Spotted hyaena Ecology and Human-Wildlife Conflict in the Caprivi Region of Namibia.

2011 Research Report

Photo: John Inglis

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Acronyms

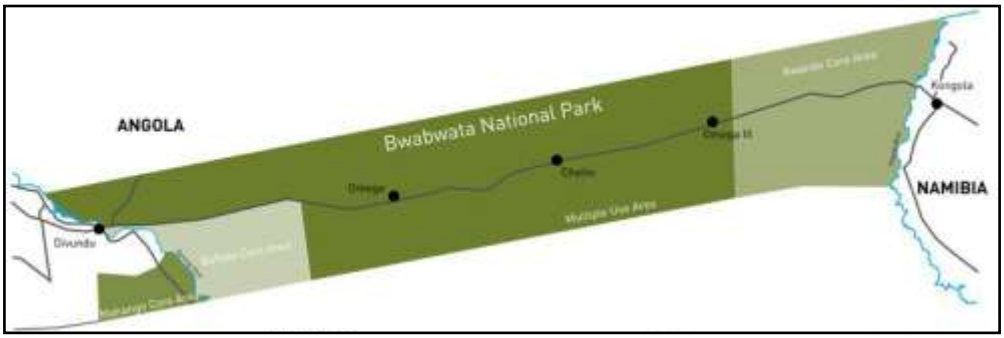
AWT	African Wildlife Tracking
BNP	Bwabwata National Park
CBNRM	Community Based Natural Resource Management
CCC	Caprivi Crocuta crocuta
CGG	Community Game Guards
CVL	Central Veterinary Laboratory
DSS	Directorate: Scientific Services
DVS	Directorate: Veterinary Services
GIS	Geographical Information System
GPS	Global Positioning System
GPTF	Game Products Trust Fund
GSM	Global System for Mobile Communications
HACCIS	Human Animal Conflict Community Insurance Scheme
HWC	Human Wildlife Conflict
ICEMA	Integrated Community- Based Ecosystem Management Project
IRDNC	Integrated Rural Development and Nature Conservation
KAZA	Kavango-Zambezi
KA	Kyaramacan Association
KML	Keyhole Markup Language
MET	Ministry of Environment and Tourism
MMNP	Mamili National Park
MNP	Mudumu National Park
MNC	Mudumu North Complex
MSC	Mudumu South Complex
NACSO	Namibian Association of CBNRM Support Organisations

NGO	Non-Government Organisation
NNF	Namibia Nature Foundation
NRWG	Natural Resource Working Group
PA	Protected Area
PCT	Predator Conservation Trust
TA	Traditional Authority
TFCA	Trans Frontier Conservation Area
VHF	Very High Frequency
WWF	World Wide Fund for Nature

Section 1 - West Caprivi (Bwabwata National Park)

Study site

The Caprivi Region relative to the rest of Namibia.



Bwabwata National Park formerly known as the West Caprivi Game Reserve
Source: www.met.gov.na

The Caprivi Region lies in north east Namibia and stretches 450 km from east to west. The west Caprivi is bordered by Angola in the north and Botswana in the south. The Kavango River lies to the west and the Kwando River lies to the east, separating the west Caprivi from the East Caprivi. The west Caprivi (formerly known as the Caprivi Strip) is approximately 200 km long, stretching from the Divundu police checkpoint in the west to the Kongola police checkpoint in the East, and is 32 km (20 miles) wide. This strip of land along with Mahango Game Reserve, which lies on the western side of the Kavango River received National Park status in 2009 and is now known as Bwabwata National Park (BNP).

BNP covers an area of approximately 6000 km^2. The landscape is shaped by thick deposits of Kalahari sands and perennial rivers with their associated floodplains. The majority of the area consists of sand dunes which are dominated by Kalahari woodland vegetation type (*Mendelsohn, et al. 1998*).

The areas adjacent to the perennial rivers within BNP are considered core conservation areas and extend for approximately 30 km into the interior. These areas have the highest concentration of wildlife particularly during the late dry season when the perennial rivers are the only sources of water in the west Caprivi. The Buffalo Core Conservation Area lies east of the Kavango River and south of the trans-Caprivi highway and the Kwando Core Conservation area lies west of the Kwando River as well and both north and south of the trans-Caprivi highway. Together these Core Areas cover an area of approximately 1500 km^2 of BNP.

