# *African Elephant Corridor Planning & Design:*

## A study of Namibian geography, cultures, and wildlife within the Kavango Zambezi Transfrontier Conservation Area

*Kelly Matheson*
*June 2012*

# African Elephant Corridor Planning & Design: A study of Namibian geography, culture, and wildlife within the Kavango-Zambezi Transfrontier Conservation Area

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# Acknowledgments

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I would also like to acknowledge my best friend, Valentina. Even though she is a busy woman herself, she volunteered her time to read my report and help me fix it up. Thanks, girlfriend!

# Abstract

This project investigates current issues and methods for wildlife population growth, especially concerning African savannah elephants (*Africana loxodanta*), within the Kavango-Zambezi Transfrontier Conservation Area (KAZA-TFCA). The KAZA-TFCA is the world's largest protected lands project, and lies in Namibia, Zambia, Zimbabwe, Angola, and Botswana. Its objectives are to simultaneously achieve economic and environmental stability with projects throughout this region. Wildlife and tourism play key roles in the economic plans for the KAZA-TFCA, making managed and protected habitats critical for development strategies. Elephants, the focal species for KAZA-TFCA projects, are faced with increasing populations, but the amount of existing land is inadequate for this growth to be sustainable. This population growth may cause them to strain the habitats that they have access to; thus, elephants in this region are in dire need of more space and options for routes of travel. The Caprivi region of Namibia is within the KAZA-TFCA and is faced with an increasing elephant population, agricultural human-elephant conflict, and land use related issues. Conservancies, which are a form of community-based natural resource management, are a fairly unique feature that Namibia uses for local governance over wildlife and natural resources. The Wuparo Conservancy is one of many in the Caprivi region, and lies between Mudumu and Mamili National Parks. Within the Wuparo Conservancy is where this project seeks to provide wildlife management options and future plans for unobstructed wildlife passage.

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# *Introduction*

*"Since the remote stages, the elephant, on account of his size, his sagacity, and his wonderful docility, has attracted the notice, and excited the admiration of philosophers and naturalists, both ancient and modern; and few travellers into Asia or Africa, have omitted giving some account of him."* - **Sir Joseph Banks, 1799**

# The Issue

Given the existing allocation of protected lands, the steadily increasing populations of African savannah elephant (*Africana loxodonta*) – referred to as "elephant" for the rest of the paper – are unsustainable. Elephant numbers have been increasing since the international ban on ivory trade in 1989, but their habitat is continually shrinking (Sierbert, 2011). African elephants are ecological drivers, meaning they directly and/or indirectly cause changes in an ecosystem. This characteristic can make them a stress to biodiversity when population density is high.

Furthermore, much of Africa experienced economic growth and an increase in agriculture before 1989 (von Gerhardt-Weber 2011). Humans have taken away land used by elephants, which leads to crop-raiding (when wild animals move from their natural habitat onto agricultural land to feed on the produce humans grow for their own consumption) and unstable livelihoods for farmers. In addition to these issues, elephants and humans occasionally kill each other because of these agricultural conflicts.

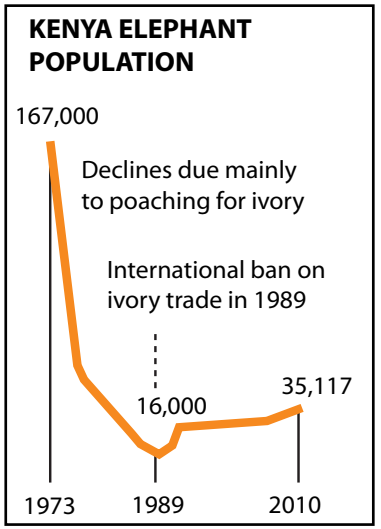



Figure 1.1 *The population trend in Kenya is similar throughout the continent.*

# Current Methods

Farmers have explored methods to deter crop-raiding elephants, but most of the techniques do not get to the heart of this issue, which is that elephants need more land. These methods can be categorized into aggressive and passive defense. Aggressive defense methods include crop guarding, drum beating, burning fires, hurling rocks, praying, shooting with rubber bullets, and chili pepper bricks (when burned they sting the elephants' sensitive nasal passages). Passive defense methods include putting up fences (which are easily taken down, even electric fences) and alarm bells. Wildlife managers use different tactics, which include culling (purposeful killing to control population size), translocation, and birth control. Culling and birth control are controversial, and translocation can only move 14 elephants at a time in addition to being expensive (von Gerhardt-Weber, 2011; Schulman, 2006).

Figure 1.2 *A Kenyan elephant has been sedated for translocation, a difficult and expensive process.*

# Personal Interest

I became interested in human-elephant (HEC) conflict after reading a *National Geographic* article, "Orphans No More." It was very touching to read about the young elephants' sensitivity to different social environments and how attached they become to caregivers. I find it amazing these elephants continue to return to the caregivers for the rest of their lives to get injuries taken care of or to show off new calves. I have also been amazed to read about elephants that come back to villages to take revenge for dead relatives, and even eat humans in fury over their lost ones. Their psychological breadth and their varied interactions with people (good and bad) are, as far as I know, unique to the animal kingdom.

The article touched on how elephants move through people's crops because they may have no other route to the next habitat patch, or because new plantations are placed in historical corridors. I immediately thought of the landscape ecology class I had taken a couple years ago and how 'simply' this problem could be solved!

In short, HEC deals with a fascinating animal, land use, and a culturally and economically complicated problem for humans – all of which are stimulating topics for me.

Figure 1.3 *A caretaker with orphaned elephants. From the article "Orphans No More."*

# Objectives

*"Rising numbers of elephants in protected areas, ecosystem degradation, and human-elephant conflict are issues of concern to elephant managers, conservation biologists, local communities and political leaders."* - **Assessment of South African Elephant Management, 2008**

## General

Provide a wildlife corridor connecting Mudumu and Mamili National Parks in Namibia. African savannah elephants (*Loxodonta africana*) are the focal species of the corridor, which will provide additional space for elephants to travel outside of protected lands between core areas. This will also alleviate the impact that high elephant density has on biodiversity.

## Specific

Reduce crop-raiding, HEC, and economic loss through designated travel space for African savannah elephants. Additional space will also reduce the need for wildlife managers to resort to culling.

# *Corridor as a Solution*

*"Increasing numbers of elephants are causing major changes to the vegetation of the park, destroying trees and reducing habitat available for other wildlife species. When elephant numbers go up, tree numbers go down. At what point do you want to stop that?"* - **Dr. Hector Magone, Conservation Services Director of South African National Parks**

Both elephant and human populations are growing in Africa, and HEC will only worsen if action is not taken (von Gerhardt-Weber, 2011). Aside from HEC, elephants significantly impact their environments through intense eating and foraging. When relative elephant abundance is high, they disturb other living things in their ecosystems. Many reserves are inadequate for sustaining increasing numbers of elephants, and wildlife managers have already seen the results with loss of plant populations and decreases in other animal species (Schulman, 2006).

Aside from wildlife management tactics, methods for averting crop-raiding do not work because elephants are extremely intelligent and adaptive. Fences, bells, fires, etc. may work at first, but elephants quickly learn that these tactics can be overcome or will not actually harm them. A couple of methods gaining more attention are chili pepper bricks and appropriately spaced bee hives (elephants are afraid of bees). But in the end, elephant population growth and health will depend on a holistic approach, rather than a symptomatic approach (von Gerhardt-Weber, 2011; Schulman, 2006).

Figure 3.1 *As ecological drivers, elephants directly impact their environment.*

Furthermore, the issue is a spatial one, rather than a numerical one (Hoare & du Toit, 1999; Schulman, 2006). Humans have encroached onto historical elephant ranges, and they and their livestock compete with elephants for water (Sukumar, 1990). The methods villagers use for dealing with elephants in human settlements work some of the time, and definitely do not work in the long run. People are left with few options for handling HEC, but humans are in the elephants' range and must be the ones to adapt.

The literature repeatedly shows that elephants need more space (von Gerhardt-Weber, 2011; Harris et al., 2008). Without the space they need for their home ranges and core areas, local abundance will become very dense and they will strain ecosystems and human communities.

*"We advise that a promising approach for minimizing these issues is by providing elephants more space. This strategy would re-establish linkages between elephant populations, and therefore facilitate elephant movements, ease pressure on habitats, enable more natural population regulation, and reduce conflicts when planned in concert with local communities."* - ***Katharina von Gerhardt-Weber, 2011***

# *Corridor Design Theory*

*"Although [protected areas] are the cornerstone of biodiversity conservation efforts, they are insufficient in scale and number - either on the land or in the sea - to significantly address this gap in human management of landscapes and the processes and life they contain. Linkages are the vehicle for benefits to be provided beyond park boundaries."* - **Andrew F. Bennett, *Linkages in the Landscape***

# Corridor Benefits

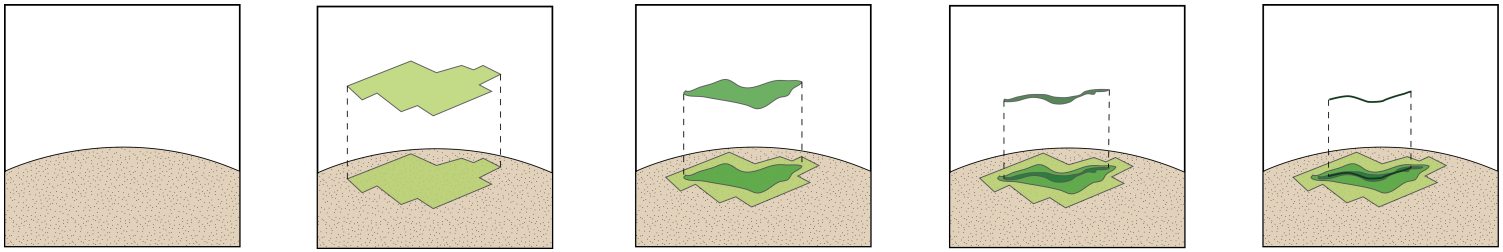
For elephant population growth to be sustainable over time, they will require an increase of their current range (KAZA-TFCA Website; von Gerhardt-Weber, 2011). But a wildlife corridor, a strip or band through which nondomesticated organisms may move (especially between areas of habitat), would benefit fauna and flora other than elephants. The elephant's large area requirement will overlap the needs of most other organisms, making them a natural choice for a focal species. Other animals in Wuparo include lions, buffalo, leopards, roan, tsessebe, kudu, duiker, reedbuck, blue wildebeest, and warthogs (NASCO Website; Hellmund & Smith, 2006).

Figure 4.1 *Wildlife corridor for reptiles and amphibians near agricultural lands.*

Wildlife corridors enable natural processes to take place, through which ecosystem services are provided. These services include functional connectivity, which is the flow of individuals and their genes among habitats and populations; daily and seasonal movement; rescuing small populations from extinction; a long distance range for adaptation to new factors, such as climate change; serving as habitat for certain types of species; providing a barrier or filter separating areas; and a source of environmental and biotic effects on the surrounding matrix (Hellmund & Smith, 2006; Forman & Godron 1986).

# General Design Process

Figure 4.2 *Corridor design process adapted from Hellmund and Smith's (2006) ecological greenway design method.*



| Stage 1: Identifying potential issues, stakeholders, and preliminary goals. | Stage 2: Defining a broad region to study. | Stage 3: Selecting nodes and swaths. | Stage 4: Selecting alternative alignments and setting widths. | Stage 5: Implementing and managing. |
|---|---|---|---|---|
| **In this booklet under:** | | | | |
| Introduction<br>Objectives | Site Selection | Site Selection | Site Analysis & Inventory<br>Master Plan | Master Plan |

Creating a corridor design can be a daunting and complicated task, which is why following a few general guidelines can narrow down the project focus and lead to the appropriate steps. It is the designer's job from here to modify the steps to suit the specific issue. There are no hard and fast rules for corridor design because every situation is going to be different and often lacking in conclusive research. Yet, experienced planners and designers have come to the same general conclusions about methodology (Hellmund & Smith, 2006).

# Design Aspects

A specific width can not be recommended for a corridor, but most agree that the wider the better. A larger area will have a larger diversity of habitats and species, as well as reduced edge effects. A network of corridors are better than one corridor, which helps make sure that one passage does not get overused with time. Where there are roads, GPS technology can be used to locate areas with the highest occurrence of roadkill. This information can determine where wildlife crossings should be built (Hellmund & Smith, 2006; Forman & Godron, 1986).

# Human Integration

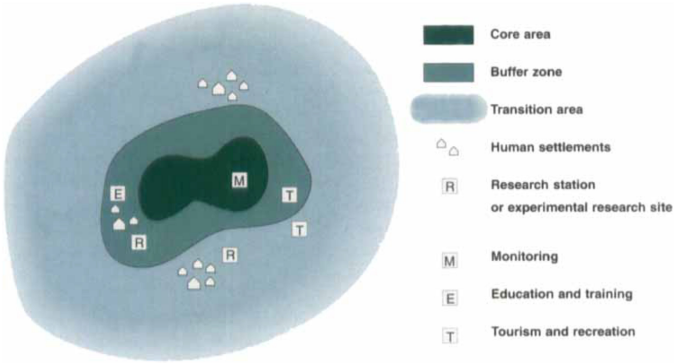



Figure 4.3 *Conceptual layout of a bioreserve.*

Michel Batisse (1997) explains that bioreserves (areas of ecological hotspots) will incoporate a, "... *conservation function*, which aims to preserve landscapes, ecosystems, species, and genetic variations; the *development function*, which concentrates on fostering social, cultural, and ecologically sustainable economic and human development to benefit local peoples; and the *logistic support function*, which facilitates research, monitering, demonstration projects, education, and training ...," (page 12). Although this corridor may not be an ecological hotspot, the desires of the community and the outlook for Namibian economic development fall in line with Batisse's core bioreserve elements. A planned park, protected area, bioreserve, etc. is not likely to work unless people play a role in its maintenance and longevity.

