



Zambia Wildlife Authority

# **Fire Management Plan for Kafue National Park and its Surrounding Game Management Areas**

Prepared by:



May 2007

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CBNRM	Community based natural resources management	
CRB	Community resource board	
CSO	Central Statistics Office	
FAO	Food and Agriculture Organization (of the United Nations)	
GMA	Game management area	
KNP	Kafue national park	
NPWS	National Parks and Wildlife Services	
PWD	Public Works Department	
UNDP	United Nations Development Programme	
WPO	Wildlife Police Officer	
WRMU	Wildlife Resource Monitoring Unit	
ZAWA	Zambia Wildlife Authority	

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The compilation of the KNP Fire Management Plan was carried out by Jairus Chanda, Social Anthropologist, and the Fire Management Manual was prepared by Munshimbwe Chitalu, Environmentalist.

**Robins Development Associates Limited**

May 2007.

## **Preface**

This fire management plan for the Kafue National Park presents a conceptual framework of implementing fire management in the park by the Zambia Wildlife Authority (ZAWA). The framework conceptualises the establishment of a fire breaks system as the basis for managing fire in the park. The plan acknowledges the pattern of fire occurrence in the park, among which are the following;

- (a) The entire KNP experiences fire annually.
- (b) The gradient of fire is higher in the northern and north-eastern parts of the park. These parts of the park receive higher rainfall and, correspondingly, higher accumulation of fuel loads resulting from lush vegetation growth (grass and low bushes) induced by the high rainfall occurrence.
- (c) Fire burning in the park occurs in three stages namely; early burning, from end of April to June; mid dry season burning, from July to August, and late burning, from September to beginning of November
- (d) The fire ignition sources are diverse and they include the bordering GMA and open area communities, travelers crossing the park, tour operators and hunting outfitters
- (e) The fire effects in the park include transformation and fragmentation of unique habitats.

The fire breaks system proposed for implementation in this fire management plan for KNP takes into cognizance these factors relating to the fire occurrence in the park. A fire breaks system, which recognizes the importance of the various zones of the park, is of critical focus in this plan.

The implementation of this fire management plan is considered within the available resources, which include recently acquired motorized graders, tow graders, tractors and fire beaters, and a donor supported budgetary provision of US\$50,000. An initial three years – implementation period is recommended to allow for a trial run of the plan and possible review, including building capacities to manage fire in the park.

# 1.0 Background Information

## 1.1 Location

Zambia has a total of 19 national parks, among which the Kafue National Park (KNP) is the oldest and largest park in the country. It was proclaimed a national park in 1950.

The Kafue National Park is located between 25° 27' East and 13° 17' South. The Park stretches some 306 km in north-south direction and 143 km in east-west direction, covering the area of approximately 22,480 square kilometres. This area covers about 33% of the country's national park estate.

There are nine Game Management Areas (GMAs) bordering the KNP and occupying an estimated area of 40,000 square kilometers (**See Map 1**). The remaining surrounding open areas occupy an equally estimated area of 40,000 square kilometers (KNP General Management Plan, 1999).

The KNP shares boundaries with nine (9) districts in five (5) provinces. These are Kasempa district in North western province, Mumbwa district in Central province, Namwala, Itzhitezhi and Kalomo districts in Southern province, Sesheke and Kaoma districts in Western province, and Kalulushi and Lufwanyama districts in the Copperbelt province.

Management of the KNP is a sole responsibility of the Zambia Wildlife Authority (ZAWA), whose administrative headquarters is at Chilanga. The management of the park is conveniently divided into the southern and northern parts. The headquarters for the southern administration is located at Ngoma and the northern administration headquarters at Chunga. The management of the park is supported by park entrance gates located at various entry points to the park, and outposts located in strategic areas of the park. The operations at some of the outposts are seasonal and/or periodical according to patrol assignments. However, the study learnt that efforts were being made to provide for permanency of operations at all the outposts in order to enhance protection of the park resources.

The Government's vision is to make the KNP an attractive and popular local and international tourist destination and to enhance the park's contribution to the national economy. In this respect, the protection of the KNP resources against any external effects, including fire, is of prime importance to the tourism industry.

### *Climate*

The location of KNP is in an area that experiences relatively mild climatic conditions for most months of the year. As with the rest of Zambia, the KNP experiences a climatic pattern that is divided into three distinct seasons, namely;

- (a) A hot and rainy season from beginning of November to mid April
- (b) A dry and cold winter period between May and July inclusive
- (c) A dry and hot period between August and beginning of November

The characteristics of this climatic pattern of the park can be summarized as follows;

**Rainfall:** The KNP receives higher rainfall in the northern part. The average rainfall distribution is about 1000 mm in the north and 800mm in the south.

**Temperatures:** The annual mean temperature in KNP is 20°C. The coldest month is July, with average temperatures of 10° C. The hottest temperatures of 30° C are experienced during the month of October.

**Relative humidity:** The average humidity variation of 60% in the south and 65% in the north are experienced. The seasonal park humidity variations are, 40% in the dry season and 80% in the rainy season.

**Winds:** The Park experiences predominantly easterly winds “blowing from the NE-SE quadrant 80% of the year”.

## **1.2 Natural Resources Endowment in KNP**

The KNP and its surrounding GMAs is significantly rich and endowed with abundance of natural resources (wildlife, vegetation, water). The resources are protected under the 1998 Zambia Wildlife Act.

### ***Soils***

The KNP is part of the Katanga sedimentary strata system. The “FAO/UNDP Multipurpose survey of the Kafue River Basin” (1968) describes soil distribution of the entire Kafue basin area and its geological formation. Based on this report, soils of the Kafue area are grouped into three categories, comprising the northern plateau soils, floodplain grassland soils, and soils of aeolian origins.

The general soil distribution overview of the three soil groups in the KNP, based on the FAO/UNDP survey, is presented below (**See Map 2**).

- Alluvial soils in the north-western part of the park, which is a perennial swampy area that forms part of the Busanga Plain. Alluvial soils are also found along the Kafue River
- Karroo sediments in the central and north-eastern parts of the park
- Grey dambo soils along the Lufupa River and some areas of the Kafue River that experience flooding
- Heavy black clay soils in the Busanga Plain and the Kafue Flats
- Soils of aeolian origins in the southern parts of the Kafue area
- Sandy clays in a small area along the south-eastern boundary of the KNP

### ***Water Resources***

The major water catchments in the KNP are the Kafue River and its two major tributaries, i.e. the Lunga and Lufupa Rivers. The Kafue River flows across the Park from north-east (Copperbelt) to the south where it leaves the park at Itezihitezhi. To the south, before it leaves the national park, the Kafue River has been harnessed to form the Itezihitezhi dam, which is a major water catchment for the generation of hydroelectric power.

The Kafue River has often been referred to as the “common hydrology denominator” for the Kafue National Park, because all waters in the park (from rivers, seasonal streams and water catchments) end up flowing into the Kafue River.

In addition to the two main tributaries of the Kafue River (Lufupa and Lunga Rivers), the other main rivers in the park include the Lushimba and the Mukunanshi rivers. There are several other smaller rivers that drain the park, some of which are seasonal.

The wetlands, that comprise the Busanga flood plains to the north, and the Kafue flats to the south, form part of the drainage systems of the KNP. Numerous water collection troughs and depressions, called Dambos, are also found in several parts of the park. These form important water drinking points for wildlife. Groundwater resources in the park have not been studied, although this potential has been acknowledged.

## Wildlife Resources

The KNP is a sanctuary to a large and diverse population of wildlife species, distributed across the park. Aerial and ground based surveys conducted by ZAWA have indicated considerable density and abundance of wildlife in KNP. Ground based count of wildlife conducted by Wildlife Resources Monitoring Unit (WRMU) in the Mumbwa West and Namwala GMAs also indicated abundance of wildlife in these areas (WRMU, 2000).

The KNP General Management Plan (1999), has explained the variety of animal species in the KNP that comprise of “158 species of mammals, 481 species of birds, 69 species of reptiles, 35 species of amphibians and 58 species of fish”. The KNP General Management Plan further indicates that the majority of the large wildlife mammals known to exist in Zambia are also found in the KNP. The exceptions cited by the General Management Plan are, giraffe and tsessebe (KNP General Management Plan, 1998).

This position is complemented by recent studies carried out on the KNP wildlife resources, among them are the aerial animal surveys carried out by Simwanza (2002).

## Vegetation

The KNP is generally covered by the *Miombo* type of vegetation, which is the denominator of the vegetation in the park. This is a woodland ecosystem dominated by trees in the genera *Brachystegia*, *Julbernardia* and *Isoberlinia*. The KNP miombo vegetation is interspersed by localized grass plains and depressions, commonly known as Dambos, which become waterlogged during the rainy season. These provide important grazing and water points for the wildlife in the park.

It is worth noting that, studies of the KNP vegetation have shown that the miombo vegetation species in the park are varied, comprising of related genera. The principal ones are, *Baikiaea*, *Pterocarpus*, *Erythrophleum*, *Burkea* and *Cryptosepalum*.

In his studies on the vegetation of the Kafue National Park, Fanshawe (1971) recorded a total of 750 woody species, identified under vegetation categories as presented below.

- I. Closed Forest
  - A. Climatic
    - 1. Dry Deciduous Forest
      - a) *Baikiaea* Forest
      - b) Secondary *Baikiaea* Forest
      - c) *Pteleopsis* Forest
  - B. Edaphic
    - 1. Riparian Woodland
      - a) *Suffrutex* Savanna
- II. Open Forest with Grass
  - 1. Miombo Woodland
    - a) *Kirkia* Woodland
  - 2. Kalahari Woodland
    - a) *Suffrutex* Savanna
  - 3. Mopane Woodland
  - 4. Munga Woodland
    - a) Munga Scrub
    - b) *Suffrutex* Savanna
- III. Termite Mound Vegetation
  - 1. Mopane *Termitaria*
  - 2. Munga *Termitaria*
  - 3. Riparian *Termitaria*



#### IV. Grasslands

1. Dambo Grassland
2. Riverine Grassland
3. Flood plain Grassland

The morphological vegetation map of the KNP shows that most areas of the park have dense vegetation (**See Map 3**). The vegetation and natural resources endowment of the park based on this map, shows that the land surface is 62% woodlands, 19% grasslands, 14% shrub lands, 3% forests and 2% water. This is clear indication of the value of vegetation in the KNP. The protection of vegetation, as of the other resources, including wildlife and water, is a critical management priority to the preservation of the park.

A summarized version of the vegetation types in KNP (based on Fanshawe, 1971), and the effects of fire among some of the vegetation types, is presented in **Appendix 4**.

### 1.3 Human population

Most of the human population in the Kafue area is concentrated in the GMAs and open areas surrounding the park. The 2000 Census of Population and Housing indicates that the GMAs and the surrounding areas of the KNP have a low population density of 4.4 inhabitants per square kilometer (CSO, 2000). This position is, however, bound to change with increased settlements in the GMAs, as explained below.

The ethnic groups settled in these areas are the Kaonde people who occupy the GMAs to the north and north-east of the KNP in Kasempa district, and to the south east in Mumbwa district; the Nkoya and the Lozi occupy the north-western open areas; while the Ila, including the Tonga and Toka Leya groups, occupy the southern GMAs. Parts of the GMAs to the south-east are occupied by the Kaonde-Ila and Nkoya of Mumbwa district.

#### *Settlements in the GMAs and surrounding areas*

The Kafue National Park is surrounded by population settlements concentrated in the GMAs and the non-protected surrounding areas. The populated areas within the park include the ZAWA camp posts and the lodges.

Characteristically, settlements in the Namwala and Mumbwa GMAs are increasing and expanding closer to the national park. There are no known laid down plans to regulate either the increasing settlements in the GMAs and/or expansion of such settlements closer to the national park.

The increase in settlements in the GMAs is very evident: (i) near the Nalusanga Gate, westwards to the southern boundaries of the Mumbwa West GMA; (ii) on both sides of the road linking Itezihitezhi, to M9 Road junction, in the Namwala GMA; (iii) along the southern banks of the Kafue, east of Lubungu; and (iv) into the interior parts of the Kasonso Busanga GMA.

Resulting from this increase in settlements, the demand for land in the Kafue GMAs and the open areas is likely to increase in the coming years (KANTIPO, 2001). The KANTIPO Report estimates that the number of households settling in the area is likely to increase at the rate of 4% per annum, with the average household size of 6.7 (**See Table 1 below**). The current settlement trends evident in the Namwala and Mumbwa West GMAs are supportive to this projection made in the KANTIPO Report.

This growth in land demand in the GMAs and the open areas will imply;

- Increase in economic activities based on natural resources utilization, including agriculture, charcoal burning, harvest of grass, timber and honey gathering

- Increased fire threat, economic and environmental pressure to the national park

**Table 1: Estimated land demand trends in the Kafue GMAs and open areas**

*Source: KANTIPO, 2001*

Description	Arable land in sq. km	Total land in sq. km
KNP	See foot note <sup>1</sup>	22,400
GMAs (10% of land is used for agriculture)	4,000	40,000
Open areas	20,000	40,000
Total arable land in sq. km	24,000	102,400
Estimated land demand (in ha.) per household	25	
Estimated increase in number of household settlers per annum	4%	
Est. Number of households in 2000: 67,017; Average household size: 6.7; Total population: 448,746		

#### *Livelihoods aspects*

The primary sources of livelihoods for the majority of the people settled in the GMAs and the surrounding areas are linked to the exploitation of natural resources, including wildlife hunting, fishing, honey gathering, agriculture (crop farming and cattle rearing) and charcoal burning. Crop farming and charcoal burning are carried out by cutting and burning trees to clear the bush. With the declaration of these areas as protected GMAs, some of these activities, particularly hunting, have become illegal.