The interior of BNP, excluding the core areas is considered a multiple-use area, where approximately 6500 park residents live in villages and settlements. The majority of people living inside the park boundaries are concentrated around the defunct military bases of Omega 1 and Omega 111 as well as the settlement of Chetto. The mostly Khwe San community are largely

dependent on gathering veld foods for survival and some keep livestock on a subsistence basis (*Alpers, 2011*).

Background

With increasing wildlife numbers in the Caprivi, HWC has become a threat to conservation (*C. Murphy, 2003*), with protected areas often viewed as a source of problem animals. Park residents struggle with crop raiding elephants and predators killing their livestock, but due to the PA status of BNP, these animals cannot be declared "problem animals" and dealt with accordingly. Until recently the park residents in BNP were considered the most marginalized community in Namibia with no opportunities to benefit from natural resources (*F. Alpers, 2011*), unlike the communities in the conservancy programme adjacent to the park in the east Caprivi. IRDNC, a long-standing Namibian NGO, that works on building capacity among rural communities to utilize and manage their natural resources sustainably, provided the necessary support to park residents to establish a residents association called the Kyaramacan Association (KA). This framework provided a system whereby resource utilization within this PA could benefit the immediate community, similar to benefit distribution within the neighbouring conservancies.

Two hunting concessions were established within BNP, where the community could benefit financially through work opportunities, trophy fees and meat distribution. By placing some of the problem causing animals on the quota, trophy fees could also play a role in wildlife related damage reimbursement.

Wildlife trends within BNP are rigorously monitored by annual transects counts within the core areas during the dry season, undertaken by CGG from KA in collaboration with MET field staff (*S. Mayes*, *R. Peters, D. Ward, pers.comm.*). CGG's also conduct independent patrols along fixed routes in the multiple-use areas as part of their work responsibilities under the KA. All direct observations as well as spoor of species are recorded in the Event Book. The Event Book is a community-based wildlife monitoring system (*Stuart-Hill, et al. 2005)* that is carried out and maintained by the community with logistical support provided by WWF in Namibia. These transect counts along with the event book system data as well as reports of incidences of problem causing animals contribute to the process of setting hunting quotas that are sustainable (*G. Matongo, pers.comm*.).

Spotted hyaenas, leopards and crocodiles were the three large carnivore species on the trophy hunting quota for BNP during 2011. KA requested from MET that lions be removed from the quota from 2008 due to their importance and value for tourism conducted in the park (*F. Alpers, pers. comm*.).

Spotted hyaena quotas for BNP are based on the assumption that the species is abundant due to the frequency and abundance of spoor in the core areas as well as their role in livestock depredation in the multiple-use areas and possibly even the conservancies of the east Caprivi. Spotted hyaena density in the core area was assumed to be approximately 5 to 8 hyaenas per 100 km^2. (*Hanssen & Stander, 2004*)

The two hunting concessions within BNP cover an area of approximately 4340 km^2 and three spotted hyaenas were put on the hunting quota for 2011. These hyaenas were to be sourced from clans living outside the core areas of the park.

The focus of this study for 2011 was to collect sufficient supporting evidence to justify removing spotted hyaenas from the trophy hunting quota for BNP.

Aims and objectives for 2011

1. Identify the number of clans, clan size, clan structure, home range size, density, population demography and trans-boundary movements of spotted hyaenas living within the hunting concessions of BNP.
2. Monitor changes in the Kwando Clan (long-term study clan in the Kwando Core Area)
3. Capture individuals from the clan bordering the Kwando Clan for future research
4. Examine livestock practices within BNP and suggest HWC mitigation
5. Assess the sustainability of trophy hunting of spotted hyaenas in BNP