These three elements, seen in Figure 4.3, are dispersed radially from the area of highest interest. When the management goal is to maintain the natural landscape, human activity must be spread out, low in intensity, and inversely proportional to the sensitivity of each landscape element (Forman & Godron, 1986).

# *Site Selection*

*The KAZA TFCA is home to the continent's largest contiguous elephant population, estimated at 180 000 individuals* **- KAZA TFCA Website**

# An Ideal Site

The overwhelming task of selecting a site on the African continent was the most difficult challenge from this project. For the interest of my topic, I wanted to find an elephant crossing in conflict with an agricultural settlement. This crossing had to address elephants traveling through an anthropogenic landscape, HEC, and crop-raiding. In addition to selecting a site with HEC issues, the site needed to have plenty of research in order to design a detailed project.

I have been extremely fortunate to stumble upon the Kavango-Zambezi Transfrontier Conservation Area, a relatively new project in Africa.

# Kavango-Zambezi Transfrontier Conservation Area

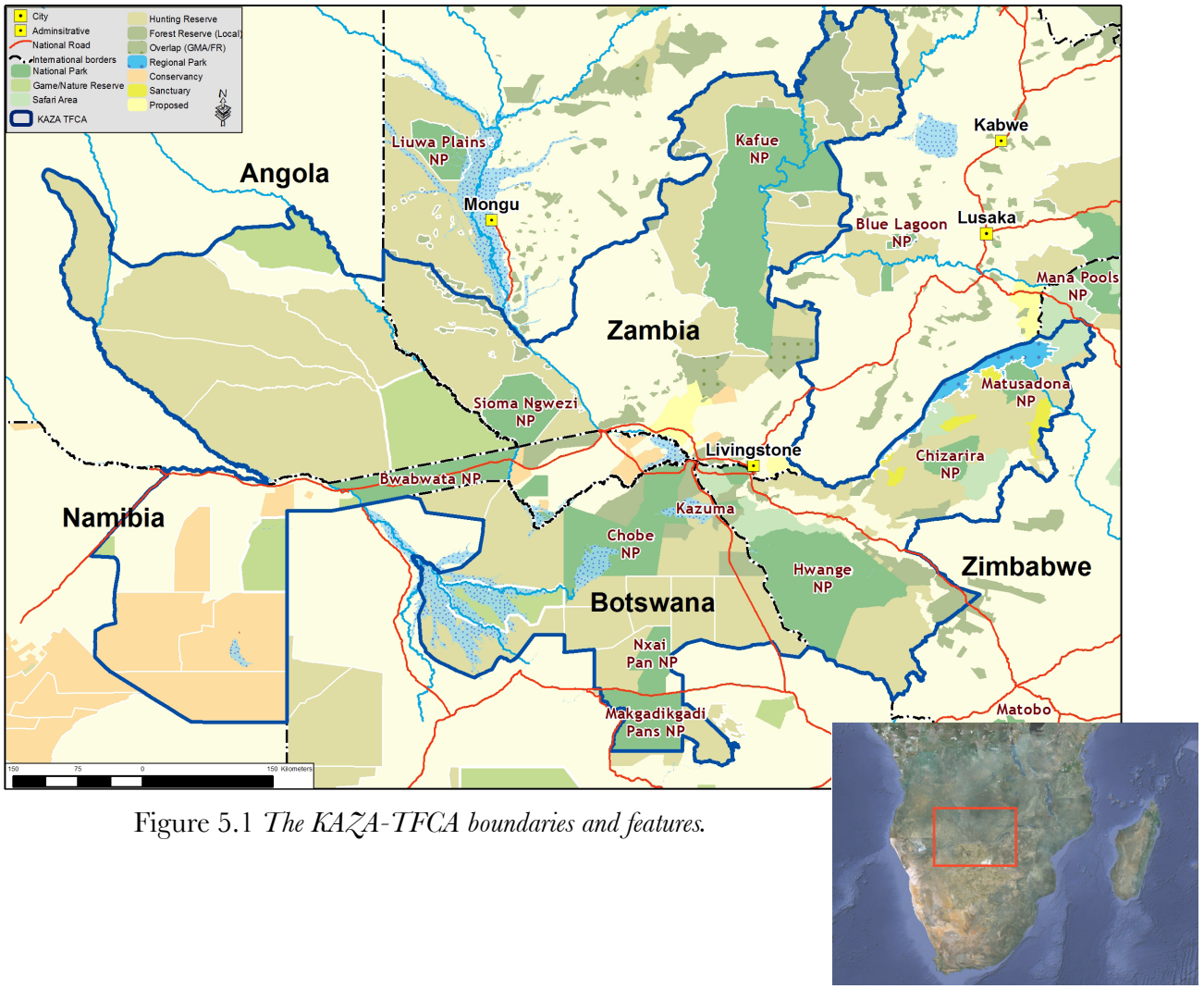



Figure 5.1 *The KAZA-TFCA boundaries and features.*

# KAZA-TFCA

At 300,979 km$^2$, the KAZA-TFCA is the largest plan for a game park in the world, covering land in Namibia, Angola, Zambia, Zimbabwe, and Botswana. It is roughly the size of Italy and includes 36 national parks, game reserves, forest reserves, and game/wildlife management areas. A transfrontier area is defined as a relatively large area between two or more countries and covers large-scale natural systems, encompassing one or more protected areas (International Relations & Cooperation Website). The continent's largest population of elephants, about 180,000 individuals, lives within the KAZA-TFCA. Recent research on the KAZA-TFCA has shown that HEC is increasing, with Northern Botswana as home to one of the fastest growing elephant populations at 5% per year (von Gerhardt-Weber, 2011).


Figure 5.2 *On December 7, 2006, the five participating countries jointly signed a memorandum of understanding.*

# Goal for the KAZA-TFCA:

"To sustainably manage the Kavango Zambezi ecosystem, its heritage and cultural resources based on best conservation and tourism models for the socio-economic wellbeing of the communities and other stakeholders in and around the eco-region through harmonization of policies, strategies and practices," (KAZA-TFCA Website).

# Caprivi Strip, Namibia

The Caprivi Strip lies in the middle of the KAZA-TFCA, and is the eastern arm of Namibia that touches Angola, Botswana, Zambia, and Zimbabwe. It is split into East and West Caprivi by the Kwando River that runs north-south across the strip.

Most of the inhabitants here practice subsistence farming with some cash cropping, while 80% of all people in the KAZA-TFCA are rural subsistence farmers (von Gerhardt-Weber, 2011). All of their food security is threatened by crop-raiding elephants, and the reserves in Caprivi are inadequate for sustaining increasing numbers of elephants (O' Connell-Rodwell et al., 2000).

The two areas I propose to connect are Mudumu and Mamili National Parks (Figure 5.4, the yellow areas above and below Wuparo). They are almost entirely connected by the Wuparo conservancy, and elephants are present in and between both parks. Their use of this space is not as intense as along the Kwando River, but this project seeks to alleviate agricultural communities and riparian ecosystems in the region by enhancing this passage between the two national parks (Elephants Without Borders Website).

## Wuparo Conservancy

The Wuparo conservancy is one of many conservancies in the Caprivi region, with inhabitants practicing subsistence farming and some cash cropping. Elephants and other wildlife are known to travel and live in this area, making wildlife conflict a persistent issue. It lies perfectly in between Mudumu and Mamili National Parks, making this location an ideal candidate to improve connectivity between the two protected areas.

Figure 5.3 *Caprivi Strip regional location.*

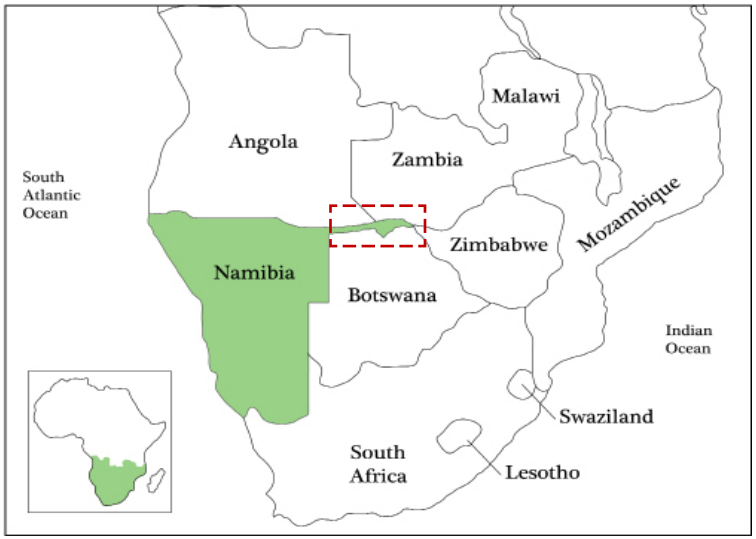
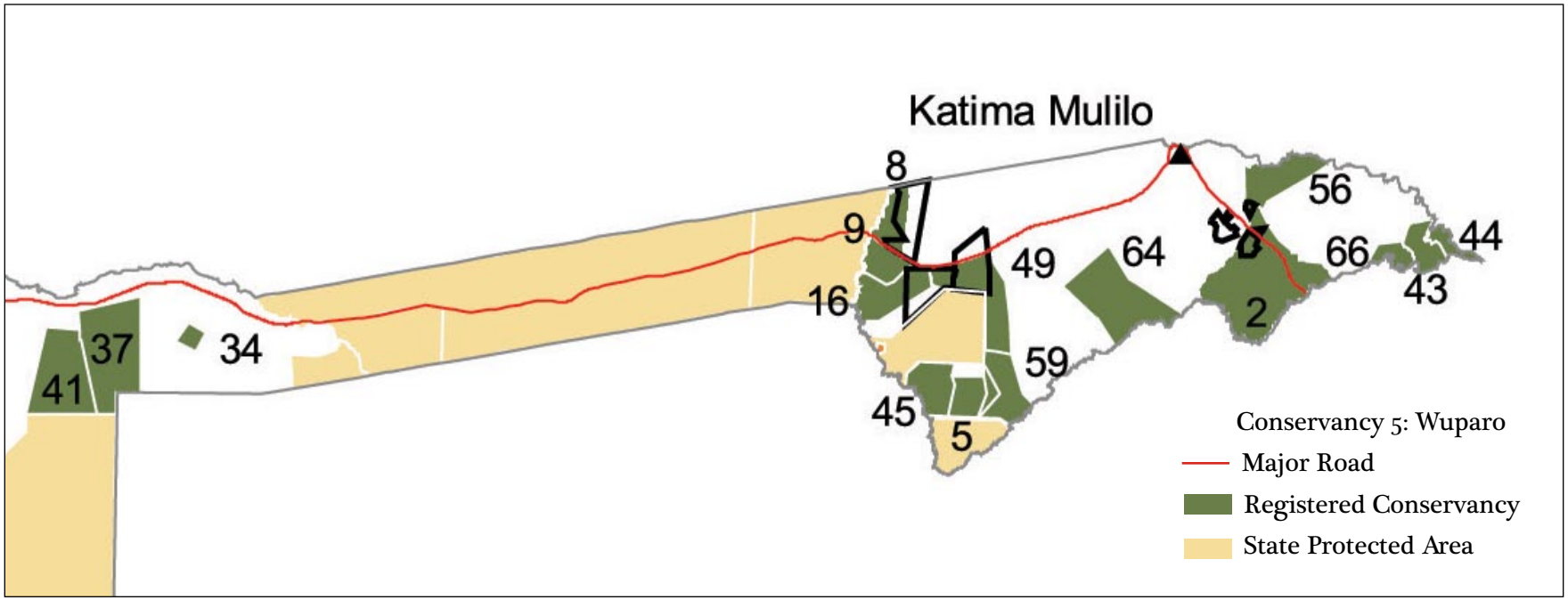



Figure 5.4 *Wuparo conservancy location.*



# *Caprivi Culture*

*"Community attitudes towards wildlife conservation have changed since the establishment of conservancies in my region ... As my people see that benefits are going directly to the community, they know it is in their interest to look after wildlife."* - **Chief Joseph Tembwe Mayuni, Chief of the Mafwe tribe in Namibia's Caprivi Strip**

# Agricultural Livelihood & Pastoralism

In the Caprivi, 98% of people practice subsistence agriculture as well as other subsistence activities, such as collecting firewood and thatching grass (Collomb et al., 2010). The Caprivi region is a fertile area where maize, pearl millet, melons, pumpkins, groundnuts, and other crops can grow abundantly. It is the nation's best-served region as far as water resources are concerned. There are two methods of agriculture, which are rain-fed cropping and winter gardening. Rain-fed agriculture is practiced on higher grounds, and winter gardening is practiced in riverbeds. The Wuparo conservancy, being near the Kwando River and in the floodplain, practices winter gardening. Farmers in the Caprivi region practice regular, controlled field-burning in order to prevent large, unpredictable fires that would destroy entire crops (von Gerhardt-Weber, 2011). A noteworthy mention is that the number of people living on freehold farms is about 9% and predicted to decline (Fuller & Prommer, 2000).

