

BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF NATURAL RESOURCES



**TEMPORAL SPATIAL DISTRIBUTION OF WILDLIFE MORTALITIES IN
ZAMBEZI AND VICTORIA FALLS NATIONAL PARKS FOR THE PERIOD 2015 -
2025**

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REQUIREMENTS OF THE BACHELOR OF SCIENCE (HONOURS') DEGREE IN
NATURAL RESOURCES MANAGEMENT**

29 MAY 2026

DECLARATION

I, PHILLIPER SIMAKANI declared that this project is my piece of work, and I did not use any information from sources without crediting the owner.

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DEDICATION

I want to dedicate this project to my mother, Prisca Mhike, my father Christopher Simakani whose unwavering support and encouragement sustained me through every challenge. To my mentors who inspired me to think critically and strive for excellence and to all those who believe in the power of knowledge to transform lives.

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D A T E

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ABSTRACT

This study investigated the patterns and drivers of wildlife mortalities in Zambezi National Park from 2015 to 2025. Using a census approach and field survey design, carcass records, patrol logs and surveillance data from the Zimbabwe Parks and Wildlife Management Authority and Victoria Falls Wildlife Trust was analyzed to identify mortality drivers, temporal and spatial patterns. The results showed that wildlife had been impacted by ecological factors throughout the landscape (2020-2025). Mortality detection was also reduced during the COVID 19 were initially concentrated along the Zambezi River corridor (2015-2017) but later became stressors such as drought and water scarcity as well as human-related pressures including encroachment and livestock interactions. Kernel Density estimation revealed that mortalities pandemic due to reduced patrol activity. The study concludes that wildlife is increasingly vulnerable to climate variability and human activity and recommends adaptive patrols, sustainable funding and community engagement.

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ACRONYMS

ZNP	Zambezi National Park
VNP	Victoria Falls National Park
PAC	Problem Animal Control
HWC	Human and Wildlife Conflict
ZPWMA	Zimbabwe Parks and Wildlife Management Authority
KAZA-TFCA	Kavango-Zambezi Transfrontier Conservation Area
GIS	Geographical Information System
GPS	Global Positioning System
SMART	Spatial Monitoring and Reporting Tool
VFWT	Victoria Falls Wildlife Trust

CHAPTER 1: INTRODUCTION

Wildlife conservation is an important part of environmental sustainability mainly in the zones of high diversity such in the Zambezi and Victoria Falls National parks, which are located within the Kavango Zambezi Trans frontier conservation area Matabeleland North of Zimbabwe. These parks provide habitat to an ever-increasing number of species, which are endangered and threatened by various anthropogenic pressures (Fynn, Thakadu, Mbaiwa, & Hoffman M, 2019). The understanding of spatial and temporal habitat uses, and spatial ecology of wildlife is fundamental knowledge of the cause of distribution and abundance (Lindsey, et al., 2013)

1.2Background

Wildlife mortalities are posing a major challenge to conservation at global, regional and national level. Wildlife populations all over the world are in rapid decline. As highlighted in the world wildlife funds living planet report, these populations have shrunk by almost 68% since 1970 (WWF, 2022). The report attributes the decline to factors like habitat destruction, climate change and poaching. The need to address such issues has drawn huge international focus which has resulted in the creation of global conservation targets as prescribed in Convention on Biological Diversity.

The Kavango- Zambezi Transfrontier Conservation Area (KAZA) is the world's second largest conservation area covering 394 300km² and extending across five countries: Botswana, Namibia, Zambia, Angola and Zimbabwe. It is globally significant for its diversity of fauna and flora, containing more than 150 mammalian species like elephants, lions and antelopes. (Chase, et al., 2016). While strongholds exist, the Kavango - Zambezi Trans-frontier conservation area (KAZA TFCA), encompassing these parks faces intense pressure. Trans-boundary poaching networks target high value species (elephants ivory, rhino horn). Climate change causes drought and waterless conditions leading to increased animal and human tensions. Uncontrolled exploitation, illicit trafficking, habitat loss, conflict and the pressures of climate change threaten the sustainability of Zimbabwe's wildlife populations (Bennett, Noyoo, & Brook, 2015).

Zimbabwe a country rich in wildlife and stringent legislation, for example the Parks and Wildlife Act which protect the wildlife in both public and private land. However, inadequate resources, lack of incentives, socio-economic political institutional challenges, and corruption affect law enforcement (Mutanga, Vengesayi, & Muboko, 2015). The prevalence of poaching, illegal wildlife killing is indicative of the struggles, implementation follows economic downturns, while lack of infrastructure, holes in the road network contribute to habitat losses and increases the risk of car accidents. These consequences for Zimbabwe are equally devastating. Both Zambezi and Victoria Falls national parks make up a large portion of the country's wildlife heritage and tourism, but they are not immune to pressure of wildlife mortalities. The government has recognized the need for robust conservation policies, but these trends shape conservation policies and law prompting government to adapt stricter regulations and enhance protective measures. The rise in poaching has led to community enforcement remains inconsistent due to limited resources and corruption.

Natural factors such as disease and predation contribute to wildlife deaths, yet human actions population declines, while illegal poaching remains in aspersive threat (Pereira & M, 2015) .Additionally, humans significantly increase these risks. Legal hunting, if not managed sustainably, can lead to population declines, while illegal poaching remains a pervasive threat (Benitez-Lopez, Alkemade, & Hendricks, 2017). Additionally, human wildlife conflicts often arise as communities encroach on natural habitats, leading to retaliatory killings and further losses.

These trends inform conservation policies and legislation and spur governments to institute even more stringent based policies, regulations and protection measures. Increased poaching has resulted in an increased death toll of wildlife and problems with communities. Wildlife mortality is not only an ecological issue, but a social issue, community justice and resilience issue where wildlife is a critical resource. They affect the policies and legislation regarding conservation such that governments have implemented more stringent legislation and protective measures (Ncube & Hughes, 2013). Individual stories of wildlife and the communities that live alongside them lie at the heart of this issue. Each mortality reflects a deeper interconnectedness, where the loss of an animal can impact local livelihoods and cultural identities (Kansky & Mombeshora, 2022). The response to wildlife mortalities is not only an ecological issue, but also a social issue that needs a balanced approach that prioritizes ecological health and the wellbeing of local communities.

The analysis of wildlife mortalities in national parks highlight critical issues that

necessitate these challenges include poaching, human wildlife conflict and the need for community involvement in conservation efforts. The justice and resilience of communities depend on their natural heritage.

1.3 Problem Statement

Wildlife populations in Zambezi and Victoria Falls National Parks face increasing threats from natural and human-driven factors. While species such as buffalo and impala have been the subject of previous research, demographic characteristics and mortality drivers have not been analysed within an integrated framework. Existing data often lacks geographic and land-use integration which hinders the development of effective, evidence-based conservation strategies. Variables such as species identity, sex and proximity to human activity influence mortality risk, yet remain underexplored. This knowledge gap hinders proactive interventions to reduce preventable deaths from poaching, habitat encroachment and road collisions. A systematic investigation using robust statistical and geospatial approaches is urgently needed to inform location- specific wildlife policies.

1.4 Aim

To analyse wildlife mortalities in Zambezi and Victoria Falls national parks for the period 2015 - 2025.

1.5 Objectives

1. To determine the drivers of wildlife mortalities in Zambezi and Victoria Falls National parks.
2. To determine the temporal and spatial distribution of wildlife mortalities in Zambezi and Victoria Falls National Parks.
3. To compare different species mortalities in Zambezi and Victoria Falls National Parks.

1.6 Research Questions

1. What are the main causes of wildlife mortality in Zambezi and Victoria Falls National Parks?
2. How do wildlife mortalities vary from time and territory within the parks?
3. How do mortality rates and their causes vary among the species in Zambezi and Victoria Falls National Parks?

1.7 Justification

Analysing wildlife mortalities that have occurred in Zambezi and Victoria Falls national parks from 2015 to 2025 will not only help track the health of the ecosystem and the survival of species but also provide various practical benefits to the stakeholders involved. The study results will present a factual evidence-based analysis of mortality trends such as identifying poaching hotspots, disease outbreaks or human -wildlife conflict zones. This allows resource allocation to be done more effectively, patrols to be targeted and management to be adaptive in line with the conservation efforts. Local communities will greatly benefit from the identification of the causes of wildlife mortality, for example snaring, vehicle collisions or poisoned water sources since these will be the foundation for the implementation of measures that will reduce livestock losses, crop damage and safety risks. Community involvement in data collection can cause a sense of responsibility and create livelihood opportunities based on nature. This research will provide a mortality surveillance model that can be used in transboundary landscape with shared data on cross-border threats for example illegal wildlife trade corridors, anthrax outbreaks which will lead to harmonisation of response protocols among Angola, Zambia, Namibia, Zimbabwe and Botswana. Tourism operators and guides will also benefit from early warning systems for risk related to carcasses, for example the habituation of predators to roads which will make safaris safer. Scientists and financiers will get a benchmark for assessing long term impacts and the attraction of investors for interventions that can be expanded, mortality datasets will be freely accessible leading to comparative studies across protected areas in Africa thus bringing ecological necessity with stakeholder specific returns and ensuring conservation actions are both scientifically rigorous actions for conservation.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Wildlife mortality poses a significant threat to biodiversity, ecosystem stability and conservation efforts worldwide. Population declines can trigger cascading ecological disruptions, reduced genetic diversity, altered trophic dynamics and the breakdown of ecosystem functions that support both wildlife and human communities (Ripple, W.J., & R., 2015.) Understanding the causes and spatial patterns of wildlife mortality is therefore important in developing management strategies capable of reversing these trends. In Zimbabwe, a country renowned for its biodiversity and extensive protected area network, this challenge is particularly found in regions such as Matabeleland North.

Matabeleland North is home to some of the most significant conservation areas of Zimbabwe like Matetsi and Deka Safari areas, Hwange, Kazuma Pan, Zambezi and Victoria Falls national parks. Besides these great locations the province also has community conserved areas and state forestry land. These different types of habitats are home to a wide variety of animal species. Unfortunately, activities of human beings as well as changing weather and outbreaks of diseases from time to time are resulting in the deterioration of these habitats. For example a study by (Munang'andu, et al., 2012,) has pointed out that anthrax outbreaks among the buffalo and elephant populations in Hwange are a result of drought which forces the animals to come together near the limited water sources. Similarly, the impacts of habitats loss and climate variability have been extensively studied, highlighting how deforestation and altered rainfall patterns exacerbate wildlife mortality (Finkelstein, et al., 2021).

Moreover, human wildlife conflict emerges as a critical factor contributing to wildlife deaths particularly involving large mammals such as elephants and lions (Gandiwa, Heitkönig, Lokhors, Prins, & Leeuwis, 2013) illustrated that crop raiding and livestock predation often lead to retaliatory killing further threatening wildlife population.

The challenge of wildlife mortality is compounded by the complexities of data collection and analysis. Various methods including field studies, remote sensing and citizen science are employed to monitor wildlife populations and identify mortality trends (López-Bao, et al., 2017)). However, challenges such as unnoticed wildlife deaths and reliance on specific data

sources can lead to gaps in understanding the true scope of mortality causes (William, Clout, H., & M., 2010).

2.1 Major Causes of Wildlife Mortalities

2.1.1 Disease outbreaks

Anthrax is an expanding zoonotic and tropical disease which negatively impact livestock, wildlife and human health ultimately impacting livelihoods and biodiversity conservation (Norman, et al., 2020) noted it to be a serious disease in Zimbabwe where its surveillance and control are sub-optimum even though it is causing serious losses in animals and human health. This bacterial disease, caused by *Bacillus anthracis*, has been linked to drought conditions that force these animals to congregate around limited water sources. In a notable outbreak in 2010 hundreds of elephants and buffalos succumbed to the disease, severely impacting local wildlife populations (Munang'andu, et al., 2012,).

