REPUBLIC OF ZAMBIA

MINISTRY OF TOURISM

FIRE MANAGEMENT PLAN

FOR

LUAMBE NATIONAL PARK



2022– 2026

DEPARTMENT OF NATIONAL PARKS AND WILDLIFE
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CITATION

DNPW 2021. Fire Management Plan for Luambe National Park (2022 to 2026). Department of National Parks and Wildlife. Chilanga, Zambia.

COMPILATION

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COVER PHOTOS

Left to right (Prescribed early season burning; Fire management equipment (Bladder bag, fire beater and drip torch) and pre-field fire management meeting with the community and officers at Chanjuzi Wildlife Camp).

SUPPORTED BY

APPROVAL PAGE

The Fire Management Plan for the Luambe National Park has been approved for implementation by the Department of National Parks and Wildlife.

Signature…….

Chuma Simukonda DSc
Director
Department of National Parks and Wildlife

Date :……

ACKNOWLEDGEMENT

This Fire Management Plan for Luambe National Park has been made possible due to cooperation from many Institutions, Private Sector, Community Resource Board members, and Traditional leaders. Their invaluable contributions in terms of views and ideas were cardinal to the preparation of the park Fire Management Plan.

The Department of National Parks and Wildlife is particularly indebted to the World Bank and Zambia Integrated Forests Landscape Project for both their financial and technical support rendered to the process of preparing the Fire Management Plan.

LIST OF ACRONYMS

AAR	After Action Report
AW	Area Warden
CBU	Copperbelt University
COMACO	Community Markets for Conservation
CRB	Community Resources Board
CWET	Chipembele Wildlife Educational Trust
DNPW	Department of National Parks and Wildlife
EO	Extension Officer
FMP	Fire Management Plan
FMU	Fire Management Unit
GEF	Global Environmental Facility
GMP	General Management Plan
GPS	Global Positioning System
IFAW	International Fund for Animal Welfare
IRPG	Incident Response Pocket Guide
MODIS	Moderate Resolution and Imaging System
MTA	Ministry of Tourism and Arts
PFMG	Park Fire Management Group
PR	Park Ranger
ER	Ecologist Research
LNP	Lukusuzi National Park
ELAMU	East Luangwa Area Management Unit
SWPO	Senior Wildlife Police Officer
ZAWA	Zambia Wildlife Authority
ZCP	Zambian Carnivore Programme
ZFC	Zambia Forestry College
ZIFLP	Zambia Integrated Forests Landscape Project

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FOREWORD

The Luambe National Park (LNP) Fire Management Plan (FMP) sets the direction and measures to be pursued to address the historical problem of wildfires for the benefit of both nature and people. The focus is to increase the spatial coverage of the area under early burning (i.e. prescribed fires) as this reduces the risk and impact of undesired wildfires, which are more destructive. If left unchecked, late season wildfires will endanger the integrity of the Greater Luangwa Ecosystem and constrain its contribution to national economic development *inter alia* generation of ecosystem services and growth of tourism.

Working in partnership with the Zambia Integrated Forest Landscape Project (ZIFLP) for the Government of the Republic of Zambia, this FMP was formulated to address the challenges of undesired wildfires. It builds on the overall General Management plan for 2021 – 2031. The strategy was developed through a stakeholder consultative process. The stakeholders comprised diverse groups – conservation agencies, research organizations, land owners and managers (public, private and local communities), nature-based enterprise owners and tourism businesses and civil society organizations.

The strategy recognizes that managing wildfires is a complex task particularly due to the different land tenure systems and land uses around the park. Fire management can therefore no longer be considered an exclusive function of state agencies, whether on state or communal conservation lands. This challenge can best be addressed by adopting a stakeholder-based fire management program (SFMP), which is the philosophy adopted in this plan. The SFMP is further supported by the continued low institutional management capacity among public agencies responsible for nature conservation. This approach creates the following benefits:

i. Enhance optimal resource mobilization and utilization and is in line with Government's resource mobilization strategy as outlined in the seventh national development plan (7-NDP), which recognizes the positive contribution of various stakeholders to national development;
ii. Mainstreaming of wildfire management into the country's strategic response to climate change as fire is considered one of the major drivers of climate change;
iii. Mainstreaming of SFMP into the country's National Adaptation Program of Action of 2007 and;
iv. Creating alignment between fire management and sustainable forestry management under the $REDD^{+}$ program as wildfires have been noted to contribute significantly to deforestation, degradation and atmospheric emissions of greenhouse gases and on public health and safety.

This approach and paradigm shift to a SFMP is deemed critical to sustainable wildfire management and subsequently in maintaining the ecosystem integrity and health; promote the country's sustainable forest management; reduce its carbon foot print; strengthen the carbon storage capacity of the landscape and reduce the risk of invasion of the ecosystem by invasive species.

EXECUTIVE SUMMARY

The FMP for LNP, which covers a five-year period (2022 to 2026) was prepared through a pre-field visit and stakeholders' workshop to provide guidance on management of fire in the LNP on a daily, seasonal and annual basis. This is critical as all national parks are required to have FMPs as stipulated by the fire management guidelines for protected areas.

Vision, Goal and Objectives

The FMP has the vision of ''A landscape without uncontrolled wild fires.'' To achieve this vision, the overall goal is ''to maintain the long-term integrity of the wildlife habitats.'' Six objectives under the overall goal have been formulated as provided below;

i. To reduce wildfire incidences and extent (i.e spatial coverage of uncontrolled fires);
ii. To increase the number of persons with appropriate skills and knowledge on fire by 10% annually;
iii. To build strong and functional partnerships for fire management in the LNP;
iv. To increase financial capacity for fire management by 50%;
v. To ensure the availability of minimum fire management equipment in all sectors by 2026;
vi. To conduct fire research and monitoring programmes that feed into park fire management; and
vii. To increase awareness on and participation in fire management of surrounding communities by 2026.

Action Plan

In order to achieve the above objectives, an action plan has been prepared for the LNP FMP encompassing: activities to be undertaken, period of implementation of activities, means of verification and key responsibility persons for the activities.

Fire Management Units

As part of ensuring effectiveness of fire management, the park has been divided into three fire management units (FMUs), which overlay the park management zones contained in the park's general management plan (GMP). For each FMU, details specified include; the current and proposed fire management strategies, vegetation types, current condition and desired condition, firebreaks and facilities available that will play a role in fire management for the park.

Fire Management Strategies and Procedures

The FMP will require implementation of prescribed burning, fire prevention and suppression strategies. Critical to all these strategies will be planning. Hence, the plan provides pre-season and burn planning procedures. Additionally, the plan has also laid out the procedures to be followed in case of decision making, implementing prescribed burning, fire management safety rules, response to unwanted fires and communication during wildfires. As alternatives to prescribed fire, the plan provides for mechanical treatment and fire prevention particularly public awareness.

Fire Management Organisation and Budget

Organisation and budgeting were recognized as cardinal to the implementation of this FMP during its preparation. Therefore, the FMP has proposed the establishment of a Park Fire Management Group (PFMG), which will comprise of DNPW, tour operators, conservation organisations (IFAW and ZCP) and communities to be represented by the Community Resources Boards (CRBs) inorder to involve other stakeholders in fire management. The PFMG will meet periodically in the year to support the implementation of the FMP.

Overall, the implementation of the FMP will require K991, 224.00 (USD45, 055.66) as indicated in the five-year budget.

Communication Plan

A part of the FMP has integrated a communications plan to guide the flow of information between the park and other stakeholders. Though LNP is just operationalizing its radio communication network, the plan has elucidated on aspects of internal VHF radio communication and internet communication. To ensure smooth flow of information, the communication plan has also detailed the key contact persons, medium of information transmission, type of information required and the possible sources of wild fire information.

Fire Research

The FMP reviewed the status of fire research and the need for future research. No fire research has been conducted in the LNP since its establishment implying a general lack of localized information of the impacts of fire on the park biodiversity. Therefore, the FMP has recommended for the need for fire research to be initiated in the LNP.

Monitoring and Evaluation

To keep in tandem with the management plans prepared for DNPW, the FMP provides a section on monitoring and evaluation. There are a number of activities proposed under this section, which include activation of the use of the MODIS active products, aerial surveillance using both aircrafts and drones when finances become available, taking of photo-points and capture of the fire perimeter.

Finally, the FMP will be subject to annual review preferably at the end of the year in order to assess the extent of its implementation. The FMP will adopt an adaptive management approach during its implementation.

DEFINITIONS

Term	Definition
Early Burning	Prescribed burning early in the dry season before the leaves and undergrowth are completely dry or before the leaves are shed carried out as a precaution against more severe fire damage later in the fire season
Early Fire Season	Fires which occur from April to June
Fauna	All the animal life in a particular area
Firebreak	Any natural or constructed discontinuity in a fuel bed utilized to segregate, stop and control the spread of fire or to provide a control line from which to suppress a fire; characterized by complete lack of combustibles down to mineral soil
Fire Ecology	The study of the relationships and interactions between fire, living organisms and the environment
Fire Frequency	The average number of fires or regularly occurring fire events per unit time in a designated area
Fire Intensity	Amount of heat produced by a fire. Usually compared by reference to the length of the flames.
Flora	All plants and parts of the plants in a particular area
Fire Management Plan	A systematic, technological and administrative management process of determining the organisation, facilities, resources and procedures required to protect people, property and forest areas from fire and to use fire to accomplish forest management and other land use objectives
Fire Management Units	Area where there are common fire management goals, objectives and fuels and where resource uses have been defined. FMU relates well to the strategies for managing wildland and prescribed fires that are defined in the FMP
Fire Prevention	All measures in fire management, fuel management, forest management, forest utilization and concerning the land users and the general public, including law enforcement, that may result in the prevention of outbreak of fires or the reduction of fire severity and spread
Fire Suppression	All activities concerned with controlling and extinguishing a fire following its detection (Syn. Fire control, firefighting)
Fuel	All combustible organic material in forests and other vegetation types including grass, branches and weeds
Late Burning	Prescribed burning activities towards the end of the dry season
Late Fire Season	Fires which occur from July to August
Mid Fire Season	Fires which occur from September to November
Prescribed Burning	Controlled application of fire to vegetation in either their natural or modified states, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same

	time to produce the intensity of heat and rate of spread required to attain planned resource management objectives (cf. prescribed fire)
Term	**Definition**
Fire Prevention	All measures in fire management, fuel management, forest management, forest utilization and concerning the land users and the general public, including law enforcement, that may result in the prevention of outbreak of fires or the reduction of fire severity and spread
Wildfires	Any unplanned and uncontrolled wildland fire which regardless of ignition source may require suppression response or other action according to agency policy
Wildlife Habitats	A Place where a species or ecological community naturally occurs
Wildlife	Wild animals or species of birds that are found in Zambia in a wild state and vegetation which is indigenous to Zambia and grows naturally without cultivation

1. INTRODUCTION

1.1 Background

Fire has an important role in the development and maintenance of productive and stable savanna vegetation communities. Fire is recognized as a valuable tool in the management of wildlife habitats in Zambia's Protected Areas. A Fire Management Plan (FMP) for Luambe National Park (LNP) fulfills the key requirement of the Department of National Parks and Wildlife (DNPW) fire policy for each protected area to have a specific FMP. It also provides an opportunity for managing fire in a manner that will enable DNPW to achieve best habitat management practices necessary to minimize damage to the wildlife habitat and the Luangwa ecosystem at large.

The LNP and the greater Luangwa ecosystem are critical to insulating the country against impacts of climate change due to their vast and intact wilderness. The LNP is particularly significant because it:

- Is Strategically located on the central point of other protected areas hence acting as a corridor between South Luangwa, North Luangwa and Lukusuzi National Parks
- Provides habitat for endangered species of birds such as grey crowned cranes, pel fishing owl and bat hawk
- Home to important pre-historic cultural settlements;

1.2 **Problem Statement, Need and Purpose**

Fire is a key driver of habitat change in Miombo and Mopane woodlands that dominate the Luangwa valley. Uncontrolled wild fires contribute to forest degradation in Zambia (Trapnell, 1959; Lawton, 1978; Chidumayo, 2013). Most wild fires that damage forests and woodlands in Zambia are caused by anthropogenic activities. Studies have shown that an average of 188,000 km^2 of Zambia's total land area was burnt annually between 2007 and 2012 and this accounted for approximately 25% of the total area and disproportionately affected protected areas (Sikaundi, 2013; Hollingsworth et al., 2015). The actual damage to biodiversity of these wild fires has not been adequately assessed. However, frequent late fires prevent regeneration of fire-intolerant species and induce changes in species diversity.

Fire frequently disturbs fire sensitive ecosystems and leads to land degradation with undesirable effects on water resources and soil productivity (Le et al., 2014). In Miombo ecosystems, the combination of extensive late burning in the dry season, continued population growth, wood extraction and agricultural expansion have contributed to a dramatic increase in the rate of deforestation and environmental degradation. However, in fire-adapted ecosystems, managed fire plays a positive role in ecosystem health and vitality. Both forest resources and wildlife are impacted negatively by late forest fires.

That is why early dry season burning is recommended as the main strategy to reduce fuel loads for late season wildfires, therefore protecting the ecosystem. Fire management also needs to take into account local ecology and local uses of fire by surrounding stakeholders.