Traditionally, most of Namibia's indigenous peoples practiced nomadic pastoralism. Today, human settlements are larger and more settled, making pastoralism more permanent in location. However, raising livestock is vastly different from the way Americans raise livestock. Namibians visit nearby woodlands and forests on a daily basis with their animals and return to a protected pen at night. This practice still brings farm animals to the same water holes that wild animals use (von Gerhardt Weber, 2011; Fuller & Prommer, 2000).

The future growth of the economy will depend on natural resources to develop water, fisheries, and wildlife operations. The livelihoods for the majority of the rural population currently depend on water, woodlands, and grazing land (Fuller & Prommer, 2000).

# Communities

People live in huts, known as a *kraal*, within clustered communities near water holes. These huts are in walled, treeless enclosures that protect people from wildlife. Unlike other communities further north on the Kwando River that live close to the water, settlers in the Wuparo conservancy live far away from the river (GoogleEarth aerial analysis).

Due to the regions long shape, it shares many borders, resulting in a diverse ethnic make-up. The two main groups in East Caprivi are the Mafwe and Subia, and Silozi (a Zambian language) is the common language as well as the only written language. Since Namibia's independence, Caprivi has become relatively well supplied with clinics and schools, and the literacy rate for people over 15 years is 78% (Open Africa Website).

# Conservancies

Conservancies are a form of community-based natural resource management, CBNRM, and their intense focus on wildlife makes conservancies unique for Namibia. The interested community should work with neighboring communities to delineate conservancy boundaries, have an elected committee, form a written constitution, and draw a management plan. This allows for decision-making over natural resources to be handled at the local level. The conservancies should be designed so that communities can expect benefits that will lead them to further invest time and resources into their conservancy. Fuller et al. (2000) state that, "[most] environmental issues at local levels can be most effectively solved by making those who must make investments in environmental issues the same people who benefit from them."

Although the earliest conservancies were established in the mid 1990s, they have already shown a reduction in human-wildlife conflict and economic profit for communal conservancies (Kemp et al., 2009).

# Tolerance Towards Wildlife

Several surveys in various regions of Africa show that although elephants are considered a nuisance, most people do not want to get rid of them. Part of this is because people see that elephants attract tourists and are revenue for communities that incorporate wildlife into their economic plans. As people make more money through hunting fees and allotted percentages of tourism operations, tolerance towards elephants and other wildlife continues to go up as well (Collomb et al., 2010; von Gerhardt-Weber, 2011; Fuller et al., 2000).

Figure 6.1 *Unfortunately, others who do not feel the same tolerance for wildlife simply see them as pests. This elephant was speared by Kenyan tribesmen during a crop raid.*

# *Caprivi Geography*

*"The Caprivi Region is blessed with an abundance and diversity of wildlife, and is one of the few places in the country where significant numbers of wildlife roam freely outside the confines of parks or game ranches."* - **William R. Sutton, *The Costs of Living with Elephants in Namibia***

# Land Types

Land in Caprivi is generally flat, ranging between 930 m-1,100 m in elevation. The aeolian soils here are nutrient-poor, and there are fossil dunes where *dambos* (shallow, seasonally-flooded pans) frequently form in the dune troughs and ancient river valleys (*Omaramabas*) that are dominated by grasslands.

The Caprivi Strip is characterized by broad-leafed savannah plant species. Mopane-burkea (*Colophospermum mopane, Burkea africana*) woodlands, mixed shrublands, and *Omuramba* grasslands dominate the vegetative communities in and near Caprivi. The dune ridges support the Acacia-dominated woodlands.

The Kavango, Kwando, and Linyati Rivers are perennial, while the Luiana River is seasonal. The broad floodplains flood seasonally along these rivers, and smaller, permanent wetlands occur within these floodplains (Chase & Griffin, 2006; von Gerhardt-Weber 2011).

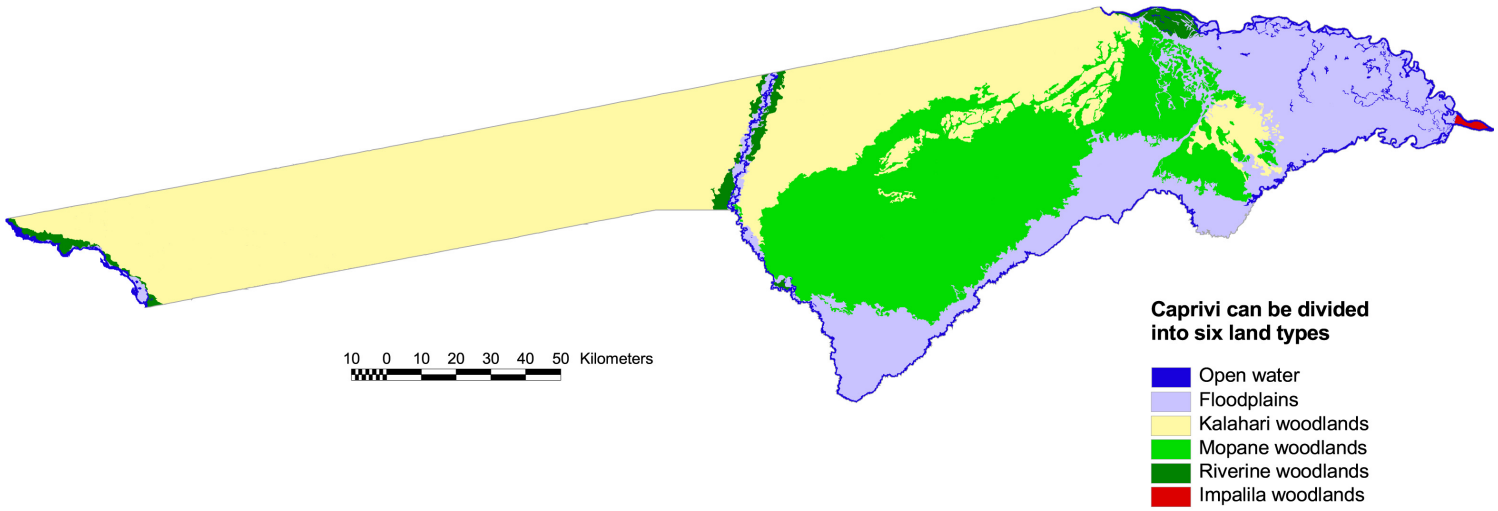



Figure 7.1 *Land types in the Caprivi Strip.*

# Climate

There are three seasons in this tropical savanna climate: a hot dry season (August to October), a hot wet season (November to April), and a cool dry season (May to July). The annual rainfall average is 650 mm, and is concentrated from November to April (Chase & Griffin, 2006).

# Land Use

There is no urbanized landscape near the Kwando River in Caprivi, and nearly all these settlements practice subsistence agriculture. The homes in Wuparo tend to stay away from open water and are clustered together. Crops are sprawled from their huts all the way south to the Kwando River and wetlands. Homes and agriculture are also common along main roads. Although few people may live here, the land use pattern gives elephants no option for avoiding crops (GoogleEarth aerial analysis).

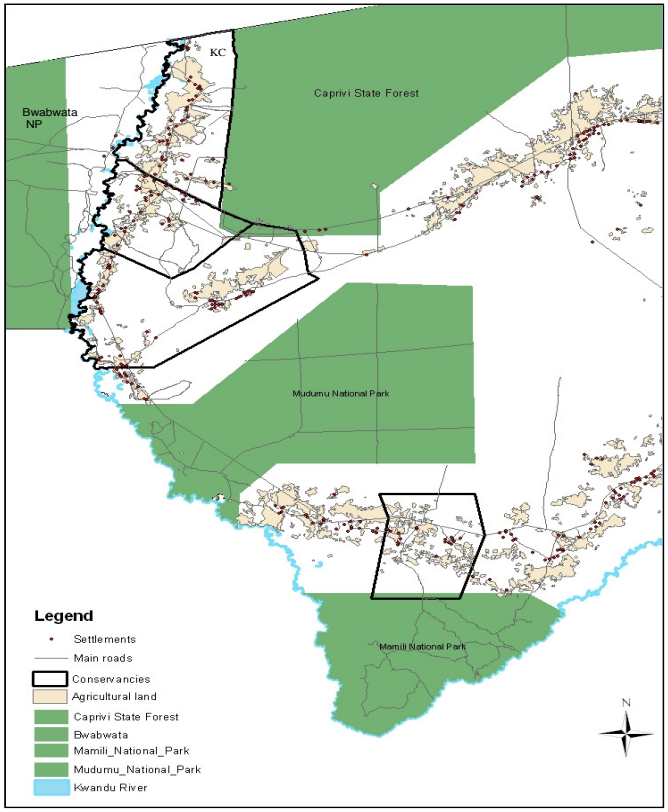



Figure 7.2 *Barriers (roads, settlements, fields) along the eastern boundary of the Kwando River. (There are conservancies adjacent to Wuparo, but most graphics show it as the only conservancy between Mudumu and Mamili National Parks.)*

# *Elephant Life History & Range*

*"Elephants are able to use tools or implements to accomplish a task they cannot perform on their own. They have been observed digging holes for drinking water, then moulding bark from a tree into the shape of a ball and placing it on top of the hole and covering it over with sand to avoid evaporation. They also use sticks to scratch their backs when their trunk can not reach and have been known to drop rocks on electric fences to damage them."* **- Andrews Elephants Website, *Elephant Intelligence***

# AFRICAN SAVANNAH ELEPHANT

## *Africana loxodonta*

Family: Elephantidae
Order: Proboscidea
Class: Mammalia
Conservation Status: Vulnerable

Figure 8.1 *An elephant feeding on grass.*

## Distribution, Abundance, and Seasonality:

Elephants tend to follow water bodies, such as rivers and wetlands, especially in dry months. In the Caprivi they are found in great abundance along the Kwando River. The historical range is across most of the African continent, but is now consolidated to several regions of Africa. The KAZA-TFCA is one of the last significant remaining populations. However, where they do exist, they are overabundant for their home ranges and ecosystems.

## Specific Habitat Requirements:

**Feeding:** They are generalist megaherbivores (herbivores exceeding 1000 kg) with the capability to take down mature trees. Their major browse forage is grass or other monocotyledonous plants, but they also eat from shrubs and trees, including bark. When sodium levels are low they are known to eat soil. Food preferences vary between subpopulations and local food abundance. An adult bull will eat 300-350 pounds of vegetation a day. They are considered somewhat 'wasteful' feeders, but the damages generate other ecological processes.

**Water:** They usually travel near water and have a daily requirement of 18-26 gallons, but can survive up to 3-4 days without water. In the Caprivi most herds are found within 30 km of a perennial river.

## Species Life History:

**Activity Patterns:** Elephants travel between four and five kilometers a day. They are more active at night, especially when near settlements. They tend to travel up to four times faster, known as streaking, when in high-risk areas near humans. They need regular access to mud and water for hygiene routines. They prefer clear water for drinking, but will drink foul water during droughts. Elephants will bathe in the same water that they first drank out of. In homogeneous habitats, they (like other animals) travel randomly. But when in heterogeneous habitats, they develop non-random search. They may switch from a diet of typical browse foods to cultivated crops when the nutrition from crops is higher during the wet season.

Figure 8.2 *A family herd at a water hole.*

**Seasonal Movements/Migration:** In Caprivi they tend to stay in the national parks near the Kwando River in the dry season, where they have unrestricted access to water. In the dry season their core habitats move closer to water bodies and their movements span over greater distances. Although they travel greater distances in the dry season, there is less turning, indicating less browsing and energy spent foraging. It is believed that elephants use a cognitive map to locate resources.

**Home Range:** The size depends on resources available to the elephant. Home ranges can be as small 60 $km^2$ (in Tanzania) and as large as 9,000 $km^2$ (in Namibian deserts). Home ranges of females are smaller than for males, as they require extra energy to lactate and travel with their young. Elephants have a 'cultural' internal map they use to locate food, water, and other resources. If these routes have been altered by humans, many elephants still take these routes their mothers taught them to use.

**Territory:** Males tend to have a larger home range than females. Males are usually solitary, but form loose, temporary associations with each other. When fertile females are nearby, the largest bull of the associated group will assert his dominance over the younger, smaller bulls. Young males may temporarily associate with female herds, especially when related. Females aggressively protect their calves, and other adult females will encircle their calves when endangered. Females travel in herds and form close social bonds with other females.

**Reproduction:** There is no known breeding season. However, bulls tend to go through musth (a sexual, aggressive period) and cows are likely to experience oestrus (fertile period) during the wet season when nutrients are rich. Males will associate with a female herd for a few days when mating, and then leave the female to raise the calf.

**Niche:** Elephants only rarely fall prey to lions, hyenas, and wild dogs (poaching by humans critically endangered elephant populations, but has become a less serious issue since the international ban on ivory.) They also compete for water with livestock.

Figure 8.3 *A mother with her calf.*

von Gerhardt-Weber, 2011; Chase & Griffin, 2006; Eltringham 1982

# *Design Considerations for Elephants*

*"...the elephants' home range size was smaller in non-fragmented forest than in fragmented forest because once habitat was cleared or converted, the availability of food plants and water sources were reduced, forcing the elephants to travel to adjacent forest areas."* - **Cardiff University News Center, *Elephants' habitat fragments in Borneo***

# Spatial & Travel Preferences

Elephants tend to raid crops close to paths and protected lands, where they can get away or hide easily. Crops near human settlements are raided much less, probably because there are fewer places to stay out of sight after a raid (von Gerhardt-Weber, 2011). In one study, crop-raiding incidents occurred within 1.54 km of natural habitat, where elephants could hide during the day from human activities (Graham et al., 2010).