Methods

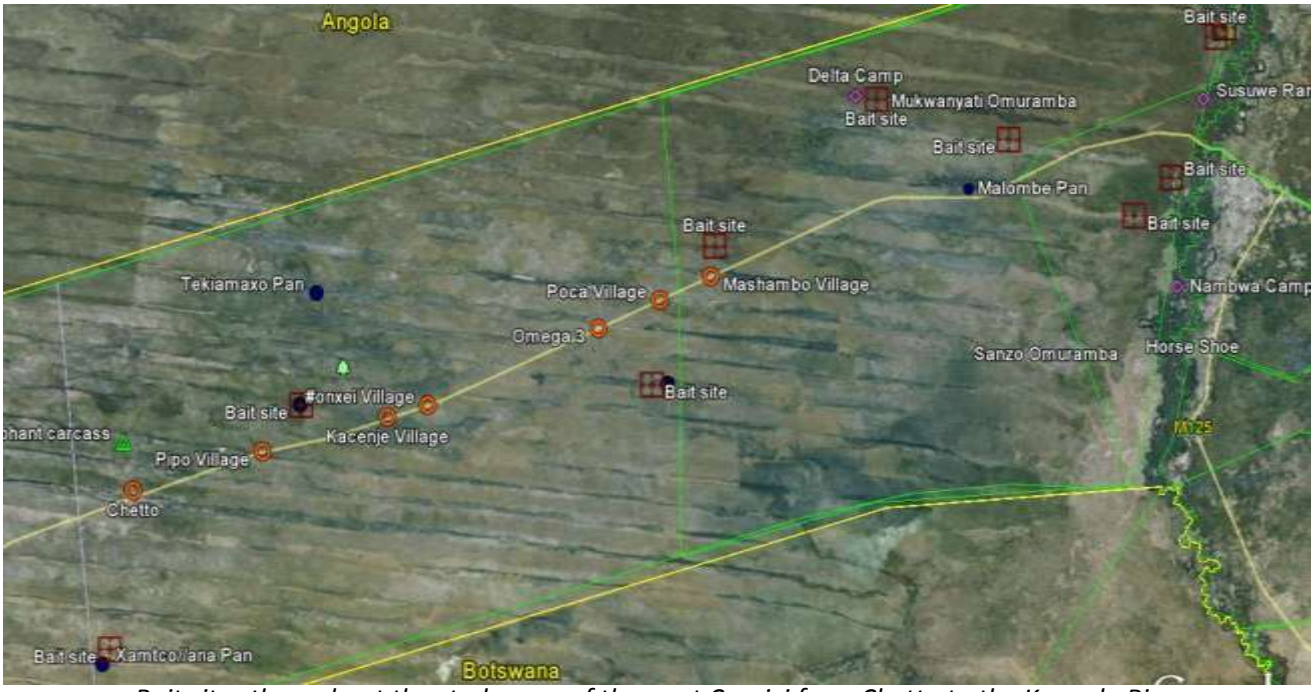
Hyaena distribution in BNP

Field activities took place between March and December 2011 and resumed in February 2012.

To capture hyaenas, bait sites were established in ten different areas between Chetto and the Kwando River and one was placed briefly at Picapau in the Buffalo Core Area in the west of BNP. Four bait sites fell within the multiple-use area and were set up at Xamto//ana pan, south of Chetto, Weyaxa pan, north of Pipo Village, Guixa Pan, south west of Omega 111 and along the core area cutline, north east of Mashambo Village. This area encompasses the settlements of Chetto, Pipo, ≠onxei, Kacenje, Omega 111, Poca and Mashambo.

Six bait sites were established in the Kwando Core Area. Of these, four were established on the northern side to capture the Mukwanyati Clan for the first time. Two were situated along the track between the Susuwe Ranger Station and the Angolan border cutline; another was situated at a water-filled pan close to Delta camp in the Mukwanyati Omuramba and one was established on the Malombe track near the junction between Immelmann airstrip road and the Mukwanyati track.

Two bait sites were established south of the tar road in order to photograph known and new individuals of the Kwando Clan to monitor changes in the clan structure.



Bait sites throughout the study area of the west Caprivi from Chetto to the Kwando River.

Baiting took place between April and December 2011. The bait sites within the multiple-use area were established only once hyaena spoor had been found after extensive tracking and searching effort. Bait trees were chosen for their height, robustness, accessibility by vehicle and visibility for darting activities. Baits consisted of beef and goats bought from the community as well as chicken and occasionally game meat supplied by MET during collaborative field work. Bait is hoisted high up the tree on a steel cable, out of reach of hyaenas. Bones, meat offcuts and chicken pieces were spread around the base of the tree so that hyaenas would be rewarded for their visits to keep them returning. Scent trails consisting of decomposed blood were laid from the bait along tracks and game trails at distances between 10 metres and 13 km.