1.3 Description of the Park

1.3.1 Location and size

Luambe National Park is located in Lumezi District of Eastern Province of Zambia. The park lies between **12^{0}23'55.0" to 12^{0}36'29.7"S** and **032^{0}10'19.2" to 032^{0}10'31.6"E**. It is bordered by Munyamadzi Game Management Area (GMA) on the west and Lumimba GMA for the rest of the Park. It covers an area of approximately 254 km^2 (Figure 1).

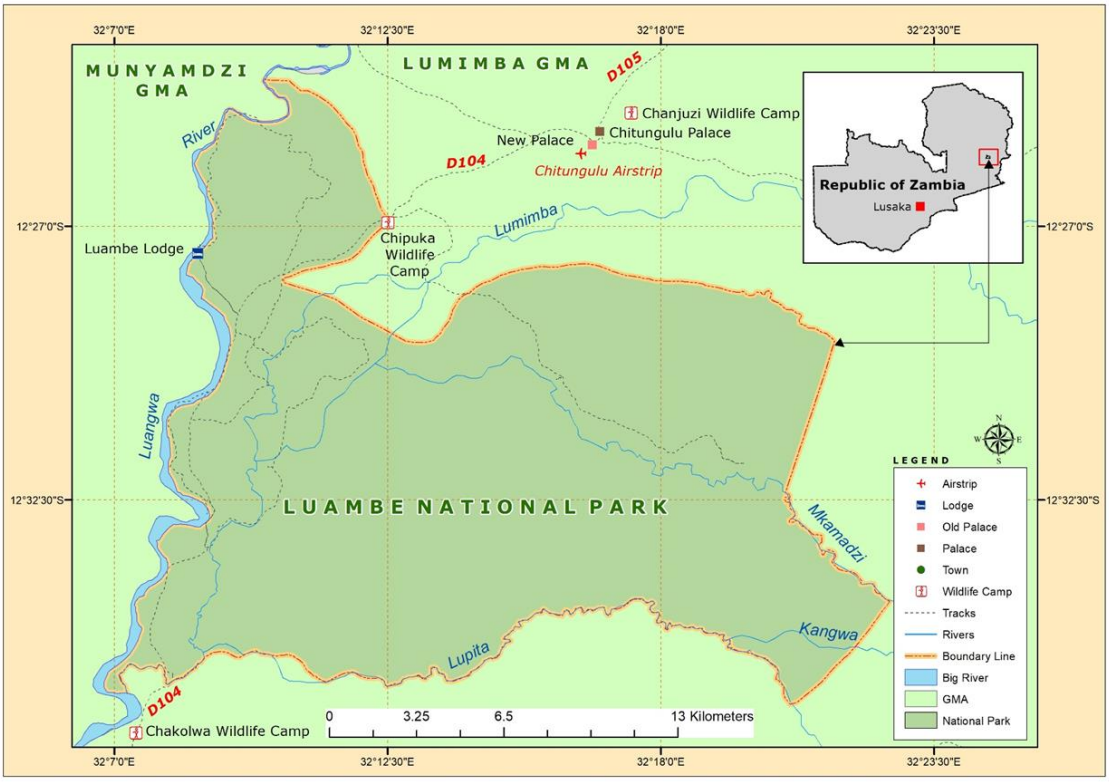

Figure 1**: Location of Luambe National Park**

1.3.2 Climate

Typically, LNP has three seasons as follows; hot rainy season (late November to April), cool dry season (May to August) and hot-dry season (September to early November) (ZAWA, 2014).

LNP generally experiences a hot climate with mean daily maximum temperatures of 32-36^{o}c, while maximum and minimum temperatures are 36^{o}c (October) and 15^{o}c (June-July). The mean annual rainfall is in the range of 400-800 mm, but can reach up to 1000 mm in the north of the valley (ZAWA, 2014).

Fire intensity varies with season (because of differences in fuel moisture) as well as with fuel load. Managers of African savannas can manipulate fire intensity by choosing the season of fire, and further by burning in years with higher or lower fuel loads.

1.3.3 Geology and Soils

Though the Luangwa Valley is similar in origin to the East African Valley System, its age is the same as that of the Zambezi Valley, as it contains Paleozoic and Mesozoic strata and not recent sediments of the rocks that form the dominant strata of the valley floor (ZAWA, 2014).

Soils in the LNP are varied depending on the location. Soils near the confluences of broad levees carry dark-brown clay to loamy alluvial soils that are moderately well drained. The meander belts are mostly flanked by interfluve areas covered by slightly saline and basic soils that are either poorly drained or well drained on sandy soils. Low hills and ridges have reddish-brown fine loams, while the escarpment has shallow loamy soils of variable texture (ZAWA, 2014).

1.3.4 Flora

1.3.4.1 Grasslands

Species composition: Tall grasses in the floodplain belong to species of *Andropogon, Cymbopogon, Hyparrhenia and Hyperthelia*.

Response to fire: Grass regrowth favoured by late fires, which remove moribund grass and damage woody plants. Prescribed fires regularly applied in areas with limited grazing remove old grass growth, while should be withheld in heavy grazing areas (Zieger et.al., 1998).

1.3.4.3 Thickets

Species composition: *Capparis tomentosa, Combretum elaeagnoides* and *C. obovatum* are the principal dominants (ZAWA, 2014).

Response to fire: Thickets have low fuel load and hence prescribed fires or wild fires burn at a very slow rate or get put off due to sparse fuel.

1.3.4.4 Wetlands

Species composition: Common aquatic plants on the lagoon include *Azolla nilotica, A. pinnata, Ceratophyllum dermesum, Ipomoea aquatica, Ludwigia stenorraphe, Marsilea minuta, Neptunia oleracea, Pistia stratoites* and *Trapa natans* (ZAWA, 2014).

Response to fire: Dry wetlands are favoured by the application of late-season fires as grasses are sparse and few woody plants are available. On wet lands with fertile clay soils, plant growth is supported and requires heavy utilization to prevent growth of tall unpalatable grass species. In this type of wetland, the recommendation is to put in early or mid-season fires on a two-year cycle (Zieger et.al., 1998).

1.3.2.5 Miombo woodland

Species composition: mainly comprising of *Brachystegia spp, Julbernardia spp* and *Terminalia spp*.

Response to fire: Annual early to mid-season fires ensure the species composition and structure are maintained for miombo woodland, but repeated late season fires converts the woodland into an open savanna where the grass component dominates the trees (Zieger and Cauldwell 1998).

1.3.2.6 Mopane woodland

Species composition: mainly *Colophosphermum mopane* with associated species belonging to *Kirkia, Terminalia, Adansonia* and *Acacia* genuses.

Response to fire: Trees are favoured by early season fires, but application of late season fires promotes grass growth at the expense of trees

1.3.2.7 Acacia-Combretum Woodlands

Species composition: Species of *Acacia* and *Combretum* dominant the woodland. Common grasses that occur in the woodland include *Andropogon gayanus, A. shirensis, Hyparrhenia cymbaria, H. dichroa, H. filipendula, H. nyassae, H. rufa, Hyperthelia dissoluta*, and *Pennisetum polystachion* (ZAWA., 2014).

Response to fire: Majority of the trees in this type of vegetation have high tolerance to fire and therefore provide a useful buffer to control fires from dambos. A number of firebreaks are set in these woodlands as they are useful firebreaks and offer good game viewing opportunities (Zieger et.al., 1998)

1.3.2.8 Riparian Woodland

Species composition: Evergreen and belong to genus of *Acacia*, *Diospyros, Khaya*, *Kigelia, Tamarindus* and *Trichilia spp*.

Response to fire: Tree growth is promoted with application of early season fires, while mid-season fires damage the smaller woody plants. Woody plants are prone to damage by late season fires (Zieger and Cauldwell 1998).

1.3.5 Fauna

The LNP has an abundance and variety of fauna owing to the combination of diverse topography, mosaic of vegetation, availability of perennial rivers and ox-bow lakes (ZAWA, 2014).

Mammals in LNP include; elephant, giraffe, eland, hippos, buffalo, zebra, waterbuck, roan, bushpig, bushbuck, warthog, kudu, cookson wildebeest, puku, reedbuck, impala, grysbok, oribi and common duiker. The carnivores include; lion, leopard, spotted hyaena, wild dog and the primates sighted are yellow backed baboon, vervet monkey and bush baby (ZAWA, 2014).

The response of mammals to fire varies depending on the species. The sable antelope requires sufficient post-fire regrowth, while roan antelope utilize both immediate post fire regrowth and sufficient post-fire regrowth. Other species like the kudu and eland following the application of dry season fires may avoid burnt areas (Goldammer and Ronde 2004).

Reptiles and amphibians data in relation to fire is limited. Nonetheless, records do exist for crocodile, rock or white throated monitor lizard. Other reptiles include black mamba, puff adder, black-necked spitting cobra and African rock python. Information on response of reptiles and amphibians to fires is limited, but most certain species like the tortoise use evasive strategies to cope, while other species get into crevices, rocks or move on bare patches of ground (Goldammer and Ronde 2004).

Bird life is diverse as well and over 700 species have been recorded in the Luangwa Valley (Carr, 1997; Astle, 1987). Birds known in the park are globally threatened species, biome-restricted species and species of regional conservation concern. Birds respond to immediate occurrence of fires due to provision of food by insects escaping from the fire or their feeding on dead insects after the fire. Certain species can also utilize the burnt areas for breeding purposes. However, the occurrence of fires can impact negatively on ground nesting species as fires can remove their habitat cover and destroy their nesting grounds (Goldammer and Ronde 2004).

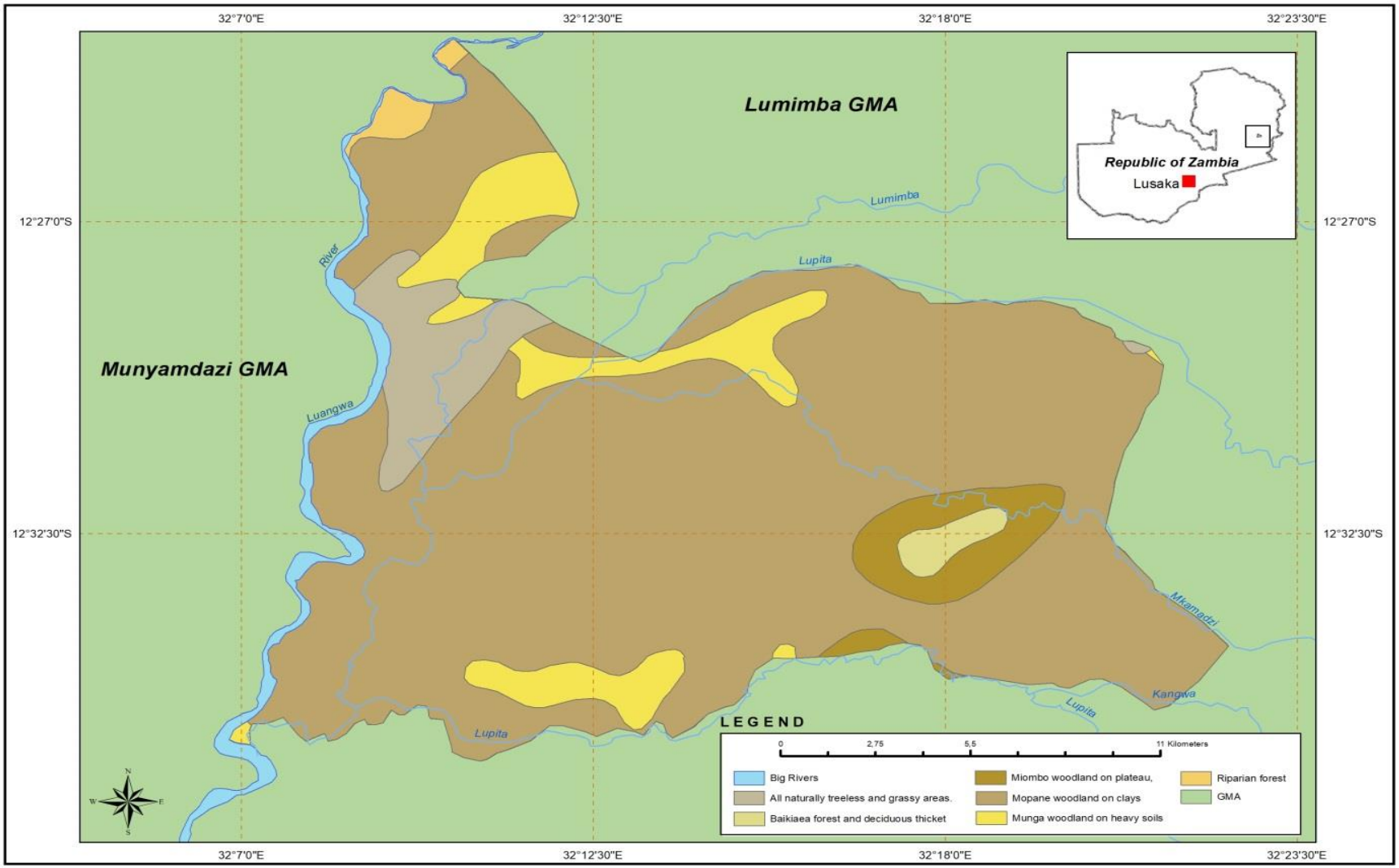

Figure 2: Vegetation types in the Luambe National Park

2 POLICY LEGISLATION ON FIRE MANAGEMENT

A major policy development with regard to fire was the development of the National Fire Policy in 2018. It establishes firefighting as primarily a local government function. The Local Government Act of 2010 and its subsidiary legislation provides for the establishment of fire authorities and mandates Government to make financial grants to relevant local councils for fire services. The act deals mostly with fire as a destructive force in urban settings. The emphasis is on fire and rescue services rather than fire as a management tool for ecosystem management. Nevertheless, the fire policy acknowledges the role of fire in rural and wilderness areas and the need to reduce the incidence of late fires.