Similarly, canine distemper virus (CDV) poses a serious threat to African wild dogs across various regions in South Africa and Zimbabwe. Documented mortality rates indicate up to 70% of infected wild dog packs have died during CDV outbreaks (Groom, et al., 2025). A particular devastating episode in Kruger National Park eliminated more than 80% of the resident wild dog population, underscoring the vulnerability of already small populations (Loots & A.K, 2017).

Rabies also affects multiple wildlife species in Southern Africa, including jackals and wild dogs. In 2015, a rabies outbreak resulted in the deaths of numerous wild dogs in the Limpopo region, with over 50 individual deaths reported (Alexander & G., 2015). The interconnection between domestic animals and wildlife exacerbates this issue, as the disease can easily spill over from pets to their wild counterparts (Grover, Bessell, Conan, Polak, & Sebakwe, 2025).

Foot and mouth disease (FMD) is prevalent in Zimbabwe and South Africa, primarily impacting cloven -hoofed animals. This viral disease can cause severe lesions and high mortality, especially in younger animals (Tshuma, Mutibvu, Mbiriri, & Chimonyo, 2023). Outbreaks have led to the culling of wildlife in protected areas to prevent transmission to livestock, resulting in the deaths of thousands of animals over the years (Bekere, Abdi, Kassaye, & Ahmed, 2023). Though less commonly discussed. Swine influenza has been

reported in South Africa, raising concerns about its potential impact on wild boar populations. While studies on this disease in wildlife are limited, there are occasional reports that suggest wildlife could act as reservoirs for the virus, posing additional risks to local ecosystems (Groom, et al., 2025).

A striking incident in 2020 involved the deaths of approximately 330 elephants in the Okavango Delta, Botswana attributed to cyanobacterial toxins in contaminated water sources (Lomeo, et al., 2024). This mass die-off underscored the issues surrounding water quality and how climate change can increase the presence of harmful algal blooms, leading to significant wildlife mortality.

2.1.2Habitat loss and Climate change

Deforestation and climate variability are increasing wildlife mortality in Matabeleland North. (Wieder, et al., 2021), Analysed satellite data showing significant woodland loss due to agriculture and fuelwood collection reducing habitat for species like sable antelopes. Climate change has also led to prolonged droughts affecting water dependent wildlife. (Kuvawoga, 2026) states that elephant mortality in Hwange during droughts finding that water scarcity forces animals to travel longer distances, increasing conflict with humans and susceptibility to dehydration.

2.1.3Road and Railway Mortalities

The Bulawayo -Victoria Falls highway and railway, Victoria Falls Kazungula highway bisect key wildlife corridors, leading to frequent animal -vehicle and train collisions (Zisadza-Gandiwa, et al., 2019) reports indicate high mortality rates for elephants, lions and antelopes along these routes. Similar findings by (Mbaiwa, Kuvawoga, Mawoko, & Bennett, 2025) call for wildlife underpasses and speed restrictions in high -risks zones. Wildlife -vehicle collisions (WVC s) pose a significant threat to African wildlife, causing both direct mortality and habitat fragmentation, which disrupts animal movement. Unlike studies in the Northern Hemisphere, African ecosystem faces unique challenges and species vulnerabilities peculiar to their geographical location. Key species affected include large herbivores like elephants and various antelope species, such as impala and kudu, which are frequently killed on roads (Mbaiwa, Kuvawoga, Mawoko, & Bennett, 2025). Carnivorous animals such as lions and hyenas can become victims of traffic accidents, when they wander close to roads to drink water or scavenge. Besides, primates; reptiles and amphibians face considerable danger during hyena's canal migrations.

Road and rail construction lead to habitat fragmentations, reducing gene flow and access to resources, while behavioral avoidance of roads can result in “functional habitat loss” and rising human presence along roads often means degradation of nearby habitats and changes in predator prey relations. Through their work that was centered on the modelling and reduction of wildlife vehicle collisions in Southern African savannas (Ngorima, 2025). High-risk road segments based on environmental characteristics and traffic patterns were identified and seasonal peaks of collisions were disclosed. Mitigation measures suggested including the construction of wildlife underpasses, control of roadside vegetation, the use of dynamic road signs and speed limit enforcement.

Apart from threatening animal species that are on the verge of extinction wildlife vehicle collisions also convey the risk of disease spreading through cumulative scavenging animals at the sites of carcasses. The expansion of road networks all over Africa needs the use of effective mitigation measures.

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2.1.4 Human -Wildlife Conflict and Retaliatory Killings

Human – wildlife conflict (HWC) is leading cause of wildlife mortality in Matabeleland North, particularly involving elephants, lions and crocodiles. (Gandiwa, et al., (2013).) studied conflict patterns near Hwange national park and found that crops raiding by elephants and livestock predation by lions frequently lead to retaliatory killings. Similarly, (Muboko, Never, Murindagomo, & Felix, 2014) reported that communities bordering wildlife areas often resort to poisoning and snaring problem animals, exacerbating mortality rates for scavengers like

vultures and hyenas. To mitigate these conflicts, scholars recommend community-based conservation programs (Dunham, et al., 2010) highlighted the success of CAMPFIRE (Communal Areas Management Programmed for Indigenous Resources) in reducing retaliatory killings by providing economic incentives for wildlife conservation. As human populations expand into wildlife habitats, conflicts arise often resulting in retaliatory killings or culling (Kiros & Abadi Berhe, 2024). Elephants and predators such as lions frequently come into conflict with farmers, leading to increased mortality rates (Dickman & J., 2010). Reductions in human-wildlife conflicts through effective conflict resolution strategies are important for both lowering wildlife mortalities and ensuring human-wildlife coexistence.

2.1.5 Poaching and Illegal Wildlife Trade

Poaching continues to be key threat problem in wildlife populations decline with elephants and rhinos in Matabeleland North being prime targets. Research by (Ripple, W.J., & R., 2015.) confirms that the royal game of elephant populations has tragically been plundered by the illegal hunters while (Lindsey, et al., 2013) states that poaching in the area is driven by international demand, poor law enforcement and poverty. Measures against poaching including more frequent ranger patrols and operations based on intelligence have been put in place. (Muposhi, et al., 2016; Mandinyenya, et al., 2018) have pointed out that socio-economic reasons are not dealt with even the best enforcement is not going to be enough. Wildlife conservation is a complex issue that needs not only enforcement but also understanding socio-economic factors. There are different types of poaching which contribute to wildlife death and disrupt the balance of nature.

Driven by poverty, people end up doing subsistence poaching, this practice involves communities hunting wildlife for food or income, leading to population declines of targeted species (Kahler & Gore, 2012). Poisoning of water sources kills wildlife by contaminating their drinking water, mainly during the dry season when animals congregate around the limited water resources. Poisoning causes mass deaths not only of the targeted species but of the whole ecosystem (Denny, 2025). Besides that, there is trapping and snaring which is often aimed at smaller mammals and birds. Trapping can result in high catch rates threatening non target species and complicating conservation efforts. Trade in body parts poaching for ivory, horns and skins is very dangerous for species like elephants and rhinos leading to major ecological disruptions.

Seasonal changes have long been known to influence death rates. For example, higher rates are often seen in animals during breeding seasons or extreme weather periods (Murray, et al., 2019). Besides different species have their own weaknesses that will result in different death variations. Endangered species for example, that might have higher death rates because of their small population sizes and low genetic diversity (Ripple, Wolf, & Gregg, 2025).

Nature changes with location so this also has an impact on death patterns. Densely human populated areas usually show higher death rates because of human related interactions (Lindsey, Andrew, Balme, Becker, & Zisadza-Gandiwa, 2013). (Homyack, 2010) points out that wildlife that dies the least are the ones that have a living environment as a factor, like the type of habitat and the availability of resources. This underlines truth is conservation must respond to the specifics of ecological conditions. That means conservation initiatives should mainly be about habitat preservation and regeneration since the species depend on these resources for their life or survival. Conservationists can be more successful if they understand how species mortality is influenced by the various environmental factors and through this implementation protection of vulnerable populations will be achieved.

It is through an understanding of wildlife mortality that suitable conservation approaches can be devised. When the main causes of death are identified it becomes possible to focus on the right actions like habitat restoration, creation of wildlife corridors and educating the public. One example would be setting up overpasses and underpasses for wildlife to crossroads safely which can really decrease deaths by vehicles (Ree, der, Smith, Grilo, & Clara, 2015). Also, promoting peaceful coexistence through community involvement and compensation programs for wildlife damage is a way of controlling human retaliation killings (Kiros & Abadi Berhe, 2024). Constant monitoring and research are equally necessary for understanding the status of a population and making the right management choices. According to (Lindenmayer, B., Likens, & E., 2010), it is a well-known fact in conservation circles that adaptive management approaches capable of incorporating new research findings should be adopted for the highest level of success in conservation efforts.

2.4 Conclusion

Deaths of wildlife seriously hinder the efforts to conserve the diversity of life and maintain healthy ecosystems. A comprehensive understanding of the causes of death natural a human induced is key to devising management strategies that work. Addressing the main drivers of mortality and supporting coexistence of humans and wildlife through conservation are ways to

strengthen the resilience of wildlife populations and preserve biodiversity for coming generations. In Matabeleland North human activities, environmental changes and illegal exploitation are inextricably mixed to cause wildlife deaths. Although conservation programs have delivered a few successes, solutions that rely on one aspect will not work soon. Integrated approaches that involve local communities, policy changes and climate adaptations strategies are necessary. Emerging threats like disease transmission from animals to humans and climate change are areas that should be prioritized in future research.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter outlines the approach and produces employed to address the temporal and spatial distribution of wildlife mortalities in Zambezi and Victoria Falls National Park, determine the drivers of wildlife mortalities in ZNP and VFNP and compare different species mortalities in ZNP and VFNP. It provides a detailed account of the study's design, the methods for data collection and analysis and the rationale for selecting these techniques. The aim is to ensure that the research process is transparent, replicable and scientifically sound. By clearly defining the methodology, this study establishes the reliability and validity of its findings.

3.1 Study Area

Zambezi national park (ZNP) is located between latitude 17°53'S and longitude 25°41'E, measuring 560 km² (Figure 1). Geologically, the Zambezi national park is characterized by gently undulating terrain of 600 to 1200m elevation above sea level ((Ndaimani, 2013). The climate is subtropical savannah experiencing seasonal rainfall, with annual mean of 650mm, mainly in the hot wet season between November and April (Chakuya, -Chikerema, & Ngorima, 2021)). The dry season is grouped into cold dry (May -August) and hot dry (September – October). The main types of soils are lithosols and regosols deposited on the Karoo volcanic and Kalahari hydrogeological formations, respectively (Mangadze, Bere, Chavula, & Zenda, 2020); (Mandinyenya 2019).

Victoria Falls National Park located northwestern Zimbabwe is a UNESCO world heritage site protecting the southern and eastern banks of the Zambezi River and the renowned Victoria Falls. The parks topography is defined by the massive waterfall and the series of dramatic gorges it has carved (Moore & Cotteril, 2010). The ecosystem is unique to the region and features a spray-fed rainforest close to the falls and surrounding woodlands. Home to valuable wildlife like elephants, buffalos, antelope and leopards, it features only 23.4km² of size.

ZNP contains an extensive wildlife, large numbers of elephant, Cape buffalo, giraffe, grants zebra and a wide array of antelope, Lions, African leopards and South African cheetahs are rare. Velvet monkeys and baboons abound. The Zambezi River has substantial populations of hippopotamuses, waterbucks and crocodiles. African bush elephant's move across the river during the dry season, and the gorges can be glimpsed by crossing of Klipspringers, honey badgers, lizards and clawless otters which are mainly known for 35 raptor species.