The Kaonde, to the north and north-east, are predominantly hunters and gatherers by tradition. Historically their home had been within the KNP. However, since the establishment of the KNP, they have been moved three times northwards in order to make way for the protection of the national park. But they still maintain their core traditional livelihood practices of hunting, fishing, honey gathering and wild fruit gathering.

The Ila people to the south, are predominantly pastoralists. They keep cattle, which is the mainstay of their economy, while subsistence crop farming is carried out for household consumption. Further to the south, the Tonga and Toka Leya, engage in medium scale crop farming, mainly maize, in addition to cattle keeping.

To the north west of the KNP, the Nkoya and Lozi, practice subsistence crop farming. There is some extent of natural resources exploitation known to be practiced by the Nkoya settled in the GMAs closer to the KNP. This includes illegal hunting activities. In recent years, semi commercial farming activities, initiated through the government supported settlement scheme, have grown in the Nkeyema area very close to the park.

The Kaonde-Ila who occupy the south-east GMAs of the KNP, are subsistence farmers and are also known to engage in hunting and gathering, as part of their livelihoods.

Generally, among the Kaonde to the north in Kasonso Busanga and Lunga Luswishi GMAs in Kasempa, and to the south-east in Mumbwa GMA; and the Nkoya to the west in Kaoma district, households dependence on exploitation of natural resources for their livelihoods, is common. The major resources exploited for this purpose include, wildlife, honey, fish, wild fruits, and wood for energy and building (**See Map 4: Natural resources dependency; and Map 5: Agriculture**).

These livelihood economic activities carried out by the communities settled in the KNP GMAs and the surrounding areas, including illegal hunting, pose a challenge to the Zambia Wildlife Authority (ZAWA).

<sup>1</sup> Economic activities in the KNP are forbidden serve for those provided for in the ZAWA Act of 1998.

## 2. 0 Historical and Current Occurrence of Fire in KNP and Surrounding GMAs

### 2.1 Historical occurrence of fire in the park

It is on record that the Kafue National Park has historically experienced fires from the time it was proclaimed in 1950. There are no reliable quantitative data on the historical occurrence of fire and its impacts during the early stages of the proclamation of the park. However inferences on fire occurrence in the park have been made from writings by various authors on vegetation in the park. The most appreciable historical account of fire occurrence in KNP has been made by de V. Moss (1976), using literature from authors on vegetation in the park, including Fanshawe (1967), Darling (1960), Boughey (1961) and Van Rensburg (1959). It is however, acknowledged that there had been no consistent historical records keeping on the occurrence of fire in KNP, including dates and actual spatial distribution of the fires in the park. De V. Moss (ibid. 1976), contends that it is however “safe to say that between 80-90% of the park has been burnt annually for the past 25 years and perhaps for many more years than that”.

A collation of available records on fire in the park from 1937-1975 was carried out by de V. Moss (ibid, 1976) to produce a map showing “the general pattern of events... and the general sequence of burning and directions of invasion”. The archiving of this map has not been recorded and could not be traced.

This study obtained records of causes and occurrence of large fires recorded in the park between 1972 and 1975 (See **Table 2** below). As can be observed, the recorded fires in the park during this period were attributed to a wide spectrum of causes, including operations of the National Parks and Wildlife Services (NPWS), the Tsetse Control Services, road clearing by the Public Works Department (PWD) and villagers. A number of these have remained relevant factors to the causes of current fire occurrence in the park.

The fires were recorded in locations that include the southern, eastern, northern and western boundary areas of the park. These records indicate that mid-season to late burning (July-Sept) had been frequent in the park. It is obvious that the recording of the fires during this period was prompted by the fact that these fires were large, intense and of destructive nature. Historical records also indicate that the Ngoma forest remained protected from fire from 1950 until the Sept 1975 fire.

**Table 2: Recorded fire occurrence and causes in KNP, 1972-1975**

Date	Location	Cause
Nov. 1972	Busanga Plain	Poachers
May 1973	Eastern boundary	Tsetse control fence clearing
July 1973	Eastern boundary	Tsetse control fence clearing
July 1974	Namwala GMA	PWD road clearing
Aug 1974	Chunga-Tateyeyo	Travellers on main road
Sept 1974	Mumbwa GMA	Tsetse control fence clearing
Nov 1974	Musa-Nkala area	Lightning
Sept 1974	Nanzhila-Sichifulo GMA	Villagers/hunters
Sept 1974	Nkala GMA-park	Villagers
Sept 1974	Nkala-Kaunga	NPWS staff chasing away lion
Sept 1974	Luansando-Katobo	NPWS staff burning fire guard
Sept 1974	Luansando-Kamano	NPWS staff burning fire guard
Oct 1974	Kanyele-Kasha	Lightning
Sept 1975	Musa-Mungosiya	Conservation working bulldozer
Sept 1975	Ngoma forest	Park visitor

**Source: Field survey/Ngoma library**

There is no evidence of any conclusive historical scientific research on the impact of fire on the flora and fauna in the park. Available records indicate that some Researchers had set up experimental plots during the period 1959-1974, in an attempt to carry out scientific measurement of the effects and impact of fire on vegetation in the park. These efforts were never completed and there were no concrete conclusive results recorded. **Table 3** below presents the list of scientists known to have set up these experimental plots in the park during this period, and whose works were never completed.

**Table 3: Historical experimental plots in KNP, 1959-1974**

Year	Researcher	Location of Experimental Plots
c. 1959-1963	J.M.C. Uys	Moshi
c. 1959-1963	J.M.C. Uys	Chunga
c. 1961	B.M. Mitchell	Ngoma
c. 1967-1968	J.Hanks	Ngoma
1973-1974	I.R. Swingland	Miombo Research Project ( <i>location not specified</i> )

**Source: de V. Moss, 1976**

It must be noted and appreciated that by account of available records on historical occurrence of fire in KNP, any explanations of the impacts of fire on fauna and flora are entirely qualitative and lack quantitative data from the period of the park status proclamation in 1950. As de V. Moss (ibid.1976) states, they are largely based on “subjective impressions” which lack conclusive historic scientific data. The “subjective impressions” include;

1. That 90% of the park is burnt every year
2. That over the years, floristic and other species subjected to the effects of fire annually, have been kept at same level over the years
3. Fire has contributed to reduction and suppression in productivity for both fauna and flora in the park
4. There are marked differences of disturbance to the park ecosystem by fire annually during different dry seasons and this has suppressed vegetation communities to “lower successional stages”.

Overall, notable documented historical records on the effects of fire to vegetation in KNP (Van Rensburg, 1968; de V.Moss, 1976; Vesey-Fitzgerald, 1972; Fanshawe, 1967) are convergent on the following inconclusive qualitative observations and assumptions;

- That even as early as 1950, some plant communities were being transformed to simplicity and reduced productivity. Key among these effects were;
  - The degrading of the primary *Baikiaea* forests to secondary *Baikiaea*
  - The modification of evergreen forests to Miombo
  - The spread of invasive species, including *Terminalia*, *Combretum* and *Acacia*, in areas where the basal cover was reduced by fires.
- That since 1950, the degradation of the KNP ecosystem as a result of fire, frequently occurring during mid-season period between July and September and late, has continued unabated. Van Rensburg (1968) notes that this had reduced the growth of woody plants and enhanced growth of grasses.
- That there had been reversal effects by fire of any gains in diversity and density of plant species in the park.

In addition, the historical impact of fire on the animal populations in KNP had been linked to the fact that the burning of the habitats had tended to affect their seasonal movements, distribution and even productivity and herd sizes. The annual burning had always affected not only availability of grazing but also the nutritional value and structure of the vegetation. In some areas of the park, the annual burning had resulted

into development of scars devoid of any browse or growth of high grasses and other plants not easily accessible to ground browsers. In their studies of the lechwe, Grimsdell and Bell (1972; 1975), noted that the populations of the herbivores in the Busanga plains were suffering limitations because of the scarcity in availability of protein content grasses caused by the effects of fire. This is supported by earlier studies. In his studies, Mitchell (1965), noted that "if pasture is ... burned fiercely for a few years, the finer grasses will die out and be replaced by the taller coarse "fire climax" species which are of less grazing value"

#### *Early Fire control efforts*

Prior to 1975, there was a prescription of managing fire in the park, which involved the park staff and researchers. The prescription used fire as a management tool to control the fire in the park. This is clearly indicated in the works by Swingland (1974) and Hanks (1968). The prescription used two approaches;

- (a) Early burning (between late April and beginning of May) and late burning, which was carried out just before the beginning of the rainy season. This was carried out in defined plots to serve as fire guards.
- (b) Maintenance of fire breaks: some remnants of the early fire breaks are visible around Ngoma forest, the western side of Lake Itzhitezhi and in the north. Other areas where the remnants of these fire breaks are very distinct include areas around Chunga and the southern parts of the park.

Over time, this approach to fire management in the KNP fizzled out and no activity to that effect has been in effect.

## **2.2 Current occurrence of fire in the park**

The current fire occurrence in KNP was assessed during interviews and discussions with the park management staff (Park Manager South, Park Manager North, Park Wardens and Rangers, Ecologists) at Ngoma and Chunga, and with entrance gate staff at Nalusanga and Tateyeyo. Comprehensive interviews were held with Henry Mwima, a reputed Researcher on the KNP, and currently conducting vegetation experimental plots in the park. The study also discussed with the CRB leadership in Mumbwa West and Namwala GMAs, and the NRM Danida Project coordinator at Itzhitezhi. Transect drives and escort walks were undertaken in Ngoma forest and selected areas severely affected by fire at this time of the year (October) around the Kafue Hook Bridge, the area between the bridge and Chunga, and the areas approaching Ngoma from Itzhitezhi.

The ZAWA management at Ngoma and Chunga Area Management Units, observe that there are three stage - burning occurrences in the park, namely;

- Early burning, from end of April to June
- Mid dry season burning, from July to August, and
- Late burning, from September to beginning of November.

Most known fires in the park are surface fires. There are few known, but unrecorded, incidences of areas within the park which have experienced undersurface fires. Sources at Ngoma and Chunga have alluded to such fires which may occur in isolated areas that experience high accumulation of biomass which have remained undisturbed over a long period, mainly in the northern parts of the park. The KANTIPO study (2001) had noted the possibility that some remote sites of the KNP experience 1-3 year non-fire intervals. In such sites, the fire return intervals and its intensity depend on fuel accumulation rates. Such sites, though few and in isolated locations deep in the park, have not been documented or mapped, although this fact is alluded to among the management at both Ngoma and Chunga.

An overview of the current occurrence of fire in the park, based on the field survey interviews with Henry Mwima at Jastis Management, the park management and ecologists at Ngoma and Chunga, and the

regional command in Mumbwa, revealed that the KNP has become more susceptible to fires during the entire dry season.

The majority of fires burning the KNP are unplanned fires originating from the GMAs and open areas bordering the park. These fires are accidentally ignited. The accidental fires are linked to economic activities such as preparation of land for cultivation among the communities in the GMAs closer to the park, or started by honey collectors, or by charcoal burners. Tourist groups are likely to cause accidental fires in the park if and when burning cigarette butts are dropped without this realization. It is also possible that ZAWA police patrol teams in the park could cause accidental fires.

Deliberate lighting of fires is carried out in the park and the GMAs by various groups that have been identified, including illegal hunters and livestock owners, to induce growth of green grass for livestock grazing and to attract wildlife animals.

The interviews with stakeholders in the field, including GMA community representatives and ZAWA staff at Ngoma, Chunga, the Western Regional Office at Mumbwa, and at the Nalusanga and Tateyeyo park entrance gates, confirmed the accidental and deliberate ignition of fires in the park.

As the park becomes more accessible and exposed to economic activities closer to its boundaries and within the park (settlements in the GMAs, safari hunting, tourism), the potential of fires that burn the park, including ignition sources, have also increased. Recent observations by the park management and other stakeholders indicate that the potential sources of fire in the KNP have increased and are diverse. (KNP General Management Plan, 1999; *Interviews with KNP staff at Ngoma, Chunga, Nalusanga and Tateyeyo park entrance gates, October 2006*). **Figure 1** below presents the diagrammatic dynamics of potential fire sources affecting the KNP.

It is observed that the current fire occurrence in KNP has continued unabated and that the assumption that up to 90% of the KNP is burnt annually has continued to be the case since the park was proclaimed. This fact has been emphasized in the KNP General Management Plan (1999). The fires in the park occur and continue to devastate the Park during the dry season, starting from end of April to beginning of November.