2.1 Legislation for Fire Management in Protected Areas

From a natural resource perspective, the following legislation deals with fire and fire management:

The Zambia Wildlife Act (2015) and Forest Act (2015) promote the participation of local communities in fire management in their respective areas. In addition, both acts prohibit the lighting of fires in a forest without requisite permission. The Forest Act makes it mandatory for persons over the age of 18 years to assist with firefighting and rescue, and makes the failure to do so an offence.

The Environmental Management Act of 2011 provides for integrated environmental management and the protection and conservation of the environment as well as the sustainable management and use of natural resources. It further mandates the minister responsible for natural resources, in consultation with the Zambia Environmental Management Agency (ZEMA), to prepare guidelines for the management of fire.

3. FIRE HISTORY

Spatial-temporal fire occurrence in the LNP was reviewed and reconstructed for a ten-year period from 2010 to 2019 using MODIS active fire products.

3.1 Temporal occurrence of fires

During the ten-year period, the trend was that of a decrease in the number of active fires detected. The number of active fires detected ranged between 56 and 82. Fire incidences increased from 2010 reaching the peak in 2016. Incidences declined in 2017 and remained constant in 2018 and 2019. The reason for the highest number of active fires detected in 2016 was not determined, but it might have been due to accumulation of grass fuel and extreme weather conditions.

With the seasonal occurrence of active fires, the mid fire season (July to August) had the highest number of active fires detected in the park. The early fire season (April to June) had the second highest number of detections and the late fire season (September to October) had the lowest number of active fires detected. Since the park lies on the valley floor, the detection of the highest number of active fires in the mid fire season is of concern as most of the vegetation has low moisture content and the weather conditions are associated with strong winds during this season. Furthermore, this park has a dominance of mopane woodlands whose grass fuel loses water rapidly just after the cessation of the rainy season unlike the miombo woodlands (Figures 4 and 5).

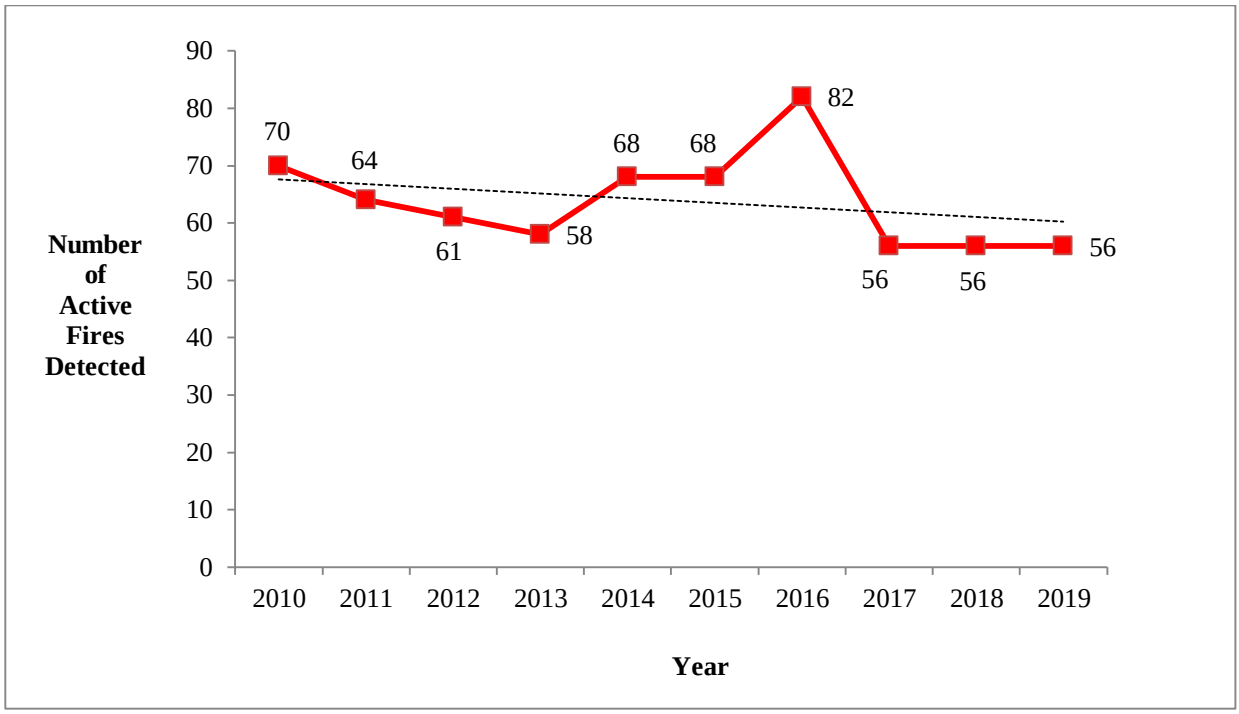

Figure 3 Annual Fire Detection for Luambe National Park - 2010 to 2019

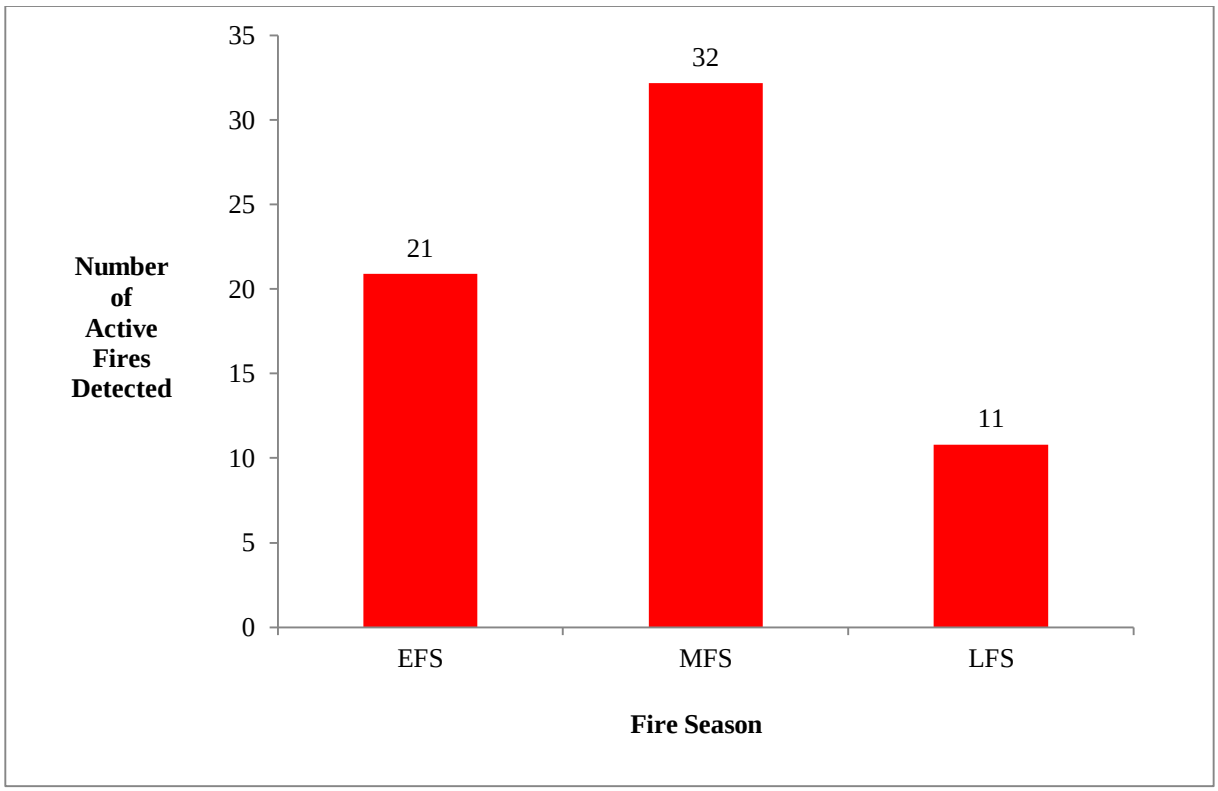

Figure 4: Seasonal Fire Detection for Luambe National Park

As much as possible, the protected area staff encourage early season fires in the LNP. Hence, the late season fires are associated more with illegal activities or cross over of fires from the surrounding communities in preparation for cultivation of fields and planting in the next farming season. Therefore, there is a need to promote interventions in line with fire management objectives that will lead to reduction in the occurrence of mid and late season fires. This is especially important in the case of frequent late season fires, which have the potential to reduce the woodland to coppice and destroy the canopy (Trapnell, 1959).

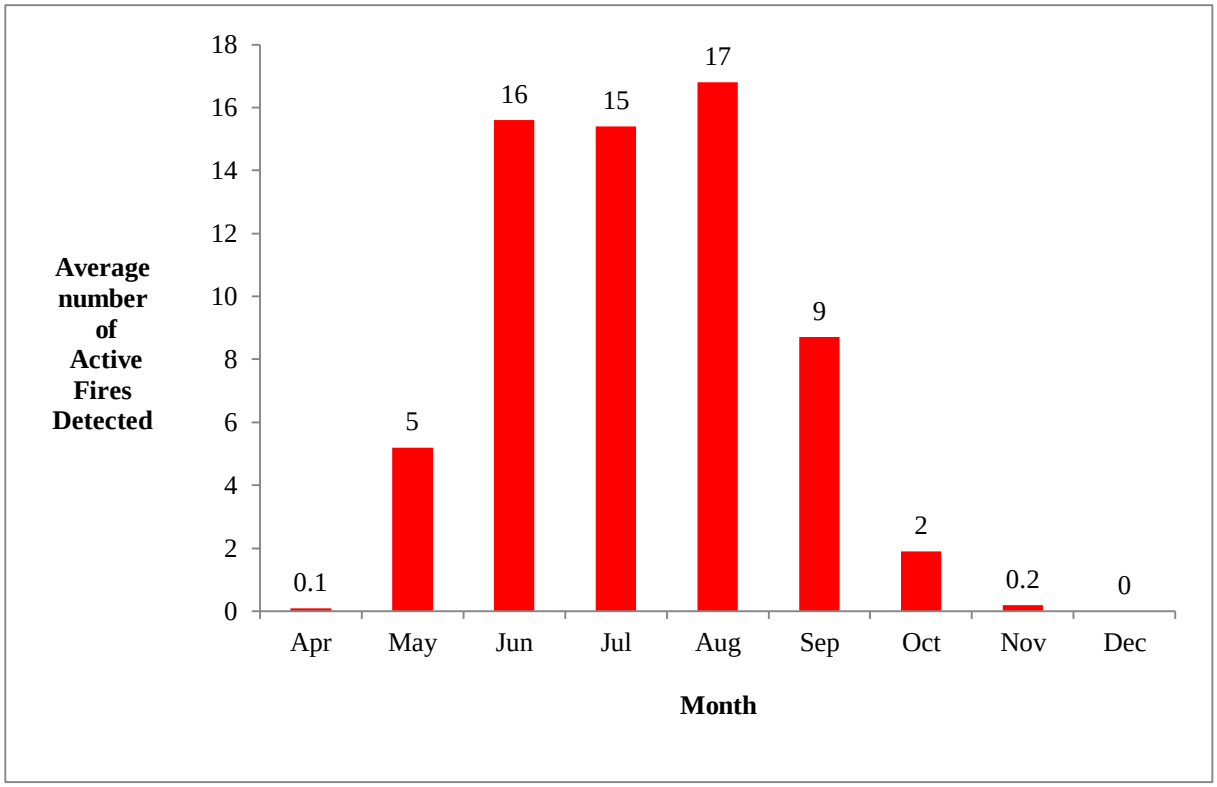

Figure 5: Monthly fire occurrence in Luambe National Park

3.2 Spatial occurrence of fires

Spatially, most of the active fires in LNP were detected between the Lumimba and Lupita Rivers from 2015 to 2017. This might be associated with prescribed early burning by field staff based at Chipuka camp. As the fire season progresses, there were more active fires detected south of the Mkamadzi River due to the gradual drying of the vegetation and increased accessibility in the park. In the late fire seasons of 2015 to 2017, the active fires were mostly detected in the east, south-east and south-west of the park, which might be associated with illegal entrants into the park.

This kind of information will be cardinal for pre-season planning and monitoring of the impact of fire on the biodiversity in the park.

4. FIRE MANAGEMENT VISION, GOALS, OBJECTIVES AND OUTCOMES

4.1 Vision

"A landscape without uncontrolled wildfires."

4.2 Goal

The overall goal for implementation of the fire management programme for the LNP as provided for in the Fire Management Guidelines for Protected Areas in Zambia is ***"to maintain the long term integrity of the wildlife habitats (ZAWA)."*** This would be achieved through a prescribed burning program to reduce fuel load and suppression strategy that would reduce the frequency and intensity of wildfires in the late dry season.