Each bait site, except for the two along the Susuwe/Angola track were monitored by an infra-red camera placed approximately five metres away and set to take a photo at intervals ranging from 15 seconds to one minute. The camera settings at Weyaxa pan were changed to take video clips of up to a minute long to record behaviour. Due to previous hyaena damage, all cameras were placed inside metal housings.

An **omuramba (pl. omiramba, Herero word) is a prehistoric river-bed occurring in the Kalahari Desert of Africa, notably in the North Eastern part of Namibia and North Western part of Botswana. The Kalahari is perhaps the greatest continuous stretch of sand in the world, and would have been classified as a semi-desert rather than a desert, were it not for the lack of any surface water. However, the omiramba provide occasional standing pools of water and more fertility that in the surrounding sand plains. They start in the central parts of Namibia and run into the central parts of Botswana, sometimes being shallow and deeper with cliffs here and there, other times being quite wide (3-4 km). The omiramba which were perennial rivers about 16 thousand years ago, now flow only for short distances and only after good rains. (Source: http://en.wikipedia.org/wiki/Omuramba)*

Photos and video footage were downloaded at intervals between two days to one week unless active capture attempts were taking place in the area in which case downloads occurred every morning. Areas surrounding the bait sites were monitored in the morning for spoor of all large carnivores and recorded on GPS for the Carnivore Atlas project.

Field activities including setting up bait sites, tracking, capture, handling of immobilized hyaenas and monitoring included either KA or IRDNC field staff that are residents of BNP and/or MET personnel. Training in field techniques took place during this time. Spoor-based data is due to the tracking skills of the community.

Study animals were immobilized with Tiletamine and Zolazepam (Zoletil 100, Virbac) at a concentration of 5mg/kg or a combination of Ketamine and Medetomidine (Domitor, Pfizer) (*O. Aschenborn, pers. comm.*) with a disposable 2 ml dart and a Pneudart rifle. An additional dose of 100 to 200 mg was hand injected intramuscularly approximately twenty minutes to half an hour after initial darting.

Blood samples and blood slides were collected. Hyaenas were measured and spot patterns, scars and natural markings were photographed. Ear notching was used to visibly mark and number the hyaenas. Tooth wear and eruption was used to establish age classes. The general condition was noted and weight was estimated.

Capture work took place between 18h00 and 06h00.

Satellite collars were manufactured by AWT in South Africa. GPS's inside the collars are set to take six locations every 24 hours. The collars also record temperature and speed of hyaena movement. Data is transmitted from the collar via satellite and can be downloaded either as KML data to be used in Google Earth or in Excel, which can be imported into GIS software. Data access codes are shared with both MET's DSS and WWF in Namibia as project partners.

All pans, tracks, dirt roads and the old Golden Highway, the remnants of which still transect the west Caprivi, were covered by vehicle and on foot looking for the presence of hyaenas through spoor and latrine observation. Hyaena faeces are large, almost always bright white, and usually conspicuous in the field (*Kruuk, 1972*) and are often found in latrines, close to home range boundaries, where spotted hyaena clans are established. Latrines are a reliable indicator of spotted hyaena clan presence.

The position of all latrines that were found was marked on a GPS to compare to home range boundaries. All scat was collected to be examined for prey remains. Scat was broken up by hand and any hair, bone fragments and other items were removed. Prey species were identified by recognizable components like fragments of tortoise shell or by hair colour and consistency which was compared to that of known wildlife. Food items identified through observation of feeding hyaenas were included.

Water availability for spotted hyaenas and other wildlife was monitored by visiting all known pans holding water between July and December until the last known pan had dried up. Monitoring of pans ceased when the first substantial rains fell in mid-December leaving sufficient surface water in puddles and smaller pans.

Demography, home range size and use and trans-boundary movement

The data for each clan is presented separately. This is based on known individuals that were marked and collared and have been monitored since 2009 as well as new study animals. Home range size, use and trans-boundary movement was established through collar data as well as spoor and latrine observations.

Human-Wildlife Conflict

HWC work was carried out by recording position of observed livestock while driving between the Kongola checkpoint and Chetto and when driving on tracks into the interior of BNP. Species and group size was also noted as well as livestock position in relation to human activity. Herding/guarding activities or lack thereof was recorded. The possibility of livestock encounters with hyaenas was established by comparing livestock locations to hyaena home range use. Some livestock kraals were looked at, but predation on kraaled livestock within villages is extremely rare (*B. Kupinga, pers comm*.). Hyaena locations occurring within a radius of 500 m, 1 km and 2 km of each village were compared to the total number of locations from the collar data to assess whether hyaenas were targeting areas of frequent livestock occurrence. Hyaena location data was examined for times of activity in order to guide livestock guarding vigilance efforts.