The general impressions resulting from the discussions with the various stakeholders mentioned above, and observations during the transect drives and walks, with regard to the current fire occurrence in the park, revealed the following;

- (a) The fires burning the park are predominantly human induced and unplanned.
- (b) The fires in the park are regular and frequent throughout the dry season period between May and end of November. The fires rage for days unabated, and the result is that almost all areas of the park, are burnt.
- (c) It is assumed that the majority of these fires are unplanned, i.e. without intent to burn the park, and ignited from GMAs and open areas where the communities are preparing their fields, burning to induce growth of greenery for livestock grazing and/or to attract wildlife by poachers.
- (d) The areas with low woodland cover and dense grass are known to experience frequent annual and intense fires. This is in contrast with areas with dense tree cover (forested), which have lower fuel loads and experience ground level and less damaging fires.
- (e) Some areas of the park have been modified from dense woodland to open wooded grasslands with scattered trees, as a result of the elephant actions, which include ring barking, breaking, pushing and uprooting of the trees. The resultant high grass growth that replaces the trees in such areas has provided higher dry seasonal fuel loads leading to increased frequency, intensity and damaging fires. This frequency and intensity of fire experienced in such areas acts as suppression to full re-growth and re-sprouting of woody plants/trees for a recovery process. These features were conspicuously observed in the areas between the Kafue Hook Bridge and the Chunga road.



- (f) There are parts of the park experiencing marked transition and transformation from woodlands to open woodlands and apart from elephant actions, fire is said to be the major contributing factor to this transformation. This assertion could be supported by studies undertaken on the dynamics of miombo woodlands by the CIFOR (Indonesia), which revealed that fire is a major agent causing transitions from woodlands to open woodlands dominated by *Combretum* spp. or *Terminalia*, to grasslands. The existence of such characteristics within the park has been alluded to by Henry Mwima (*Personal interviews, March 2007*), who is currently carrying out studies on vegetation in the park, and by KNP ecologists and other staff at Ngoma and Chunga.
- (g) Southwards, the park receives lower rainfall, 50% of the vegetation is miombo woodlands, and fuel accumulation is lower. Consequently, these areas experience comparatively lesser intensity of fires.

#### *Fire ignition Areas*

The ignition areas of the fires that burn the park annually are the bordering areas (GMAs and open areas) and some areas within the park. Specifically, these areas have been identified as follows;

1. **Areas bordering the park:** The survey findings for this fire management plan singled out the GMAs and open areas as the major ignition areas of the fires burning most parts of the park annually. Analysis of this assertion will indicate the following;
  - Overall the gradient of fire is higher in northern and north-eastern parts of the park. These parts of the park receive higher rainfall and, correspondingly, higher accumulation of fuel resulting from lush vegetation growth (grass and low bushes) induced by the high rainfall occurrence. These areas of the park are bordered by the Kasonso Busanga and the Lunga Luswishi GMAs. Livelihoods practices of the population settled in these GMAs are traditionally linked to the exploitation of natural resources, including hunting and honey gathering. These practices are carried out with extensive use of fire. Burning is carried out during the early dry season to induce re-growth of green grass to attract animals for illegal hunting and late dry season to prepare land for agriculture. Fires ignited from here, are more intense because of the high fuel accumulation, and widespread because there are no existing barriers, such as natural rivers, roads, or any significant barriers to stop the fires, all the way to the Kafue River. The diversity of vegetation types in the north, interspersed with grasslands, sparks more intense and destructive fires. As is the case in most areas of the park, there are no mechanisms in place here to control fires once started. Thus in the absence of any barriers, the fires from here are known to spread over wide areas.
  - The western boundary of the park is an open area bordering Mufunta. It is not regularly patrolled. The southern areas of these western borders of the park have low population density. This is an area of high poacher incursions and these are a major ignition of fires that burn extensive parts of the western park. As you go northwards towards Kaoma and Tateyeyo Gate, there is a high flow of settlements engaging in semi-commercial agriculture and this has association with fire.
  - To the southern borders, the Mulobezi and Sichifulo GMAs are considered as areas with lesser ignition of fires that burn the park, because of the low population density and therefore, lesser land use activities that are associated with fire. The existence of the Nanzhila Plains, bordering the park, reduces the level of fires from these areas.
  - The Namwala and Mumbwa West GMAs to the south east and Bilili GMA: the settlements here have encroached too close to the park. Livelihoods and economic activities based on clearing land for agriculture and charcoal burning, have high potential in igniting fires

throughout the dry season. These are key areas of major fires, particularly the late burning fires that burn the park.

- There is an assumption that the hunting outfitters, who conduct their hunting activities in the GMAs, are also sources of some fires burning some parts of the park, although there is no documented evidence to that effect.
- In many areas of the park periphery, the park boundary adjacent to the GMAs and the open areas is not well marked or defined. This makes such areas susceptible to encroachment and to activities of the settlement populations that use fire for their economic activities (land preparation, hunting, honey gathering and burning to induce grazing pasture), which affects the park.

2. Within the park, the fire ignition sources are diverse;

- The tourist operators have the tendency to engage in early burning as a measure to induce green grass growth to attract grazing ungulates into their areas for wildlife sightings.
- The Travellers crossing the park, either as bus passengers or motorists (including trucks), tend to ignite fires in various ways: innocently dropping burning cigarette butts, making fires in the event of breakdowns and failure to put them out afterwards.
- Illegal hunter activities within the park
- Fishermen in the northern parts of the park: Under a standing agreement with ZAWA, groups of fishermen are permitted to conduct their fishing annually in the northern areas of the park. They camp in these areas during the dry season for up to three months. They tend to burn some areas of the fishing ponds or weirs to clear weeds or reeds for visibility. These fires, in some instances, spread into other areas of the national park.

The KNP management is now able to access satellite imageries of fire occurrence in the park. This enables the management to detect the specific location of fire ignition at any given time. This study has accessed fire occurrence satellite imageries for the year 2005, and has used this data as a typical example of the fire ignition locations in the park during the early, mid and late burning periods (**See Plate 1**). The analysis of these imageries reveals that;

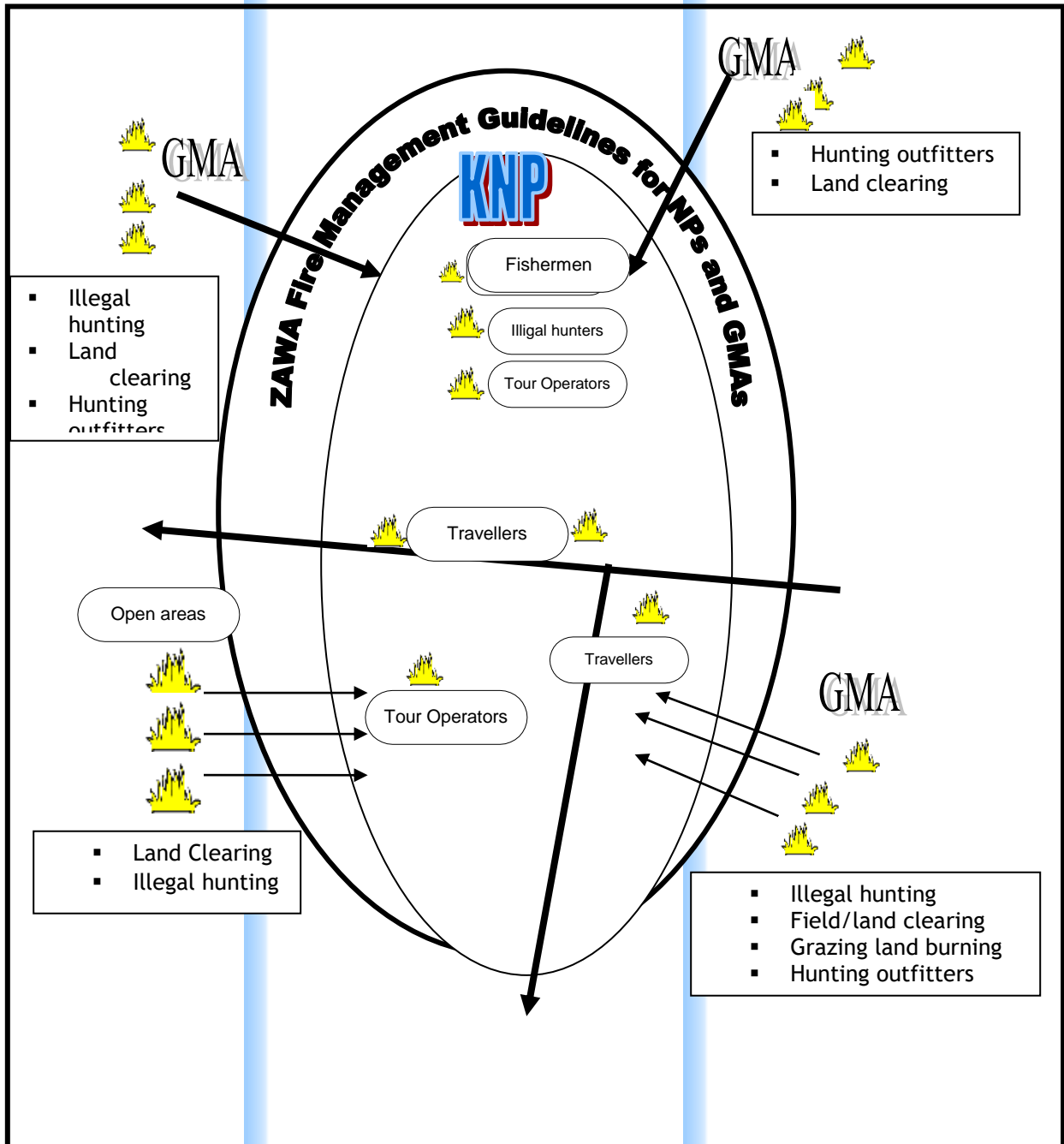
- (a) In 2005 the highest recorded fires in the park occurred during the early burning period in May. A total of 1,552 fires were recorded in May alone. The fires were spread across most parts of the entire park
- (b) During mid burning period, a reduction in the number of fires was recorded, with the maximum of 890 fires recorded in June
- (c) A marked reduction in the number of fires is noticeable during the late burning period across the entire stretch of the park, because most of the park would have been burnt. The highest recorded fires were in the month of September during which 416 fires were recorded.

This is a common pattern of fire occurrence in the park and reveals incidences of burning during the entire dry season. The peak period of fire occurrence in the park is between May and June. It is clear that many parts of the park experience early burning. This is the period when there are heightened economic activities in the GMAs, including harvesting and burning to clear and induce grazing for livestock and to attract wildlife, as well as natural resources harvesting.

A summary of the fire cause dynamics in KNP is presented in Figure 1.

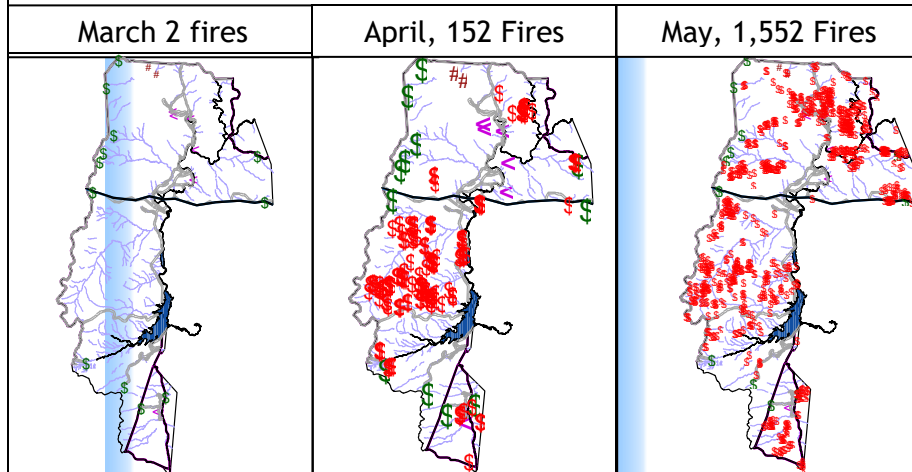


Figure 1: The fire cause dynamics in KNP: A diagrammatic presentation

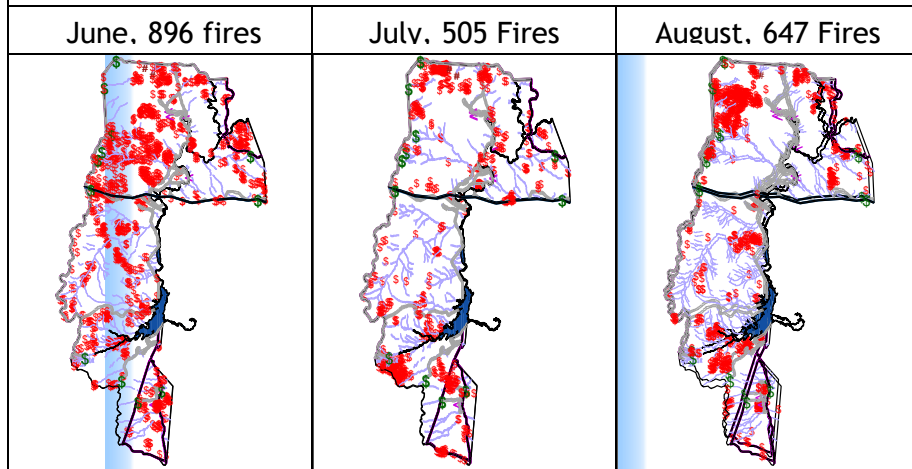


## Plate 1: KNP Fire Incidences in 2005

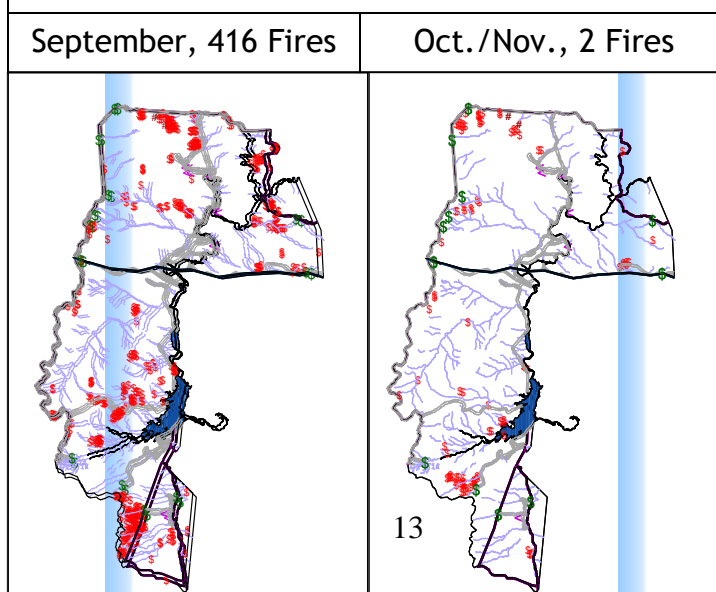
### Incidences of Early Season Fires: March 1 - May 31, 2005



### Incidences of Mid Season Fires: June 1 - August 31, 2005



### Incidences of Late Season Fires: September 1 - November 30, 2005



### 2.3 Observed impacts of fire in KNP

A number of studies carried out in the KNP have observed transformations to the vegetation in the park which are attributed to the effects of fire.