4.3 Objectives

The objectives of this fire management plan are therefore:

a) To reduce wildfire incidences and extent (i.e. spatial coverage of uncontrolled fires);
b) To increase the number of persons with appropriate skills and knowledge on fire by 10% annually;
c) To build strong and functional partnerships for fire management in the LNP;
d) To increase financial capacity for fire management by 50%;
e) To ensure the availability of minimum fire management equipment in all sectors by 2026;
f) To conduct fire research and monitoring programmes that feed into park fire management; and
g) To increase awareness on and participation in fire management of surrounding communities by 2026.

4.4 Outcomes

While prevention of unplanned fires is an important broader strategy, certain key outcomes must be achieved in order to deal with the socio-ecological aspects of fire as well as the organizational capacity within DNPW to deal with fire. This fire management plan therefore envisions four (4) key outcomes as follows:

Outcome 1: Improved landscape resiliency to impacts of late wildfires.
Outcome 2: Improved resource mobilization and utilization of resources for fire management.
Outcome 3: Information generated to feed into fire management decision making improved.
Outcome 4: Effective participation and awareness that contributes to reduced wildfire incidences.

All the above objectives have been integrated as part of the action plan, which also includes details of indicators, activities, period of activity implementation, means of verification, assumptions and responsibilities (Table 1).

Table 1: Action Plan for the Luambe National Park Fire Management Plan

No	Outcome	Management Objective	Indicator	Activities	Period (Year)	Means of verification	Important assumptions	Responsibility
1.	Improved landscape resiliency to impacts of late wildfires.	To reduce wildfire incidences and extent (i.e spatial coverage of wildfire)	Incidences of unplanned wildfires reduces by 10% of previous year	a) Form Park Fire Management Group (PFMG)	First quarter of year 1	• Minutes of inception meeting	• Qualified staff available • External partners willingness to be group members	Area Warden and Ecologist
				b) Prepare annual fire management operational plan c) Present proposed annual fire management operational plan to PFMG	Meetings held quarterly	• Minutes of park fire management committee meeting • Annual operational fire plan	• Availability of members for meetings	Area Warden and Ecologist
				d) Implement annual operational plan for selected blocks	AOP implemented quarterly	• After action report • Fire maps	• Resources available to conduct fire management activities	Ecologist and Park Ranger
				e) Suppress selected unplanned fire incidences	Second to fourth quarter	• Fire incident reports	• Resources available to enable response	Ecologist and Park Ranger
2.	Improved mobilization and utilization of resources for fire management.	To increase the number of persons with appropriate skills and knowledge on fire by 10% annually	Number of officers trained annually	a) Carry out manpower and training needs assessment for fire management	Annually	• Manpower and needs assessment report	• Manpower availability • Qualified trainers available	Ecologist, Human Resources and Management Officer and Park Ranger

No	Outcome	Management Objective	Indicator	Activities	Period (Year)	Means of verification	Important assumptions	Responsibility
2.	Improved mobilization and utilization of resources for fire management	To increase the number of persons with appropriate skills and knowledge on fire management by 10% annually	Number of officers trained annually	b) Conduct annual training of DNPW officers and other stakeholders	Annually in the second quarter	Training reports	• Financial and human resources available	Ecologist
		To build strong and functional partnerships for fire management in the LNP	Number of partnerships for fire management created	a) Identify and approach stakeholders who can contribute to fire management by the end of year 1	First quarter of year 1	• Reports • Concept notes	• Cooperation from stakeholders • Resources secured through concept notes	Area Warden and Ecologist
		To increase financial capacity for fire management by 50%	Number of proposals prepared and submitted Amount of funds allocated to fire management from DNPW and other partners	a) Conduct needs assessment and budgeting b) Identify potential funding sources c) Prepare and submit proposals for funding	On-going	• Financial reports • Proposals	• Cooperation from stakeholders • Funds available internally	Area Warden and Ecologist
		To ensure the availability of minimum fire management equipment in all sectors by 2026	Minimum equipment needs met for two sectors annually (6 beaters, 2 bladder bags and 1 drip torch)	a) Conduct annual equipment inventory and needs assessment	First quarter of every year	• Inventory lists	• Equipment gaps correctly identified	Ecologist and Park Ranger

No	Outcome	Management Objective	Indicator	Activities	Period (Year)	Means of verification	Important assumptions	Responsibility
2.	Improved mobilization and utilization of resources for fire management	To ensure the availability of minimum fire management equipment in all sectors by 2026	Minimum equipment needs met for two sectors annually (6 beaters, 2 bladder bags and 1 drip torch)	b) Carry out periodic maintenance of equipment	Quarterly	• Maintenance reports	• Maintenance kit and skills available	Ecologist
				c)Procure required equipment	Ongoing	• Local purchase order	• Resources available to procure equipment	Procurement Officer and Ecologist
3.	Information generated to feed into fire management decision making improved	To conduct fire research and monitoring programmes that feed into park fire management	Number of fire datasets created and up to date Thresholds of potential concern determined	a)Prepare project proposal to establish long term fire biodiversity research in the park b) Conduct study on knowledge levels and perceptions of stakeholders on fire management	Second quarter of year 1	• Project proposal • Technical Report/peer reviewed article	• Financial and human resources available	Ecologist
				a)Develop fire monitoring protocols b)Implement fire monitoring protocols	Fourth quarter of year 1 On-going from first quarter of year 1	• Fire monitoring protocols • Monitoring reports	• Financial resources available • Financial and human resources available	Ecologist

No	Outcome	Management Objective	Indicator	Activities	Period (Year)	Means of verification	Important assumptions	Responsibility
4.	Effective participation and awareness that contributes to reduced wildfire incidences	To increase awareness on and participation in fire management of surrounding communities by 2026	• Number of stakeholders sensitized • Number of sensitization meetings conducted • Number of fire sensitization materials prepared	a) Identify stakeholders linked to fire ignitions in the LNP b) Prepare fire sensitization materials (signage, posters) c)Hold sensitization meetings with stakeholders	Ongoing annually from first quarter of year 1	• List of identified stakeholders • Fire sensitization materials prepared • Minutes of meetings conducted	• Stakeholders with role in fire management correctly identified • Funds available to prepare sensitization materials • Communities receptive to community meetings	Extension Officer and Ecologist
			• Number of fire signs placed in the park	d) Broadcast fire management information on local radio station e) Prepare and place fire materials in strategic areas of the park and GMA	Ongoing annually from first quarter of year 1	• Signage available and in place	• Skilled manpower to prepare signage available	Extension Officer and Ecologist

5. ZONING FOR FIRE MANAGEMENT

For the purposes of fire management, the LNP will be zoned into three (3) fire management units (FMUs). Zoning for fire management will take into consideration the zones set out in the park's GMP

Zones in the GMP are set up based on the concept of limits of acceptable use. Taken into consideration when setting limits of acceptable use are the; fragility of the ecosystem, infrastructure and activities taking place in an area and future plans for that area. Based on this approach, LNP has been zoned into three zones of Natural Preservation Zone, Tourism Development Zone, and Special Protection Zone (Figure 8).

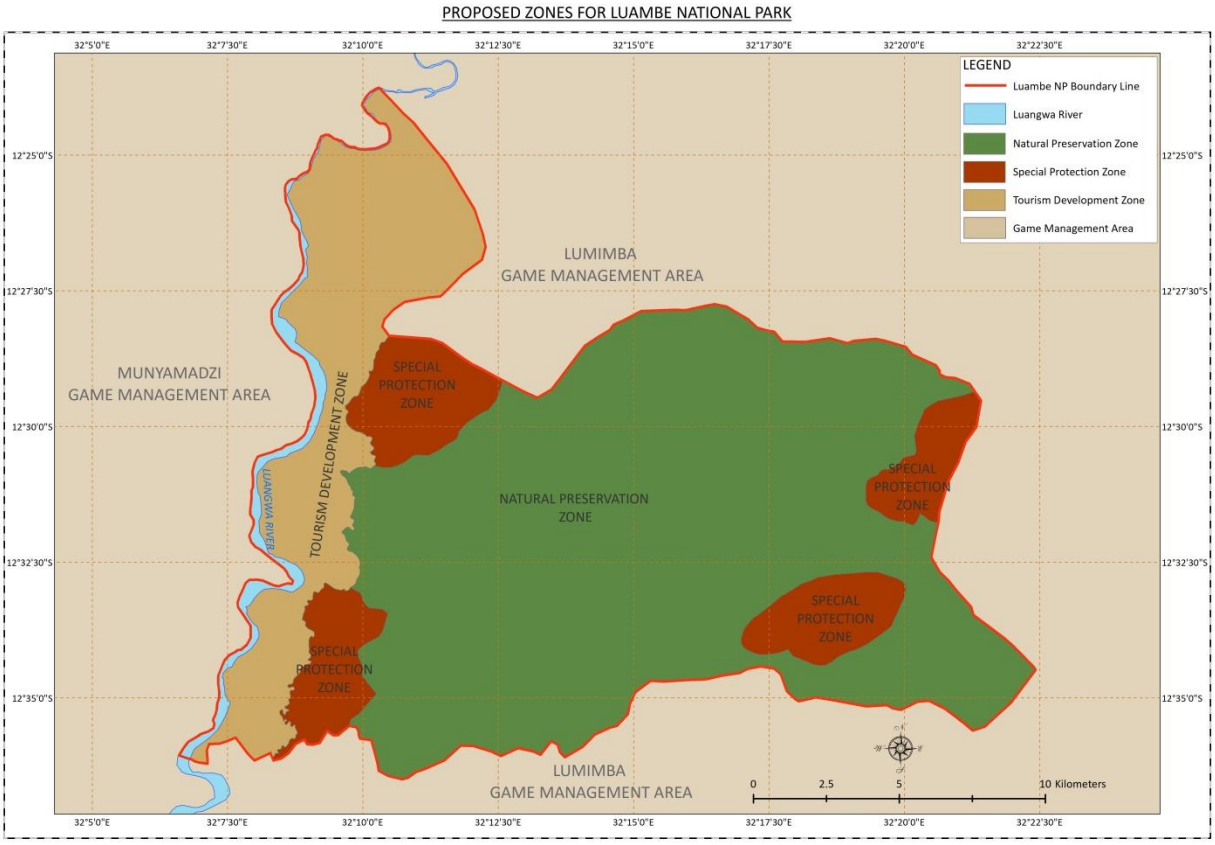

Figure 6: Management Zones in Luambe National Park

5.1 FIRE MANAGEMENT UNITS

5.1.1 Fire Management Unit 1 (Natural Preservation Zone)

5.1.1.1 Description

This zone covers the largest portion of the park. Its boundaries are largely marked by rivers i.e. the Lumimba and Lupita Rivers on the western boundary of the zone, Lupita on the northern and southern portion and partly Kangwa River on the eastern boundary. It is the only zone which comprises of all vegetation types that exist in the Park.

5.1.1.2 Fire Management Strategies

A combination of prescribed fire, fire prevention and wild fire suppression strategies maybe appropriate in this zone. Prescribed fire and fire prevention with resource objectives will be important for the conservation and maintenance of the natural habitats, which support the fauna within the zone.

5.1.1.3 Current Condition and Desired Future Condition

There has been a high frequency of late fires in this zone though the habitats are mostly still intact and have not been degraded. However, there is need to reduce the occurrence of wild fires particularly in the late fire season and ensure that prescribed burning programmes are undertaken during the right season of the year.

5.1.2 Fire Management Unit 2 (Tourism Development Zone)

5.1.2.1 Description

The Tourism Development Zone is located in the western region of the park. The eastern and western boundaries of the zone are marked by the major rivers of the Park and it harbours all the identified cultural resources of the Park.

5.1.2.2 Fire Management Strategies

In this FMU, it is recommended that a suite of prescribed fire, fire prevention and wild fire suppression strategies be implemented. The prescribed fire will play a role in maintenance of the habitats and reduce the associated negative effects of the late fires, which can spoil the visitor experience. An additional advantage of the prescribed fire strategy is that it will also protect tourism facilities from late fires by setting of early season fires that burn at low temperatures and leave burnt and unburnt patches of vegetation. Suppression strategies will also be necessary to reduce loss of the flora and fauna as well as prevent the destruction of tourism facilities. Fire prevention strategies will also play a critical role as law enforcement acts as a deterrent to illegal entrants into the park.

5.1.2.3 Current Condition and Desired Future Condition

In this FMU, there have been limited mid and late season fires. Going forward, there should be no increase in mid and late season fires as a way of promoting forage for wild animals. As much as possible, there should be an application of prescribed early season fires to prevent late season wildfires.

5.1.3 Fire Management Unit 3 (Special Protection Zone)

5.1.3.1 Description

This zone consists of four portions which mainly borders the Natural Preservation Zone. To provide for the preservation and protection of ecologically sensitive areas such as animal corridors, plains, hilly places etc.

5.1.3.2 Fire Management Strategies

In this FMU, both the prescribed fire, fire prevention and suppression strategies have been applicable to all the four zones. However, the prescribed fire has been applied far from the tourism facilities and limited prescribed fires have been applied in the Special Protection Zone.

5.1.3.3 Current condition and desired future condition

Currently, there have been a number of fires in the early fire season particularly in the SPZ in the north-west of LNP. However, in the SPZ on the south-west of the LNP, there has more occurrence of late season fires. The proposal is to have more prescribed early fires as long as it is in line with the fire management objectives.