Results

Hyaena distribution in BNP

Weyaxa Pan was the only successful baiting site in the multiple-use area. Spotted hyaena visits to the Weyaxa Pan bait were recorded by infra-red camera over a period of two months. The photos were examined for spot pattern grouping in order to identify the number of individuals. It was established that the same hyaena was visiting the bait site on an almost nightly basis during the entire baiting period of eight weeks. Hyaena spoor that had been observed at an elephant carcass almost 13 km from Weyaxa Pan during the same period of time were consistent with spoor of this same individual.

28 July 2011 *24 August 2011*

Groupings of spot patterns were used to identify the same spotted hyaena visiting the bait over two months.

The bait site at Guixa Pan was visited by one sub-adult hyaena on one occasion over a baiting period of six weeks. No spotted hyaenas were recorded visiting bait at Xamto//ana Pan over a period of one month. The Core Area cutline bait was also unsuccessful. After it was interfered with by park residents and due to the approaching wet season and end of the study season for the year; it was dismantled after two weeks.

No latrines were located throughout the multiple-use area, but some scat was found near Weyaxa Pan which was collected. No additional spoor other than that found at Weyaxa Pan and at the elephant carcass, which was consistent with the known hyaenas track size were found after baiting commenced.

In contrast, all, but one, bait sites within the Kwando Core Area were successful in attracting hyaenas. The Kwando Clan is well acquainted with their bait tree system due to sporadic baiting over a three year period. Response is rapid, usually between 24 and 48 hours, when their bait tree is reactivated. When they did not respond to renewed baiting activities and no spoor was seen in the floodplain area, it was assumed that the presence of lions at the bait tree had scared them off. The baiting was shifted from the floodplain to approximately 3 km inland. The new position was found by lions immediately, but the Kwando Clan was also photographed visiting there so lions were not the deterrent. After two leopards regularly scavenged all the bait at enormous expense to the project, the baiting effort was resumed at the floodplain position again and was found by the Kwando Clan immediately once scent trails were laid.

Intense baiting took place throughout the northern side of the Kwando Core Area in order to capture the Clan that frequents the floodplain near Susuwe Ranger Station and is assumed to be the same clan whose spoor are regularly seen in the Mukwanyati Omuramba. Hyaenas responded immediately to the bait site, but meat was consumed rapidly and hyaenas fled at the approach of vehicles. In some cases baits were found still swinging where hyaenas had been pulling on them only seconds before the arrival of the vehicle.

Latrines were found along the southern core area cutline, the Nambwa track, Immelmann airstrip, Malombe pan, Malombe Pan Road, Horse Shoe and the Mukwanyati and Sanzo Omiramba, which corresponds to open areas and easy access routes through hyaena home ranges.

Hyaena spoor was located along all tracks and some game paths throughout the Kwando Core Area, with particular areas being used far more frequently than others, which is likely due to the distribution of prey species as well as ease of access routes. This becomes particularly apparent during the dry season when most game congregates along the Kwando floodplain and hyaena spoor can be seen every morning along the entire length of the floodplain track from Horse Shoe to across the Angolan border cutline.

Bait site	**Baiting period (In weeks)**	**Area**	**No of latrines***	**Hyaenas****	**Spoor**
Xamtco//ana Pan	4	Multiple-use	--	--	--
Weyaxa Pan	8			1	√
Guixa Pan	6			--	--
Core Area cutline (north)	2			--	--
Elephant Alley	6	Kwando Core	16	4	√
Malombe Pan southern track	3			3	√
Susuwe/Angola 1	2			2	√
Susuwe/Angola 2	3			2	√
Mukwanyati	1			--	--
Malombe/Immelmann junction	1			2	√
Picapau	1	Buffalo Core	1	2	√

Table1: Hyaena distribution in BNP based on baiting effort and the presence of latrines and spoor.

*Searches for latrines covered entire areas and were not restricted to the surrounds of bait sites.
** The single hyaena observation in a period of six weeks at Guixa Pan is not included.

Clan size, structure, home range size and use and trans-boundary movement in the multiple-use area.