Extensive non-experimental surveys of the vegetation in KNP carried out by Mwima (2000), indicate that there are vegetation modifications and changes in some parts of the park towards more grasslands attributed to the effects of fire. Mwima further argues that the transformation from woodlands to grasslands in such areas “undoubtedly reduce the available habitat” for the woodland ungulate, such as the (lichtensteins) hartebeest, which is the “most characteristic” in the park. On the other hand, grasslands may provide increased habitats for other grazing animals, such as the lechwe, zebra, reedbuck and oribi.

During interviews for this assignment (March 2007), Mwima contends that the bulk of the vegetation types in the park are getting modified and that there is conversion of habitat types as a result of the effects of fire, and points out to the following specific observed impacts;

- The Ngoma forest: In 1983, the estimated size of the forest was 34 sq kms. In 1999/2000, the forest size had reduced to 18-19 sq kms principally because of fire. In the areas where the forest had reduced, there is obvious invasion of fire resistant species, particularly *Combretum*;
- Habitat fragmentation: This is occurring to all habitat types in the park, except grasslands. This fragmentation is very evident among the thicket habitats as a result of the effects of fire.

These impressions are supported by the aerial surveys carried out by Narita (1998) to select sites for “special conservation zones” in the park. The surveys had observed fire related impacts on the *Baikiaea* woodland, which had shown that the distribution of the *Baikiaea plurijuga* species in the park had been affected by fire. The species had become rare in many parts of the park, except for Ngoma Forest and the adjacent woodland. The studies by Narita had observed that the major cause influencing the distribution of the *Baikiaea plurijuga* in the park was the effects of fire. The dynamics of the Ngoma Forest in particular, had been influenced by fire, including the invasion of dense fire resistant shrub land on its fringes, dominated by *Baphia massaiensis* (Narita, ibid, 1998).

Another observation made on the effects of fire on the Ngoma Forest, is that on its eastern boundary, the woodlands had transformed into secondary *Baikiaea* (Narita and Mwima, (1998). The authentic *Baikiaea* was now concentrated deeper into the Ngoma Forest and the adjacent woodlands. The KNP General Management Plan has thus designated the Ngoma Forest, including the adjacent *Baikiaea* populated woodlands, as one of the “special conservation zones” in the park to be protected against fire.

During visits to some parts of the KNP in Ngoma and Chunga, the study team had observed that mid and late dry season fires are most common in the park. Observations showed that the late dry season fires, in particular, had been destructive. The results of the intensity of the fires in grassland and areas of low woodland cover had been observed and this was attributed to high fuel load.

It must be acknowledged, however, that to-date there are no conclusive scientific based experiments on the effects and impacts of fire in the KNP. All statements on fire impacts in the park are based on observations and impressions. The on-going experimental plots set up in various locations of the park by Henry Mwima, are expected to produce some conclusive scientific results to support these impressions.

Efforts had been made to obtain data on studies currently being conducted by Mwima on the monitoring of vegetation in the park. At the time of writing this fire management plan, Mwima's data were not yet conclusive and the author (Mwima) could not avail them for inclusion to this study.

## 3.0 The Fire Management Plan for KNP

### 3.1 Preamble

The Zambia Wildlife Authority (ZAWA) is desirous of implementing a Fire Management Plan in the Kafue National Park (KNP) in order to protect the park resources against fire. The fire management in the park will be integrated in the general management and protection of the KNP and its resources.

The underlying issue in KNP is that the annual burning of up to 90% of the park is impacting negatively on its ecosystem, including transformation and fragmentation of sensitive habitats. Our recent survey impressions of the park vegetation, and those obtained from the park management and other stakeholders, indicate that the uninterrupted annual burning of most parts of the park has had a corresponding uninterrupted decline of the integrity of the KNP biome. It is observed that more areas in the park have recently experienced more frequent and intense fires. This trend is “altering the ecosystem through the destruction of woody plants, which make more than 95% of total plant biomass in mature woodlands” of the park (Mwima, 2000).

The preservation of the integrity of the KNP ecosystem, including its diversity and abundance in wildlife, is important to avoid this shift and to support the government policy of enhancing the development of tourism in the park. A fire management strategy will make significant contribution to the preservation of the integrity of the KNP ecosystem. A plan for managing fire in the KNP is presented.

### 3.2 The ZAWA fire management guidelines

The overriding objective of the ZAWA fire management guidelines for national parks and GMAs is to utilize fire “to maintain the long-term integrity of the wildlife habitats” (ZAWA, 2005). The means to achieve this is spelt out in the guidelines as;

- To develop and implement fire management plans for all protected areas subject to wild land fires by 2010
- To provide adequate financial resources for annual fire management programmes
- Coordination between ZAWA and stakeholders, including government institutions
- Sensitization of the public on fire management in protected areas

The basis of developing the fire management plan for KNP takes into cognizance these ZAWA fire management guidelines for national parks and GMAs.

### 3.3 Basis for the KNP fire management plan

This fire management plan for KNP has been developed under the guiding principles of using fire as a management tool basically to ensure **prevention** and **control** of fire in the park. The integration and implementation of the fire management plan will be done in cognizance of the following facts of fire occurrence in the park;

- Up to 90% of the park is burnt annually by wild fires;
- The annual burning of the park has been observed to result into modifications of vegetation and habitats, including habitat shrinkage and fragmentation. In specific unique habitats, such as the Ngoma forest, the *Baikiaea* forest species are reducing and invasive species, including *Combretum*, are taking over the fringes of the forest.

- The fires burning the park are human induced and unplanned: The GMAs and open areas bordering the park, and within the park, the illegal hunting and activities of tour operators/lodge owners and hunting outfitters, and Travellers crossing the park are the main fire ignition agents.

The development of this fire management plan for KNP has taken into account these fire occurrence patterns and ignition causes, and places emphasis on preventive measures than control by using fire as a management tool. This fire management plan provides a phased approach that targets all areas of the park and the participation of stakeholders, including communities in the GMA and open areas, the tour operators, hunting outfitters and Travellers. This is underlined by strengthening ZAWA capacities at the two park management centres at Ngoma and Chunga, and at all the outposts and park entrance gates.

The plan provides for the development of partnerships with the GMA and open areas communities, the tour operators and the hunting outfitters to participate, take responsibilities and make substantive contribution towards the prevention and control of fire in the park.

### **3.4 The fire management plan objectives**

The overall objective of the fire management plan for KNP is to reverse loss of biodiversity and secure critical habitats and species in the park and surrounding GMAs. Essentially, the fire management in KNP should be focused at maintaining its habitat diversity and eliminate any possibility of losing the ecological integrity of the park through fire.

Specifically, this fire management plan is aimed at achieving the following objectives;

- (a) Reduce size of area of the park that is annually burnt and affected by fire.
- (b) Drastically reduce or eliminate fires starting from GMAs and open areas
- (c) Eliminate or reduce fires affecting unique habitats
- (d) Reduce fires started as a result of illegal hunting
- (e) Eliminate fires started by tour operators, hunting outfitters and tourists in the park
- (f) Eliminate fires started by Travellers on M9, the Itezihitezi Road, and other roads crossing or bordering the park
- (g) Provide mechanisms for effective response to any fire occurrence in various parts of the KNP
- (h) Ensure resources availability (equipment/funding/staff training) for fire management in the park
- (i) Significantly reduce any incidences of late burning in the KNP
- (j) Identify, mainstream and mobilize stakeholders (community/lodge operators/ Travellers/transporters, etc) for their participation in the fire management focus and planned actions
- (k) Initiate a participatory process in managing fires by the communities in the GMAs and the surrounding areas in a more informed manner (through concerted efforts of sensitization and awareness strategies)
- (l) Operationalise the fire management plan within the framework of the KNP General Management Plan

### **3.5 The fire plan**

This fire management plan for KNP proposes the establishment of an elaborate fire breaks system in the park anchored on three approaches, namely;

- (a) Firebreaks
- (b) Fire guards
- (c) Prescribed early burning

### 3.5.1. Fire breaks

The KNP Project Document provides for the construction of a strategic fire breaks system that will cover a total of 795km of internal tracks and fire breaks. This is considered to be appropriate to address the problem of fire in the park.

Generally, the fire breaks will include all internal roads and loops within the park and its boundaries, and those that were purposely built in the past to serve this purpose. The use of fire breaks will take precedence in the implementation of the fire management plan for KNP. Prior to 1975, fire breaks had been preferred as the most practical mechanisms for the management of fire in the park, i.e. for prevention and control.

Our assessment is that the fire breaks still remain the most practical mechanism in managing unplanned fires in KNP because of the size of the park. Besides, there is already defined location of the fire breaks in the park. Some remnants of the early fire breaks are visible around Ngoma forest, the western side of Lake Itezihitezhi and in the north. Other areas where the remnants of these fire breaks are very distinct include areas around Chunga and the southern parts of the park. These fire breaks have not been maintained over a long period and stopped serving their purpose.

The implementation of the fire breaks system in the fire management plan for KNP should therefore be prioritized and phased such that;

Firstly, immediate task should start with the clearance and rehabilitation of the old fire breaks in the park.

Secondly, new fire breaks should be constructed around the special conservation forest zones, where these are not available. (**See Map 6**). New fire breaks should also be constructed in the northern part of the park, outside the Busanga plains, to increase the capacities of breaking and stopping fires in the area. This should form part of the task to be commenced in the second year of the plan implementation. It should be noted that ZAWA capacities are limited and the construction of new fire breaks should only be done when surplus resources are made available above the current resources

The KNP fire management plan will integrate a permanent programme of maintaining the fire breaks, which will be part of the general management of the park.

The road network in the park, which includes tourist roads and loop roads, will serve as part of the fire breaks system.

Overall, the fire breaks will be sustained through a regular maintenance of the road network in the park. The proposed road infrastructure in the park, which was integrated in the KNP General Management Plan (1999), should be implemented and completed to increase the fire breaks capacity in the park (**See Map 7**).

This fire management plan suggests that ZAWA commences to build and implement a permanent fire breaks system in the KNP in phases, commencing with the following strategic activities;

- (a) Clearance and rehabilitation of the old fire breaks
- (b) **Construction of strategic fire breaks:** These should be constructed in areas prone to high-fire risk and sensitive habitats. We feel it is mandatory that KNP management prioritises this activity. Three locations for the construction of the strategic fire breaks have been identified, as follows;

1. The strategic fire breaks to protect **sensitive habitats**, that have been defined in the KNP General Management Plan as **special conservation zones** include;

- Rehabilitation of the fire break around Ngoma forest
- Around Busanga Plains in the northern part of the park
- Around the Nanzhila Plains in the south



2. Strategic fire breaks construction **along the M9 Road and the Itezhihezhi Road from the M9 junction**: The areas along these roads are regarded as prone to high fire risks. Fires here are lit by travellers using the roads on public transport or private motorists, including truckers who experience breakdowns along the roads. A strip of 200 meters on either side of the roads cleared each year using seasonal labour, would serve as effective fire breaks.

3. Strategic fire breaks construction on the eastern boundary area, **south of Ngoma to Dundumwezi**: several fires are known to originate from the GMAs in this area

The strategic fire breaks in these locations should be built against the prevailing easterly winds, which drive fires from the GMAs into the park, to serve a meaningful purpose.

It is important to construct strategic fire breaks in the three locations identified for the following reasons;

- (i) These areas are patronized by the public (travelers, settlers, hunters, etc) who are prone to light fires
- (ii) Prevailing easterly winds drive fires from the adjacent GMAs into the park
- (c) All existing roads in the park, including the tourist roads and the hunting tracks, should effectively be used as fire breaks through a routine and regular maintenance. The lease agreement between ZAWA and the tour operators and the hunting outfitters, should be revised to include a requirement by these stakeholders to maintain their access roads for use as fire breaks. This is achievable as has been demonstrated by some operators, such as Puku Pan Lodge, Lunga Cabins and others.
- (d) Construction and maintenance of the entire park boundary roads. This is a reasonable approach to provide barriers to anticipated fires from the GMAs and open areas bordering the park.