Table 2: Park zones and proposed fire management strategies for fire management units of the Luambe National Park

Fire Management Unit	Park Zones	Fire Management Strategies
1	• Natural Preservation Zone	• Prescribed fire • Wild fire suppression • Fire prevention
2	• Tourism Development Zone	• Prescribed fire • Wild fire suppression • Fire prevention
3	• Special Protection Zone	• Prescribed fire • Wild fire suppression • Fire prevention

6. FIRE MANAGEMENT PLANNING AND PROCEDURES

6.1 Fire Management Planning

6.1.1 Pre-season Planning

The best time for pre-season planning will be the months of February to March, which coincides with reduced activities in the park due to inaccessibility during the rainy season. Pre-season planning will be initiated in the Research Unit, that will work with the Conservation, Infrastructure and Law Enforcement Units. The pre-season planning will be through an internal meeting that will involve the park management staff from the level of Senior Wildlife Police Officers and above. It would be ideal that pre-season planning be finalized by end of March as in most years there is a marked reduction in the amount of rainfall activities by the end of this month.

The following should be considered during the pre-season planning process;

a) Review the past season prescribed burning program using reports and fire maps (seasonal)
b) Consider the resources required and available for the coming fire season
c) Identify and map the areas/blocks to be affected by prescribed burning in the coming season
d) Consider firebreaks and/or fire blocks that will be vital or be in place in the implementation of the prescribed burning program
e) Identify and communicate to partners/collaborators that might be affected by the prescribed burning program
f) Identify facilities in the areas proposed for prescribed burning
g) Determine points and types of ignition for the upcoming prescribed burning programme
h) Schedule fire refresher training for park staff
i) Develop list of action items addressing the following topics: Specify tasks to be undertaken, responsible officer, start date, extent of completion of task, completion date and comments. Action items might include budget for fire management, preparation of prescribed burn plans and maintenance of equipment. This activity should be undertaken during the pre-season planning process.

A key output of the pre-season planning will be the annual burn plan for the park. During the first meeting of the Park Fire Management Group, the annual burn plan shall need to be presented in order to provide information to other stakeholders.

6.1.2 Burn Plan Writing Process

Preparation of the prescribed burn plan will be part of the pre-season planning process. The burn plans will be prepared for identified blocks were prescribed burning will take place in a particular year by the Research Unit with input from Law Enforcement and Conservation units. In the case of areas with tourism facilities, DNPW shall seek either the participation or input of the tour operators in the preparation of the prescribed burn plans. After review, the prescribed burn plans will be edited and finalized in preparation for implementation at the required time. The process of writing the burn plan will need to consider the following aspects:

Table 3: Inputs of the prescribed burn plan writing process

Prescribed Burn Plan Summary (Ronde., et.al 2004)	Detail of content
a) Purpose and objectives	• Reason for fire prescription
b) Burn Plan Map	• Map of the block or unit
c) Equipment and Personnel	• List of equipment and manpower
d) Fire Prescription	• Species composition • Weather conditions
e) Estimated Number of days for prescribed burning	• Season of the year to burn
f) Time of Day	• Standard work day • Knowledge of local weather • Reliability of weather forecast
g) Firing Plan	• Narrative section • Detailed map
h) Escaped-Fire Plan	• Potential fire escape and actions to take (LCES) • Contingency resources
i) Safety/Emergency Plan	• Safety guidelines (IRPG) • After action review (Formal)
j) Control and Mop-up	• Safeguards to contain fire depending on area
k) Evaluation	• Records of actual weather conditions, fire behavior, effects of fire on the environment

6.2 Fire Management Procedures

6.2.1 Decision Making for Fire Management

Percentage of area to be burned annually will be determined by the amount of seasonal rainfall and biomass availability. Criterion for burning will also include risk assessments of people and property interacting with that part of the system.

- Risk assessment which includes biomass assessment and risk to human life
- Whether the vegetation is dry at that time (extent of curing)
- Fire return interval for each vegetation type
- Range condition especially in years of low rainfall

6.2.2 Implementing Prescribed Fire

The commencement of the prescribed burning programme will be determined by the extent of fuel curing after the cessation of the rainy season based on field assessments by field officers. Once, it

has been confirmed that prescribed burning can start; the following procedure will need to be followed;

a) All necessary equipment should be in a working order and organized a day before the prescribed burning programme
b) Weather forecast conditions should be obtained from the nearest Zambian Meteorological Department in this case, Mfuwe International Airport
c) The team should periodically record and monitor weather conditions using the kestrel at 2 to 3 hour intervals throughout the burning period
d) The team implementing the prescribed burning process should be given the procedure on prescribed burning of the area
e) Test burning should be carried out before firing
f) Operators and other stakeholders should be informed about the prescribed burning programme before its commencement if facilities are within the burn block
g) Communication should readily be available to enable information dissemination in case of the prescribed fire becoming a wild fire
h) The location of all prescribed fires ignited should be recorded using a GPS

6.2.3 Fire Management Safety Rules

Implementation of the fire management plan will need consideration of rules that ensure that risks to officers, property, tourists and individuals from photographic tourism facilities are reduced or kept to a minimum. In any fire situation, human life will be placed as a top priority above property and equipment. The implementation of safety rules will require that notification of prescribed burning be provided to the local communities that transit through the park and the photographic tour operators. Other users of the park will be informed on a case by case basis.

The Ten Standard Fire Orders, Eighteen Watch Out Situations and LCES (Lookouts, Communications, Escape Routes, and Safety Zones) provide the safety rules for the fire management program. The ten fire orders and eighteen Watch Out Situations that have been in use in other countries and will be in use in Zambia are as follows;

a) Keep informed on fire weather all the time
b) Know what your fire is doing at all times
c) Base all actions on current and expected behavior of the fire
d) Identify escape routes and safety zones, and make them known
e) Post lookouts when there is possible danger
f) Be alert, Keep calm and Think clearly, Act decisively
g) Maintain prompt communications with your forces, your supervisor and adjoining forces
h) Give clear instructions and insure that they are understood
i) Maintain control of your forces at all times
j) Fight fire aggressively, having provided for safety first

6.2.4 Responding to Unwanted Fires

Unwanted fires (wild fires) will continue to occur in a protected area like the LNP despite all efforts by management as it is a vast park. The wild fires are potentially attributed to illegal incursions and carelessness by travelers or users of the park. Due to competing demands as a result of limited manpower levels and financial resources, it has and will not be possible to respond to all wild fires.

Moving forward, there is need to put in place guidelines that will assist in determining, which fires park management should respond to as well as the procedures to be followed in responding to wild fires. Unwanted fires can affect the species composition of flora and deplete the food available for fauna and hence unwanted fires should be managed to benefit the resources of the park. Currently, the manpower levels are low in the park and it is proposed that a combined team of officers from the research and law enforcement sections should always be on stand-by especially from the last month (August) of the mid fire season to the last month (October) of the late fire season. A minimum of seven officers including the driver is recommended for this particular scenario. However, if funds will be available, it may be good to consider the hire of casual workers from the surrounding communities to assist with fire suppression.

The following should be considered when responding to a wildfire in the LNP;

a) Any unwanted fire report should be properly documented and information should be transmitted to the research and law enforcement units
b) The park team should try as much as possible to determine the exact location of the fire and assess the resources at risk from the unwanted fire and determine if it is an unwanted fire that should be responded to
c) The team should always suppress fires that occur in critical habitats of the park
d) The team should consider the weather conditions of the day and determine if it is the right time of the day after considering the resources at risk (fires in the daylight during the hot dry season in the valley are very difficult to control and there is potential for someone to be scorched)
e) The stand-by team should be informed as soon as a decision has been made that there is need to respond to the unwanted fire
f) The stand-by team should be dispatched with all necessary equipment and food resources
g) Safety of the officers involved in fighting the wild fire should not be compromised and should be top priority
h) The team should assess the situation once at the site of the unwanted fire (wild fire) and decide on how best to fight the fire
i) A mop-up operation should be conducted once the fire has been put off (controlled)
j) The team leader should inform the Area Warden once the fire has been put off in the park

6.2.5 Communication during Wildfires

Flow of information during wild fires will be important as it can save lives and property. The communication will mainly revolve around the park management office, field officers fighting the

wild fire and any stakeholders in the park that might be affected by the fire. The following will need to be communicated during wild fires;

a) Area of the park where the wild fire is burning
b) Property which might be at risk due to the wild fire
c) Manpower available to fight the wild fire
d) Equipment available to fight the wild fire
e) Appropriate time to fight the wild fire
f) Weather conditions
g) Firebreaks that might assist to fight the wild fire
h) Direction in which the wild fire is likely to go

The team battling the wild fire will be able to communicate with the park headquarters using the radio handsets and cellphones, while exchange of information between DNPW and other stakeholders might have to be using the internet, mobile phones and the base radio.

6.2.6 Best Management Practices for Fire Management

The implementation of the fire management plan will ensure the application of the best management practices in order to reduce potential negative impacts from fire management. A number of management practices, which have been applied in other protected areas will also be considered for application in the LNP. Table 6 below outlines a number of best management practices for fire management (Daigneault 2014).

Table 4: Best management practices for fire management in the Luambe National Park

Activity	Best Management Practice
1. Prescribed burning	• Carry out the prescribed burn with trained team • Avoid prescribed burning on steep slopes with high erosion potential or high erodible soils • Avoid intense burning which might expose mineral soil • In wetlands, organic matter should not be completely consumed • Consider the weather, time of year and fuel conditions
2. Firebreak/Fireline construction	• Natural barriers should be used as firelines/firebreaks in areas where artificial construction would result in excessive erosion and sedimentation • Firebreaks/firelines should not be placed in sensitive habitats like wetlands, dambos, lagoons unless it is absolutely necessary • Construct firelines/firebreaks in a way that reduces erosion and sedimentation and prevents runoff directly entering watercourses • Firebreaks should not be constructed straight up and down hill but on the contour • Hand tools should be used when linking firebreaks into stream channels

6.2.7 After Action Review Process

Fire management activities will be subjected to review immediately after they are undertaken in order to improve future decision making for fire management. The review will focus on activities such as prescribed early burning and wild fire suppression. Part of the review process will require documentation of recommendations from the field staff involved in implementation of the fire management programs when they report back to the Ecologist and Park Ranger.

The following aspects should be considered during the review process;

a) The effectiveness of ignition and extent of burning
b) Any challenges encountered during prescribed burning or wild fire suppression
c) State of equipment after each event

d) Areas for improvement in the next year

The following questions might be part of the AAR, which should be limited to 30 minutes:

- What was planned?
- What actually happened?
- Why did it happen?
- What can we do better next time?

7. ALTERNATIVES TO PRESCRIBED FIRE

7.1 Mechanical Treatment

Slashing or mowing of grass particularly around tourism and park management facilities is an option that has been and will continue to be of use in the park. The advantage of slashing and mowing is that it reduces the amount of fuel and hence reduces the danger of large conflagrations of wild fires during the mid or late fire seasons. This activity should be undertaken in the early fire season before the commencement of the early burning programme and continue during the mid-fire season.

7.2 Fire Prevention

The prevention of fire in the LNP will require a combination of activities. Some of the activities that have proven successful in other areas include law enforcement, public awareness and reduction of fire risks. With the exception of law enforcement, the other two activities have been implemented on a minor scale. The challenge however with law enforcement has been the low number of law enforcement staff available to carry out patrols in the park. The following approaches will therefore be taken into consideration when implementing the two activities that have not been part of fire prevention in the LNP;

7.3 Public awareness

7.3.1 Current Status of Public Awareness

There a limited number of public awareness programmes being implemented close to the LNP in the Chiefdoms of Lumimba GMA by COMACO. These programmes have mostly focused on wildlife conservation awareness with limited emphasis on fire management. A public awareness programme that explicitly deals with fire will therefore need to be developed and taken to the right audience.

The development of the public awareness programme will need to cover a number of topics that can assist in reducing the potential of wild fires entering the park from the communities and also discourage other park users from intentionally or accidentally lighting fires in the park. Topics that can be covered in the public awareness programme include; prescribed burning, causes of wild fires, reporting of fires, fire use by communities, protection of facilities and human life etc.

7.3.2 Target audience

The target audience may be identified by their potential to be a source of wild fires in the park. Wildfires ignited by communities in the Lumimba GMA are likely to enter into the park in areas where there are no natural or manmade firebreaks. However, the wildfires ignited by communities residing on the west of the LNP cannot enter the park due to the Luangwa River. Not to be forgotten are the communities, which frequently transcends the LNP. Apart from the surrounding communities in the buffer areas of the park, it is important to include the lodge workers who spend almost six months in the park and can also be a source of wild fires.

7.3.3 Dissemination of Public Awareness Information

The information on fire management will have to be communicated through community meetings, radio programmes on community radio stations, leaflets, posters, notice boards and sign posts. In developing these materials, DNPW can work closely with other Conservation organisations like Chipembele Wildlife Educational Trust (CWET) and COMACO that have experience in conducting environmental education and preparing materials for dissemination.

7.4 Reduction of fire risk

The unplanned occurrence of fires should also be reduced by managing the fire risk. There are a number of options available to reduce fire risk and these include;

a) Operations with potential to result in wild fires should include firefighting equipment on their list i.e. fire beaters
b) Designated camping sites in the LNP should provide a secure place for cooking
c) Any burning should be conducted during the appropriate time of the day

8. FIRE MANAGEMENT FACILITIES AND EQUIPMENT

8.1 Facilities

The facilities available to assist with fire management in the LNP are limited. Amongst the facilities, which might play a critical role is the Luambe Lodge, which has water from a borehole and water tank. There are two park gates, the Chipuka and Chakolwa, but both have treadle water pumps for use by the officers. For communication purposes, there are radios at the two entry gates, which if enhanced will assist in communication during fire management.