Elephants have a nocturnal tendency to use human roads, which can be a great land use planning tool. Roads and pathways can facilitate movement in a disturbed matrix, link predictable sources, and serve to maximize optimal foraging. Near the Kwando River water holes are found along 54% of all pathways (von Gerhardt-Weber, 2011).

There is varied information as to how far elephants tend to stay from human settlements. Harris et al. (2008) state that elephants stay about 0.4 km from settlements, while von Gerhardt-Weber (2011) states that cows tend to stay 5 km away from settlements. Since males are more aggressive in terms of their range sizes and do not have young to care for, this project will use information based on female herd data. They tend to be much more conservative about what routes they take and how far they will travel (Chase & Griffin, 2006).

Figure 9.1 *A traveling herd.*

# Current Underuse of Wuparo

The Wuparo conservancy is an unprotected area with no physical boundaries, and its inhabitants practice regular controlled-burning. Von Gerhardt-Weber (2011) found the elephants in her study avoided non-protected areas in the dry season, which coincided with months of highest burning (runaway fires and land-clearing burns). Elephants avoid traveling near fires because of their fear for them, but also because fires fragment landscapes. This cultural practice in Wuparo makes the area less appealing and habitable for elephants.

People and livestock drink from the same water holes that wildlife use. Consequently, inter-species competition with humans and livestock outside of protected areas may be another significant factor in elephants favoring protected areas (von Gerhardt-Weber, 2011). This makes the water holes a high-risk factor in elephant travel routes, rendering most shared water holes unusable. In addition to inter-species competition, most water holes dry up after the rainy season has passed and there are fewer water holes outside the flood plain (GoogleEarth aerial analysis).

Elephants have risk awareness for unprotected lands and practice extreme avoidance of humans (Hoare & du Toit, 1999; von Gerhardt-Weber, 2011; Chase & Griffin, 2006). Most GPS collared elephants are traveling between national parks, and streaking (moving up to four times faster than normal) in between.

As the elephant population increases and the Kwando River reaches its ecological limits, the significance of less used travel routes will increase.

# *Wildlife Tourism*

*"The elephant has always been shown by our surveys to be the number one attraction; it is the icon of our industry."* **- Heidi Herriot, Outdoor Amusement Business Association**

The KAZA-TFCA and Namibian conservancies strive to utilize wildlife for economic gain, making tourism impossible to overlook for a wildlife management plan (KAZA-TFCA Website; von Gerhardt-Weber, 2011). The KAZA-TFCA *Memorandum of Understanding* states its mission is, "[to] sustainably manage the Kavango Zambezi ecosystem, its heritage and cultural resources based on best conservation and tourism models for the socio-economic wellbeing of the communities and other stakeholders in and around the eco-region ...," (KAZA TFCA Strategic Action Plan, 2011). This 'economic wellbeing' will come from tourism operations, including large-game hunting fees.

The Namibian constitution states in Article 95 that, "[the] State shall actively promote and maintain the welfare of the people by adopting international policies aimed at the following: maintenance of ecosystems, essential ecological processes, and biological diversity of Namibia, and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future," (Stefanova, 2005). This legislature allows local communities to work with private companies to establish and manage their own tourism market.

Figure 10.1 *Wildlife tourism in Namibia.*

Conservancies are interested in helping wildlife if the wildlife can help them. It is a necessary element of this project because of policies and legislature, but also because tolerance for wildlife increases when economic gain increases. Employment opportunities are formed and conservancies receive fees and turnover percentages from tourism operations. This also gives conservancies the flexibility to repay farmers for losses to crops or livestock from wildlife (von Gerhardt-Weber, 2011). The success of a wildlife corridor in agricultural lands will greatly depend on the direct economic gain received by the area's inhabitants.

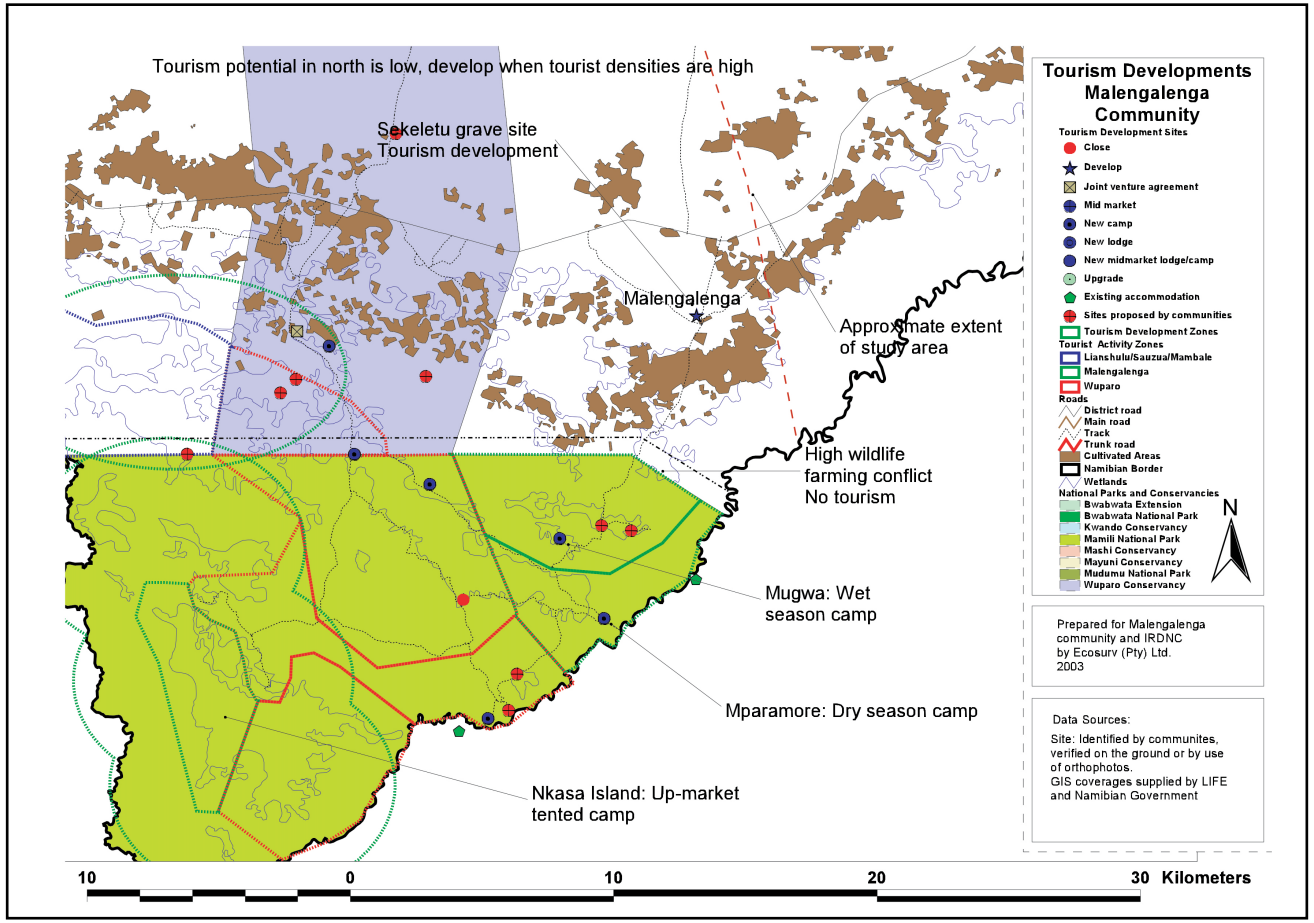



Figure 10.2 *Current tourism operations and future plans near the Wuparo Conservancy (2003).*

# *Precedent Studies*

*"... national parks and other strictly protected areas today confront a number of equally disturbing programs that stem largely from their isolation."* **- Michel Batisse, from *Biosphere Reserves: A Challenge for Biodiversity Conservation & Regional Development***

# Mudumu North Complex, Namibia

The MNC in the Caprivi Strip is comprised of the Sobbe, Mashi, Mayuni, and Kwando conservancies and its mission is, "[to] work together to rehabilitate and manage the area's fauna and flora, and guide the development of tourism and resource use for social, cultural, and economic benefits...," (Kemp et al., 2009). It contains the Kwando, Lubutu, and Masida community forests, and Bwabwata and Mudumu national parks. The corridors for wildlife passage approximate from 1 km to 6 km in width.

Chief Mayuni of the Mayuni conservancy gained support from his community to execute the MNC wildlife management plan. This involved moving settled communities into planned zones, where housing and cropping are allowed. It also involved working with the neighboring conservancies to make the project large enough to be successful. HEC has decreased significantly since the design's implementation in 2007. The plan is even more successful because of Namibia's integrated approach for managing protected lands and forests (von Gerhardt-Weber, 2011; Kemp et al., 2009).

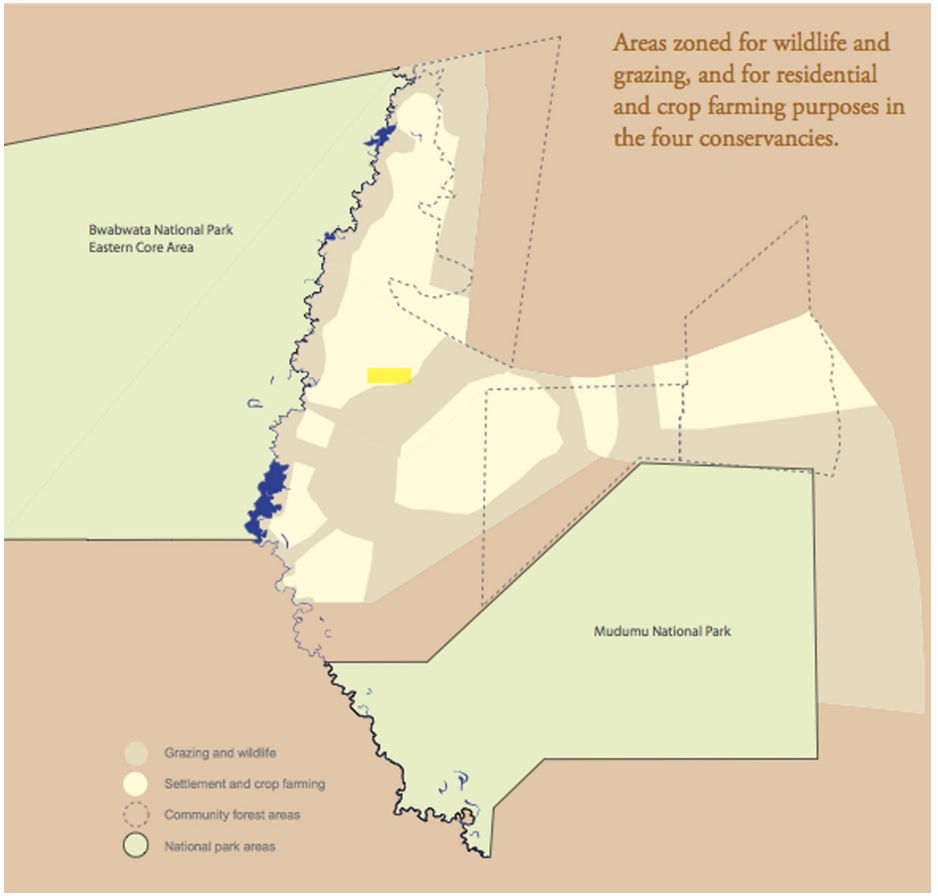



Figure 11.1 *A management plan for the Mudumu North Complex.*

# Kitendeni Corridor, Tanzania

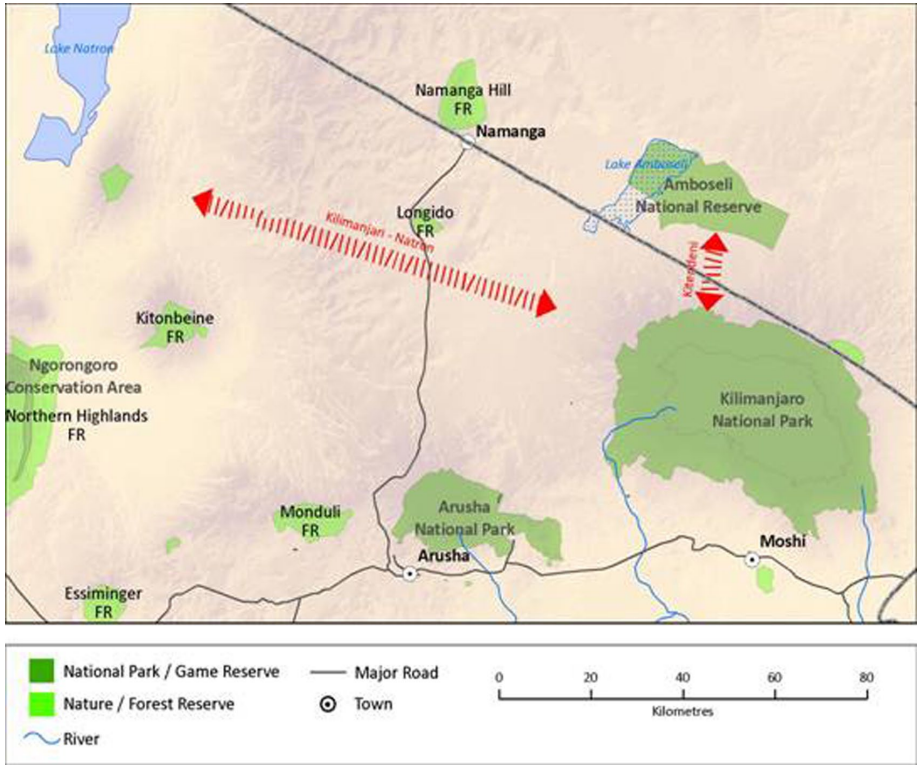



Figure 11.2 *The Kitendeni Corridor is the smaller of the two red arrows.*

Two Masaii villages in northern Tanzania experienced problems with elephant crop-raiding and decided to establish a conservation corridor. Although the villagers considered elephants a nuisance, they did not want to kill them because they believed elephants attracted tourists. The Kitendeni Corridor, also known as the Kilimanjaro/ Amboseli Corridor, is about 20 km long. It was 10 kilometers wide in the 1990s, and has reduced to 5 kilometers wide in 2000. A 5 kilometer width is still functional for the local elephant herds, but the rapid pattern of disappearing landscape caused government officials and the community to take action. The corridor is predicted to strengthen the passage between Tanzania and southern Kenya. The Kitendeni Corridor is the first federally protected wildlife corridor in Tanzania, but faces challenges in protecting the 600 elephants that use it. The African Wildlife Foundation is involved in improving the viability of the corridor (Kikoti et al., 2010; Tanzania Wildlife Corridors).