There are currently no established clans in the multiple-use (hunting concessions) of BNP.

In addition to the absence of latrines and presence of spoor limited to the single known collared hyaena (CCC-9) during the dry season, an independent census of hyaenas and lions was conducted by Ortwin Aschenborn (MET Carnivore Co-ordinator) and Michelle Kastern by using calling stations throughout the study area. Hyaenas responded to the exercise in both the Buffalo and Kwando core areas, whereas there was no response in the multiple-use areas (*O. Aschenborn, M. Kastern; unpubl. data*)

CCC-9 from the Weyaxa bait site was captured after a total of 88.5 hours of sitting at the bait tree in a vehicle. After examination it was established that he is a young male of two years old and weighs approximately 50 kg. His overall condition was good, but he had fresh bite wounds on his neck and scabs on his flank. This suggests that he has recently emigrated from his natal clan as males disperse after sexual maturity around the age of two years old (*Maddox, 2003; Smale, et al. 1997; Van Horn, 2003*) and has had some contact with hyaenas of higher rank. Natal clan males are higher ranking and extremely aggressive towards immigrant males (*Holecamp, et.al. 1998b*).

In November, Weyaxa Pan was the last pan to dry up resulting in no surface water throughout the study area, with the exception of the Kwando River. From satellite collar locations, CCC-9's movements were very restricted with the majority of his time spent close to the dry Weyaxa Pan and an area lying between Kacenje Village and the Angola border cutline. During a period of six weeks from when Weyaxa Pan dried up until the rains returned and water was once again available in the area, it appears that CCC-9 did not drink at all. Spotted hyaenas have been known to go without water for extended periods and have exceptionally concentrated urine (*L. Frank; G. Mill, pers. comm*).

During the wet season the collar data indicates that CCC-9 is still regularly returning to those two core areas, but makes forays into the immediate vicinity and sporadic forays far into Angola. In one particular incident he travelled over a distance of almost 20 km in four hours from Angola to a location just north of Chetto where he remained for an extended period of time. The current home range of this hyaena covers an area of 1550 km^2 with a core area of 650 km^2. Although hyaenas can walk long distances in search for prey and still return to a central location to utilize migratory prey (*Hofer, et al. 1993*), it is still not clear whether CCC-9's movements are as a result of utilisation of a larger home range as hyaenas become flexible in foraging as a response to seasonal changes (*Hofer et al 1995; Trinkel et al 2006*) or from foraging trips made sporadically out of a smaller condensed home range.

Clan size, structure, home range size and use and trans-boundary movement in the Kwando Core Area.

Kwando Clan

The Kwando Clan has been monitored since 2009 when the first hyaenas were captured and collared for this study. At the start of the study the clan was known to consist of five adults (one male and four females) and one large cub/sub-adult male (CCC-2).

During 2010 with ongoing monitoring through an infra-red camera placed at the dens sites, an additional female sub-adult (CCC-6) was identified. She was later captured, marked and examined and found to have the same tooth eruption pattern and wear as the sub-adult male. As dentition is identical between male and female hyaenas of the same age (*Van Horn, 2003*), it is likely that the two sub-adults were siblings. The female was markedly bigger than the male at 1.5 years of age. Three small cubs of between 6 and 8 weeks (*M. Weldele, pers.comm*.) were also photographed at the den.

During April/May and June/July 2011 an infra-red camera was placed at both baiting sites in the Kwando Clan's home range over a period of nine weeks. All adults except CCC-6 were photographed. An adult hyaena (sex unknown) was found killed by lions by MET rangers during a foot patrol in March 2011 (*A. Sibongo, pers. comm.*). As this occurred within the Sanzo Omuramba, which is regularly used by all clan members, it is highly likely that this accounts for the missing CCC-6. All three cubs from 2010 appear to have survived to one year of age and have been tentatively sexed as one female and two males.

CCC-2 (sub-adult male during 2009 and sibling of CCC-6) was photographed only once visiting the bait tree over the entire period of nine weeks. Given his current age of between 2.5 and 3 years old, it is highly likely that he is in the process of dispersing from his natal clan. Before dispersal, males use the range of their current clan as a secure base from which to explore. (*Boydston, et al. 2003b; Smale, et al. 1997)*

As there was no recruitment into the adult age class, as CCC-2 is dispersing and it appears that CCC-6 died, the adult age class in this clan has remained constant at five individuals over a period of three years of monitoring. The clan size has increased from 5 to 8 members over the same period due to the three cubs surviving into the sub-adult age class.