8.2 Equipment and Supply Needs List

In order for the implementation of the fire management plan to be successful, the Department will need to procure equipment that is affordable, easy to use and maintain by its staff. Currently, the park has no fire equipment in stock. Recommended equipment include: fire beaters, backpack pumps, vehicles, tractor, tow grader, motorized grader and water bowser. Though basic and simple, match sticks have been very useful in starting prescribed fires within the park. Appendix III lists the current and required basic equipment for park fire management.

8.3 Firebreaks

Currently, there are no designated firebreaks in the LNP. However, there are a number of game viewing loops and management roads, which will be vital in the management of wild fires during the prescribed burning and fire suppression. The west side of the park has a natural firebreak, the Luangwa River.

Hence, it is recommended that firebreaks be designated in the LNP. However, when setting up the unnatural firebreak system in the park, the following features will need to be considered;

i) The research, workshop, conservation and law enforcement units should work together to identify the firebreaks to be maintained based on funding availability
ii) Ideally, firebreaks should be 15 m in width, but were not possible burning on the side maybe the option
iii) DNPW should identify as to which loops the lodges will assist in grading
iv) Funding and weather conditions permitting, all physical firebreaks should be in place before the commencement of the prescribed early burning season
v) Lodges should continue to put in place firebreaks around their facilities to avoid potential damage to their property

9. FIRE MANAGEMENT ORGANIZATION AND BUDGET

9.1 Fire Management Organisation

9.1.1 Formation of Fire Park Management Group

To enhance participation of other stakeholders in fire management for the park, there is need to form a park fire management group (PFMG) with defined responsibilities linked to fire. This group should comprise of the DNPW, representatives of the tour operators, conservation organisations and communities contiguous to the national park (Figure 11). The Area Warden will chair the group and coordinate communication with all members of the group. The Ecologist will assume lead responsibility for implementation of the fire management programme for the park and will collaborate with the Park Ranger-Law enforcement, who supervises the Senior Wildlife Police Officers that lead patrol groups, the Park Ranger infrastructure responsible for infrastructure and the Conservation Officer. Support will also be provided by the other units of the Department like Accounts, Infrastructure and Workshop on a need by need basis.

The group should meet and at least hold one meeting in a year with the first being the pre-season planning meeting in March, the second in June/July to review the implementation progress of the approved annual fire management programme and the last one in November/December to review implementation of the annual fire management programme.

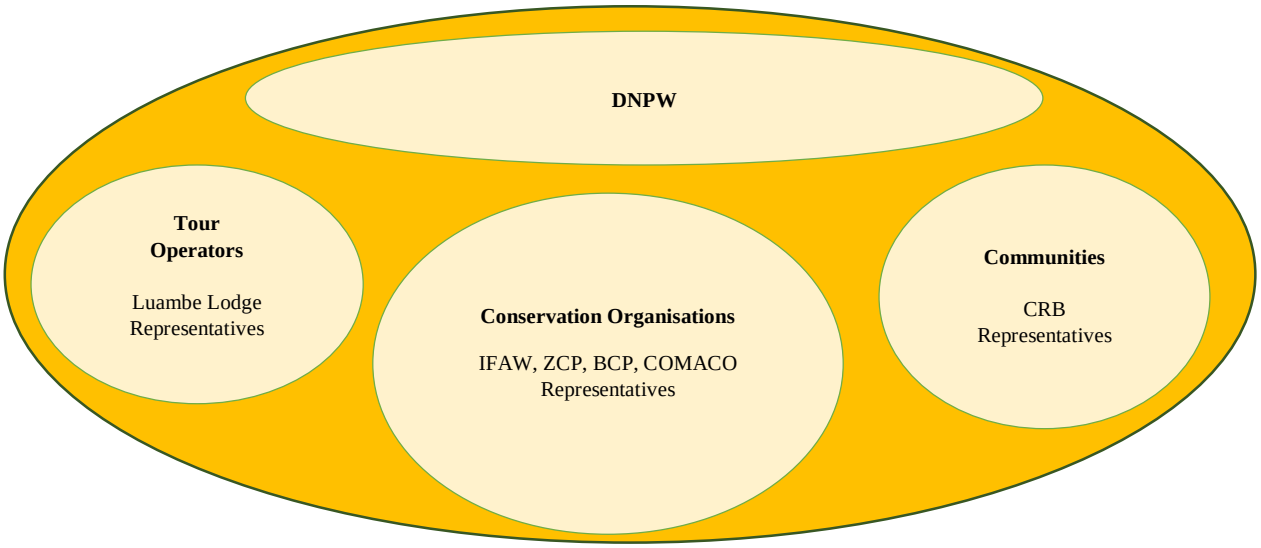

Figure 7: Composition of the Fire Management Group for the Luambe National Park

9.1.2 Training

Ideally, there is need for training in fire management of all field staff so that they have a better understanding of fire management. In the short term, priority should be given to officers that spend most of their time in the field or officers who are most likely to be involved in fire management.

Currently, DNPW has incorporated fire management training as part of the training for all trainee Wildlife Police Officers. To bring all the officers at the same level, there will be need to conduct fire training at the beginning of every fire season if resources permit. Additionally, other institutions like the Copperbelt University (CBU) and Zambia Forestry College (ZFC) hold short training courses in fire management and it would be worthwhile for DNPW to take advantage of such opportunities for the sake of exposing field staff to current developments in fire management.

Apart from fire management, there is need for the officers to receive training in first aid as well. Being recipients of first aid training will not only assist them during fire management, but during other field operations in the park.

9.1.3 Collaborative Partners

A number of partners are operating in the park with interests in the photographic, conservation and research areas. Currently, certain tourism operators particularly in the central section of the park are involved in active fire management with DNPW. The partners also assist in relaying information on the occurrence of unplanned fires in the park especially in the dry season when there is a potential threat to their property and when it burns in their game viewing area. However, there is a possibility for enhanced collaboration with the various partners of the park by incorporating them on the PFMG (Figure 11). The current partners operating in and around the park that might be of assistance in the implementation of the fire management plan are listed in table 5.

Table 5: Collaborative partners operating inside and outside the Luambe National Park that can or play a role in fire management

Consumptive Tourism Operators	Non-Consumptive Tourism Operators	Conservation and Research Operators	Government Departments
• Nyaminga outfitter • Chanjuzi outfitter • Mwanya outfitter	• Luambe Lodge	• IFAW • Zambian Carnivore Programme • COMACO • Biocarbon Partners	• Zambia Meteorological Department • Forestry Department • Lumezi District council • Ministry of Agriculture

9.2 Budget

The Zambian Government through the DNPW provides the funds for the fire management programme in LNP. Funds for the implementation of the fire management programme do not fall under a single budget line as various units have the potential to contribute to fire management in the park. However, it may be necessary to source for funds for fire research, public awareness programmes and other activities as it will be beyond the current limited annual operational budget for fire management. The total projected cost for the implementation of the LNP fire management plan for five-years amounts to **K991, 224.00 (USD45, 055.64).**

Details of the budget to support full operationalization of this plan is in appendix VI.

10. COMMUNICATIONS PLAN

Communication will continue to be maintained through the existing and established system within DNPW and with its external partners. Regular communication will mainly be through cell phones, internet and VHF radio network. The current channels of communication are highlighted in the annual operational plan for the LNP and below;

a) Internal VHF radio communication: DNPW has an established radio communication system in place though the entire park is not covered due to limited coverage. There are limited radios for the patrol teams, which have been part of the fire programmes in the park. In any case, the field teams will continue to make use of the available radios to communicate with the park HQs when implementing prescribed burning and putting off wild fires in the park.
b) External VHF radio communication: DNPW has no established radio network with the only available tour operator, Luambe Lodge to enable communication. It would be good to consider having a channel as this option would enable for easy flow of information between the park gates and the tour operators taking all factors into perspective. This channel will be one option to relay information on wild fires within the park from the lodges to DNPW.
c) Internet communication: Lodges normally have wireless internet facilities for communication purposes and therefore maintain regular direct contact with DNPW. When working, this means of communication will provide a quick approach to report and get back ground information on wild fires in the park.

Table 6: Communication protocol for fire management in the Luambe National Park

Source of wildfire information	Organisation recipient of wildfire information	Contact person	Media of information transmission	Contact information	Type of information
Luambe Lodge Chanjuzi outfitter Nyaminga outfitter	DNPW	Ecologist	Phone	TBA	• Wildfire location (Descriptive) • Property at risk (Descriptive) • Direction of wildfire (Descriptive)
			Email	TBA	
		Ranger	Phone	TBA	
			Email	TBA	
		SWPO	Phone	TBA	
			Email	TBA	
			Email	TBA	
		DNPW radio operator	Radio	TBA	
			Phone	TBA	
		Duty Officers	Direct contact	Main gate	
			Phone	Chipuka gate	
		Duty Officers	Direct contact	Chakolwa gate	
			Radio	Chanjuzi gate	
DNPW field officers	DNPW	DNPW radio operator		DNPW base radio	• Wildfire location (Coordinates) • Fire behaviour (ground, surface, crown, rate of spread, direction) • Weather conditions (Temperature,
Tourists	DNPW entry/exit gates			Chakolwa	• Wildfire location (Descriptive)
				Chipuka	

11. FIRE RESEARCH

11.1 Current Status of Fire Research

Currently there is no on-going long or short-term research on fire and its impact on biodiversity within the LNP. Most of the information that guides fire management in the LNP is based on information that has been generated on fire ecology in either other parts of Zambia or other countries.

11.2 Need for Fire Research

Better decisions on fire management will require generation of information through research on fire and biodiversity within the LNP. The establishment of a long-term fire ecology or fire research programme will be important especially with evolving climate change issues globally. The department will need to prepare a detailed proposal and source for funding for the initiation of research on fire and its impacts on biodiversity in order to generate information. As manpower levels are currently low in the Research Unit and a project of this size will require extra manpower, DNPW should make use of either undergraduate students or postgraduate students to collect data and use it for their final year thesis report. Alternatively, the DNPW can utilize individuals who were once attached to DNPW as students to work as interns to undertake the research work under the supervision of its fulltime Research Ecologists. Furthermore, this will provide an opportunity for all DNPW ecologists to participate on a single project, which will build up their experience and enable them to publish peer-reviewed work that will aid management decisions.

12. MONITORING AND EVALUATION

Monitoring and evaluation will be a cardinal aspect as it will enable park management to determine whether the fire management strategies are contributing towards the achievement of the fire management objectives. A number of monitoring approaches will be put in place.

The following are proposed as part of the monitoring program for fire management in the LNP;

12.1 Fire Data Collection

12.1.1 MODIS web fire mapper

The University of Maryland provides data on active fires detected using the terra and aqua satellites in protected areas every 24 hours to subscribers. To make use of this data source, an officer should be assigned to download and store the data from MODIS on a daily basis. Wild fires that will be detected from the MODIS platform will be checked and depending on the location be suppressed by park management. The MODIS data will be used to prepare fire maps monthly, quarterly and annually as a way of monitoring the spatial and temporal occurrence of fires in the park. Furthermore, the fire maps will provide an input into the pre-season planning activity.

12.1.2 Aerial Surveillance

As the park is vast and causes of certain fires are unknown at the time of detection by either MODIS web fire mapper or by other sources, it will be necessary to check these fires using an aircraft. This will particularly be important when the detected fires have not been started by park management or when the source of ignition is unknown. Currently, the airstrip in Chanjuzi hunting block is the nearest to the LNP though there is no aircraft or arrangement with any conservation partners to monitor the park. If and when, an aircraft will become available, there will be need to integrate verification of reported detected fires by MODIS in its flight plan. In future, when resources are available, the park can consider the procurement and use of unmanned aerial vehicles (UAVs) in monitoring of both wild and prescribed fires.

12.1.3 Photo-points

Photo-points are a useful approach to monitor the impacts of wild fires and prescribed fires in a protected area. There will therefore be need to establish points in selected sections of the park were photos can be taken periodically and then stored for future reference. The photo-points will be integrated in the fire-biodiversity research programme of the park, where experimental plots will be photographed in order to assess their response to different fire regimes that will be applied on them.

12.1.4 Capture Fire Perimeter

The methodology to capture the perimeter of a fire will vary depending on the extent of the burnt area. Small fires can easily be captured using a hand held GPS unlike large fires, which require satellite imagery or an aircraft to fly over the area affected by the fire. Considering the prescribed burning approach were fires are ignited and allowed to burn, it might be difficult for officers to follow the perimeter of a previous fire. Large fires in the LNP will therefore be captured using the MODIS burnt area product, which is available from the University of Maryland and allows mapping of the extent of fires in large protected areas.

12.2 Adaptive Management Strategy

The implementation of the fire management plan will make use of the adaptive management strategy. This will involve management intervention as a tool to strategically probe functioning of an ecosystem, both to change the system and to learn about the system (Wilgen., 2011). In this particular case, fire will be the management intervention. A cardinal aspect of the adaptive management strategy will be the monitoring of the effects of fire on the biodiversity of the park over time. As time passes with the implementation of the fire management plan, adjustments will be made accordingly in response to observations in the park.

12.3 Annual Fire Management Plan Review

The review of the FMP will be conducted annually to ensure that activities are being carried out as planned. Review of the FMP will be conducted in November as tourism activities would have declined and most tour operators will be available.