(Mandinyenya, et al., 2018)) Pointed out there are 5 types of vegetation in the Zambezi National Park, mixed, *Vachellia*, Zambezi teak (*Baikiaea plurijuga*), terminalia and grasslands. The mixed flora is *Colophospermum mopane*, which occurs along with *Celtophorum africanum*, *Combretum apiculatum* and *Dichrostachys cinerea*. *Vachellia* is made up of *Vachellia nilotica* and *senegalia nigrescens* are the dominant species (Mandinyenya, et al., 2018). Zambezi teak consists of *Baikaia plurijuga* occurs in association with *Pterocarpus angolensis*, *Guibortia colesperma*, (Benth & J) *Bauhinia petersiana* Bolle and *Baphia massaiensis* Taub. Terminalia comprised with *Terminalia randii* Baker occurs in association with *Combretum imberbe* Wawra, *Dichrostachys cinerea* and *P. africanum*. Grassland comprising of grasses is dominated by fibrous plant material.

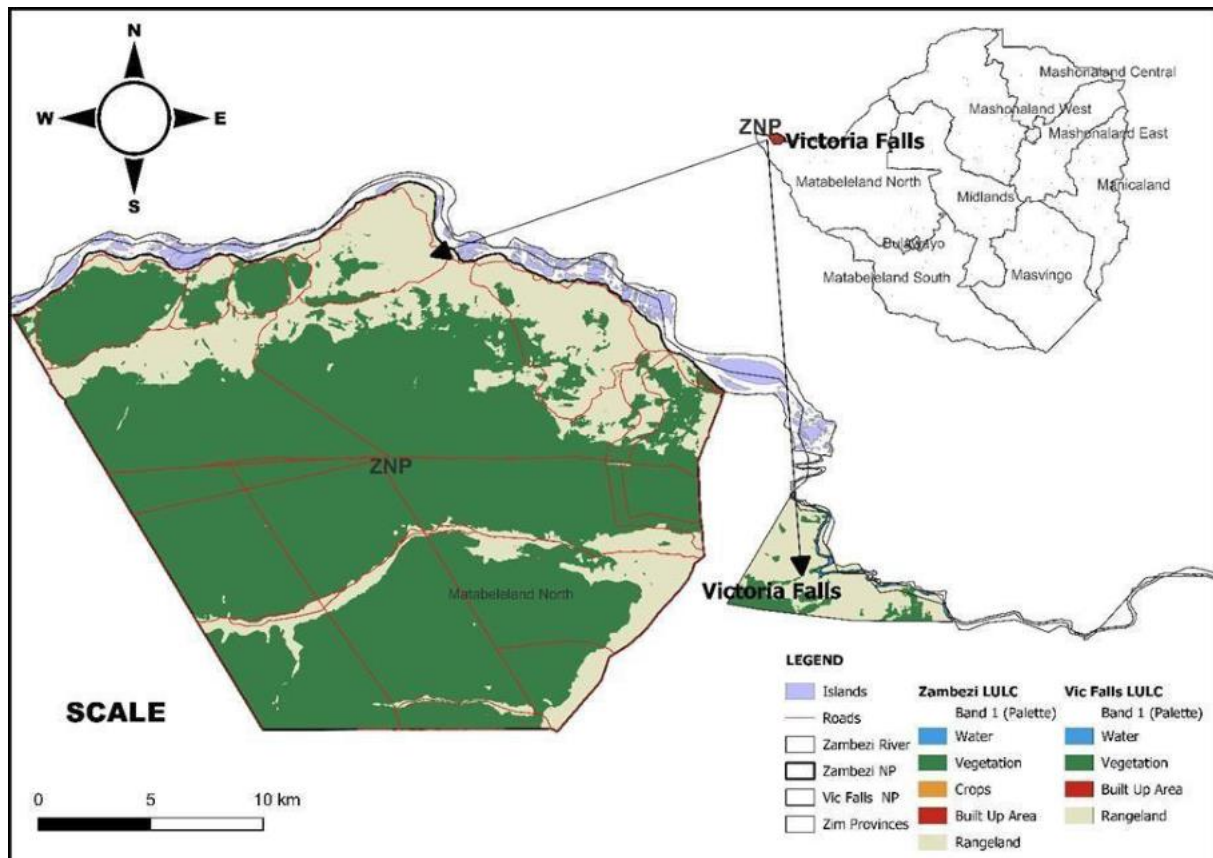


Figure 3.1: Study area, Zambezi and Victoria Falls National Park North-Western Zimbabwe.

ZNP is bordered to the north by Zambezi River, to the east by Victoria Falls town and Victoria Falls national park, to the south by fuller forest land and to the west by Matetsi Safari Area Unit 7 (Mandinyanya, et al., 2018). It is an unfenced protected area which is part of the Kavango-Zambezi Transfrontier Conservation Area shard between Angola, Botswana, Zambia, and Zimbabwe in 2011. The area has a poor natural water supply in the southern side of the parks and is compensated by artificial boreholes whereas the northern side of the park has a rich water supply from the Zambezi River and some natural springs (Figure 3.1).

3.2 Research Design

The study adopted a field survey research design to analyse wildlife mortality through direct data collection and field observations. This field survey design was appropriate as it enabled the primary examination of both spatial and temporal patterns of wildlife mortality within the study area. The study incorporated both descriptive and analytical approaches. The descriptive component summarized observed mortality patterns and environmental conditions documented during the survey, while the analytical examined spatial clustering and temporal

trends based on the primary data gathered in the field.

3.2.1 Target Population and Sampling

The target population comprised all recorded wildlife carcasses within ZNP and VFNP during the study period. A census method was employed by incorporating all carcass records available on the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) database were included.

3.2.2 Temporal Stratification

To ensure representative sampling of seasonal effects, the study incorporated temporal stratification. Two seasons were used, cold-dry season which is related to low temperatures and resource abundance spanning from May to October hot-wet which is connected to high temperature, high rainfall and resource abundance from November to April.

3.3 Data Collection Procedures

Wildlife data was collected through multiple complementary approaches which are systematic patrols, incidental sightings and standardized protocols

3.3.1 Routine Patrols

The researchers and park rangers undertook regular systematic foot and vehicle patrols on predefined paths, ensuring regular censusing of all available wildlife and detection of carcasses. Along established routes.

3.3.2 Opportunistic Observations

Additional carcass records were obtained from incidental sightings by park staff, researchers and tourists. These observations were verified and recorded following standard protocols.

3.4 Research Instruments

The study relied on field survey data obtained from Zim parks and Victoria Falls Wildlife Trust law enforcement patrols. The following instruments were used in data collection and processing:

- GPS devices (Garmin GPSMAP 64s) for recording locations with an accuracy of 3 meters.
- SMART software and data sheets were used by the researchers and park rangers for field data entry, systematic report generation and document carcass data.
- Microsoft Excel (2013) for data storage and preliminary analysis.
- Arc Map 10.2.2 for spatial analysis and mapping.
- Google Earth pro 7.3 was used for spatial verification and reference.

These tools allowed for the accurate capture of spatial, temporal and ecological variables that could have an influence on animal mortality.

3.4.1 Recorded Variables

All carcasses' attributes included:

- Geographic coordinates
- Date of discovery
- Species identification
- Age class (adult, sub adult, juvenile)
- Cause of death
- Habitat type
- Distance to water sources and roads

3.4.2 Cause of Death Classification

Carcasses were categorized into poaching, natural causes, predation, unknown and problem animal control (PAC). Classification relied on field observations physical injuries, feeding patterns and environmental

conditions that act as current indicators.

Data Analysis Procedures

The data was analysed using a mixture of spatial and statistical methods.

3.4.3 Spatial Analysis (Kernel Density Estimation)

Kernel density estimation (KDE) in Arc Map (10.2.2) was used to detect the spatial distribution of mortality and critical zones. A fixed bandwidth of 500m was applied and raster outputs were generated. Density values were normalized to allow comparison across seasons and years.

3.4.4 Temporal Analysis

Temporal trends were analyzed using annual carcass counts. Line graphs and percentage change calculations were used to analyse inter-annual variability and seasonal differences.

3.4.5 Descriptive Statistics

Frequency distributions and percentages were used to compare causes of death across years and parks.

3.4.6 Comparative Analysis

Spatial overlays were used to compare mortality patterns between seasons and causes of death illustrating differences in hotspot locations.

3.5 Data Management

Data was entered, cleaned and validated in Microsoft excel (2013). Records with missing key variables (coordinates or dates) were excluded from analysis. The final dataset available for analysis included the most complete and valid mortality records.

CHAPTER 4: RESULTS

4.0 Introduction

The results of the study conducted in Zambezi National Park (ZNP) and Victoria Falls National Park (VFNP) on the spatial and temporal distribution of wildlife mortalities in the study area during 2015 -2025. The results are based on kernel density estimation (KDE) and descriptive statistics of the carcass data. Special attention is given to the recognition of seasons, spatial clustering and variations in the causes of death across the landscape.

The results are laid out in three parts, an analysis of the distributions of mortalities by cause of death, unknown causes, poaching related deaths and predation. The distribution of seasonal mortality is analyzed to emphasize the spatial variation between the wet and dry periods. The chapter also provides information on the number of carcasses per cause and assesses trends across the eleven-year study period. All results are presented objectively, with interpretation limited to observed patterns and trends.

4.1 Carcass Counts by Cause of Death

The sum of recorded carcasses and the recorded causes of death were as follow: poaching (n = 214), natural causes (n = 138), unknown causes (n =221) accident (n = 27), and problem animal control (PAC) (n = 10) Figure 4.15)

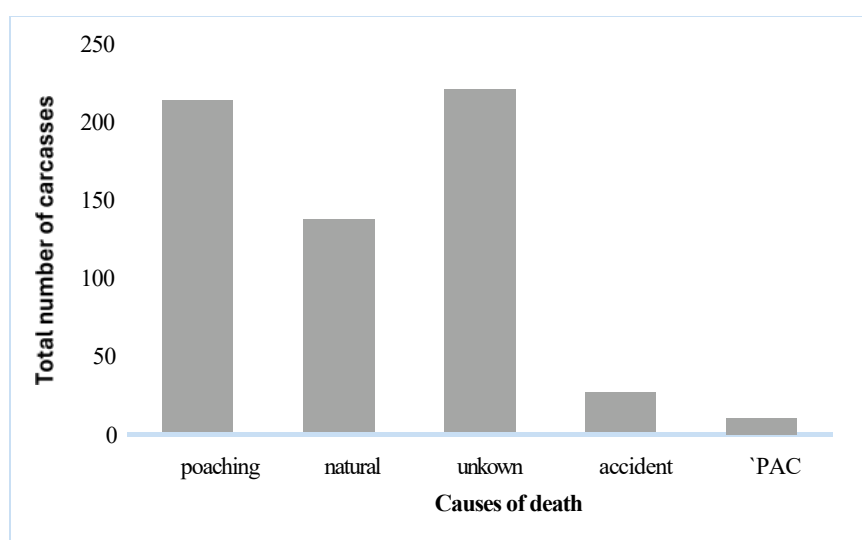


Figure 4.1 Number of carcasses recorded per cause of death

4.2 Seasonal Mortality Distribution

During the 2015 cold-dry season, wildlife mortality was very focused along Zambezi River corridor. The river channel had a distinct continuous hotspot, suggesting that most of the fatalities were related to this permanent waterway. The intensity of the kernel densities ranged from 0.00 to 0.85/km², and the highest intensity (0.75-0.85) was found within 500 meters of the river's edge. Overall mortality was not highly dispersed across the landscape however, it seems rather unequivocal linear band paralleling the course of the river does not cross the landscape, instead it forms a distinct linear band aligned with the rivers course (Figure 4.2a)

Conversely, the distribution during the wet season was very dispersed in shape. Carcass density ranged from 0.10 to 0.25 per km² and small isolated hotspots were found throughout the ZNP and VFNP. Spatial limited spatial cohesion was found in these clusters and there was no dominance within them. Rather their occurrence in the landscape was relatively uniform (Figure 4.2b)