Age Classes	2009	2010	2011
Adult Females	4	4	4
Adult Males	1	1	1
Sub-adults	1	2	3
Cubs	?	3	?
Total (Adults and sub-adults only)	6	7	8

Table 2: Changes in clan size and structure between 2009 and 2011

The home range size of the Kwando Clan has been calculated as 500 km^2 based on locations from three GSM collars. The home range of the whole clan will be larger as home range size increases with the number of collars placed on hyaenas (*Gasaway, et al. 1989).* Although the home range appears to fall over the border with Botswana, this is only because of two feeding excursions outside the home range boundaries by one of the adult females. Although the Kwando Clan lives exclusively in Namibia, they are dependent on resources in Botswana from time to time.

The Kwando Clan spend much of their time around the three dens sites which are situated 3.44 km west of the Kwando River and approximately 400 to 800 metres apart from each other. The area immediately alongside the Kwando River floodplain and the Omiramba are well used. The Omiramba consisting of savannah-like habitat provide easy access routes throughout their territory. The northern boundary of their home range, which falls along the Immelmann airstrip and Malombe Pan System is highly frequented. This is also the southern boundary of the neighbouring Mukwanyati Clan and can be identified as a common clan boundary by the large number of latrines found in the area. This copious boundary marking behaviour is likely due to active patrolling by clan members from both sides. The Malombe Pan/Mukwanyati Omuramba system has the highest frequency of hyaena use in the BNP.

Mukwanyati Clan

Baiting took place between September and December 2011 in four different bait sites set up within the Mukwanyati Clan area. Despite sitting for a total of 105 hours in order to capture one clan member, these hyaenas were extremely wary of vehicles and only visited baits in between vehicle approaches. They would not approach a bait when a vehicle was parked anywhere in the vicinity. On one occasion when responding to call ups used at the bait site, they fled at the sight of a vehicle. A large female (CCC-11) was eventually immobilized on 16th December while scavenging on a dead hippo on the floodplains on the northern side of the Kwando Core Area (*O. Aschenborn, pers.comm*)

Due to length of time it took to capture CCC-11 and having to close down the study site for the wet season, further field work on this clan was not possible, but will resume during 2012.

Home range size is limited to three months of data from one satellite collar. However, the home range appears to be very similar to that of the Kwando Clan, except that it falls on the northern side of the tar road. CCC-11 spends the majority of her time in the area immediately alongside the Kwando River floodplain and the southern boundary of her home range, where it borders with the Kwando Clan in the Malombe Pan/Mukwanyati Omuramba system. Approximately half of the home range of the Mukwanyati Clan falls across the international border shared with Angola.

Density, sex ratio and population estimate for BNP

Hyaena density was calculated by using the home range size of the Kwando and Mukwanyati Clans of approximately 500 to 600 km^2 and a clan size ranging from 5 to 8 individuals, based on the Kwando Clan. Sex ratio was based on known adult individuals in the Kwando Clan which is currently one adult male and four adult females. Population estimate was based on number of clans, the density and the distribution of spotted hyaenas in BNP. Results are presented below.

Clan size	5 – 8
Sex ratio	1 : 4
Home range size	500 – 600 km^2
Density (Core Areas)	0.6 – 1.5 hyaenas/100 km^2
Density (Multiple-use areas)	0.01 – 0.1 hyaenas/100 km^2
Population estimate for BNP	15 – 25 hyaenas

Table 3: Population density, population estimate and home range size for spotted hyaenas in BNP.

Prey species and food items of BNP hyaenas

It is difficult to observe hyaenas hunting in BNP due to lack of road access and thick riverine woodland vegetation. Hyaenas in the park are difficult to observe in general as they are shy and readily run from vehicles and people. The sheer number of elephants present in the Kwando Core Area during the dry season and late wet season makes it impossibly dangerous to follow hyaenas on foot at night. Knowledge of feeding behaviour is limited to observations of hyaenas scavenging on large food items like elephant and hippo carcasses (*D. Stephens, M. Shikongo, B. Zingolo; pers.comm*.) or eating elephant dung found around the bait trees (*pers. obs*.). There appears to be a lack of scavenging opportunities on kills made by lions as lions group size exceed those of small hunting groups or single spotted hyaenas and therefore cannot be displaced at kills. Hyaena