REFERENCES

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5. Gregoire, J, M and Simonetti, D. 2010. Inter-annual Changes of Fire Activity in the Protected Areas of the SUN Network and Other Parks and Reserves of the West and Central Africa Region Derived from MODIS Observations. Remote Sens. 2010, 2, 446-463
6. Goldammer, G and Cornelis de, R. 2004. Wildland Fire Management Handbook for Sub-Sahara Africa. Global Fire Monitoring Center
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9. Pricope, G, N and Binford,W, M . 2012. A spatio-temporal analysis of fire recurrence and extent for semi-arid savanna ecosystems in southern Africa using moderate-resolution satellite imagery.
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Appendix I: Template for Prescribed Burn Plan

Province:	
District:	
NP/GMA:	
Fire Management Unit:	
Fire Block:	
Chiefdom:	
Closest Village:	
GPS Coordinates Location	Eastings: (1) (2)
	Northings: (1) (2)

PRESCRIBED BURN OBJECTIVE: range management, brush reduction, training, research etc.…

_____
_____
_____
_____
_____

SITE DESCRIPTION (i.e vegetation, topography, elevation)

_____
_____
_____
_____
_____

REQUIRED NOTIFICATIONS:

Title	Name	Contact Information	Date Contacted
Lodge			
Lodge			
Lodge			
Lodge			
Wildlife outpost			
Chief:			
Nearest Community:			
Area Councilor:			
Other:			
Other:			

FUEL AND WEATHER PRESCRIPTION:

Weather Parameters	Minimum	Desired	Maximum
Air Temperature (ºC)			
Relative Humidity (%)			
Wind Speed (kph)			

EQUIPMENT & PERSONNEL:

Item	Quantity	Source
Weather kit		
First Aid Kit		
Water		
Food		
Axe		
Slasher		
Hoe		
Machete		
Beaters		
Flappers		
Protective Clothing		
Personnel		

FIRE IMPLEMENTATION PLAN:

Burn boss: _____

Firebreak preparations: _____

_____

Safety zones and escape routes identified: _____

_____

Map attachments: estimated area to be burned, directions, location of control lines.

_____

CONTINGENCY PLAN:

_____

_____

POST FIRE MANAGEMENT PLAN:

How long will the site be rested:	
Dates and times to be visited:	

Notes:_____

_____

_____

_____

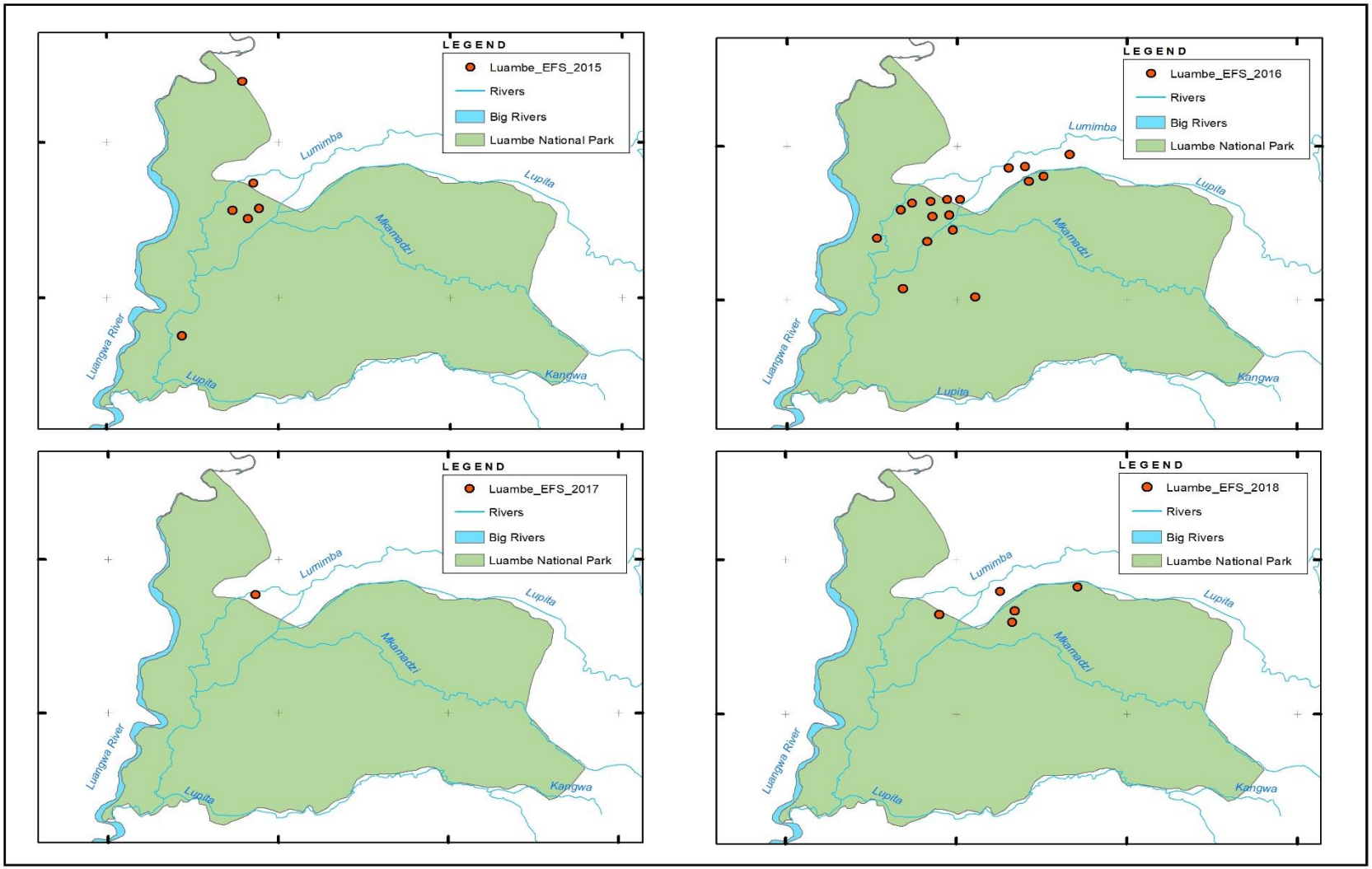
_____

Appendix II: Current and proposed numbers of various equipment*

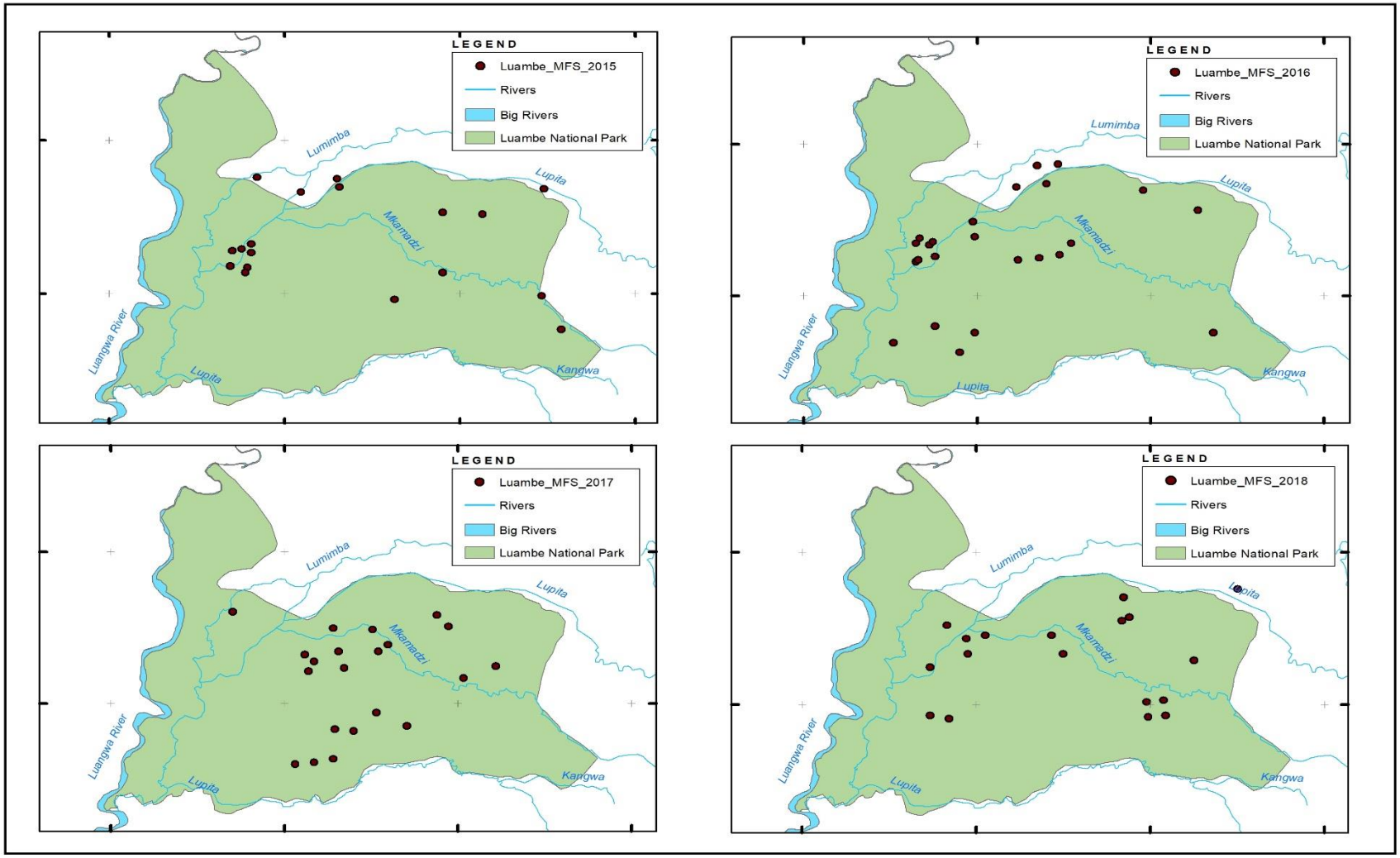
No	Equipment	Current	Required	Additional number required
1	Fire beaters	0	20	20
2	Kestrel	0	3	3
3	Vehicle	0	1	1
4	Drip torches	0	3	3
5	Googles	0	20	20
6	Gloves	0	20	20
7	Weather Station*	0	1	1
8	Tractor*	0	2	2
9	Water bowser*	2	2	2
10	Radio communication	1	3	2
11	Tow grader*	0	1	1
12	Motorised grader*	0	1	1
13	Front end loader*	0	1	1
14	Bladder bags	0	6	6

*Luambe National Park General Management Plan

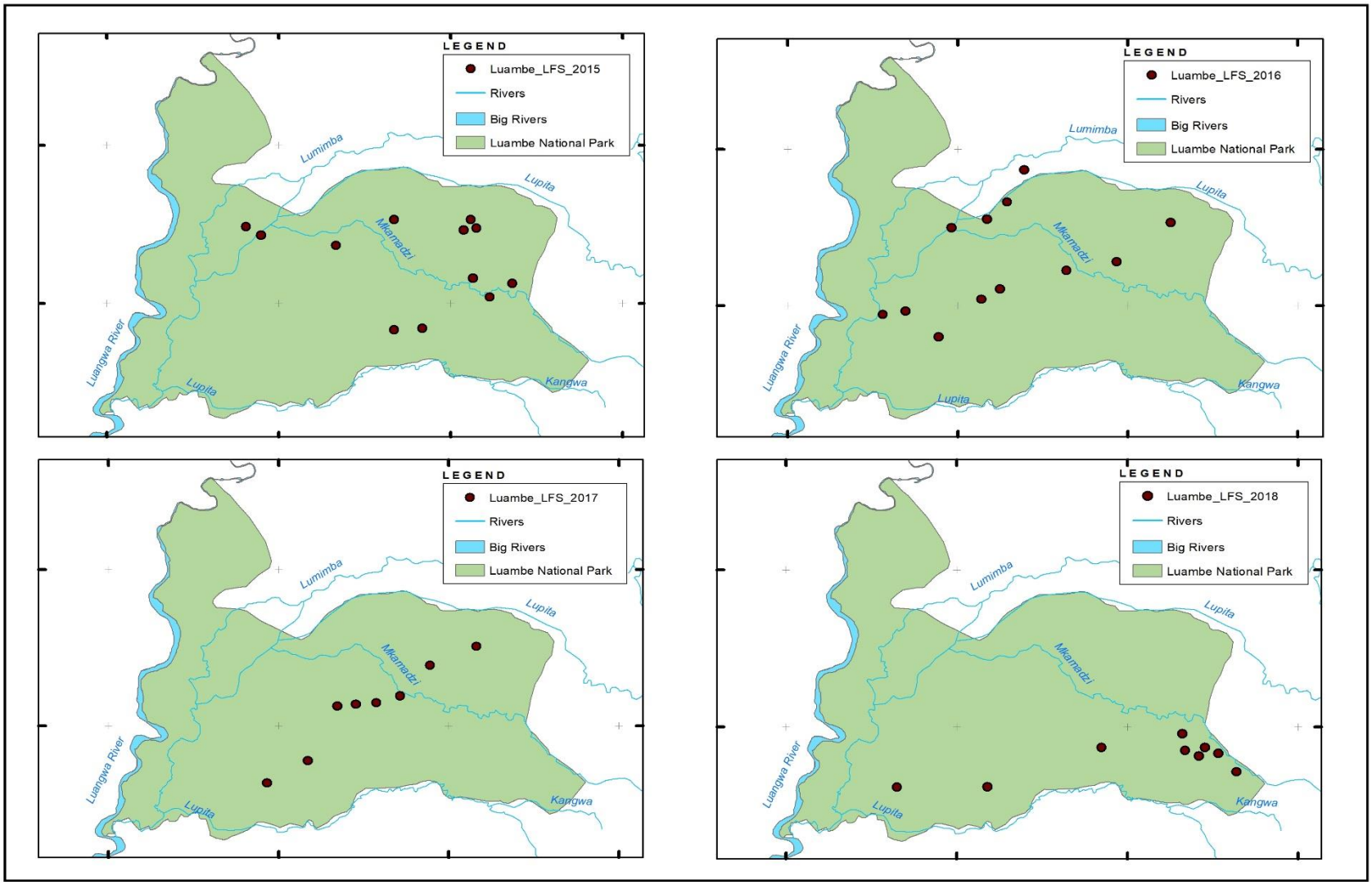
Appendix III: Spatial fire occurrence during the early fire season in the Luambe National Park (2015 to 2018)