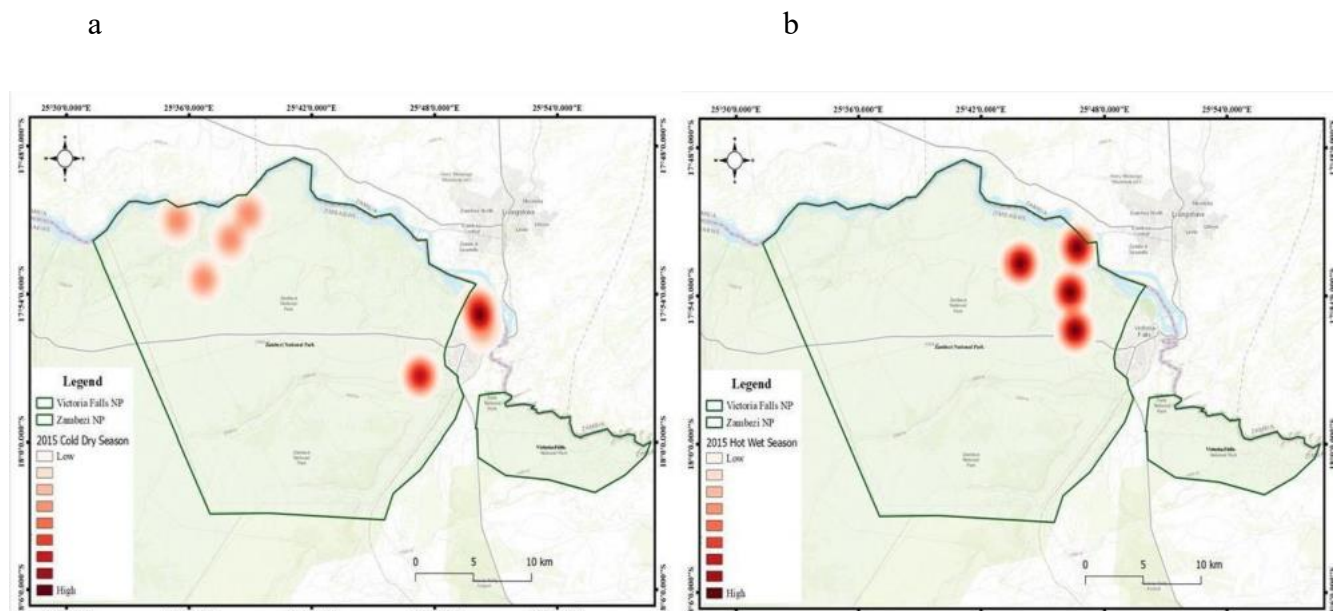


Figure 4.2: Wildlife mortality distribution in Zambezi and Victoria Falls national parks for 2015(a) cold-dry season (b) hot-wet season

In 2016, the pattern of wildlife deaths in the Zambezi and Victoria Falls national parks was broadly diffused (0.12-0.30 carcasses/kilometre squared) but with small spatial structure. As number of deaths grew, more events were observed showing possible emerging spatial clustering. However, although there was a shift in overall intensity, there was no dominant hotspot (Figure 4.3a).

The dry-season pattern strengthened and amplified the riverine pattern seen in 2015. Along Zambezi River the Kernel density is higher upwards of 0.89/km² otherwise in a measurable rise of concentrations. The hotspot was more continuous and spatially coherent (Figure 4.3b) revealing a higher spatial clustering within the riparian zone and limited spatial extent outside of it.

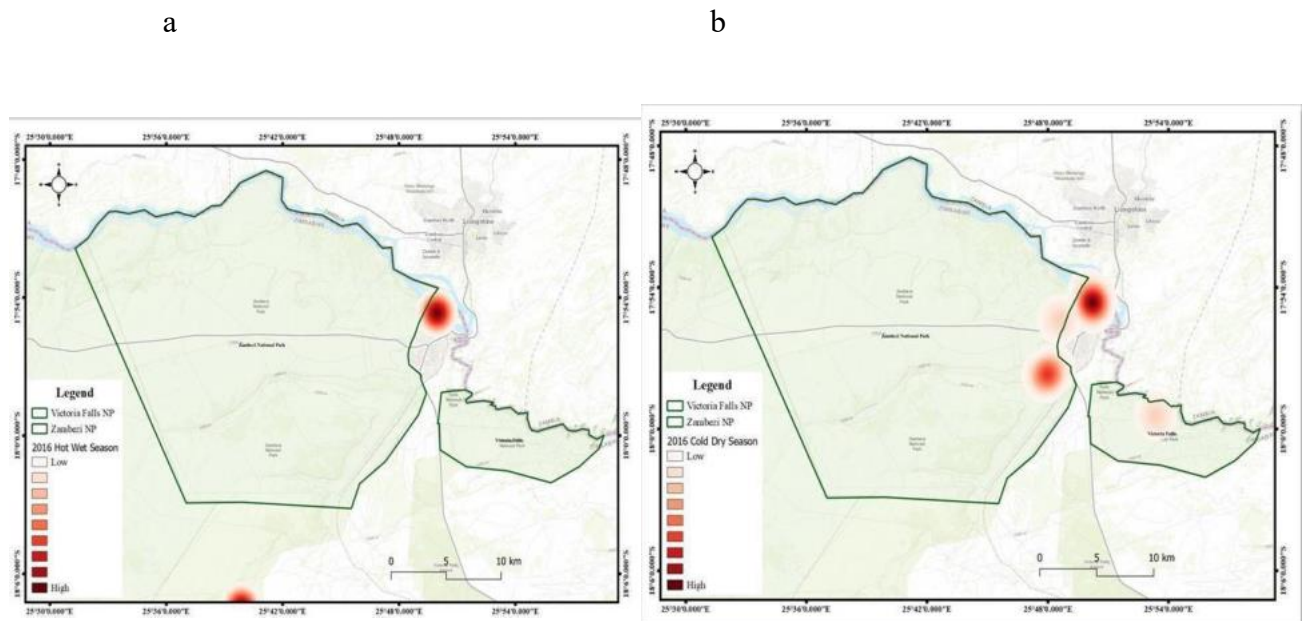


Figure 4.3 Mortality distribution in Zambezi and Victoria Falls national parks for 2016

(a) hot-wet (b) cold-dry.

In 2017 a significant shift from the previous season in the wet season was noticed. Mortality was organized along linear axis along the Zambezi River rather than spread out. The riverine corridor was a continuous band of moderate intensity with a seasonal persistence of mortality (Figure 4.4a) due to kernel density.

The earliest period studied was the most intense in terms of riverine hotspot density in 2017, reaching 0.92. Mortality was largely concentrated on the immediate river edge, forming a

sharply defined high intensity band (Figure 4.4b) While areas to the interior had little or no activity and further confirmed the strong spatial dependency on the river.

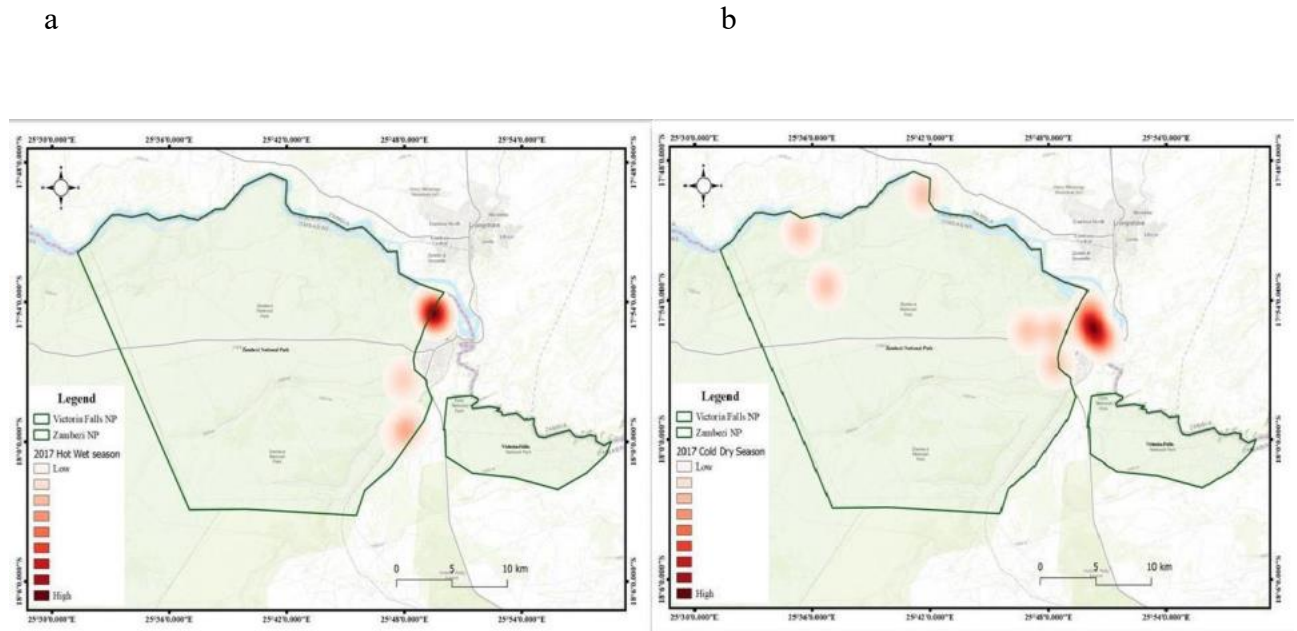


Figure 4.4 Mortality distribution of species across Zambezi and Victoria Falls national parks for 2017

(a) hot-wet season (b) cold-dry season

The highest mortality rate in the data set was 0.95 -0.98 carcasses per square kilometre found at kernel density values. The river sections were generally quite active, but this was pronounced as an area of activity (Figure 4.5a).

During the wet period there was a significant spatial change as the mortality hotspots emerged in the southern and central interior ZNP. These newly developed clusters were clearly outside of the historically dominant riverine area and showed an increase in the space into which mortality was spread (Figure 4.5b).

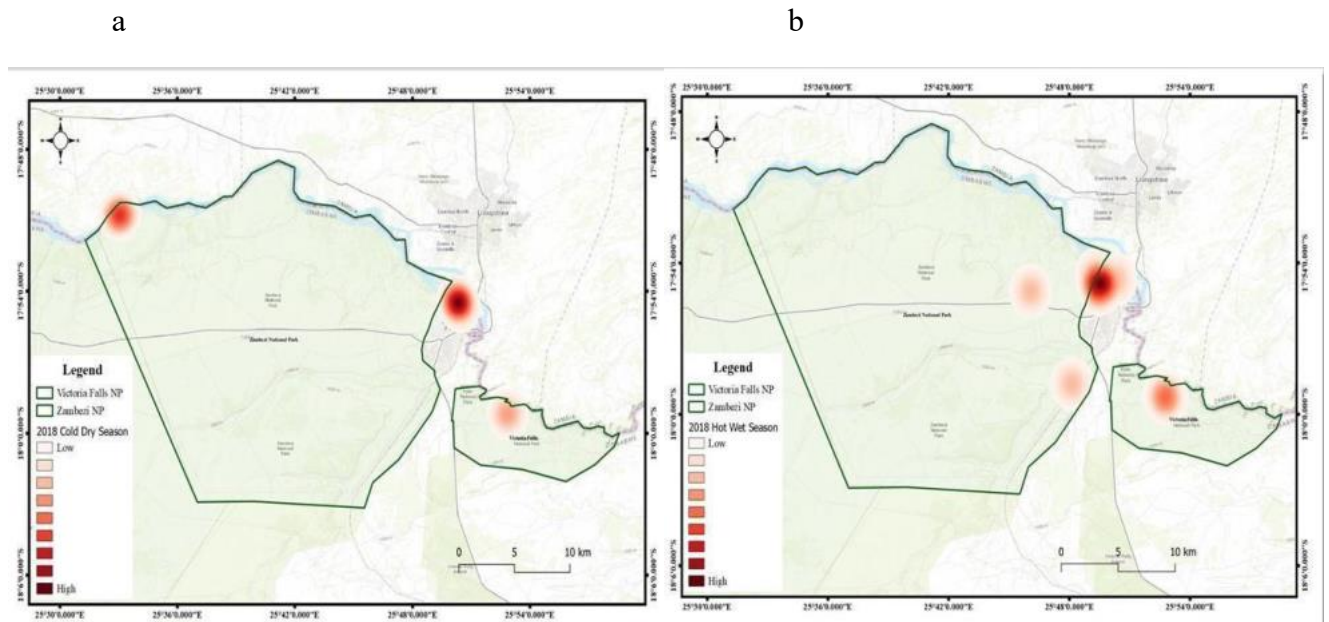


Figure 1.5 Seasonal mortality distribution for 2018 in Zambezi and Victoria Falls national parks

(a) cold-dry season (b) hot-wet season

The interior hotspots first identified in 2018 and persisted and intensified in 2019. Clusters within southern ZNP became increasingly well-defined with densities approaching those observed along the river. The spatial pattern took on a clear bimodal form, with dual peaks within the interior and riverine areas (Figure 4.6a).