### 3.5.2. Fire guards

In this plan, the fire guards are defined as cleared paths constructed either by a single grader blade or by hoe or slashed. Conveniently, two parallel paths, about 100 meters apart, are constructed to provide a double barrier to fires. The intervening 100 meters is burnt to enhance the barrier function of the fire guards. The fire guards are distinguished from the firebreaks, explained above, which are basically roads.

Fire guards will be an integral tool of the fire management plan in KNP. The fire guards will be used for the control and prevention of fire in the park. The fire guards will overly be used to provide protection of large portions of the park against fire.

The specific utilization of the fire guards will be to establish fire exclusion zones in unique habitats. Considering that many of these habitats have experienced burning annually, both the fire guards and the fire breaks in this plan should provide these habitats with an initial three year fire exclusion period. This approach is meant to provide a period for their recovery.

The unique habitats mainly occupy the following;

- The special conservation zones
- The riverine vegetation: The riverine vegetation is found along the Kafue River and its perennial and non-perennial tributaries. Some of the tributaries have, in recent years, experienced shrinkage in riverine vegetation and this needs attention. Their protection, using the fire guards, should include the areas starting from their sources all the way to the points of drainage into the Kafue River.

There can be a variation of the clearance of the fire guards each year, in terms of their strategic location, the numbers required in each area and distant coverage. This can depend on the experiences of each location and peculiarities of the vegetation, wildlife distribution and land surface features (assessment of expected

fuel loads/water points retention period/etc). Thus the fire guard clearing or re-clearing will be annually planned by the KNP management.

Careful timing of fire breaks and fire guards clearance and construction will be important to ensure that these activities are effective in managing fires in the park. This is explained in the Action Plan **Appendix 2b**.

### **3.5.3. Early burning**

Early burning of select habitats, a method of using fire as a tool for managing fire in the park, is generally appreciated as an efficient practice for prevention and control and had historically been applied in KNP. The strategic purpose for early burning is to reduce fuel loads.

Early burning should be carried out in and around specific habitats in the park, such as;

- Along the M9 Road and other established roads that cut across or through the park, including tourist roads. Burning of an area extending from 100 meter up to 200 meters bordering both sides of the road to create a fire guard is proposed to keep off any fires that could be caused by Travellers.
- Around the tourist lodges and hunting areas (**Intensive utilization zones**): This should be carried out under strict and regulated controlled early burning to create visibility for animal viewing and hunting. The extent of the area subjected to this early burning should be known and approved by ZAWA.
- The loop roads and fire breaks surrounding the identified unique habitats, such as the Ngoma forest.
- Areas parallel to riverines, to create fire exclusive areas to these habitats
- The Busanga and Nanzhila grasslands, to maintain the ecological integrity of these habitats
- The Wild and Wilderness zones (**See Map 9**)

Rotational burning at two - three year intervals is suggested considering that the entire KNP ecosystem had experienced annual burning and needs to recover. This is explained in the Action Plan **Appendix 2c**.

## **3.6 Resources for the implementation of the fire plan**

### **3.6.1 Fire Management Resource Availability in KNP**

The basis for the mobilization of resources to implement this fire management plan is based on the consensus reached by participants to the Draft Fire Management Plan Report presentation. The participants included the managers of KNP North and South, the KNP based - Ecologists and staff from the Research and Planning Directorate. The emphasis is on the utilization of available resources, which includes benefiting from the routine programmes of road maintenance.

This position implies that this plan will not include major capital equipment procurement but will be implemented within the ambit of the available resources, including the current donor supported budgetary provision to the park.

#### *Equipment and Financial resources*

By May 2007, KNP had acquired equipment through the donor supported programme to the park. In addition a budgetary support of US\$50,000 had been provided to the park. A confirmation of the equipment received indicates the following;

- One (1) Motor grader
- Four (4) Tow graders
- Four (4) Tractors
- Two (2) Water bowsers
- 100 fire beaters



It is anticipated that the park will receive additional equipment, including one (1) tractor and one (1) tow grader in the next three years.

A summary of the resource availability for the fire management in KNP is presented in the Matrix below.

**Matrix 1: KNP Fire Management Plan Implementation Resource Availability**

Out puts	Activities	Resource Availability		
		Equipment	Human	Financial
Fire breaks	Clearance of old fire breaks	<ul style="list-style-type: none"> <li>✓ Motorised graders</li> <li>✓ Tow graders</li> <li>✓ Tractors</li> </ul>	✓ ZAWA staff	Sourced from available budget
Fire guards	Clearance and early burning	<ul style="list-style-type: none"> <li>✓ Slashers</li> <li>✓ Hoes</li> <li>✓ Shovels</li> </ul>	✓ Casual labourer	Sourced from available budget
Awareness and sensitization campaign	<ul style="list-style-type: none"> <li>✓ Production of fliers</li> <li>✓ Mounting of notice boards at park entry</li> <li>✓ Points</li> <li>✓ Community and schools awareness campaigns</li> </ul>	<ul style="list-style-type: none"> <li>✓ Document production materials: paper</li> <li>✓ Desk top computers</li> <li>✓ Photocopiers</li> <li>✓ Bill board materials</li> </ul>	✓ ZAWA staff	Sourced from available budget

#### *Human resources*

The park will use its current human resources stationed at Ngoma and Chunga. However, a minimum number of casual labourers to be determined by the park management at the two centres, will be recruited from the adjacent GMAs and the open areas. The engagement of casual labourers will be for a period not exceeding two months, from March to April every year, for the purpose of clearing fire breaks and fire guards, where necessary.

The approach to source seasonal workers from the GMAs and open areas to support fire management in the park has the following advantages;

- (a) The GMAs and open areas will provide availability and easy to source reservoir of human resources for this purpose
- (b) It will help in establishing the role of the communities in the management of fire in the park, and in forging and building relationships between ZAWA and the communities for this purpose.

### 3.6.2 Outpost infrastructure

Currently the majority of the ZAWA outposts in KNP are in dilapidated and disused state. The outposts are currently used as camping sites by ZAWA park patrol teams. Efforts have been made by the southern park management to rehabilitate the outposts in their part of the park. It was hoped that these efforts would be completed by end of 2006.

The ZAWA outposts will be used as strategic points of support to the fire management in the park. These will be the points of assembly and operation bases for the seasonal casual labour teams in the park. This is intended to enhance effectiveness and efficiency in mobilization of casual labour for the clearance of the fire breaks and early burning of the stretches of the park identified in this plan. Consequently, there is need to rehabilitate the outposts and make them fully operational. From these outposts, the casual labour teams will be supervised by ZAWA staff to carry out the outlined duties, for a period of two months, from March to April.

### 3.7 Implementation Schedule

The implementation of the fire management plan for KNP is based on a phased three-year period presented in the **Matrix** below. The three year period is considered adequate as an initial stage for the mobilization of resources and to put in place an operational system for the plan. The action plan of activities for implementation of the KNP fire management plan is presented in **Appendix 2**.

**Matrix 2: Three Year Initial Implementation Schedule**

Plan Component	Major Line of Action	Yr 1	Yr 2	Yr 3
Procurement	Dedicated budgetary allocation			
	Procurement of work tools: hoes, slashers, etc			
	Procurement of work clothes (including jumpers, boots, hats, jerseys) for casual labourers			
Fire breaks	Identification and clearance of old fire breaks			
	Identification and construction of new fire breaks			
Fire guards	Seasonal workers recruitment: March to April			
	Clearance of fire breaks and fire guards			
Awareness campaign strategies	Communities			
	Tour operators			
	Hunting outfitters			
Construction of resource centres	Busanga GMAs			
	Luswishi GMA			
	South park boundary open areas			
	West park boundary open areas			

### **3.8 ZAWA response to fires outside the park**

Having underlined the fact that fires burning the park are human induced, largely from the GMA and open areas, ZAWA needs to put in place mechanisms that will adequately respond to this phenomenon. The following response strategies to the fires outside the park are proposed for adoption by ZAWA;

- Work towards curbing continued encroachments and settlements in areas of the GMAs and open areas close to the park to reduce fire threats from these areas. This is a policy matter concerning settlements in the GMAs and ZAWA will need to consult with the Ministry of Tourism Environment and Natural Resources.
- Put in place an annual clearance of the entire park boundary to be used as fire break.
- Mobilisation and training of the communities for prevention and control of fires within the GMAs and open areas. This should aim at giving these communities the responsibility to control and prevent fires.

### **3.9 Stakeholder role**

The stakeholders in KNP include ZAWA, the communities in the GMA and open areas, the tour operators and hunting outfitters. These are expected to play various roles in managing fire in the park. As indicated in the foregoing sections to this plan, these stakeholders are at the centre of fire occurrence and its management in the park. Their role in the fire management plan of the park will be crucial. The proposed roles are explained below.

#### **3.9.1 ZAWA**

The key role for ZAWA is to provide leadership in the management of fire in the park. ZAWA will coordinate all the activities of fire management in the park, including clearance and maintenance of fire breaks, and mobilization of the other stakeholders. Coordination, regulation and control of activities that impacts on fire management in the park, will be a major focus in ZAWA's role as a stakeholder in the management of fire in KNP.

#### **3.9.2 The GMA and open areas communities**

Admittedly, the relationship between ZAWA and the communities in the GMAs and the open areas has never been good. There is a lot of mistrust existing between the two parties.

There is no doubt that the WPOs are feared by the communities and that on the other hand, the officers treat the communities suspiciously because many of those that engage in illegal activities relating to poaching, are suspected to launch their incursions from these areas or are based or come from the communities.

If the communities have to play a meaningful role in the management of fire in KNP, both ZAWA and the communities must lay foundation to remove the existing mistrust and suspicion between them. This can be done by establishing linkages that will ensure effective engagement on matters of looking after the resources of the park.

The role of the communities is to ensure that they become part of the process to manage fire and the resources of the park and the GMAs. ZAWA will engage the communities and make them play a role in the management of fire in the park:

- Engagement and recruitment of casual workers from the communities for the clearance of fire breaks and fire guards, as explained in the preceding sections. As explained, this will build confidence and responsibility among the communities. It will be an effective approach for the transmission of messages for the prevention and control of fire in the GMAs and the park. ZAWA

will take advantage of this engagement to sensitise the communities on the adverse effects of fire to the park and the environment. It will also be used as a conveyance of educating the communities on the use of fire as a management tool for their environments to support their economic activities.

Besides, the engagement of the seasonal workers from the communities will provide them with tangible financial benefits, in terms of wages, and as an alternative for income to enhance their livelihoods. In this respect, the role of the communities will be to participate in the prevention, control and use of fire as a management tool for the conservation and protection of the environment in the park and the GMAs.

### 3.9.3 Tour operators and hunting outfitters

Tour operator and hunting outfitters presence and activities in the park are noticeable at three levels;

- (a) Location of their activities within the park
- (b) Access roads leading to their locations and areas of operation
- (c) Early burning to create easy visibility for animal viewing and attraction to green pastures for hunting

The location of tour operators/lodges in the park is such that they are accessed by access roads for which they are directly responsible and maintain as private roads. In addition, the operators use loop roads for tour movements around the park. Equally, the hunting outfitters use known hunting tracks.

The role of the two stakeholders in fire management in the park should be focused on the following;

- (i) Maintaining their access roads and the tour loop roads at standards to which they will be used as fire breaks
- (ii) Carry out controlled early burning in the animal viewing and hunting areas, which will be used as fire guards.

### Matrix 3: Summary of stakeholder roles in KNP fire management

Stakeholder	Role
ZAWA	<ul style="list-style-type: none"> <li>• Coordination of all stakeholders</li> <li>• Clearance of old fire breaks</li> <li>• Annual maintenance of fire breaks</li> <li>• Construction of new fire breaks around unique habitats and special zones</li> <li>• Engagement of seasonal workers</li> <li>• Awareness campaign</li> </ul>
Tour operators/hunting outfitters	<ul style="list-style-type: none"> <li>• Maintenance of tourist access and loop roads</li> <li>• Early burning of prescribed animal viewing and hunting areas</li> </ul>
GMA and open area communities	<ul style="list-style-type: none"> <li>• Participation in fire break clearance and maintenance</li> <li>• Early burning</li> <li>• Control and prevention of fires entering the park</li> </ul>

## 3.10 Fire awareness campaign

### 3.10.1 Communities

In order to ensure that the communities in the GMAs and surrounding areas contribute to fire management practices in the park, and reduce the fires originating from these areas, ZAWA will need to adopt community awareness and sensitization strategies that will promote partnerships, participation and improvement of the knowledge, attitudes and practices that will significantly curtail the fires. The strategies should develop

effective use of communication, participatory methods and community based approaches to mobilise actions towards the achievement of the KNP fire management objectives.

Two approaches are proposed;

- (a) Establish wildlife education and resource centres in the communities: These will be used to fulfill the following awareness campaign purposes;

- As conduits for educating the communities and the schools on conservation and protection of the environment and wildlife
- As training centres on use of fire as a management tool for their environments
- Training and orientation for targeted seasonal recruits for clearance of fire breaks and fire guards.

These resource centres will engage in awareness programme activities which will include;

- Conducting awareness education for groups of community members
- Conduct conservation and fire management education through tours of the park
- Work with the schools in the communities to provide wildlife, environmental conservation and protection education to pupils
- Production of conservation materials: Posters, fliers, leaflets, videos/DVDs, etc, as will be considered appropriate for enhancing awareness among the communities

These centres will provide a practical approach to the awareness campaign and give opportunity to communities to plan their own programmes. Thus, after the three year initial implementation period, these centres should be handed over to be run and managed by the communities.