Appendix IV: Spatial fire occurrence during the mid-fire season in the Luambe National Park (2015 to 2018)



Appendix V: Spatial fire occurrence during the late fire season in the Luambe National Park (2015 to 2018)



Appendix VI: Budget for implementation of the Luambe National Park for five years

Outcome 1: Improved landscape resiliency to impacts of late wildfires.						**Year**				
No	**Activity**	**Category**	**Item**	**Units**	**Unit Cost**	**1**	**2**	**3**	**4**	**5**
1a	Form Park Fire Management Group	Stationery	Paper	1	140.00	140.00				
			Sub-total			**140.00**				
		Fuel	Local movements	50	15.59	779.50				
			Sub-total			**779.50**				
			Total			**919.50**				
1b	Prepare annual fire operational plan	Fuel	Mfuwe vehicle	191	15.59	2,977.69	2,977.69	2,977.69	2,977.69	2,977.69
	(including burn plan)		Outpost within the park	100	15.59	1,559.00	1,559.00	1,559.00	1,559.00	1,559.00
			Sub-total			**4,536.69**	**4,536.69**	**4,536.69**	**4,536.69**	**4,536.69**
		Allowances	Driver	2	530.00	1,060.00	1,060.00	1,060.00	1,060.00	1,060.00
			Ecologist	2	810.00	1,620.00	1,620.00	1,620.00	1,620.00	1,620.00
			Park Ranger	2	810.00	1,620.00	1,620.00	1,620.00	1,620.00	1,620.00
			Camps in charge	6	100.00	600.00	600.00	600.00	600.00	600.00
			Sub-total			**4,900.00**	**4,900.00**	**4,900.00**	**4,900.00**	**4,900.00**
		Stationery	Paper	2	140.00	280.00	280.00	280.00	280.00	280.00
			Flip chart	1	140.00	140.00	140.00	140.00	140.00	140.00
			Toner	1	1,500.00	1,500.00	1,500.00	1,500.00	1,500.00	1,500.00
			Sub-total			**1,920.00**	**1,920.00**	**1,920.00**	**1,920.00**	**1,920.00**
			Total			**11,356.69**	**11,356.69**	**11,356.69**	**11,356.69**	**11,356.69**
1c	Present proposed annual fire management	Fuel	Mfuwe vehicle	191	15.59	2,977.69	2,977.69	2,977.69	2,977.69	2,977.69
	operational plan to PFMG			0	0	0.00	0.00	0.00	0.00	0.00
	(Include annual review of implementation		CRB and WDC	100	15.59	1,559.00	1,559.00	1,559.00	1,559.00	1,559.00
	of fire management for previous year)		**Sub-total**			**4,536.69**	**4,536.69**	**4,536.69**	**4,536.69**	**4,536.69**
		Allowances	Drivers	1	530.00	530.00	530.00	530.00	530.00	530.00
			Area Warden	1	810.00	810.00	810.00	810.00	810.00	810.00
			Ecologist	1	810.00	810.00	810.00	810.00	810.00	810.00
			Extension Officer	1	810.00	810.00	810.00	810.00	810.00	810.00
			Sub-total			**2,960.00**	**2,960.00**	**2,960.00**	**2,960.00**	**2,960.00**

		Lunch	Food	10	100.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
			Sub-total			**1,000.00**	**1,000.00**	**1,000.00**	**1,000.00**	**1,000.00**
			Total			**8,496.69**	**8,496.69**	**8,496.69**	**8,496.69**	**8,496.69**
1d	Implement annual operational plan for selected blocks	Lunch	Food	5	4,000.00	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00
			Sub-total			**20,000.00**	**20,000.00**	**20,000.00**	**20,000.00**	**20,000.00**
		Fuel	Local vehicle	750	15.59	11,692.50	11,692.50	11,692.50	11,692.50	11,692.50
			Sub-total			**11,692.50**	**11,692.50**	**11,692.50**	**11,692.50**	**11,692.50**
		Support staff	Casual workers	250	150.00	37,500.00	37,500.00	37,500.00	37,500.00	37,500.00
			Sub-total			**37,500.00**	**37,500.00**	**37,500.00**	**37,500.00**	**37,500.00**
		Stationery	Paper	1	140.00	140.00	140.00	140.00	140.00	140.00
			Flip charts	1	140.00	140.00	140.00	140.00	140.00	140.00
			GPS Batteries	140	30.00	4,200.00	4,200.00	4,200.00	4,200.00	4,200.00
			Sub-total			**4,480.00**	**4,480.00**	**4,480.00**	**4,480.00**	**4,480.00**
			Total			**73,672.50**	**73,672.50**	**73,672.50**	**73,672.50**	**73,672.50**
1e	Suppress selected unplanned fire reports	Lunch	Food	2	2,000.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00
			Sub-total			**4,000.00**	**4,000.00**	**4,000.00**	**4,000.00**	**4,000.00**
		Fuel	Local vehicle	300	15.59	4,677.00	4,677.00	4,677.00	4,677.00	4,677.00
			Sub-total			**4,677.00**	**4,677.00**	**4,677.00**	**4,677.00**	**4,677.00**
		Support staff	Casual workers	40	150.00	6,000.00	6,000.00	6,000.00	6,000.00	6,000.00
			Sub-total			**6,000.00**	**6,000.00**	**6,000.00**	**6,000.00**	**6,000.00**
			Total			**14,677.00**	**14,677.00**	**14,677.00**	**14,677.00**	**14,677.00**
	Overall total for 1					**109,122.38**	**108,202.88**	**108,202.88**	**108,202.88**	**108,202.88**
Outcome 2: Improved mobilization and utilization of resources for fire management.										
No	**Activity**	**Category**	**Item**	**Units**	**Unit Cost**					
2a	Carry out manpower and training needs assessment for fire management		None	0	0	0.00	0.00	0.00	0.00	0.00
			None	0	0	0.00	0.00	0.00	0.00	0.00
			Total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2b	Conduct annual training of DNPW officers and other stakeholders	Lunch/Allowances	Fire refresher	30	530.00	15,900.00	15,900.00	0.00		
		Allowances	Trainers	12	810.00	9,720.00	9,720.00	0.00		
		Allowances	Drivers	8	530.00	4,240.00	4,240.00	0.00		

			Sub-total			**29,860.00**	**29,860.00**	**0.00**		
		Fuel	Mfuwe vehicle	300	15.59	4,677.00	4,677.00	0.00		
			Chilanga	295	15.59	4,599.05	4,599.05	0.00		
			Sub-total			**9,276.05**	**9,276.05**	**0.00**		
		Stationery	Paper	2	140.00	280.00	280.00	0.00		
			Flip charts	2	140.00	280.00	280.00	0.00		
			Note books	15	30.00	450.00	450.00	0.00		
			Pens	15	10.00	150.00	150.00	0.00		
			Markers	10	20.00	200.00	200.00	0.00		
			Sub-total			**1,360.00**	**1,360.00**	**0.00**		
			Total			**40,496.05**	**40,496.05**	**0.00**		
2c	Identify and approach stakeholders who can contribute to fire management by the end of year 1	Fuel	Mfuwe vehicle	200	15.59	3,118.00	0.00	0.00	0.00	0.00
						0.00	0.00	0.00	0.00	0.00
			Sub-total			**3,118.00**	**0.00**	**0.00**	**0.00**	**0.00**
			Total			**3,118.00**	**0.00**	**0.00**	**0.00**	**0.00**
2a	Conduct needs assessment and budgeting					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
			Total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2b	Identify potential funding sources					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
			Total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2c	Submit and prepare proposals for funding					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
			Total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2a	Conduct annual equipment inventory and needs assessment					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
			Total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
2b	Carry out periodic maintenance of equipment	Fuel	**Chipata**	100	15.59	1,559.00	1,559.00	1,559.00	1,559.00	1,559.00
		Maintenance	**Accessories**	30	30	900.00	900.00	900.00	900.00	900.00
			Sub-total			**2,459.00**	**2,459.00**	**2,459.00**	**2,459.00**	**2,459.00**

		Total				**2,459.00**	**2,459.00**	**2,459.00**	**2,459.00**	**2,459.00**
2c	Procure required equipment	Equipment	Fire beaters	10	700.00	7,000.00				
			Kestrel	2	5,500.00	11,000.00				
			Drip torches	1	4,400.00	4,400.00				
			Bladder bags	4	6,600.00	26,400.00				
			Googles	10	200.00	2,000.00				
			Gloves	12	200.00	2,400.00				
			Weather Station	1	5,500.00	5,500.00				
			Handheld radios	2	6,600.00	13,200.00				
			Talkabout two way radios	4	3,300.00	13,200.00				
			GPS	2	10,000.00	20,000.00				
		Sub-total				**105,100.00**				
		Total				**105,100.00**				
	Overall total for 2					**151,173.05**	**42,955.05**	**2,459.00**	**2,459.00**	**2,459.00**
Outcome 3: Information generated to feed into fire management decision making improved										
3a	Prepare project proposal to establish long term fire biodiversity research in the park					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		Total				**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
3b	Conduct study on knowledge levels and perceptions of stakeholders on fire management					0.00	0.00	0.00	0.00	0.00
			Sub-total			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
		Total				**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
3a	Develop fire monitoring protocols	Stationery	Paper	2	140	280.00	0.00			
			Fuel	200	15.59	3,118.00	0.00			
			Sub-total			**3,398.00**	**0.00**			
		Total				**3,398.00**	**0.00**			
3b	Implement fire monitoring protocols					0.00	0.00			
			Sub-total			**0.00**	**0.00**			
		Total				**0.00**	**0.00**			
	Overall total for 3					**3,398.00**	**0.00**	**0.00**	**0.00**	**0.00**
Outcome 4: Effective participation and awareness that contributes to reduced wildfire incidences										

4a	Identify stakeholders linked to fire management in the LNP	Stationery	Paper	1	140	140.00	0.00			
			Fuel	100	15.59	1,559.00	0.00			
			Sub-total			**1,699.00**	**0.00**			
			Total			**1,699.00**	**0.00**			
4b	Prepare and place fire sensitization materials (posters, signposts) in strategic areas of the park and GMA	Stationery	Posters	6	1,000.00	6,000.00	6,000.00	6,000.00	6,000.00	
			Signposts	3	10,000.00	30,000.00	0.00	0.00	0.00	
			Sub-total			**36,000.00**	**6,000.00**	**6,000.00**	**6,000.00**	**0.00**
		Fuel	Mfuwe vehicle	300	15.59	4,677.00	4,677.00	4,677.00	4,677.00	
			Sub-total			**4,677.00**	**4,677.00**	**4,677.00**	**4,677.00**	**0.00**
			Total			**40,677.00**	**10,677.00**	**10,677.00**	**10,677.00**	**0.00**
4c	Hold sensitization meetings with stakeholders (ie communities)	Fuel	Mfuwe vehicle	400	15.59	6,236.00	6,236.00	6,236.00	6,236.00	6,236.00
			Sub-total			**6,236.00**	**6,236.00**	**6,236.00**	**6,236.00**	**6,236.00**
		Lunch	Food	80	50.00	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00
		Allowances	Extension officer	6	810.00	4,860.00	4,860.00	4,860.00	4,860.00	4,860.00
			Ecologist	6	810.00	4,860.00	4,860.00	4,860.00	4,860.00	4,860.00
			Driver	6	530.00	3,180.00	3,180.00	3,180.00	3,180.00	3,180.00
			Area Warden	6	810.00	4,860.00	4,860.00	4,860.00	4,860.00	4,860.00
			Sub-total			**17,760.00**	**17,760.00**	**17,760.00**	**17,760.00**	**17,760.00**
			Total			**23,996.00**	**23,996.00**	**23,996.00**	**23,996.00**	**23,996.00**
4a	Broadcast fire management information on local radio station	Information circulation	Broadcast message	20	500.00	10,000.00	10,000.00	10,000.00	10,000.00	10,000.00
			Sub-total			**10,000.00**	**10,000.00**	**10,000.00**	**10,000.00**	**10,000.00**
			Total			**10,000.00**	**10,000.00**	**10,000.00**	**10,000.00**	**10,000.00**
	Overall total for 4					**76,372.00**	**44,673.00**	**44,673.00**	**44,673.00**	**33,996.00**
	Grant-total (ZMW)					**340,065.43**	**195,830.93**	**155,334.88**	**155,334.88**	**144,657.88**