Although the river was intensively along secondary drainage networks and boundary areas. Increased broadening of spatial extent accounted for a shift away from the broad river corridor that dominated the hot-wet season (Figure 4.6b).

a

b

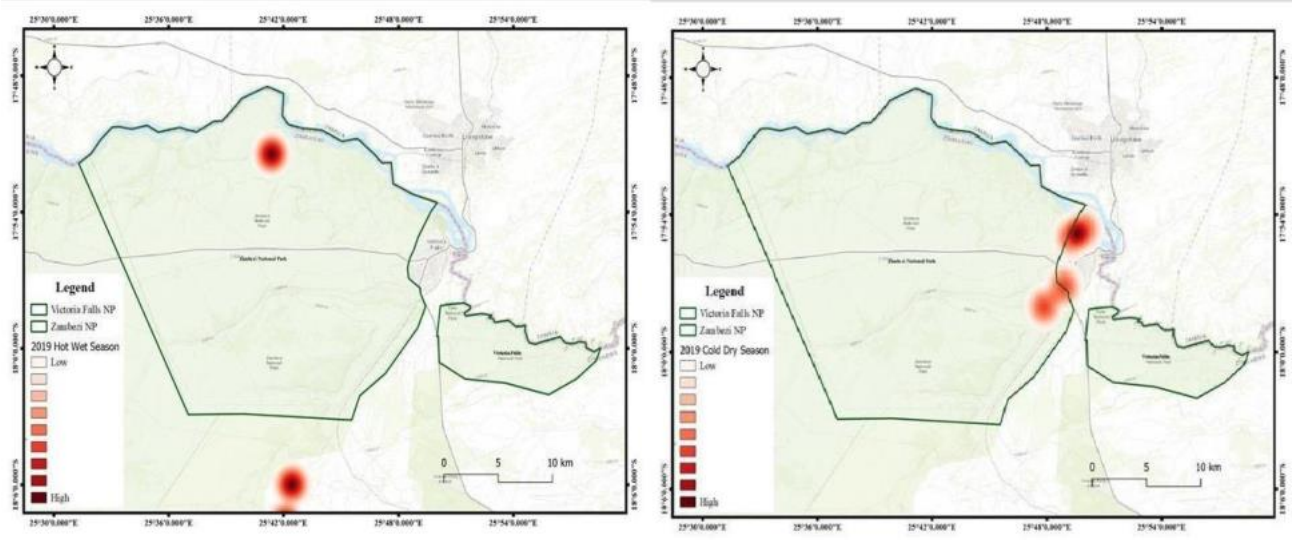


Figure 4.6 Kernel density mortality distribution map in Zambezi and Victoria Falls national parks 2019

(a) hot-wet season (b) cold-dry season

Mortality patterns spread out generally by the 2020 dry season. Mortality continued across various drainage basins and increased around the edge of the parks. The river continued to play a role, but now there was more than one dense focal area throughout the (Figure 4.7a).

Interior hotspots increased in size and magnitude in 2020 wet season and even outcompeted some riverine hotspot densities (0.70-0.85). The bimodal pattern continued but interior clusters became predominant and filled much of the interior of ZNP (Figure 4.7b).

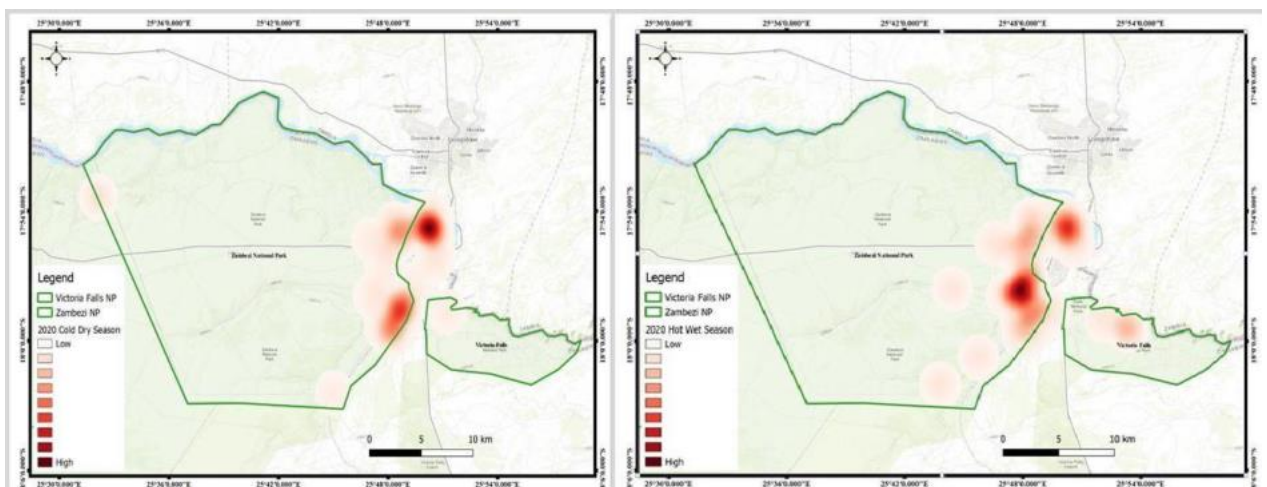


Figure 4.7 Mortality distribution across Zambezi and Victoria Falls national parks in 2020(a)cold-dry season (b)hot-wet season

In 2021 interior mortality reached its high level of dominance. A high intensity hotspot in southern ZNP became the most pronounced feature of the period. Riverine areas showed only moderate activity playing a secondary role in the overall spatial configuration (Figure 4.8a). The riverine intensity was a bit weaker (0.70) during the 2021 cold dry season, but it is still significant. Mortality also showed up where boundaries and interior drainage lines coincided with a generalized landscape- wide distribution (Figure 4.8b).

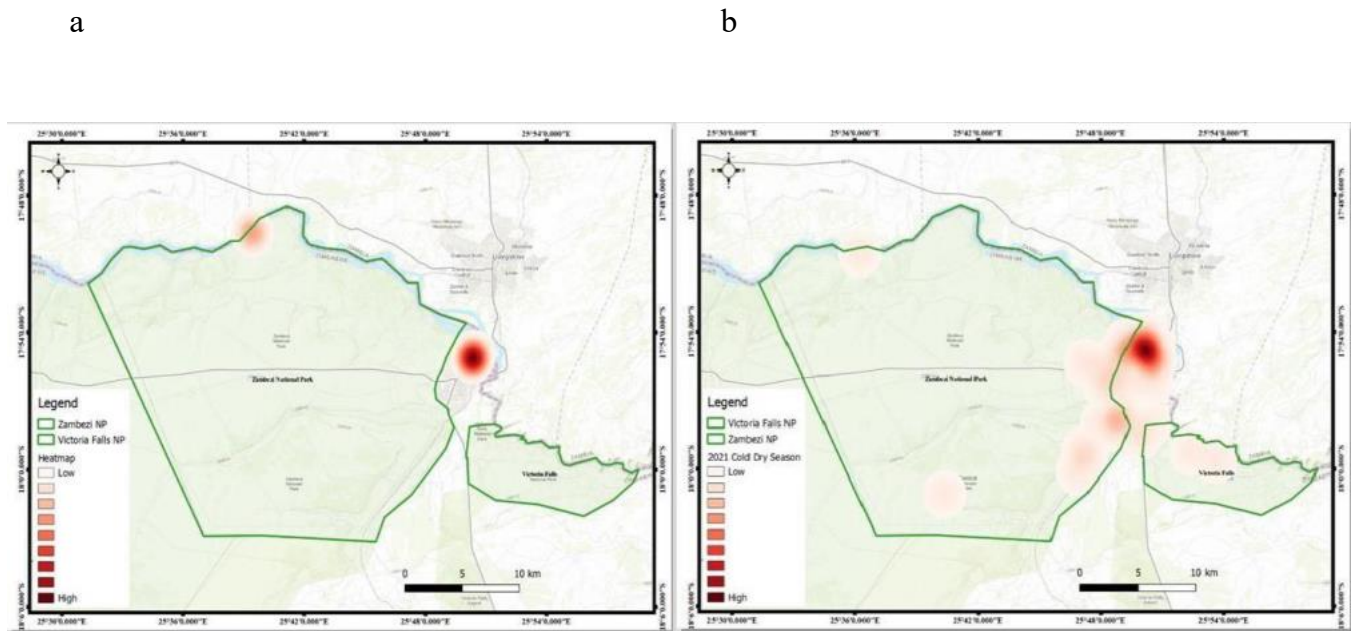


Figure 4.8 Seasonal mortality distribution across Zambezi and Victori Falls national parks in 2021

(a)hot-wet season (b) cold-dry season.

In 2022, the dry season adopted a multi-nodal pattern with active dry zones scattered across the landscape. High levels of activity were seen in the park boundaries and drainage lines and in areas that were previously not active. The river was clearly visible but no longer prominent (Figure 4.9a).

In 2022 wet season, spatial complexity became more complex. Plentiful high-density areas developed throughout the interior zones along the river bends and within sections of the river channel. The resulting pattern was fragmented with no single area clearly dominating the landscape (Figure 4.9b).

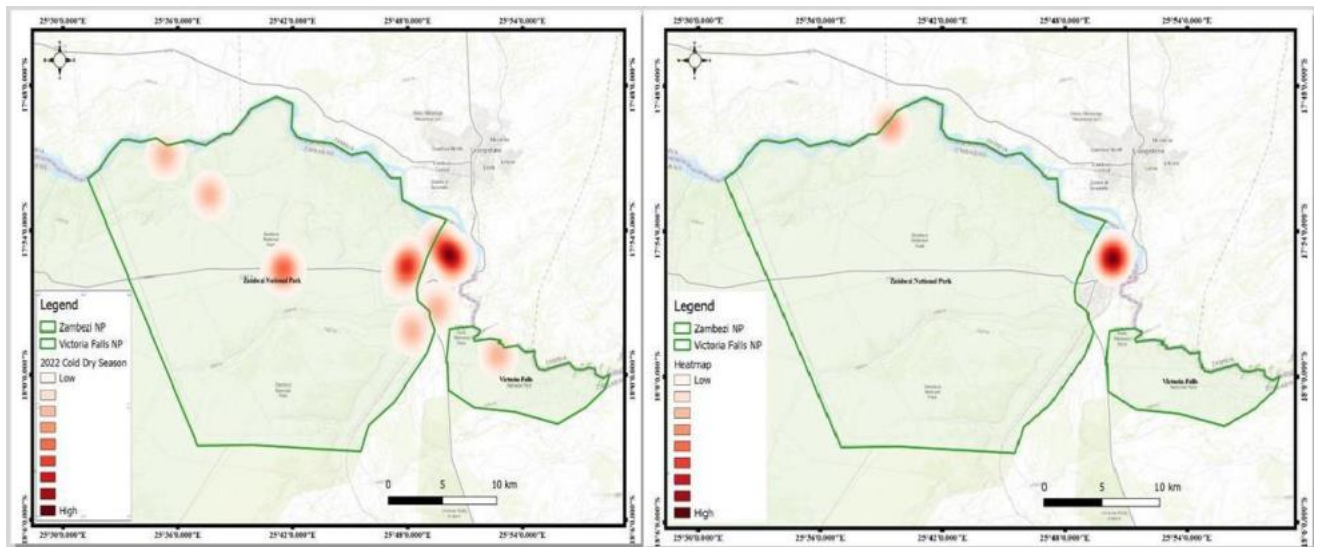


Figure 4.9 Seasonal mortality distribution in Zambezi and Victoria Falls national parks 2022

(a) cold-dry season (b) hot-wet season

Spatial complexity continued to increase in 2023. Numerous hotspots were distributed throughout the landscape, with prominent concentrations in interior zones, near park boundaries and along sections. No single spatial configuration prevailed across either season (Figure 4.10a).