Currently, the CBNRM has established resource centre in Mumbwa GMA at Kaindu, Shakumbila and Mulendema; and in Namwala GMA at Lubanda (Chief Shimbizhi). In associating with the CBNRM, ZAWA will utilize these facilities and channels of awareness campaign with the communities in these GMA locations. However, in order to spread the awareness campaign more effectively to other GMAs and open areas void of these centres, ZAWA should replicate both the design and operationalisation of such centres. The areas identified for replication include the Busanga and Luswishi GMAs and the open areas to the western boundaries of the park.

- (b) We recognize that ZAWA may not have the capacities for community based approaches, including participatory methodologies. It is therefore important that ZAWA establishes linkages with stakeholder organisations already working among these communities, particularly the Danida funded Community Based Natural Resources Management Project (CBNRM), to implement specific strategies, as suggested below. The implementation should ideally work through the existing structures in the communities, such as the CRBs.

#### *Specific community awareness strategies*

ZAWA should not re-invent the wheel with regard to awareness campaign in the GMAs and open areas where the communities are already involved with the CBNRM project and other stakeholders, in aspects of natural resources conservation and protection, including aspects of fire prevention and control. Instead, ZAWA should establish linkages with these programmes to work towards consolidation of fire management aspects with these communities and avoid creating a situation of going it alone, which will place the communities in the position of making choices and preferences of association. In working with the existing programmes, ZAWA will emphasise its objectives in fire management in KNP, and what should be achieved.

Therefore, ZAWA will adopt the following specific strategies for awareness campaign in the communities;

- Strengthen ZAWA-community relationships through existing structures: CRBs and the CBNRM projects

- Channel resources through the CRBs/CBNRM projects to enhance their current programmes on fire prevention
- Provide direct technical assistance and institutional support to the CRBs for fire management
- Conduct training in the communities to build their capacities to appropriately respond to fires based on prescribed ZAWA procedures (fire guards, fire breaks, early burning)
- Build fire observatory towers in strategic areas in the communities to strengthen community based early fire warning system
- Establish environmental/conservation education/resource centres in the communities for delivery of education on conservation and protection of natural resources (flora and fauna)

### **3.10.2 Tour operators and hunting outfitters**

The fire awareness campaign targeting the tour operators and the hunting outfitters should focus on sensitisation and education on the importance of defining extent of areas to be subjected to early burning and fire control in their wildlife viewing and hunting zones. The sensitization of the tour operators and the hunting outfitters could follow two approaches, thus;

- (a) Workshop meetings at which ZAWA will make presentations on the fire issues in the park. The invitation to these workshops should be extended to all the operators in the park, and conducted within the park. The sensitization workshops, to be held for not more than two days period, should include practical transect drives or walks to specific areas where fire effects are known to be visible. Detailed workshop programme content should be worked out by ZAWA.
- (b) Production of leaflets for distribution to the operators and to serve as notice to their clients. The leaflets will spell out the disadvantages of fire in the park with an emphasis on avoiding incidences of igniting fires within the park (e.g. dropping burning cigarette butts).

### **3.10.3 Travellers**

Categories of travellers crossing the park include private motorists, tourists and those using public transport. The travellers are known to ignite fires along the M9 Road and the Itezhi-tezhi road. Similar incidences of fire occur on other roads used to cross the park. Travellers may ignite fires in various ways, including disposal of burning cigarette butts, failure to extinguish purposefully prepared fires and even deliberate setting of fires.

Current arrangements show that there is no awareness campaign in place to sensitise travellers crossing the park on prohibition of starting or avoiding igniting fires in the park.

The sensitization of travellers should focus on the following approaches;

- Mounting of permanent notices at park entry gates and points
- Briefings to be conducted by the WPOs at the park entry gates and points on avoiding fires: This should take as little time as is currently spent on enquiring details from travellers crossing the park.
- With regard to the public transport travellers, this will require the WPOs to physically enter the buses and conduct the briefings.
- Production of one page leaflets/fliers for distribution, spelling out responsibilities of the travellers to avoid igniting fires in the park.

## **3.11 Legal framework**

The Zambia Wildlife Authority (ZAWA) is an autonomous statutory institution tasked with management and protection of natural resources in protected areas within the legal framework of the Zambia Wildlife Authority Act of 1998. Under this legal framework arrangement, based on the 1998 Act, ZAWA has the mandate to control and manage the wildlife resources in all National Parks and Game Management Areas.

The legal framework for the management and protection of natural resources and the environment in Zambia is enshrined within an array of environmental legislations. The most relevant legal frameworks to fire management in protected areas are the Forest Act, the ZAWA Act and the Environmental Protection and Pollution Control Act.

Both the ZAWA Act and the Forest Act have underlined that it is illegal to set fires to the protected areas.

The ZAWA Act is not specific in dealing directly with the perpetrators causing fire in protected areas as a misdemeanor for which specific charges or actions can be laid against offenders. This is a serious gap within the existing laws that needs to be addressed. Legal reform within the ZAWA Act is necessary to address the issue of dealing with persons or communities igniting fires affecting the protected areas.

#### *By- laws*

It is possible for ZAWA to overcome this limitation in the law governing fires in the national parks. The legal framework in Zambia provides for local authorities through the District Council, to institute by – laws to exercise legal jurisdiction on any activities that directly concern them and within their areas. Thus, Chiefs can submit and propose to their District Councils by-laws to exercise jurisdiction on activities of their subjects. In this respect, ZAWA can work with the local Chiefs to draw by-laws to regulate the use of fire and its restriction in the GMAs and open areas, to ensure prevention to burn the national park (s). This would include provision of arrest and punishment against perpetrators of this misdemeanor.

This is a task which ZAWA should follow up.

### **3.12 KNP fire monitoring**

Examination of records and monitoring practices indicate that there is no coherent fire monitoring in the Zambian national parks. This is evidently so in the case of the practices being applied in the KNP. The system currently applied to monitor fires in the park uses the wildlife police officers (WPOs) as part of their duties when patrolling the park. These patrols do not take fire monitoring as a priority, rather the officers record fire occurrences when they encounter them. Consequently the current data being recorded may not be reliable.

In working out a fire monitoring system, it is important that this responsibility is dedicated both in terms of personnel, equipment and financial resources to ensure effectiveness. A systematic procedure of monitoring fire in relation to the ecosystem in KNP needs to be put in place. It is important to put in place a monitoring system with a foundation, which is interactive and provides feedback to the park management, ZAWA headquarters and the policy institutions (MTENR).

The monitoring system would capture the following broad parameters:

- Assessment of the status of the ecosystem resulting from fire effects
- Assessment of the accomplishments of fire management put in place
- Measurement and evaluation of the results of the fire management system over a period of time

Current efforts by Henry Mwima (PhD), who has set up experimental plots in selected locations in the park, are expected to provide both quantitative and qualitative scientific data on fire and its effects on vegetation and wildlife in KNP. The initial results of his current works in the park, provide indicators for monitoring any transformations to the vegetation types in the park resulting from external effects, including potential impacts of fire. The Matrix below explains the parameters and indicators developed by Mwima 2006. These parameters and indicators could equally be applied in fire monitoring in KNP.



**Matrix 4: Vegetation monitoring indicators based on Mwima (2006)**

Indicator	Parameter Measurement
A. Biomass	1. Shrub biomass transformation into tree category <u>OR</u> 2. Shrub biomass deteriorating into grassland level
B. Species	Changes in the vegetation species, inclined more into fire resistant species invasion
C. Species diversity	Focus on the species more susceptible to the effects of fire
D. Ranking value	Based on linkage to species diversity: effects of fire on structure of forest types.
E. Resident fauna	Distribution over time and linked to availability of grazing or palatable grazing pasture
F. Canopy cover	Changes to the canopy cover: drastic or moderate
G. Damage on tree species	Based on a combination of actual sitings and past records

**Source: Mwima, 2006**



### 3.13 KNP fire monitoring data sheet

The KNP fire management monitoring data sheet has been structured to complement the vegetation monitoring data sheet developed by Mwima (2006) for use in monitoring vegetation in KNP. This will enable complementing the application of the two monitoring systems that will be implemented in the same park. In many ways, the data monitoring sheets present aspects that can easily be compared to enhance protection of the park resources (both fauna and flora) against fire.

**KNP Fire monitoring data sheet**

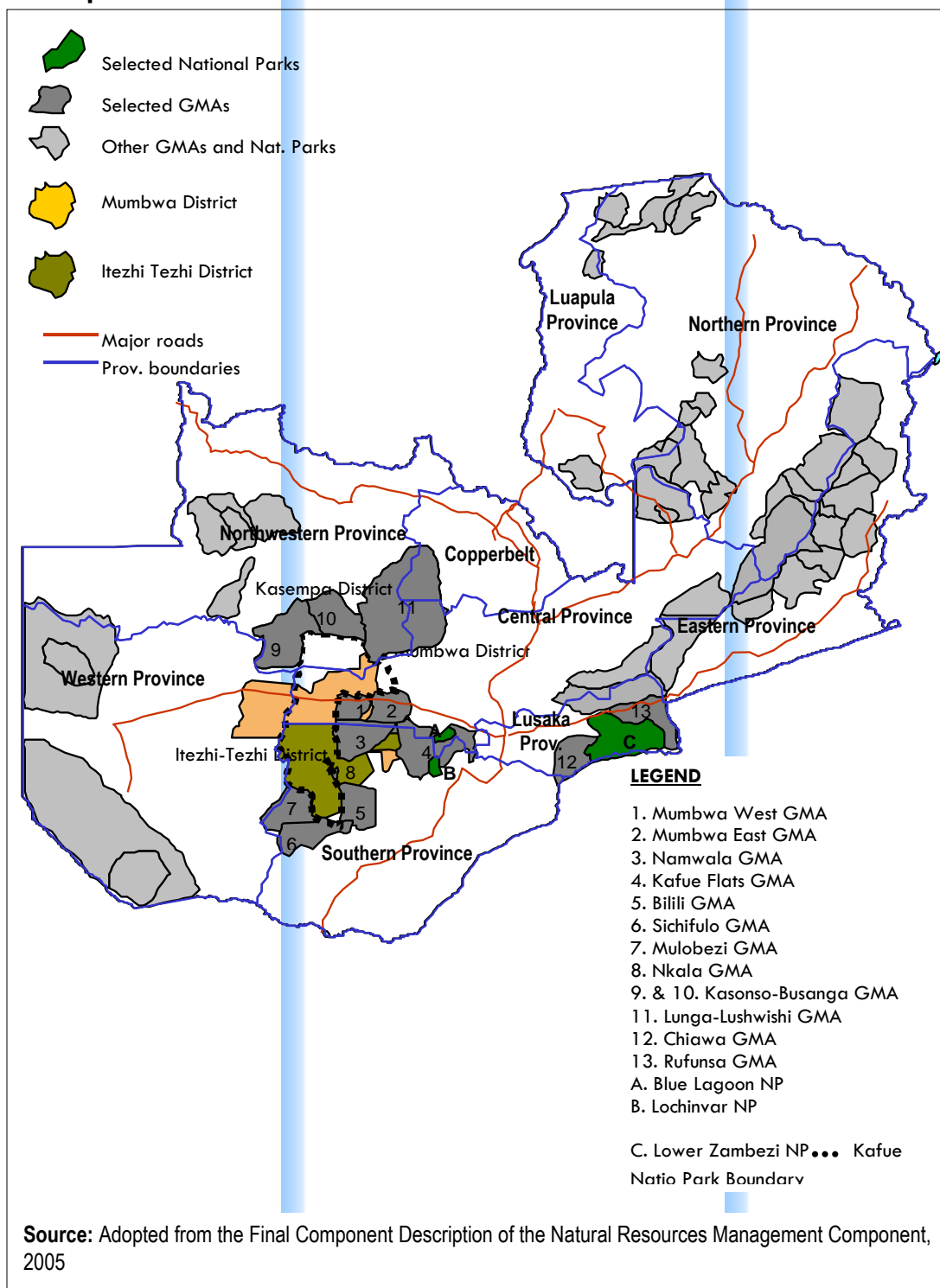
Date: .....		Time: .....					
Fire Location:	Out post:	Block:	GPS Reading:		Est. Duration of Fire		
	.....	Name .....	S .....		Burning (/Hrs):		
	.....	No.: .....	E .....		Hrs: ..... Min: .....		
Cause of fire/Probable	.....						
Fire Affected Area:	Dominant Vegetation Type: (Tick as appropriate)	Forest	Shrubs	Grassland	Thicket	Terminaria	Herbaceous
		.....	.....	.....	.....	.....	.....
Observed Fire Impacts: Describe identified impacts.	Trees	Shrubs		Grass		Animals	Other (Specify)
Affected unique habitat(s)/special zone(s)	Name..... Area: .....	GPS Reading: S ..... E .....		Specify fire impacts:			
Additional Notes:							
Name of Recorder: Date: Time: Signature:							

**Notes: The key features of fire effects to be recorded:**

- 1. Trees: Effect on crown; branches; bark**
- 2. Grass: Complete or partially burnt**
- 3. Animals: Dominant animal species affected; migration**

# MAPS

# Map 1: Location of the Kafue National Park GMAs



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# Appendixes

## Appendix 1: Terms of Reference

The Terms of Reference for this assignment were;

- i) Examine in detail the historical and current frequency of occurrence of fires in the park and its surrounding GMAs
- ii) Assess the temporal and spatial distribution of wild fires in the park and its surrounding GMAs
- iii) Describe in detail the observed potential impact for the fires on the ecosystems
- iv) Based on (i) to (iii) above, develop an adaptive fire management plan for the park and the surrounding GMAs. Among other considerations, the plan should include the following;
  - (a) A programme that will ensure maintenance of fire breaks in good condition
  - (b) Determine resources (human, equipment, etc) that are crucial for the implementation of the fire management plan
  - (c) Prescribe management responses to wild fires from within and outside the park
  - (d) Describe in detail the role of other stakeholders, particularly local communities, tour operators, and hunting outfitters in its implementation
  - (e) Outline an effective fire awareness campaign targeting various stakeholders, including the general public, learning institutions, local communities and park users
  - (f) Outline a legal framework governing the prosecution of cases of wild fires; and
  - (g) Prescribe a monitoring programme that will help document the impacts of fires on the fauna, flora and land use practices in the area. As such, the plan will recommend the establishment of experimental fire plots in selected critical habitats. For effective and meaningful use of the fire plots, the monitoring programme shall consider the following;
    - Use of specific indicators of impacts on the vegetation
    - Identification of parameters to be monitored and specify how such parameters are to be measured
    - Designing appropriate data sheets for monitoring of the vegetation in the critical habitats
    - Formulating a fire monitoring manual; and
    - Training of members of staff in data collection, storage (both manual and electronic) including retrieval and analysis.