# *Site Inventory & Analysis*

*"Ultimately, the decisions on elephant population management are all about choices of what we want. Do we want elephants to be the main asset of the park and thus manage for elephants or do we want to manage the parks for the entire functioning of the system?"* **- Dr. Hector Magome, Conservation Services Director of South African National Parks**

# Biological & Physical Context

This graphic shows the relationship between land types, national parks, and elephant movement. Studies by Chase and Griffin (2006) show that a majority of herds in the Caprivi region occurred within 30 km of perennial rivers, and the minority of herds found away from rivers were associated with manmade water sources. Herds were most abundant in protected areas and in conservancies between Mudumu and Mamili National Parks.

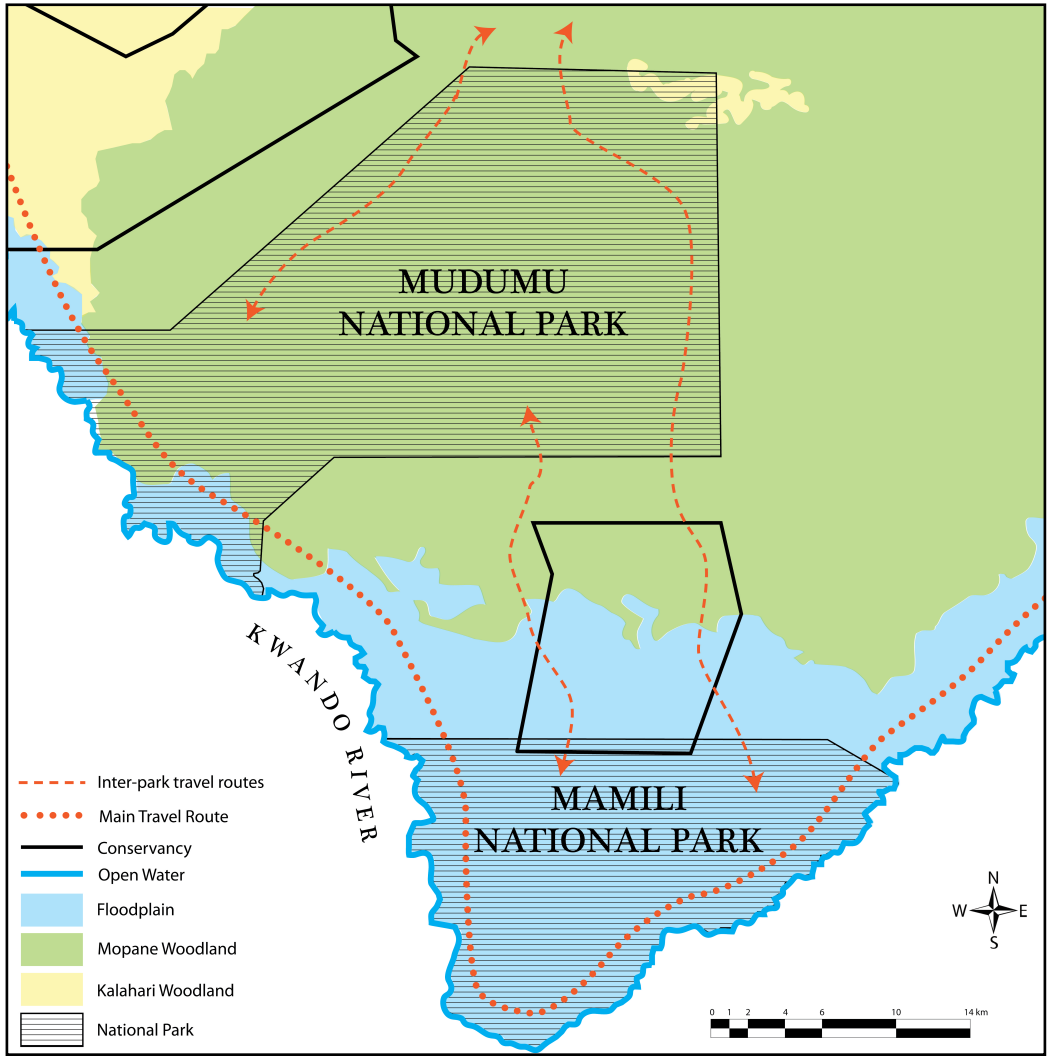



Figure 12.1 *Biological and physical context inventory map.*

# Cultural Context

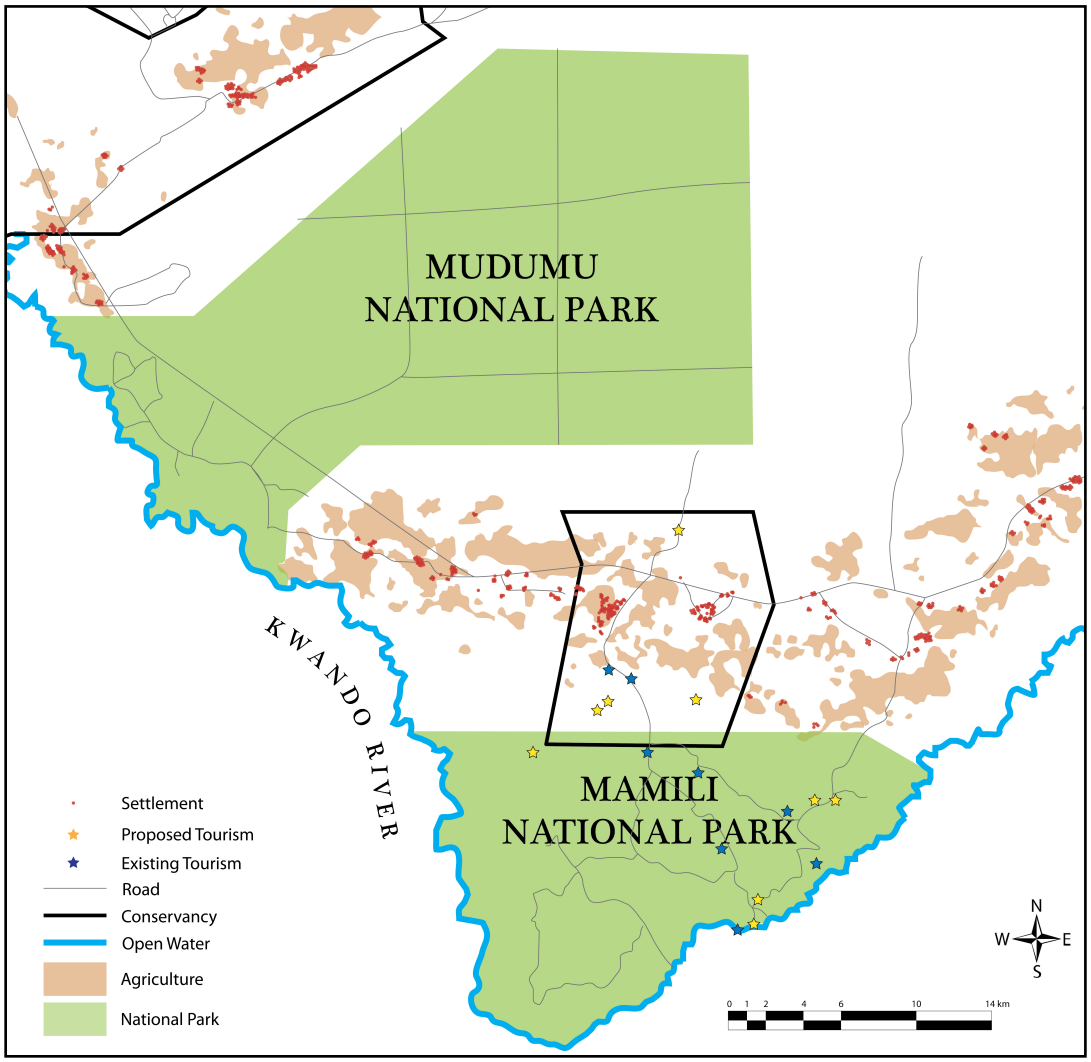



Figure 12.2 *Cultural context inventory map.*

This graphic shows where people live, agriculture, roads, and tourism locations. It is easy to see that the elephants' main obstacle between the two parks is agricultural land. At the same time, this is where people practice controlled-burning. Other obstacles are the two roads, one going east-west and the other going north-south.

# Opportunities & Constraints

This graphic illustrates the potential land planning opportunities as well as constraints. There is a large, international veterinary fence that forces north-south movement in the KAZA-TFCA toward the Kwando River (see Appendix, page 53). The funneled migration of elephants makes alternative routes important for elephant population growth.

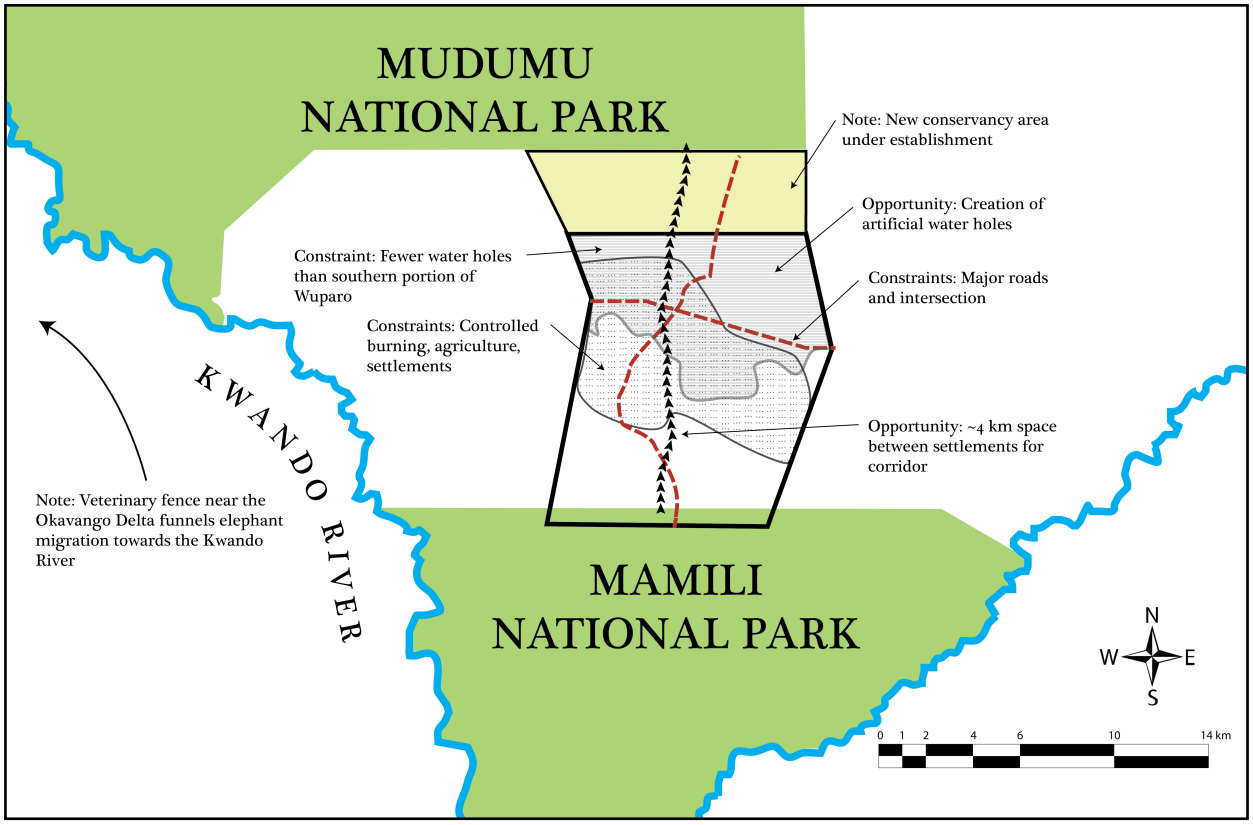



Figure 12.3 *Site analysis.*

# *Final Design*

*"It is also vital that African elephant range states develop long-term, large-scale national and regional plans for elephant and land management that allow elephant populations to exist without danger to ecosystems and local communities. These plans should also provide benefits to local communities."* **- Dr. Susan Lieberman, Director of WWF's Global Species Programme**

# Risk Awareness

This graphic is intended to raise awareness of the spatial arrangement of settlements in Wuparo. It is easy to see how people have clustered together, leaving an uninhabited space for north-south elephant passage. However, the ~4 km wide passage is a minimum width and elephants may still stray near homes (von Gerhardt-Weber, 2011). There needs to be an increasing awareness and acceptance that many African people live within an elephant home range, and that a peaceful coexistence between the two species will be most beneficial to all involved.