The cold-dry season showed a similar multi-focal pattern, with mortality concentrated in several discrete areas across the landscape rather than forming a continuous riverine band in (Figure 4.10b). The river was identifiable as a mortality zone in the cold dry season but had become one of many rather than primary concentration areas.

a

b

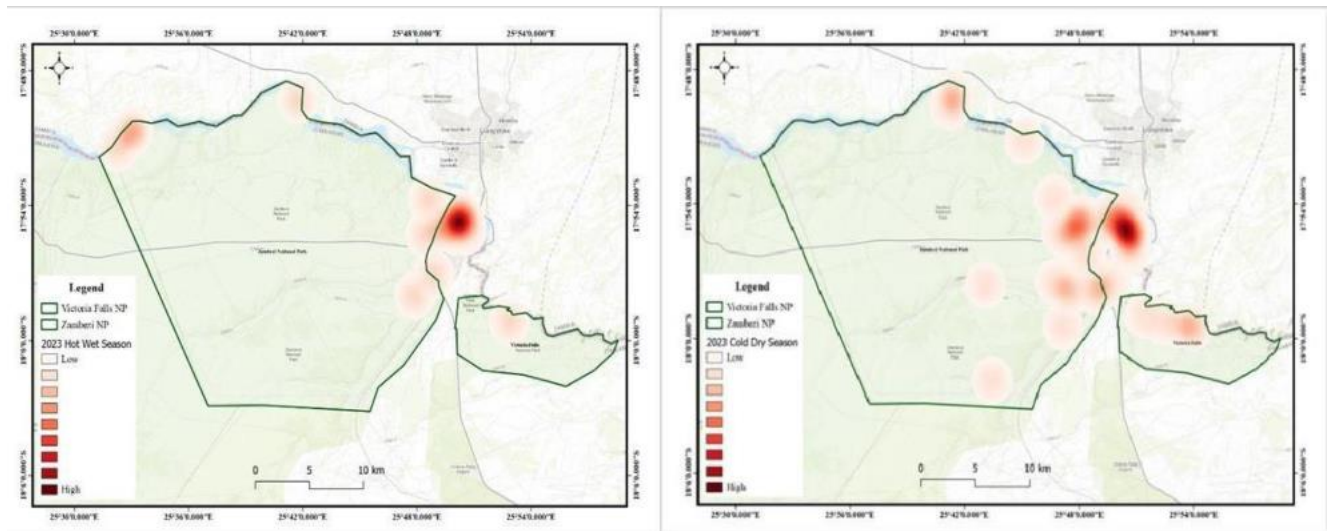


Figure 4.10 Seasonal mortality distribution in Zambezi and Victoria Falls national parks 2023

(a) hot-wet season (b) cold-dry season

The cold -dry season of 2024 showed a diffuse, multi-focal pattern, with mortality concentrated in several discrete areas rather than forming a continuous riverine band. The river remained visible as one of several mortality zones, but not the dominant feature. Boundary areas and interior locations showed comparable or higher intensities (Figure 4.11 a)

The hot -wet season continued the landscape wide distribution of mortality, with multiple high-density kernels scattered across ZNP and VFNP. Hotspots varied in size and intensity as shown in (Figure 4.11 b) but no single pattern or location dominated.

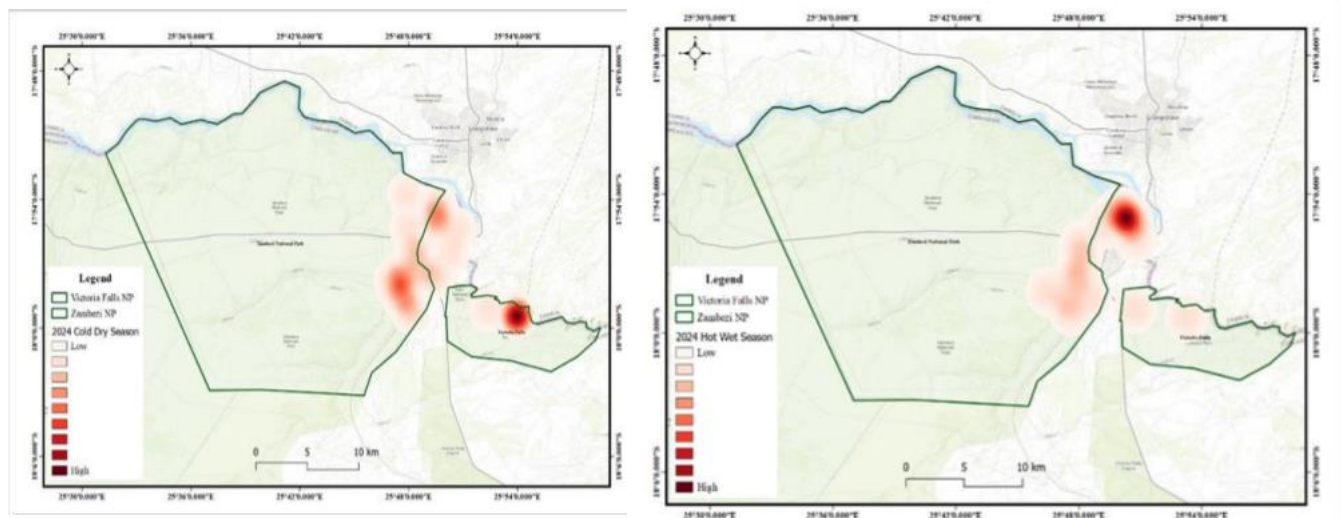


Figure 4.11 Kernel density mortality distribution of wildlife species in Zambezi and Victoria Falls national parks 2024 (a) cold dry season (b) hot -wet season.

The cold -dry season showed a multi-focal distribution, with mortality concentrated in interior areas, boundary zones and along the river. The continuous riverine band that characterized the early years of the study was absent, replaced by discrete hotspots at multiple locations (Figure 4.12a).

The hot-wet season of 2025 displayed a complex mosaic of mortality hotspots across the entire landscape. Multiple high- density areas were visible in interior zones, boundary areas and along the Zambezi River with no single pattern dominating. The distribution appeared richly multifocal (Figure 4.12b)

a

b

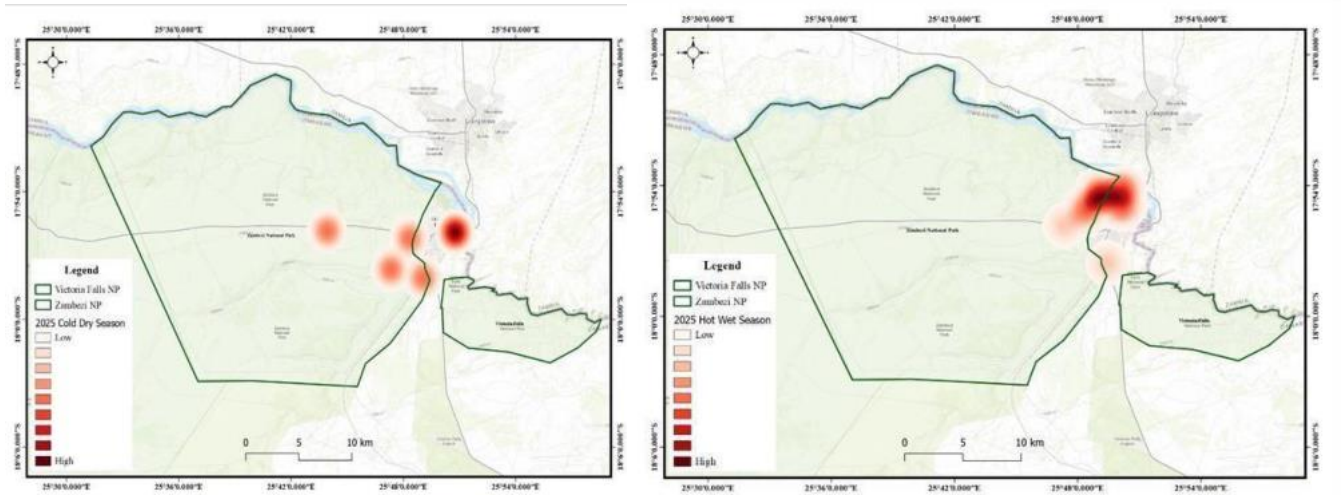


Figure 4.12 Seasonal mortality distribution in Zambezi and Victoria Falls national parks 2025

(a) cold-dry season (b) hot-wet season.

4.13 Spatial Distribution of Unknown Cause Mortalities

Carcasses where cause of death could not be determined, kernel density estimation revealed a strong concentration along the Zambezi River corridor and its major tributaries. Hotspots formed a continuous band following the main river channel, with smaller extensions along secondary drainage lines. Intensity was highest immediately adjacent to the river and diminished with distance from the channel as shown in (Figure 4.13). Interior regions of both parks showed very low densities of unknown cause carcasses appearing as cold spots.

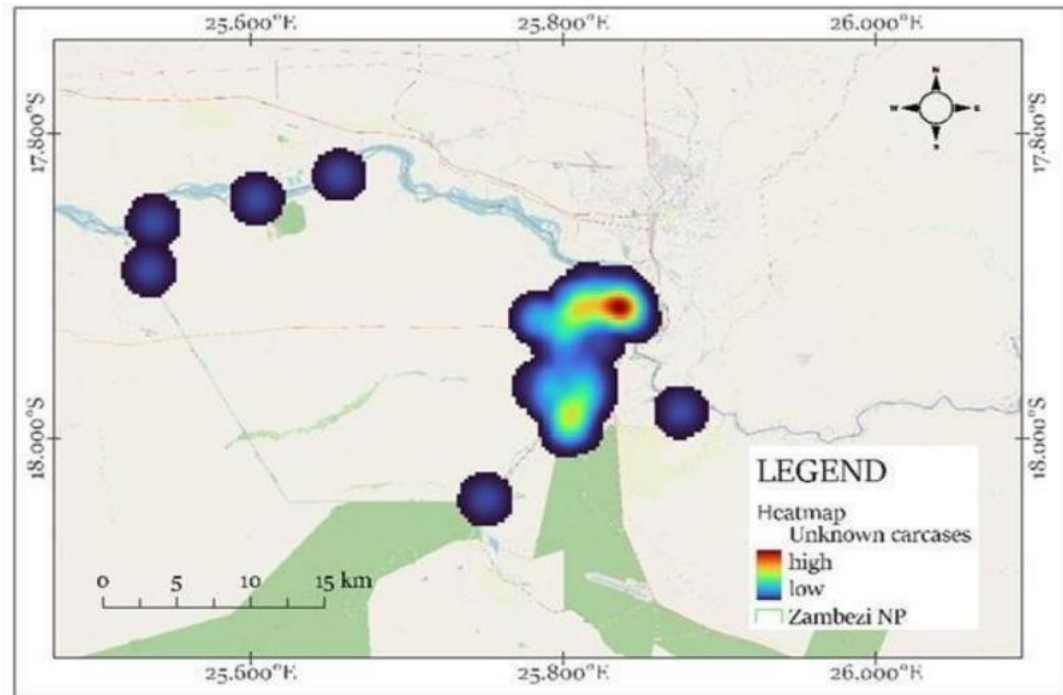


Figure 4.13 Kernel density estimation of carcasses with unknown causes of death in Zambezi and Victoria Falls national parks.