## Appendix 2: KNP Fire Management Implementation Action Plans

The action plans of activities for the implementation of the plan are presented in **Appendixes 2 (a) – 2 (d)** below.

### (a) Implementation schedule

Activity	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Draw work plan and budget for fire management												
Budget allocation for identified fire management activities												
Procurement of work tools: hoes, slashers, shovels, work clothes.												
Clearance of fire breaks/fire guards												
Construction of strategic fire breaks												
Awareness campaign strategies												

**(b) Annual implementation activities for management of fire breaks and fire guards and burning of protected habitats and zones**

Activity	Month											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Clearance of fire breaks												
Locate and design fire guards around the zones												
Hire and engage seasonal casual labourers from GMAs and open areas and deploy to outposts												
Fire guards clearance and early burning by casual labourers												
Disengage casual labourers												
Early burning of utilisation and special conservation zones												
Late burning in select habitats in southern park												
Park boundary clearance												
Construction of strategic fire breaks: ✓ Mumbwa-Mongu road ✓ Itezhitezhi road ✓ Eastern boundary (South of Ngoma to Dundumwezi) ✓ Around sensitive habitats: Ngoma Forest												
Clearance of tourist loop roads												

## 2 (c): Use of Fire as a Management Tool: Three Year Action Plan

This action plan emphasizes the use of fire as a management tool in the identified unique habitats, including special conservation zones, wilderness zones, wild zones and intensive utilization zones (See Map ....)

Location	Early burning			Late burning			Fire Exclusive		
	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3	Yr 1	Yr 2	Yr 3
Busanga Plains									
Nanzhila Plains									
Ngoma Forest									
Kafue River banks stretch									
Along M9									
Along Itezihitezhi Road									
Middle and upper parts of Lufupa River									
Islands on the three major rivers Kafue, Lufupa and Lunga									
Lunga River banks stretch									
Special conservation zones									
Wilderness zones									
Wild zones									
Intensive utilization zones									



**(d): Fire breaks clearance and construction**

<b>Period</b>	<b>Location</b>
Year 1 to Year 3	Clearance of old fire breaks: <ul style="list-style-type: none"><li>➤ Around Ngoma forest</li><li>➤ West of Lake Itezihitezhi</li><li>➤ Northern park</li><li>➤ Around Chunga</li><li>➤ Southern park</li></ul>
Year 2 to Year 3	Construction of new strategic fire breaks: <ul style="list-style-type: none"><li>➤ Around special conservation zones</li><li>➤ Park boundary</li><li>➤ Busanga Plains</li><li>➤ Around special conservation zones</li><li>➤ Along the M9 Road and the Itezihitezhi Road</li><li>➤ Eastern boundary area, south of Ngoma to Dundumwezi</li></ul>

### Appendix 3: Persons Met

Name	Position and Organisation
Dr. V. Siamudala	Director, Research and Planning, ZAWA
W. Chansa	Head of Research, ZAWA
C. Simukonda	Senior Ecologist, ZAWA
Dr. F. Mkanda	KNP North Park Manager, ZAWA
O. Nelson	KNP South Park Manager, ZAWA
W. Simpamba	Ecologist, KNP South, Ngoma, ZAWA
A. Nkole	Area Warden, KNP North, Chunga, ZAWA
C. Banda	Ecologist, KNP North, Chunga, ZAWA
Dr. H. K. Mwima	Executive Director, Jastis Management and Consulting Services
O. Tembo	Project Coordinator, CBNRM Itezhitezhi
S. Sindern	Director, ZELU Ltd, Former KANTIPO General Manager
K. Namangala	West Regional Office: ZAWA, Mumbwa
L. Daka	Park Ranger, KNP South, Ngoma, ZAWA
C. Kaoma	Ranger, KNP South, Ngoma, ZAWA
B. Kabungo	Research Assistant, KNP South, Ngoma, ZAWA
Simangolwa	Senior Wildlife Police Officer, West Regional Office: ZAWA, Mumbwa
R.B Pathy	Sales Rep. Barlowworld Equipment Zambia Ltd
C. Chisonga	Sales Rep. Power Equipment Ltd
Mutambo	Sales Rep, CAMCO Equipment (Z) Limited

## Appendix 4: Vegetation types in the Kafue National Park

(Based on Fanshawe, 1971)

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### Biakiaea Forest

Biakiaea forest is a two-storeyed dry deciduous forest with an overwood of *Baikaea plurijuga* (Zambian Teak) and *Pterocarpus antunesii* in varying proportions and a dense thicket-like underwood – the mutemwa. *Lonchocarpus nelsii* is a frequent subdominant. Common small trees at the lower canopy level include *Baphia massaieiensis* ssp. *Obovata* and *Combretum celastroides*.

The mutemwa consists largely of *Acacia ataxacantha*, *Acalypha chirindica*, *Alchornea occidentalis*, *Citropsis dawsoniana*, *Combretum elaeagnoides*, *Dalbergia martinii*, *Grewia avellana*, *Popowia obovata*, *Terenna luteola*, *Tricalysia allenii*, *Triumfetta elaeagnoides*, *Dalbergia martinii*, *Grewia avellana*, *Popowia obovata*, *Terenna luteola*, *Tricalysia allenii*, *Triumfetta dekindriana* and the invasive *Waltheria indica*.

Herbs and sub-shrubs are mostly rainy season annuals but there are a few common perennials – *Achyranthes aspera*, *Blepharis maderaspatensis* and *Plumbago seylanica*. *Baissea wulffhorstii* and *Hipocratea parviflora* are the only common climbers besides the more scandent of the mutemwa shrubs e.g. *Combretum celastroides*.

The remaining *Baikiaea* forests in the Park are all relics or old secondary *Baikiaea* forests. There are four remaining groups of forest around Ngoma of which the Ngoma forest is the best preserved. There are also smaller relic forests on or near the western boundary. At one time there must have been many more forests or perhaps the present relics covered a far greater area judging by the amount of secondary *Baikiaea* in the Park today.

### Secondary Baikiaea Forest

Fire, cultivation and browsing by game, particularly elephant, degrade *Baikiaea* forest to open woodland and finally scrub. At the same time the gaps are invaded by fire hardy elements of the munga woodland on the surrounding flats to produce *Acacia* – *Combretum* – *Terminalia* woodland with *Baikiaea* forest relics. The immediate surround which presumably once carried primary *Baikiaea* forest is now covered with secondary *Baikiaea* forest.

Tall trees are chiefly *Acacia galpinii*, *Ac. Giraffae*, the occasional *Baikiaea plurijuga*, *Burkea africana*, *Combretum collinum*, *Erythrophleum africanum*, *Lonchocarpus capassa*, *Terminalia sercea*, and *Xeroderris stublmannii*.

Common small trees include *Acacia fleckii*, *Baphia massaieiensis* ssp. *Obovata*, *Combretum celastroides*, *C. psidioides*, *Croton gratissimus*, *Markhamia obtusifolia* and *Terminalia brachystemma*.

Shrubs are chiefly *Acacia ataxacantha*, *Ac. Schweinfurtii*, *Bauhinia macrocarpa*, *Combretum elaeagnoides*, *Dalbergia martinii* (locally), and *Grewia* spp. with *Achyranthes aspera*, *Cleodendrum uncinatum* (a plant spread by cultivation), *Disperma crenatum*, *Hemizygia bracteosa*, *Justicia betinica*, *Tephrosia cephalantha* and *Waltheria indica*.

The few climbers are occasional at best. The presence of the climber *Combretum microphyllum* represents local invasion from the riparian woodland.

## Pteleopsis Forest

Pteleopsis forest occurs on old sandbanks, on termite mounds in the Nanzhila area, on sandstone capped hills and on the fringes of the Kalahari sand northwards from Ngoma. It is invaded by riparian elements on the old riverine sand-banks.

Tall trees include *Entandrophragma caudatum*, *Pteleopsis myrtifolia* and *P. anisoptera* besides *Pterocarpus antunesii*. Common small trees include *Baphia massaiensis* ssp. *Obovata*, *Combretum celastroides*, *Croton gratissimus*, *Markhamia obtusifolia*, *Strychnos madagascariensis* and *Vetex payos*.

The characteristic mutemwa species are *Acacia schweinfurthii*, *Acalypha chirinica*, *Alchornea occidentalis*, *Baphia capparidifolia*, *Combretum elaeagnoides*, *Croton polytrichus*, *Dalbergia martini*, locally *Mundulea sericea* and *Popowia obovata*.

Common sub-shrubs include *Achyrothes aspera*, *Belepharis maderaspatensis*, *Dicliptera nemorum*, *Phaulopsis longifolia*, *Sansevieria desertii* (succulent) and *Triumfetta dekindtiana*. Climbers are mostly *Baissea wulfhirstii*, *Bonamia spectabilis*, *Hippocratea parvifolia*, *Strychnos lucas*, *St. usambarensis* and *Tiliacora funifera*.

*Pteleopsis* forest degrades as a result of fire, cultivation and animal damage to a type of secondary forest indistinguishable from *Baikiaea* forest except for the absence of relic *Baikiaea*.

## Riparian Woodland

A more or less continuous strip of gallery woodland clothes the rivers, streams and permanent waterholes. It is at its best around Kafue Hook and Kafwala where the shrub layer is absent but the landward side is protected by a dense deciduous thicket against encroaching fires.

On the Lufupa River banks, the gallery woodland is divided into two zones separated by a sandbank and a trough. The outer zone consists almost exclusively of *Syzygium guineense* ssp. *Barotsense* growing in the water, the inner of typical evergreen riparian species. This division of the gallery woodland is carried to extremes at Moshi and Ntemwa and probably elsewhere with the riparian element restricted to termite mounds up to half a mile from the river. It suggests that at these places the riparian woodland was once much more extensive and covered the area between the riparian termite mounds. Fire or possibly changes in drainage have destroyed the *Eriosema psoraleoides*, *Gnidia* woodland on the flats leaving only the woodland on the *termitaria*.

Common tall trees are reduced to *Garcinia livingstonei* and *Syzygium guineense* ssp. *Barotsense* with occasional *Diospyros mespiliformis*, *Manilkara mochisaia*, *M. obovata* and *Mimusops seyberi*. *Terminaria sericea*, *Acacia* spp. *Hypbaene* palm are locally common on the landward fringes.

Small trees are chiefly *Chrysophyllum magalismontanum*, *Oncoba spinosa*, *Rhus quartiniana* and *Tricalysia coriacea* with clumps of *Phoenix reclinata* palms and the local willow (*Salix subserrata*) in gaps.

Common shrubs include *Antidesma venosum*, *Baphia capparidifolia* in rocky places, *Canthium zanzibaricum*, *Diospyros lycioides*, *Dombeya wittei*, *Ficus capreifolia*, *F. pygmatea*, *Maytenus buchananii*, *Phyllanthus reticulatus* and *Tricalysia andongensis* with *Phragmites mauritianus* reeds in gaps.

Characteristic climbers include *Artabotrys monteiroae*, *Cocculus birsutus*, *Hippocratea africana*, *Jasminum fluminense*, *Mikania cordata* as a second invasion, *Paullinia pinnata*, *Tacazzea apiculata* and *Tiliacora funifera*.

## Miombo Woodland

Miombo woodlands dominated by *Julbernardia paniculata*, covers large areas in the north and centre of the Park. The woodland is of poor quality with a relatively low canopy and occurs both on light and heavy plateau soils. It grades into Kalahari-miombo woodland as a result of repeat heavy burning leads to invasion by munga elements and eventually to munga woodland.

In the north around the Busanga plain patches of miombo have become isolated as a result of erosion and changes in drainage and now form bush groups. If the surrounding terrain has become waterlogged or is periodically inundated the bush groups carry a fringe of riparian species e.g. *Protea welwitschii*.