# Settlement Recommendations

The area between the two clustered settlements is heavily cultivated and threatened by crop-raiding. The most ideal situation for elephants is to have no farming in this area whatsoever, allowing them to travel peacefully. As people become aware of their landscape, they will hopefully decide to farm outside of the natural corridor. The same move will hopefully be made by the single, northern-most settlement. This settlement will not be in the corridor delineation until it is no longer occupied.

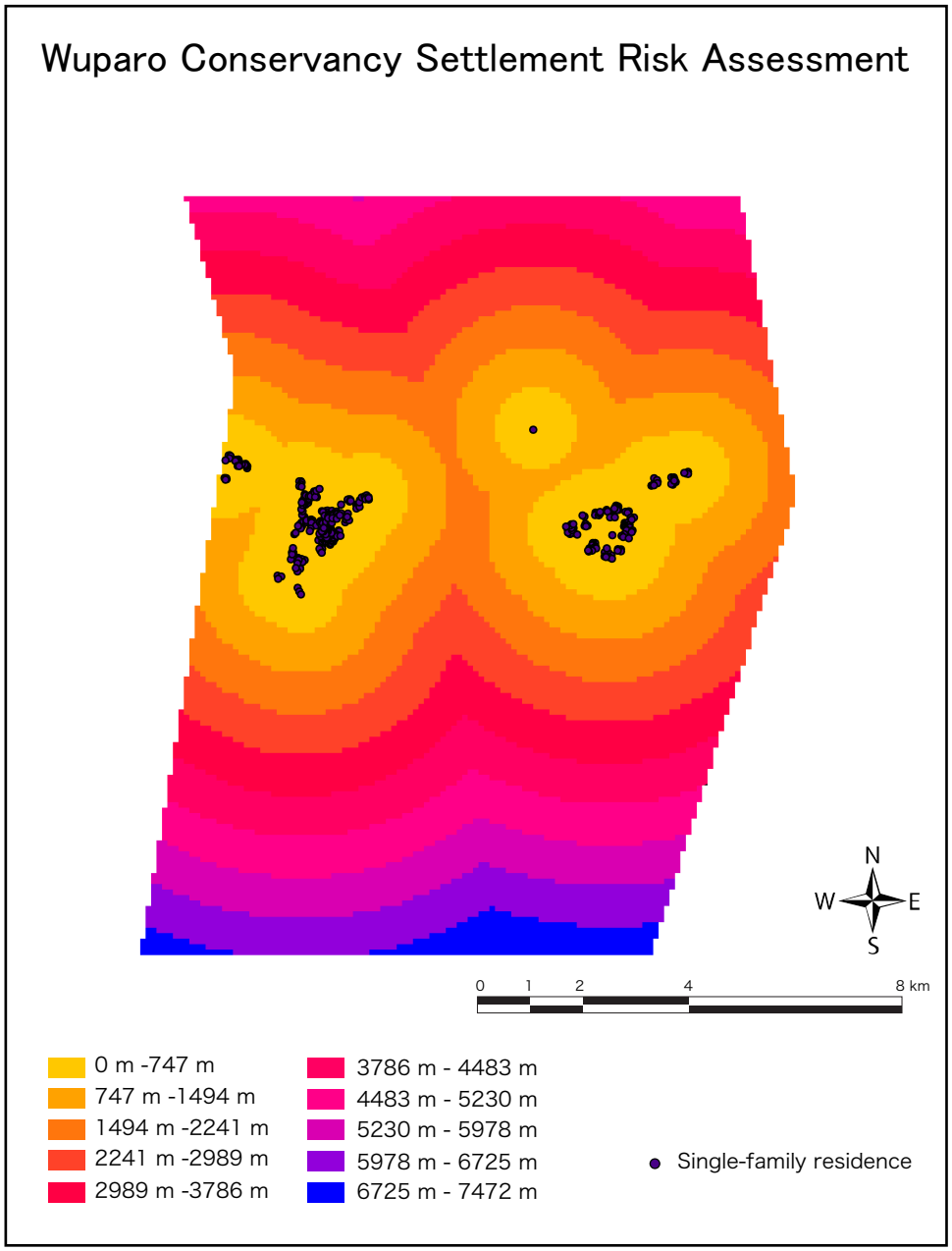



Figure 13.1 *Risk assessment for settlers in Wuparo, created using GIS.*

# Master Plan

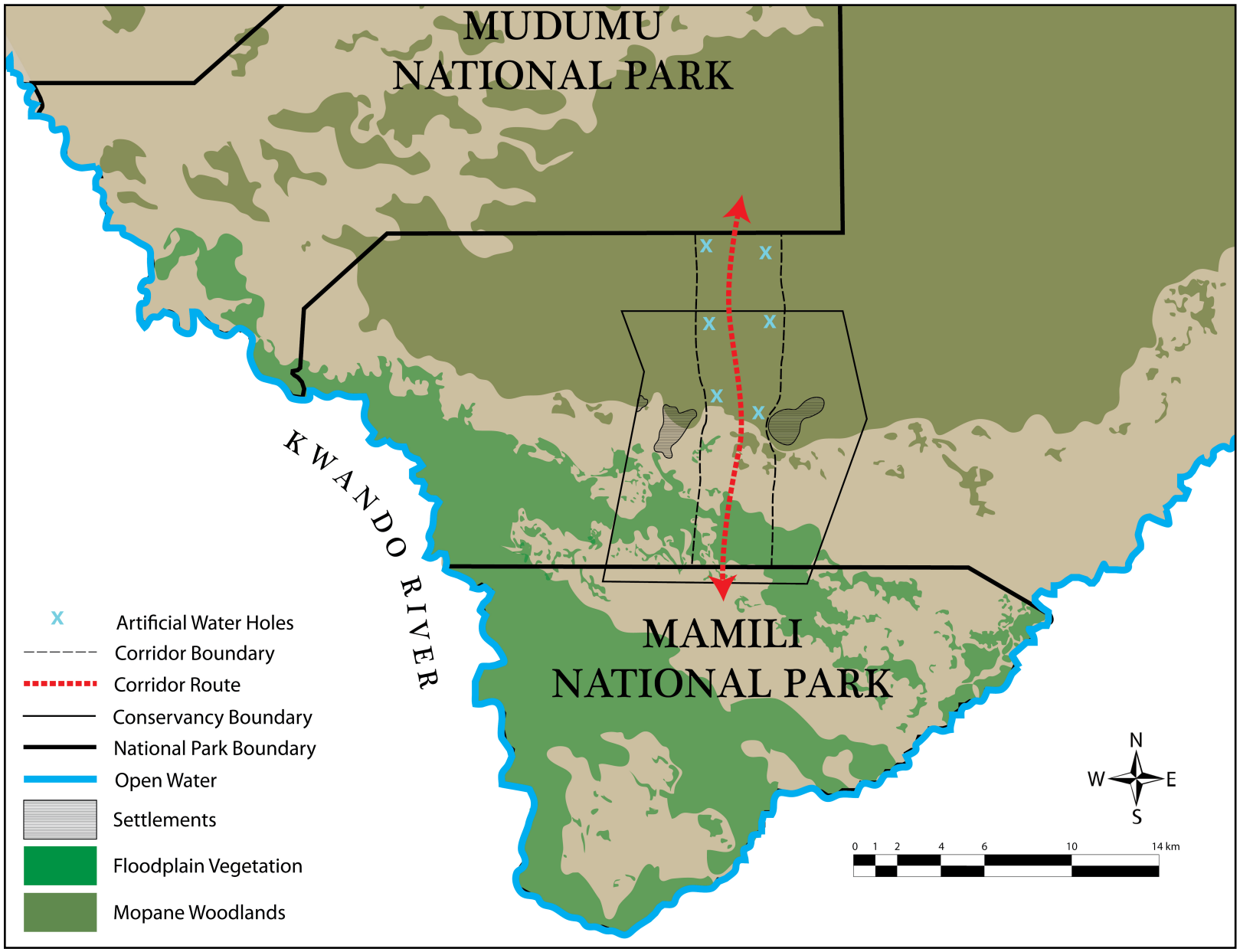



Figure 13.2 *Corridor master plan design.*

## Size

The width of the corridor is about 4 km, which is as wide as the Wuparo settlements will allow. This is a similar width to the corridors in the Mudumu North Complex, which range from 1 to 6 km. The MNC corridors have significantly reduced wildlife-conflict in a region with many more elephants than Wuparo (refer to elephant movement in Appendix, page 53).

## Management

Although the corridor will still provide grazeland for pastoralists, people will eventually not be allowed to reside within the corridor. New settlements, cropping, and controlled burning (except by wildlife managers) will be prohibited within the corridor. Site-specific methods, such as putting up warning bells, will be recommended (see Appendix, page 52).

## Federal Protection

Since elephants have a risk-awareness for protected and unprotected land, it is imporant to formally establish the area and its boundaries. This will not include a physical barrier, but will be a cultural and legal boundary.

## Tourism

This project does not propose any new tourism because of the high number of existing operations. However, if new tourism businesses develop, their locations should be at the outer edges of the corridor (Batisse, 1997).

## Water Holes

The mopane woodlands have significantly fewer water holes than the floodplain area, and its water holes dry up after the rainy season. Man-made water holes in the mopane woodlands would entice elephants during the dry season, promoting extended use of the corridor. Some conservationists are skeptical of the impacts from man made water holes, but they can be a very powerful management tool when used appropriately. The water holes on the plan are diagramatic and placed at 4 to 5 km apart, the average daily distance traveled by an elephant. If year-round use is not immediately desired, water holes can be part of a later phase of implementation (von Gerhardt-Weber, 2011).

## Signage

Signage is another important element of the MNC corridors that contributed to its success. There will be ample elephant crossing signage for drivers since there are two roads within the corridor. There will also be signs at the corridor boundaries to raise community awareness of traveling elephants.

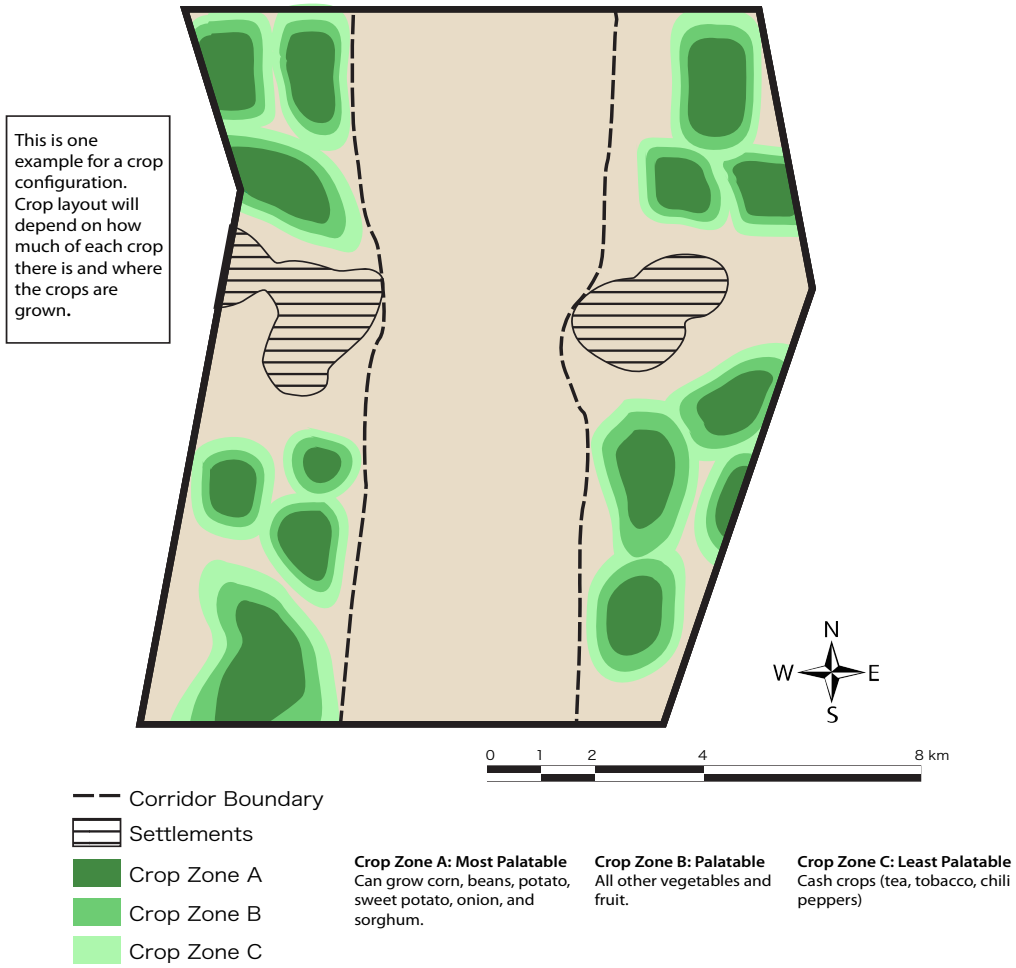



Figure 13.3 *Crop zoning example in Wuparo.*

## Crop Zoning

When elephants raid crops, they usually damage 6% or less of all cultivated areas. Over a whole season and across all crop-raiding species, elephants make a relatively low impact. However, they are seen as the biggest pest because they have the potential to destroy an entire season's growth in one night (8% of all cases).