4.14 Spatial Distribution of Poaching Mortalities

Poaching related mortality showed a spatial pattern that differed substantially from that of unknown cause deaths. The most intense hotspots were concentrated in remote interior region of ZNP and most notably along international park boundaries. A band of high-density poaching mortality followed boundary lines, particularly on southern and western edges of the park system. Secondary hotspots emerged at confluence points of drainage lines at locations with topographic features offering concealment and in areas proximate to former settlement sites. Riverine areas showed comparatively lower poaching intensity than boundary and interior zones (Figure 4.14).

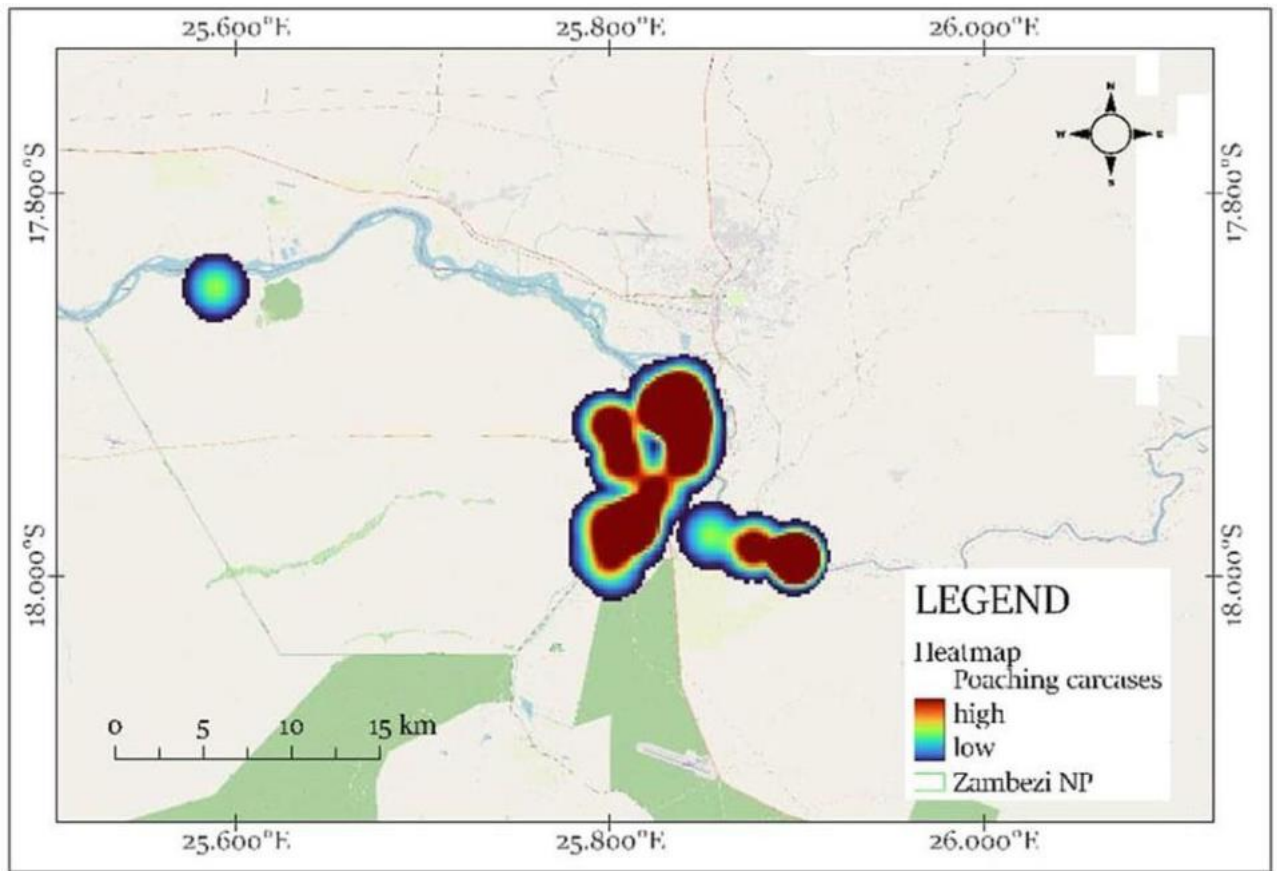


Figure 4.14 Kernel density estimation of poaching -related carcasses in Zambezi and Victoria Falls national parks.

4.15 Spatial Distribution of Predation Mortalities

Mortalities resulting from predation showed more dispersed pattern than either unknown cause or poaching related mortality. Predation hotspots showed strong association with ecotones transitional zones between habitat types particularly at woodland-grassland interfaces and along highest densities were areas with complex habitat and vegetation cover providing ambush opportunities. These locations with their complex vegetation structure offer optimal conditions for ambush predation. Predation hotspots were generally smaller and more numerous than those associated with other mortality causes reflecting the localized event specific nature of predation (Figure 4.15)

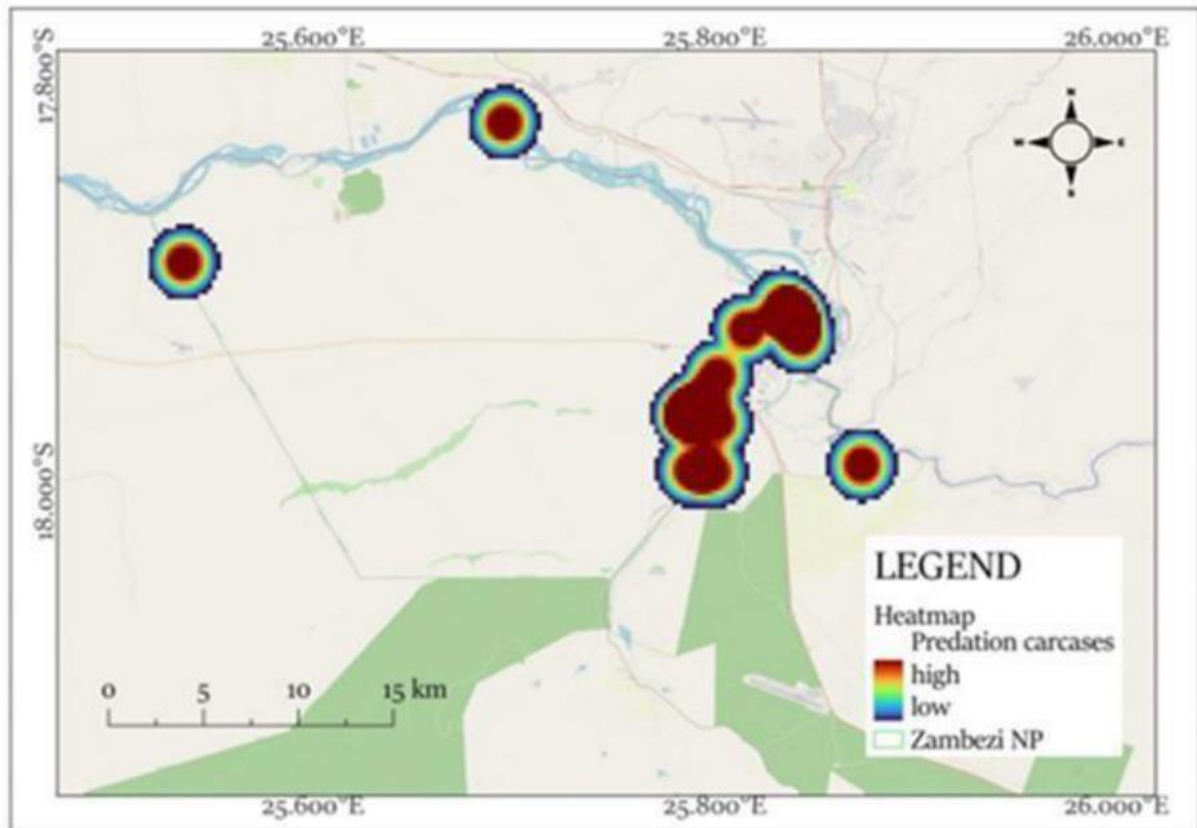


Figure 4.15 Kernel density estimation of predation -related carcasses in Zambezi and Victoria Falls national parks.

4.4 Temporal Trends in Carcass Counts (2015-2025)

The total annual count of carcasses from (2015–2025) illustrates distinct interannual variability in numbers. Counts were stable and low until 2019, with the lowest count being in 2016 with 30 carcasses and the highest again in 2019 with 76 carcasses. An obvious upsurge in number of carcasses appeared in 2020 with substantial high of 387 recorded carcasses, with second highest of 264 in 2021. Number of carcasses then showed a gradual falling trend from 180 in 2022 to 164 in 2024. A marked reduction to 68 carcasses was recorded in 2025 though this figure may reflect incomplete data entry for the final year of study (Figure 4.4).

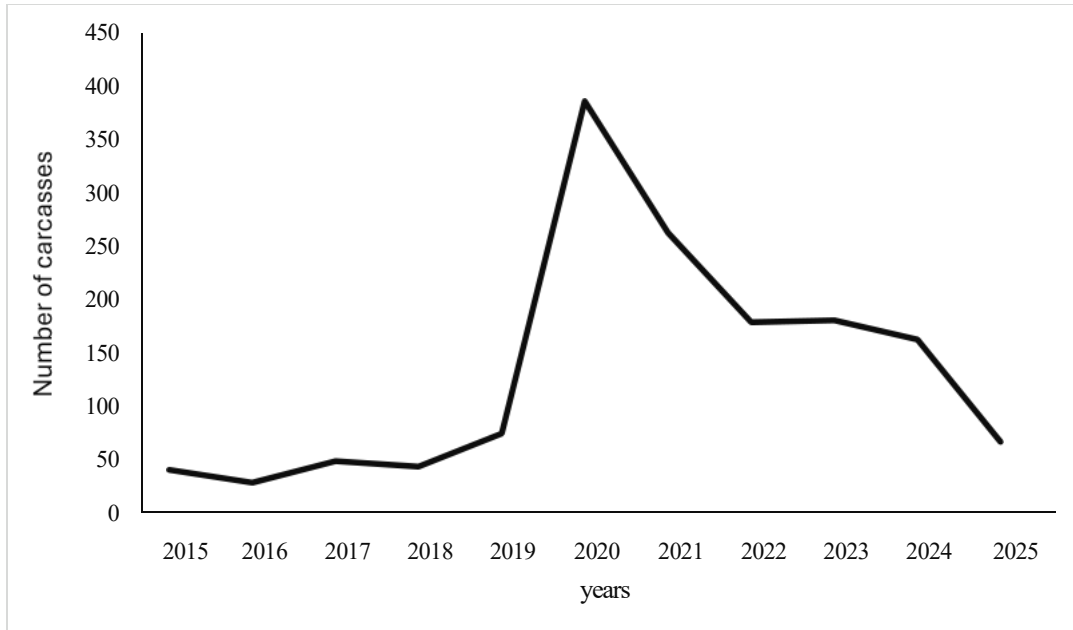


Figure 4.4 Annual number of carcasses recorded from 2015 – 2025

CHAPTER 5: DISCUSSION

5.0 Introduction

This chapter aims to critically analyse the results for research objectives and existing literature. The discussion is centred on providing an ecologically grounded explanation for spatial and temporal patterns of wildlife observed in Zambezi and Victoria Falls National Parks between 2015 and 2025. Particular attention is directed at unravelling the ecological factors influencing seasonal mortality, causes of mortality variation within the park system and shifts in long term mortality trends. The results are analysed for existing ecological concepts as well as in reference to similar research carried out in comparable savannah ecosystems.

The annual carcass counts over the eleven -year period (2015-2025) showed marked inter-annual variability, with a dramatic peak in 2020 followed by a gradual decline. The relatively low and stable counts between 2015 and 2019 ranging from 30 to 76 carcasses represent baseline mortality under normal conditions. The 2020 peak (387 carcasses) is extraordinary and warrants specific attention.