In general the common canopy trees are *Brachystegia floribunda*, *Br. Longifolia*, *Br. Spiciformis*, *Br. Taxifolai* (locally), *Br. Utilis*, *Isoberlinia angolensis* and *Julbernardia paniculata* (dominant). *Terminalia sericea* invades the fringes on sandier soils. *Isoberlinia*, *Br. Longifolia* and *Br. Spiciformis* normally appear towards dambo margins while *Br. Floribunda* and *Br. Utilis* only occur in the Mumbwa section east of the Kafue River.

Small trees are chiefly *Baubinia petersiana*, *Dalbergiella nyasae*, *Diplorbynchus condylocarpon*, *Pseudolachnostylis maprouneifolia*, *Syzygium guineense* ssp. *Macrocarpum*, *Uapaca sansibarica* are dambo elements invading the miombo fringe.

Common shrubs include *Baphia massaiensis* ssp. *Obovata* (on sandy soils), *Hymenocardia acida*, *Kotchya strobilantha*, *Protea angolensis*, *Tricalysia angolensis* and *Uapaca pilosa*.

Sub-shrubs are a feature especially *Abrus pulchellus* ssp. *Suffruticosus*, *Adenodolichos punctatus*, *A. rhoboideus*, *Clematopsis scabiosifolia*, *Combretum platypetalum*, *Desmodium barbatum*, *Diospyros virgata*, *Diplolpbium zambesianum*, *Eriosema ellipticum*, *Helichrysum kirkii*, *Hibiscus rhodanthus*, *Indigofera* spp. *Ipomoea vernalis*, *Lannea edulis*, *Sphenostylis marginata*, *Strobilanthes linifolia* and *Triumfetta dekindiana*. The few climbers are occasional at best and do not reach the canopy.

## Kirkia Woodland

A well-marked ecotone between miombo and valley munga woodland dominated by *Kirkia acuminata* and *Julbernardia globiflora* occurs on the sandstone scarps fringing the Kafue River between Kalala and Itezhi Tezhi. The characteristic feature of this type of woodland is the presence of paper bark trees belonging to the genera *Albizia*, *Commiphora* and *Sterculia*. Besides the dominant *Brachystegia spiciformis* and *Erythrophleum africanum* are common canopy constituents, at least locally.

Small trees are chiefly *Combretum celastroides*, *Commiphora mossambicensis*, *C. ugigensis*, *Dalbergiella nyasae*, *Diplorbynchus condylocarpon*, *Euphorbia matabelensis*, *Pseudolachnostylis maprouneifolia* and *Vitex paysonii*.

Shrubs are few, mostly *Cissus cornifolia*, locally *Croton gratissimus*, and *Holarrbena pubescebs* and *Ochna pulchra*.

Similarly vegetation occurs on the granite domes such as in Kaingabaila by the Lufupa River. A *Euphorbia*-like succulent small tree—*Synadenium kirkii*—is characteristic of this locality. Bare granite domes like Lubulanzulu hill carry succulents like *Euphorbia fortissimo*, *Aloe chabaudii* and *Aeolanthus myrianthus* and fibrous *Vellozia equisetoides*, mostly in rock crevices.

## Kalahari Woodland

Kalahari woodland covers the greater part of the Kalahari sands in the Park. Most of it is dominated by *Julbernardia panicu*, but there are small areas of *Brachystegia spiciformis* woodland and a tiny patch of *Guibourtia coleosperma* woodland on Nakalombe hill. In places Kalahari woodland of the above types degrades to *Burkea- Erythrophleum* woodland and finally to *suffrutex* savanna as a result of fire. Most of the Kalahari woodland is of poor quality except on the northern boundary between Kabanga and Masoshi where there is an area of top quality woodland.

In general characteristic tall trees include *Brachystegia longifolia*, *B. spiciformis*, *Burkea Africana*, *Comretum collinum*, *Erythrophleum africanum*, *Isoberlinia angolensis*, *Julbernardia paniculata* and *Terminalia sericea* (particularly on the fringes).

The well-marked shrubs layer contain mostly *Baobab urbaniana*, *Bridelia duvigneaudii*, *Byrsocarpus orientalis*, *Copaifera baumiana*, *Eriosema ellipticum*, *Grewia falcistipula*, *Kotschya strobilantha*, *Paropsia brasseana*, *Sida cordifolia*, and *Tricalysia angolensis* with marginal *Syzygium guineense* ssp. *Buillense*

Subshrubs are a feature especially *Annona stenophylla* ssp. *Nana*, *Brackenridgea arebaria*, *Chamaecitandra benriqueessian*, *Combretum platypetalum*, *Cryptosepalum maraviense*, *Diospyros virgata*, *Eugenia angolensis*, *Fadogia monticola*, *Landolphia camptoloba*, *Ochna leptoclada*, *Parinari capensis*, *Pygmaeothamnus zeyheri*, *Sapim oblongifolium* and *Tricalysia cacondensis*. Climbers are few and occasional at best.

## Suffrutex Savanna

Two areas of suffrutex savanna are identified;

1. Moist seepage dambos carry a vegetation of shrubs, suffrutices, grasses and sedges up to 5 feet high. The species grow gregariously in small colonies or scattered. Common shrubs include *Eriosema psoraleoides*, *Gnidia kraussiana*, *Hyptis spicigera*, *Conyza welwitschii* and *Syzygium guineense* ssp. *Buillense* with occasional groups of juvenile *Hyphaene ventricosa* palms.

2. Suffrutex savanna on Kalahari sand which is dominated by suffrutices rather than grasses or sedges and drainage is free. It is in fact the ultimate stage in the degradation of the Kalahari woodland, hence the characteristic species are those found in the suffrutex layer of Kalahari woodland. These species tend to persist for a long time after the shrubs and trees have been destroyed by fire.

The commoner, suffrutices include *Annona stenophylla* ssp. *Nana*, *Brackenridgea arenaria*, *Combretum platypetalum*, *Diospyros virgata*, *Eugenia angolensis*, *Gnidia kraussiana*, *Lannea edulis*, *L.gossweileri*, *Ochna manikensis*, *O.pygmaea*, *Parinari capensis*, *Pygmaeothamnus zeyheri* and *Syzygium guineense* ssp. *Buillense*. Many of these species like *Ochna*, *Parinari*, *Pygmaeothamnus* and *Syzygium* are rhizomatous and grow gregariously in small to large colonies.

## Mopane Woodland

Open park-like tall mopane woodland is uncommon in the Park. Most mopane trees are on or around termite mounds. Besides the strong dominant mopane there are few common species—*Acacia nigrescens* in the canopy, *Acacia erubescens* and *Balanites aegyptiaca* as scattered small trees, the sprawling shrub *Bossia matabelensis* on low mounds and the climbers *Cissus quadrangularis* and the python vine – *Fockea multiflora*. Low relic termite mounds carry colonies of *Sansevieria desertii* and *matabelensis* and little else.

## Munga Woodland

Munga woodland is characteristic of the flood plains along the Kafue River and its tributaries. Soils vary from the loose sand of comparatively recent sand banks to feature of munga woodland especially with *Acacia* spp. and may well be the result of fire and drainage conditions. Seasonal flooding encourages purity of stand and fire has probably helped by reducing competition. There are pure or almost pure stands of *Acacia albida*, *A. pilispina*, *A. polyacantha*, *A. seyal* and *A. sieberana*. There are even pure stands of *Combretum imberbe*.

Composition of the munga woodland at most reveal an extremely variable series of secondary vegetation types varying from almost closed to very open woodland, from comparatively tall to low woodland to scrub. It may be dominated by *Acacia*, *Combretum* or *Terminalia* ssp. or any mixture of all three genera. Munga woodland is dynamic and tends to invade and eventually replace all other vegetation types with which it comes in contact. Ecotones occur on the contact notably with mopane in the south, miombo in the north and centre, and dry deciduous forest and Kalahari woodland and the fringes of the Kalahari sand. Termite mounds are a feature of munga woodland areas.

In general characteristic tall trees are *Acacia albida*, *A. nigrescens*, *A. polyacantha*, *A. robusta*, *A. sieberana*, *Albizia harveyi*, *Ficus sycomorus* and *Terminalia mollis* and occasional groves of *Hyphaene ventricosa* palms.

Common small trees include *Acacia seyal*, *Baubinia petersiana*, *Combretum ghasalense* (the tree type), *Dalbergiella nyasae*, *Diplorbynchus condylocarpon* and *Piliostigma thonningii* with *Maytenus senegalesnis* and *Dichrostachys cinerea* as the commoner shrub.

Sub-shrubs are chiefly *Ipomoea vernalis* and the dambo suffrutices like *Gnidia*, *Hibiscus*, *Lannea* and *Ozoroa*. Climbers are uncommon.

## Munga Scrub

Ten (10) feet high open munga scrub covers a large area in the central section of the Park on black cracking clay containing limestone nodules. The composition is restricted to seven tree species, namely *Acacia nilotica*, *A. seyal*, *Baubinia petersiana*, *Combretum ghasalense*, *Diospyros kirkii*, *Piliostigma thonningii* and *Terminalia stenostachya* with a ground cover of scattered woody *Ipomoea vernalis*, *Lannea edulis* and *Conyza welwotschii* and herbaceous *Hygrophila pilosa* and *Sphaeranthus humilis*.

## Mopane Termitaria

The vegetation of termite mounds in the mopane belt is a mixture of munga and mopane elements forced to retreat to termite mounds as a result of flooding of long duration. It has the habit of closed munga woodland.

Tall trees are chiefly *Acacia nigrescens*, mopane (*Colophospermum mopane*), *Commiphora mollis* and *Kirkia acuminata*. Common small trees include *Acacia erubescens*, *Balanites aegyptiaca*, *Euclea divinorum*, *Gardenia resiniflua*, *Markhamia acuminata* and *Ziziphus mucronata*.

Shrubs are a feature especially *A. schweinfurthii*, *Boscia matabelensis*, *Canthium frangula*, *Cissus cornifolia*, *Combretum elaeagnoides*, *Croton gratissimus*, *C. menybartii*, *Euphorbia espinosa*, *Maerua parvifolia*, *Plectranthus cylindraceus* and *Steganotaenia araliacea*.



*Ipomoea shirambensis* is the only common climber. The succulents *Aloe chabaudii* and especially *Sansevieria desertii* are abundant.

### **Munga Termitaria**

Termite mounds are a striking feature of the alluvial flats, usually with a surround of Munga woodland. Occasionally even the fire hardy munga elements are destroyed and the termite mounds remain with skeletal vegetation almost exactly like that of munga scrub. The vegetation of munga *termitaria* is otherwise almost exactly like that of munga woodland, except on waterlogged terrain when the mounds carry a fringe of riparian species like *Rhus*, *Syzygium* or *Phoenix* palms.

Tall trees are chiefly *Acacia robusta*, *Albizia harveyi*, *Commiphora mollis*, *Lonchocarpus capassa* and *Ziziphus mucronata* with local stands of *Hyphaene ventricosa* palms.

Common small trees include *Albisia anthelmintica*, *Azanza garckeana*, *Baobab petersiana*, *Combretum ghasalense*, *Cordia goetzei*, *Croton gratissimus*, *Euclea divinorum*, *Markhamia obtusifolia* and *Steganotaenia araliacea*.

Characteristic shrubs include *Acacia schweinfurthii*, *Acalypha chirindica*, *Capparis*, *Combretum elaeagnoides*, *Phyllanthus reticulatus* and *Popowia obovata*.

### **Riparian Termitaria**

Termite mounds carrying evergreen riparian vegetation occur on the river banks within the gallery woodland strip or on alluvial flats once covered by riparian woodland from which the woodland has disappeared, as at Moshi and Ntemwa. The physiognomy is that of riparian woodland.

Characteristic tall trees are *Diospyros mespiliformis*, *Garcinia livingstonei*, *Manilkara mocharis*, *M. obovata* and *Mimusops zeyheri*. Common small trees are chiefly *Oncoba spininosa*, *Rhus quartiniana* and *Syzygium guineense* ssp. *bullense* with local stands of *Phoenix reclinata* – wild date palms.

Shrubs are a feature especially *Acalypha chirindica*, *Baphia capparidifolia*, *Cantium zansibaricum*, *Diospyros lycioides*, *Maytenus buehneri* and *Phyllanthus reticulatus*. The commonest climbers are *Hippocratea africana*, *Paullinia pinnata*, *Taccaea apiculata* and *Tiliacora funifera*. The succulent *Sansevieria desertii* forms local colonies.

### **Dambo Grassland**

The sandy dambos carry a short wiry grassland dominated by *Loudetia simplex*, *Monocymbium cerasiiforme*, *Eragrostis* spp. (Love grass) *Setaria* spp. (Timothy grass), *Themeda triandra*, *Trachypogon spicatus* and *Tristachya superba*.

### **Riverone Grassland**

The black calcareous clay flood plains carry a tall tussock grassland especially of *Hyparrhenia rufa* (Thatching grass), *Jardinia angolensis*, *Chloris gayana* and *Setaria mombassana* (Timothy grass).

### **Floodplain Grassland**

The floodplain grasslands of the Busanga and Nanzhila flats carry *Echinochloa stagnina* and *E. pyramidalis* (Antelope grass) or *Vossia cuspidate* (Hippo grass) associated with *Leersia hexandra* and *Oryza longistaminata* (Wild rice grass).

Reed/sedge swamps occur here and there with *Phragmites mauritianus* reeds, *Typha domingensis* bulrushes or tall sedges like *Cyperus articulatus* and *Cladium marisus*.