When elephants are near a village, people put their lives on hold to protect their crops. Children skip school and people do not sleep, making a stressful and disturbing situation for people threatened by elephant crop-raiding.

By planting unpalatable crops at the edges of cultivated areas, this threat can be reduced. The most frequently damaged crops are Maize *Zea mays* L. (63% of cases), beans *Phaseolus vulgaris* L. (40%), potato *Solanum tuberosum* L. (37%), sweet potato *Ipomoea batatas* L. (20%), onion *Allium cepa* L. (17%), and sorghum *Sorghum vulgare* L. (15%) (Graham et al., 2009; von Gerhardt-Weber, 2011).

# *Further Research & Discussion*

*"Over the last thirty years literally hundreds of studies on African elephants (*Loxodonta africana*) have been carried out across the continent. We have learned more about elephants than, perhaps, any other large undomesticated African mammal, and yet we are just beginning to understand their complex lives."* **- Joyce Poole, *The African Elephant***

Some questions arose during my research, which currently remain unanswered. The answers would have helped me produce a more thorough final product, but I present the missing information instead.

The Wuparo Conservancy is one of the older conservancies in Namibia, but there is no literature or report as to how the delineations were formed in 1997. The shape of the conservancy spans across part of Mamili National Park, but is shy of reaching Mudumu National Park. The gap between Wuparo Conservancy and Mudumu National Park is a part of the wildlife corridor and would need to be addressed in a real-world context of this project. Without CBNRM in this region, it may be unfeasible to establish a corridor through this gap. Fortunately, NASCO (Namibian Association of CBNRM Support Organisations) GIS data shows an establishing, linear conservancy that will soon fill this gap. However, the goals for the Wuparo Conservancy and how it was shaped may offer insight as to how the community envisioned future wildlife management.

Furthermore, all registered Namibian conservancies are supposed to have a wildlife management plan. Wuparo does not yet have a formalized plan, which would have provided important goals and methods for my project.

In hindsight, I would have liked to plan several corridors across multiple conservancies instead of just Wuparo. But due to time constraints and discovering new information with poor timing, I have decided to stick with just Wuparo for my senior project.

# *Appendix*

*"Unless we can allow not only elephants but all the wild animals their place in the sun, we can never be whole ourserlves."* **- Lawrence Anthony, Elephant Whisperer**


Figure 15.1 *Elephant range in southern Africa.*

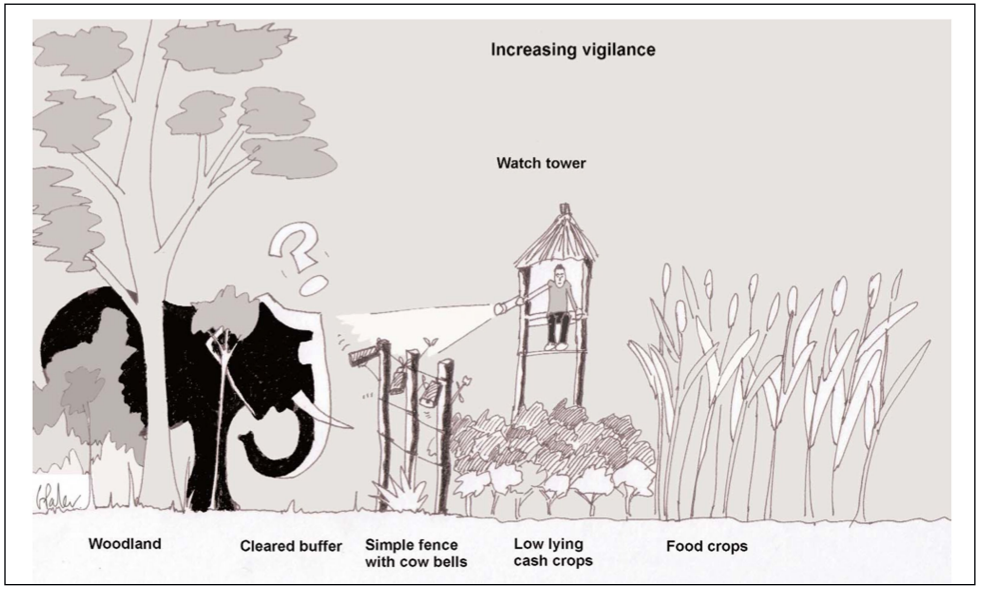



Figure 15.2 *Elephant management recommendations.*

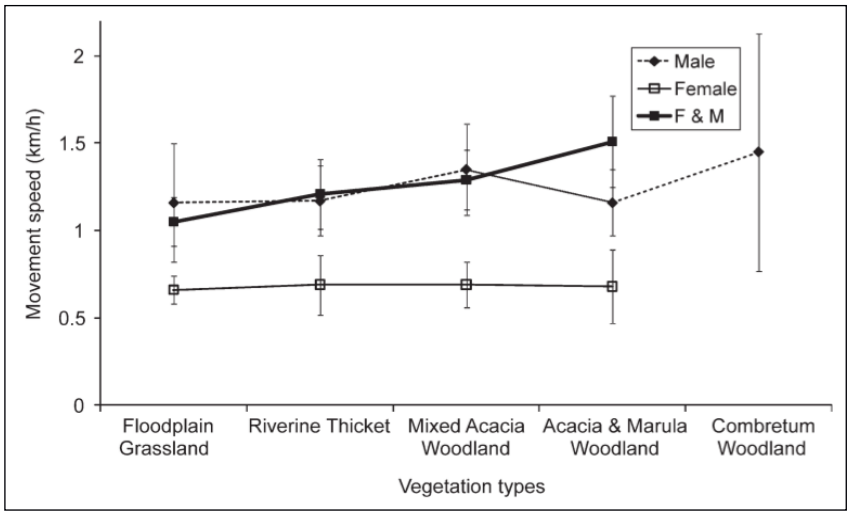



Figure 15.3 *Movement patterns of African elephants in different habitat types.*

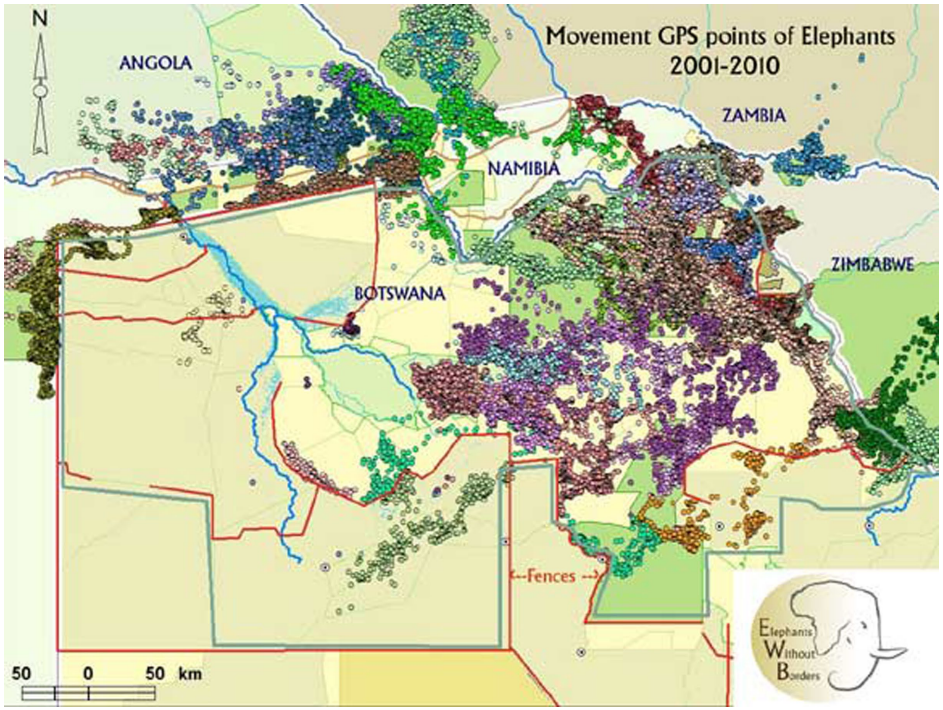



Figure 15.4 *Ranges of GPS collared elephants.*

Figure 15.5 *Aerial photo of settlements in Wuparo.*

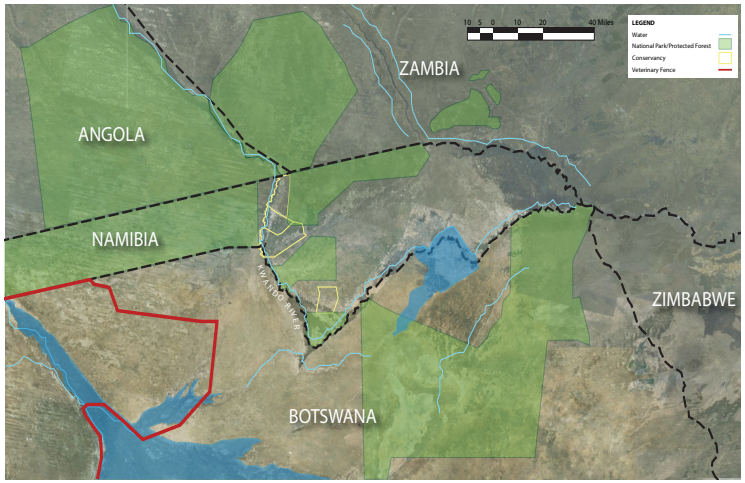



Figure 15.6 *The red line is the veterinary fence intended to prevent bovine tuberculosis.*

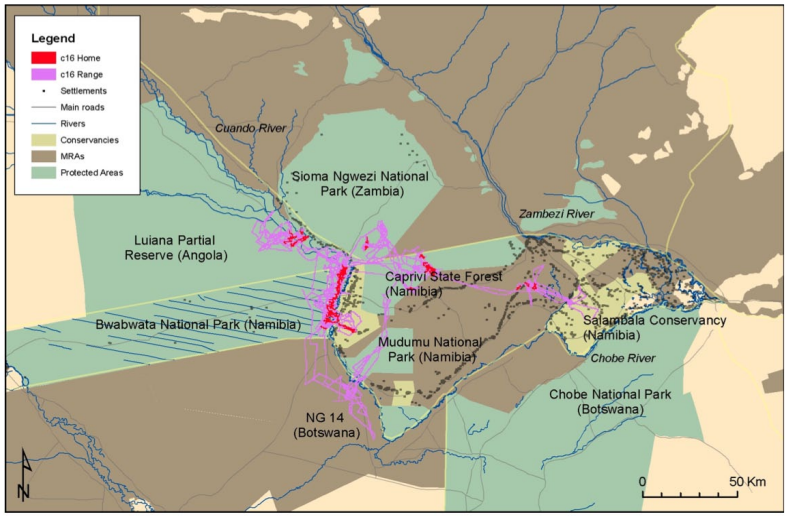



Figure 15.7 *von Gerhardt-Weber studied 3 different elephants for her thesis. This image shows a male's core habitat and range.*

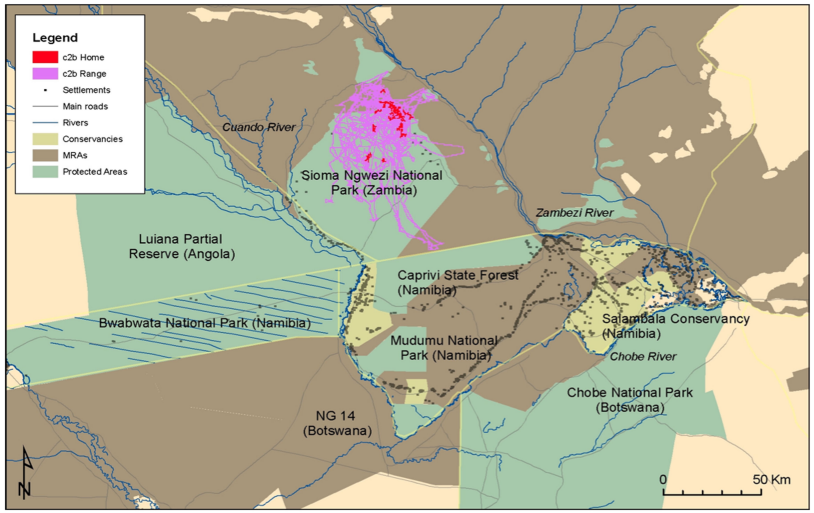



Figure 15.8 *This image shows a female's core habitat and range.*

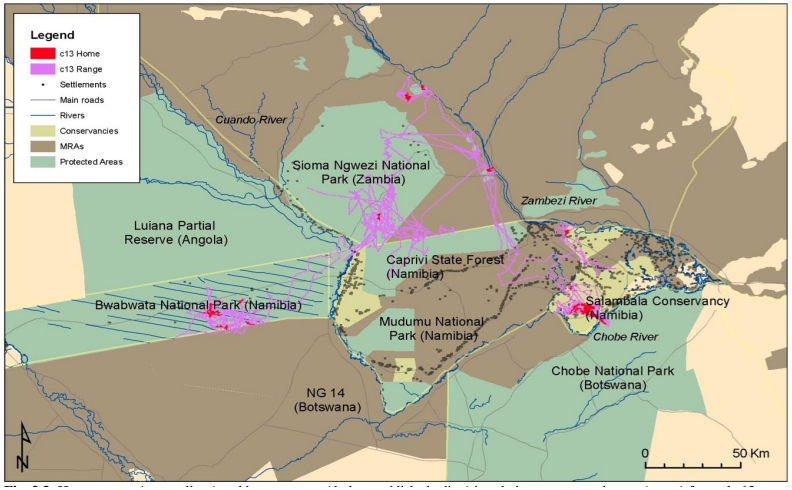



Figure 15.9 *This image shows another female's core habitat and range.*

# References


"Caprivi Wetlands Paradise Route." *Namibia*. OpenAfrica, n.d. Web. 6 Mar. 2012. <http://www.openafrica.org/route/Caprivi-Wetlands-Paradise-Route>.

