *Burkea, Terminalia sericea, Combretum* spp., *Erythrophleum, Ochna, Bauhinia, Baphia, Diplorhynchus,* etc. savanna woodlands and scrub.	1. If required to clear (for better game viewing, increased grass yields, etc.) a late, hot burn (Oct.–Nov.) just before or just after the first rains will be necessary. Perhaps every two–three years. (Interval not finally decided.)
Numerous woody suffrutices, e.g. *Brackenridgea, Lannea, Pygmaeothamnus, Ancylanthos, Dichapetalum,* etc.	2. Where there is a lack of sufficient grass "fuel" fire may be relatively ineffective in scrub clearance, and mechanical or chemical methods may prove necessary in small selected areas.
3. *Acacia giraffae, A. tortilis, A. luederitzii, A. fleckii, Lonchocarpus nelsii* etc. woodlands and savanna woodlands *Acacia giraffae, A. tortilis, A. luederitzzi, A. flecki, Lonchocarpus nelsii,* etc. woodlands and savanna woodlands.	1. Protect* 2. Perhaps, (*if really necessary*) an infrequent (every four–five years) cool, early burn (singe) in some localities to clear dead grass and herb top-hamper to aid re-generation (? heat treatment of seeds). 3. If acacia, etc. spp. are encroaching too much into valuable grassland then a late, hot burn in the areas affected, every two–four years may kill woody seedlings and hold woody spp. in check. Care required. * Kalahari Sands
4. Mopane, *Combretum* spp. mixed savanna woodland. (+ coppice and sulfrutices) Kalahari sandy-loams (more compact).	1. As for 2, if really required Care. (Keep a balance between grasses, woody coppice and regeneration, and tree growth.
5. Mopane, *Combretum* spp., *Terminalia* spp., *Commiphora* spp. etc. Lithosols, gritty, shallow. (+ basalts).	1. Protect (Conserve) 2. No burning; rest and prevention of soil capping and erosion (dangerous here) essential. Re-establishment of grasses (together with artificial reseeding, laying of brushwood, seed/silt traps and 'chipping) necessary. Prevent excessive

	animal concentrations. (Nevertheless, animals are required in reclamation.) Active conservation required. Prevent compaction and trampling in wet season (puddling) of basaltic clayey areas. 3. There may be a case for very infrequent burning in isolated areas with slightly deeper soils, where due to lack of grazing, grass cover has become unhealthy, (owing to the accumulation of top-hamper and subsequent dying out of grass tufts). In such areas a late burn, not more often than once in five years, may prove beneficial. Nevertheless it is strongly urged that licks be used rather than fire, if at all possible.
6. Open grass vleis, sponges (springs, etc.) Heavy, clayey soils (basaltic).	1. Protect 2. If necessary, i.e. grass top-hamper too rank, grasses dying out (unhealthy); not enough grazing pressure; then a late burn just before or just after first rains should be required, (after seeding and translocation have taken place). Once every three–five years. Burn a fairly large area to prevent too great a concentration of animals on the new flush. Burn as infrequently as possible. Again, if practical, licks and water manipulation should be used rather than fire to promote grazing of the grass rather than burning. 3. If there is any marked encroachment of woody spp. into the grassland then a late hot burn every three–four years in those areas affected may be carried out with care. (Will kill woody seedlings and hold woody growth, in check but is unlikely to kill off the underground root stocks.)
7. Open grass vleis, flats and glades with *Combretum hereroense, C. imberbe, Diospyros mespiliformis, Hyphaene ventricosa, etc.* Kalahari Sands (some loamy-clay fractions) (often sodic subsoils). Open grass vleis, flats and glades with *Combretum hereroense, C. imberle, Diospyros mespiliformis, Hyphaene ventricosa,* etc.	1. Protect 2. No burn unless grass really becomes too rank for select grazers etc. 3. Prevent too great overutilization by close grazers (e.g. zebra and wildebeest). 4. If there is encroachment of woody spp. or undesirable woody herbs a late, hot, infrequent burn three–five years in areas affected, may act as check. 5. As a grazing conservation measure, the burning (carefully planned) of adjacent unused areas, just prior to the first rains, may help to take pressure off the heavily utilized area during the

	vital spring-early summer new grass growing period.
8. Riverine woodland, banks and reed areas.	1. *Strictly protect* (actively conserve). Very unlikely that burning treatments will be necessary.
9. All areas in the immediate vicinity of permanent water supplies.	1. Strictly protect. Active conservation methods often required in such areas.

NOTE:—There is harvester termite danger throughout the Park, but especially so on the clayey basaltic soils and shallow, gritty lithosols and one some of the more compacted Kalahari sand areas. Serious consideration must be given to termite control in many areas, to encourage grass growth.

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