5.1 Carcass Counts by Cause of Death

Several factors may explain the 2020 peak. The region experiences severe drought conditions during 2019-2020 which increases mortality from starvation, dehydration and disease in wildlife populations (Dunham, et al., 2010). Second, the COVID19 pandemic led to reduced tourism and potentially reduced park patrols and anti-poaching activities which could have increased poaching mortality and reduced detection and reporting. The pandemic has disrupted carcass removal and management, leading to a backlog of reporting. Furthermore, a disease outbreak, for example anthrax which is known to occur in the region could have caused mass mortality events.

The elevated counts in 2021 (264 carcasses) indicate that the factors driving high mortality persisted into the following year, though with declining intensity. The gradual decline from 2022 to 2024 suggests a return towards baseline conditions, though counts remained above pre-2020 levels. The significant reduction to 68 carcasses in 2025 indicates genuine improvement but it is best to note that this reflects incomplete data for the final year of the

study period. The cause of death distribution showed that natural causes (n=138) and problem animal control (n=10) were most frequently recorded categories followed by poaching (n=214)

5.2 Seasonal Mortality Distribution Dynamics

5.2.1 Early Period Riverine Concentration (2015-2017)

The high concentration of wildlife mortality along the Zambezi River corridor during the cold-dry seasons of 2015 and 2017 reflects the critical ecological role of perennial water sources during periods of water stress. Kernel density statistics of 0.75 to 0.92 within 500 meters of the riverbank reflect a high mortality risk with distance to the river. In support of (Cain & Macandza, 2012), who cited that water-dependent ungulates tend to aggregate around perennial water bodies during dry seasons, this study observed the same trend and a resulting increase in local population size and mortality risk due to multiple co-occurring factors including predators and physiological stress.

The formation of a linear band running parallel to the river rather than a broad dispersed cluster underscores the role of Zambezi as an ecological lifeline, a narrow strip of viable habitat in an otherwise increasingly arid landscape. Similar patterns have been documented in Hwange National Park, where artificial water points created localized water points created localized hotspots of herbivore activity and associated predation (Jammes, Charbonnel, Madzikanda, & Fritz, 2016). However, the consistent riverine concentration in ZNP and VFNP persisted across multiple years, indicating that natural river systems create more stable mortality hotspots than artificial water points which can be managed or rotated.

The first period was marked by dry and hot season distributions that had scattered low intensity with isolated hot spots over the various parts of the parks. That is why contrast in seasons indicates the presence of water sources and newly grown grass in the wet season all over the landscape allowing the wildlife to disperse in essence. This is in line with the resource hypothesis that argues that animal distribution is dependent on the pattern of dispersion of key resources (Braak & Prentice, 1988)

5.2.2 Transition Period and Emerging Interior Hotspots (2018–2019)

The 2018 dry season was the most intense riverine hotspot ever observed for the entire study period with kernel densities of (0.950-0.98) at a specific bend of the Zambezi River. This very high concentration could be due to several factors, extreme dry season, depletion of resources in a specific area and higher predator activity at this site. Not all areas of the river are equally vulnerable and geomorphological characteristics such as shallows, bends and crossing points can focus wildlife movements and make certain areas vulnerable.

During the 2018 wet season a significant spatial change occurred with the emergence of mortality hotspots in the southern and central interior areas of ZNP. This represented the first significant shift from traditional riverine patterns and was an increase in the spatial scale of mortality. The presence and increase of these hotspots in 2019 density near to the river (0.60–0.75) indicates that more interior areas of the region become dangerous for the wildlife (Gift, et al., 2020). In 2019, the spatial structure was very clearly bimodal with two clusters in the interior and riverine areas.

This bimodal distribution may reflect changes in wildlife distribution patterns, potentially driven by factors such as establishment of new artificial water points in interior areas (Muposhi, E., & Muboko, 2024), changes in vegetation structure or fire regimes affecting habitat quality (Chamaille-Jammes, Mandinyenya, & Fritz, 2026) , shifts in predator territorial behavior (ZPWMA, 2024), or anthropogenic disturbances along the river corridor pushing animals into interior areas. Similar shifts in habitat use have been documented for sable antelope in ZNP, where disturbance from the Victoria Falls-Kazungula highway and helicopter flights caused animals to move west towards Matetsi Safari Area (Muposhi, et al., 2016)

5.2.3 Late Period Landscape-Wide Distribution (2020–2025)

The most striking finding of this study is the progressive shift from a riverine concentrated mortality pattern to a landscape-wide, multi-focal distribution by the end of the study period. From 2020 onwards, mortality extended along multiple drainage networks, intensified near park boundaries and established high-density clusters in interior zones that sometimes-exceeded riverine densities. The 2020 wet season saw interior hotspots expand markedly in extent and intensity covering large parts of the southern and central ZNP.

By 2021, interior mortality achieved peak dominance, with a high -intensity hotspot in southern ZNP becoming the most pronounced feature of the period. Riverine areas played only secondary role in the overall spatial configuration. The 2022 and 2023 seasons exhibited complex multi-nodal patterns with multiple high-density areas across interior zones, boundary regions and river sections, with no single area clearly dominating the landscape.

This shift in wildlife patterns stems several potential factors. It reflects genuine changes in wildlife distribution, possibly driven by long-term changes in water availability, vegetation or anthropogenic pressures (Crosmarty, Chamaille-Jammes, & Fritz, 2012). It further indicates improvements in detection effort in interior areas over time, though the consistent annual patrol protocols make this less likely (Spencer, M., & Doormaal, 2021). The shift represents actual increase in mortality drivers for example (poaching, predation and disease) in previously low risk areas (Micheal, Tempe, & Schmidt, 2020). During the COVID-19 era 2020-2021, a decline in tourism and potential shifts in poaching behavior significantly altered mortality dynamics and sighting frequencies (Duffy & Smith, 2021). The rise in peaks of total carcass sightings from 2019(76 carcasses) to 2020 (387 carcasses) signals a five times increase and corresponded with drought, disease and even management operations being disturbed in the COVID 19 period, exceeding 2021 (264 carcasses), with a declining trend thereafter from 2022 to 2024. The decrease to 68 carcasses in 2025, could be due to lack of sightings or less detection at time of entry.

5.3 Spatial Distribution by Cause of Death

5.3.1 Unknown -Cause Mortality

The focus of carcasses along the Zambezi River and its large embankments is that carcasses within this zone may be less definitive than other zones for cause accuracy. This pattern reflects several possibilities, carcasses in the riverine areas decompose more rapidly due to high humidity and scavenger activity, obscuring cause of death, riverine mortality results from drowning, crocodile predation or other causes that leave less distinctive evidence and examination of riverine carcasses are more challenging due to terrain and access limitations (Wilson, J., & Creel, 2017). The highest intensity immediately adjacent to the river environment itself as a factor in either mortality occurrence or cause determination difficulty.

5.3.2 Poaching -Related Mortality

The spatial pattern of poaching -related mortality differed from unknown cause mortality, with the most intense hotspots in remote interior regions of ZNP and along international park boundaries. The band of high-density poaching mortality following boundary lines, particularly on southern and western edges of the park system, indicates that park borders are areas of elevated poaching risk. This finding is consistent with studies across Africa that document increased poaching pressure near protected area boundaries, where access is easier and law enforcement presence may be lower (Muposhi, et al., 2016); (Lindsey, Andrew, Balme, Becker, & Zisadza-Gandiwa, 2013)

Secondary hotspots at confluence points of drainage lines, areas near former settlement sites and locations with topographic features providing cover suggest that poachers use landscape features strategically. Drainage lines provide concealment and travel routes, former settlement sites offer access to existing paths or resources, and topographic features provide vantage points. The relatively lower poaching intensity in riverine areas compared to boundary and interior zones contrasts with the unknown cause pattern, indicating that riverine mortality is predominantly non-poaching related.

The total of 138 poaching related carcasses recorded over eleven-year period likely underestimates true poaching mortality as many poached animals may be removed from the park entirely or are detected but classified as unknown when evidence is insufficient.

5.3.3 Predation -Related Mortality

Predation mortalities showed more dispersed pattern than either unknown or poaching mortality, with hotspots strongly associated with ecotones transitional zones between habitat types particularly at woodland- grassland interfaces and along minor drainage lines away from the main river. This pattern reflects predator hunting strategies; ecotones provide ambush opportunities, cover for stalking and increased prey encounter rates (Preez, Hart, & Loveridge, 2015). The smaller size and greater number of predation hotspots compared to other mortality causes reflects the localized nature of predation events, which typically involve single kills or small groups rather than mass mortality events.

The overlap with riverine areas was limited, suggesting that while predators do hunt near water, the highest predation risk occurs in habitat transition zones that offer optimal hunting conditions. These findings shed light on understanding the way predators and their prey affect each other in the environment of fear (Schmitz, Suttle, Ripple, & Luciana, 2010), as prey animals must balance the need for water and food with the risk of encountering predators.

5.4 Temporal trends in Mortality

The 2021 increased figures (264 carcasses) indicate that the causes of high mortality include issues of conflict between humans and wildlife in a human settlement area and adjacent infrastructure for tourism. Natural mortality is so extensive that it is important for the population underpinning the observed demographic changes level of mortality did not rise again after 2020. Genuine trends in mortality rose in 2023 and started to fall after 2021. It is possible that the population re-established itself and mortality rates reduced between 2022(180) and 2024 (164) although counts revealed changes in death patterns with animal control problem cases (n =10) and natural (n =138) being improved but this also shows that data from the last year of the study are incomplete. It must be noted with reason unknown (n =221) and accident (n =27). Animal control deaths represent a major issue in drought, disease and starvation. These are examples of natural abiotic factors that regulate wildlife populations and can cause large swings in numbers. To develop effective conservation plans and ensure the long-term survival of affected species, these factors must be frequently monitored.

The highest mortality rate in 2020-2021 emphasizes the vulnerability of natural forecasts for Southern Africa show an increase in the frequency and severity of droughts suggesting that mass deaths will happen more frequently. Adaptive strategies including readiness and extra water supply should complement management strategies. Populations to simultaneous stressors (disease, drought and reduced management capacity). Future climate provision strategies, implementation of livestock vaccination and treatment programs, disease detection and surveillance and an array of animal control measures. Deaths indicates ongoing human-wildlife conflict that requires mitigation measures such as improved fencing, early warning systems, and community-based conflict resolution programmers.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusions

- Wildlife deaths moved from being concentrated near the Zambezi River (2015-2017) to spread across the entire landscape by 2025.
- Fatalities from unknown causes remained river-focused, while poaching shifted to remote interior zones and park edges.
- Mortalities from predation occurred most frequently in edge habitats (ecotones) and near natural drainage lines.
- Mortality spiked in 2020 and remained high through 2021, likely due to the triple threat of drought, reduced park oversight during the COVID 19 pandemic.
- Poaching and unidentified causes were the primary drivers of wildlife loss throughout the study.

6.2 Recommendations

- Schedule more law enforcement patrols in remote interior zones and park edges (poaching hotspots).
- Improve water security to better handle future droughts.
- Frequently engage community to lower human wildlife friction.
- Launch permanent year-round mortality tracking system to feed spatial data directly into park management decisions.
- Collaborate more closely with partners across the Kavango- Zambezi Transfrontier Conservation Area.

APPENDICES

WILDLIFE MORTALITY FIELD OBSERVATION FORM
Project: spatial analysis of wildlife mortalities

Study site (park): _____ Date: _____

Primary Observer: _____ Weather conditions: _____

GPS coordinates X	GPS coordinates Y	SPECIES	SEX	Age class	Estimated time of death	Suspected cause

Reference code

Sex: M= Male, F= female, U= unknown **Age Class:** A = adult, S= sub adult, J= juvenile

Time of death (carcass state): 1 = fresh (wet), 2=recent ((dry skin), 3=old (bleached bones),
4=scattered fragments

CAUSES: poaching, snaring, predation, natural, PAC, accident, poisoning and unknown

Field officer signature

Verified by supervisor

Philliper Simakani

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