Chase, Michael J., and Curtice R. Griffin. *Elephant Distribution and Abundance in the Lower Kwando River Basin and West Caprivi*. Rep. N.p.: n.p., 2006. Print.

Collomb, J. G., W. Kanapaux, P. Mupeta, G. Barnes, J. Saqui, and B. Child. "Assessing the Success of Community-based Natural Resources Management through the Integration of Governance, Livelihood and Conservation Attitude Indicators: Case Studies from Caprivi, Namibia." 2010. Web.

"Elephants Without Borders." *Elephants Without Borders*. N.p., n.d. Web. 3 Apr. 2012. <http://www.elephantswithoutborders.org/index.php>.

Eltringham, S. K. *Elephants*. Poole: Blandford, 1982. Print

Forman, Richard T. T., and Michel Godron. *Landscape Ecology.* New York: John WIley & Sons, 1986. Print.

Fuller, Ben, and Isolde Prommer. Population-Development-Environment in Namibia. Publication no. IR-00-031. University of Namibia, Multidisciplinary Research and Consultancy Centre, 2000. Print.

Graham, M. D., I. Douglas-Hamilton, W. M. Adams, and P. C. Lee. "The Movement of African Elephants in a Human-dominated Land-use Mosaic." *Animal Conservation* 12 (2009): 445-55.

Harris, Grant M., Gareth J. Russell, Rudi I. Van Aarde, and Stuart L. Pimm. "Rules of Habitat Use by Elephants Loxodonta Afriana in Southern Africa: Insights for Regional Management." *Oryx* 42 (2008): 66-75. Print.

Hellmund, Paul Cawood., and Daniel S. Smith. *Designing Greenways: Sustainable Landscapes for Nature and People*. Washington: Island, 2006. Print.

Hoaës, Irene. "Namibia: Wuparo Receives N$1 Million Grant." *AllAfrica*. AllAfrica, 4 Oct. 2011. Web. 5 Apr. 2012. <http://allafrica.com/stories/201110041340.html>.

Hoare, Richard E., and Johan T. Du Toit. "Coexistence between People and Elephants in African Savannas." *Conservation Biology* 13.3 (1999): 633-39.

KAZA Secretariat, 2011: Kavango-Zambezi Transfrontier Conservation Area 2011 – 2016 Strategic Action Plan, iv + 37pp

"KAZA-TFCA." Kavango Zambezi Transfrontier Conservation Area, n.d. Web. 1 Mar. 2012. <http://www.kavangozambezi.org/index.php>.

Kemp, Lucy, John Mendelsohn, and Brian Jones. *Conservancies in the Mudumu North Complex*. N.p.: Namibia Nature Foundation, 2009. Digital.

Kikoti, Alfred P., Curtice R. Griffin, and Lee Pamphil. "Elephant Use and Conflict Leads to Tanzania's First Wildlife Conservation Corridor." *Pachyderm* 48 (2010): 57-66. Web.

"Kilimanjaro-Amboseli (Kitendeni)." T*anzania Wildlife Corridors.* N.p., n.d. Web. 9 May 2012. <http://www.tzwildlifecorridors.org/corridors/kilimanjaro-amboseli-kitendeni/>.

Loarie, S.R., et al. Fences and artificial water affect African savannah elephant movement patterns. Biol. Conserv. (2009), doi:10.1016/j.biocon.2009.08.008

O' Connell-Rodwell, C.E., Rodwell, T., Rice, M. & Hart, L. (2000). Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five year case study in East Caprivi, Namibia. *Biological Conservation* 93, 381-391.

Shulman, Mark. "WWF - A Numbers Game: Managing Elephants in Southern Africa." *A Numbers Game: Managing Elephants in Southern Africa*. WWF Global, 18 July 2006. Web. 11 Mar. 2012. <http://wwf.panda.org/who_we_are/wwf_offices/south_africa/news/?75340/A-numbers-game-Managing-elephants-in-southern-Africav>.

Siebert, Charles. "Orphans No More." *National Geographic* Sept. 2011: 40-65. Web.

Stefanova, K. "Protecting Namibia's Natural Resources." *EjournalUSA* (2005): n. pag

Sukumar, R. (1990). Ecology of the Asian elephant in southern India. II. Feeding habits
and crop raiding patterns. Journal of Tropical Ecology 6: 33-53.

"Transfrontier Conservation Areas (TFCAs)." *International Relations & Cooperation*. N.p., n.d. Web. 14 May 2012. <http://www.dfa.gov.za/foreign/Multilateral/inter/tfcas.htm>.

von Gerhardt-Weber, Katharina E. M. *Elephant Movement and Human-Elephant Conflict in a Transfrontier Conservation Area*. Stellenbosch University: Department of Conservation Ecology and Entomology, 2011. Print.

"What Is NACSO?" *NACSO*: Home. N.p., n.d. Web. 23 Apr. 2012. <http://www.nacso.org.na/index.php>.

# Figure Sources

Figure 1.1 – *Elephant population chart*. 2011. Magazine. "Orphans No More." *National Geographic*.

Figure 1.2 – *Elephant translocation*. Photograph. *Kenya Wildlife Service.* Accessed 2 Jun. 2012. < http://www.kws.org/info/news/2011/28_09_2011_translocation.html>.

Figure 1.3 – Nichols, Michael. *Orphan elephants with caretakers.* 2011. Photograph. *Kristin Richey*. Accessed 2 Jun. 2012. <http://kristinrichey.com/?p=65 National Geography 2011>.

Figure 3.1 – *Tree damage from elephants*. Photograph. *Wildlife Extra.* Accessed 3 Jun. 2012. <http://www.wildlifeextra.com/images/elephant-damage.JPG>.

Figure 4.1 – *Wildlife corridor.* 2005. Photograph. *Iowa NRCS*. Accessed 10 Jun. 2012. <http://www.ia.nrcs.usda.gov/news/brochures/ReptilesAmphibians.html>.

Figure 4.2 - Hellmund, Paul Cawood, and Daniel S. Smith. *Ecological greenway design process*. Diagram sketch. 2006. *Designing Greenways: Sustainable Landscapes for Nature and People*. Page 216. Washington: Island.

Figure 4.3 - Batisse, Michel. *Zoning pattern of a biosphere reserve*. Plan diagram. 1997. Page 13. "Biosphere Reserves: A Challenge for Biodiversity Conservation & Regional Development." *Environment: Science and Policy for Sustainable Development*.

Figure 5.1 – *KAZA-TFCA boundary and elements*. Map. *Kavango Zambezi Transfrontier Conservation Area*. Accessed 14 Mar. 2012. <http://www.peaceparks.org/news.php?mid=1148&pid=1098&year=2011&lid=1008>.

Figure 5.2 – *KAZA-TFCA ministers shake hands*. "Five presidents sign a treaty to establish the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA)." Photograph. *Peace Parks Foundation*. Accessed 18 Mar. 2012. <http://www.dfa.gov.za/foreign/Multilateral/inter/tfcas.htm>.

Figure 5.3 – Matheson, Kelly. 2012.

Figure 5.4 – *Namibian conservancies*. Map. *Republic of Namibia Ministry of Environment & Tourism*. Accessed 3 Apr. 2012. <http://www.met.gov.na/Directorates/Parks/Pages/Conservancies.aspx>.

Figure 6.1 – *Speared elephant*. Photograph. "14 Elephants Speared Near Amboselli – 4 Die." *Wildlife Extra*. Accessed 20 May 2012. <http://www.wildlifeextra.com/do/ecco.py/view_item?listid=1&listcatid=257&listitemid=2332#cr>.

Figure 7.1 – *Caprivi land types*. Map. "Environmental and social profiles of Caprivi and Kunene Regions." *Integrated Rural Development and Nature Conservation*. Accessed 8 Mar. 2010. <http://www.irdnc.org.na/areas.htm>.

Figure 7.2 – Von Gerhardt-Weber, Katharina E. M. *Barriers (roads, settlements, fields) along the eastern boundary of the Kwandu River*. Map. *Elephant Movement and Human-Elephant Conflict in a Transfrontier Conservation Area*. Page 90. Stellenbosch University: Department of Conservation Ecology and Entomology, 2011.

Figure 8.1 – Romanowicz, Adam. *Elephant eating grass.* Photograph. *3scape Photos: Photography by Adam Romanowicz.* Accessed 1 Jun. 2012. <http://3scape.com/pic/6621/Elephant-eating-grass>.

Figure 8.2 – *Elephant herd drinking water*. Photograph. *Follow the Piper: A blog by a dog who is an adorable and somewhat opinionated basenji.* Accessed 1 Jun. 2012. <http://piperbasenji.blogspot.com/2011/07/african-elephants.html>.

Figure 8.3 – *Elephant mother with calf*. Photograph. *Blogspot*. Accessed 1 Jun. 2012. <http://3.bp.blogspot.com/-I606Djxd3N4/T6tXfvQiP7I/AAAAAAAACHw/8t4r9el_D0E/s400/African-Elephant-8.jpg>.

Figure 9.1 – *Elephants traveling*. 2012. Photograph. "Saying Goodbye: Elephants Hold Apparent Vigil to Mourn Their Human Friend." *George Stroumboulopoulos*. Accessed 2 Jun. 2012. <http://www.cbc.ca/strombo/social-issues/saying-goodbye-elephants-hold-apparent-vigil-to-mourn-their-human-friend.html>.

Figure 10.1 – *African Tourism Etosha National Park*. Photograph. "Amazing Safari at Etosha National Park in Namibia, Africa." *Tourism*. Accessed 1 Jun. 2012. <http://www.tourismnewsinfo.com/wp-content/uploads/2011/02/Africa-Tourism-Etosha-National-Park.jpg>.

Figure 10.2 – *Tourism plans*. Map. "Resource database, incorporating ConInfo: search results." *Namibian Association of CBNRM Support Organisations.* Date accessed 25 May 2012. <http://www.nacso.org.na/literature/searchresults_publications.php?choice=999999&searchType=maps>.

Figure 11.1 – Kemp, Lucy, John Mendelsohn, and Brian Jones. *Joint management in the Mudumu North Complex*. 2009. Plan graphic. *Conservancies in the Mudumu North Complex*. N.p.: Namibia Nature Foundation.

Figure 11.2 – *Kilimanjaro-Amboseli (Kitendeni)*. Map. "Kilimanjaro-Amboseli (Kitendeni)." *Tanzania Wildlife Corridors: Mapping the movement of wildlife in East Africa.* Accessed 10 May 2012. <http://www.tzwildlifecorridors.org/corridors/kilimanjaro-amboseli-kitendeni/>.

Figure 12.1 – Matheson, Kelly. 2012.

Figure 12.2 – Matheson, Kelly. 2012.

Figure 13.1 – Matheson, Kelly & Steve Greco. 2012.

Figure 13.2 – Matheson, Kelly. 2012.

Figure 13.3 – Matheson, Kelly. 2012.

Figure 15.1 – *Elephant distribution in Southern Africa*. Map. "Elephant Distribution." *Information System for Rare Species Management*. Accessed 14 Apr. 2012. < http://www.nnf.org.na/RARESPECIES/InfoSys/elephant/distribution/La_Distribution_Africa.htm>.

Figure 15.2 Hesse, Alan. *Elephant management techniques.* n.d. Graphic. Page 2. *Reducing Crop-Raiding by Elephants.*

Figure 15.3 – Duffy, J. Kevin, Xiaohua Dai, Graeme Shannon, Rob Slotow & Bruce Page. *Movement patterns of African elephants in different habitat types*. 2011. Graph. *Patterns of African Elephants (*Loxodonta Africana*) in Different Habitat Types*. BioOne.

Figure 15.4 – Griffin, Kelly and Michael Chase. *Movement GPS points of Elephants 2001-2010*. Map. Accessed 24 Apr. 2012. "Tracking." *Elephants Without Borders*. < http://www.elephantswithoutborders.org/tracking.php>.

Figure 15.5 – *Caprivi Village*. 2012. Accessed 5 Apr. 2012. *GoogleEarth*.

Figure 15.6 – Matheson, Kelly. 2012.

Figure 15.7 – von Gerhardt-Weber, Katharina E. M. *Home ranges (mauve lines) and home sectors (darker, reddish shading) in relation to protected areas (green) for male 16*. Page 21. 2011. Map. *Elephant Movements and Human-Elephant Conflict in a Transfrontier Conservation Area.*

Figure 15.8 – von Gerhardt-Weber, Katharina E. M. *Home ranges (mauve lines) and home sectors (darker, reddish shading) in relation to protected areas (green) for female 2.* Page 23. 2011. Map. *Elephant Movements and Human-Elephant Conflict in a Transfrontier Conservation Area.*

Figure 15.9 – von Gerhardt-Weber, Katharina E. M. *Home ranges (mauve lines) and home sectors (darker, reddish shading) in relation to protected areas (green) for male 13.* Page 22. 2011. Map. *Elephant Movements and Human-Elephant Conflict in a Transfrontier Conservation Area.*