hunting groups in BNP are small. All observations of groups of spotted hyaenas are of one or two individuals apart from one occasion where the whole Kwando Clan of five individuals was seen together (*pers. obs*.). Although hyaenas tend to be most gregarious during periods of abundant prey (*Smith, et al. 2008*) observations of spotted hyaenas in BNP are too few to correlate with high prey density. Hyaenas have never been observed attempting to rob lions of their kills or spending time around the same food source although there has been one observation of a group of spotted hyaenas mobbing a male lion (*A. Cillier, pers. comm*.).

Prey species and food items were identified by observations of these few scavenging opportunities and through identifying prey remains through scat (n = 72) collected opportunistically throughout the study site. It was assumed that scat consisting of calcium powder only is the result of scavenging on bones, which are readily available at the NDF base dumpsite in the park, one of the most frequently visited areas in the Kwando Clan home range. When scat consisted mostly of hair and other items, it was assumed this was the result of prey species killed and consumed by hyaenas.

Impala and kudu make up the majority of prey choice in the Kwando Core Area. This is consistent with these two species being the most prevalent species in the area apart from elephants and buffalo (*NRWG, 2011*).

About one fifth of the scat samples consist of calcium powder only and are likely due to scavenging on bones. Other species and food items found in the scat of Kwando hyaenas include bushbuck, warthog, scrub hare, spring hare, tortoise, baboon, elephant, hippo, buffalo, duiker, steenbok, sable, lechwe, sitatunga, vervet monkey, birds and elephant dung. Additional items identified included tooth and bone fragments, insect pupa casings, beer bottle glass, wax wrap and nylon sacking.

Only two scat samples were located in the multiple-use area in the vicinity of Weyaxa Pan where CCC-9 was captured. These contained hair from kudu and warthog. During the study period CCC-9 regularly visited an elephant carcass that had been killed by a falling tree north of Chetto.

One latrine was located in the Buffalo Core Area along the Botswana border track. These scat were mostly white powder, but contained some hair of kudu and steenbok.

Food items in are presented in the table below in descending order of occurrence.

Prey species	**No of times identified**
Kudu	32
Bones	29
Impala	22
Warthog	6
Scrub hare	4
Steenbok	4
Baboon	2
Elephant dung	2
Hippo carcass	2
Insect pupa casings	2
Elephant carcass	2
Sitatunga	2
Buffalo carcass	1
Bushbuck	1
Spring hare	1
Duiker	1
Sable	1
Lechwe	1
Vervet monkey	1
Tortoise	1
Bird (Unknown)	1

Table 4: Food items of BNP spotted hyaenas.

Human-Wildlife Conflict mitigation in BNP

All livestock observed (n = 423) between the Kwando River and Chetto settlement consisted of donkeys and goats. There were three incidental observations of cattle around Omega 1 while driving further west through BNP. Out of 48 observations of livestock in the west Caprivi, 33 were of animals grazing close to or within the surrounds of human settlements. This area was judged to be within a radius of 200 metres from the village. Fifteen observations were of groups of livestock occurring at a distance of at least one km or more from human activity. Of these fifteen, five occurred within the Kwando Core Conservation area and must have originated from Mashambo Village, which is situated adjacent to the cutline. On one occasion a herd of cattle was observed in the Kwando Core Area, but these had managed to run through the Kongola checkpoint and originated from the East Caprivi.

Except for the three observations of cattle which were in the process of being herded at Omega 1, all other livestock observed in the study area of the west Caprivi were not guarded or herded in any way.

The collar data was examined to establish how often CCC-9 occurred within village surrounds in order to determine whether he was targeting areas of livestock prevalence. A radius of 500 metres was chosen as village limits. The number of locations occurring within these limits as well as those within a distance of 1 km and 2 km from each village was compared to the total number of locations over a period of six months from the satellite collar. Mashambo was excluded as CCC-9's home range only extends to Poca Village.

The table below presents the number of times CCC-9 has been located within varying distances from villages out of a total of 1085 locations over six months.

Village/Settlement	Within a 500m radius.	Between 500m and 1 km	Between 1 km and 2 km
Chetto	0	1	0
Pipo	1	3	3
Kacenje	1	5	3
≠onxei	1	4	4
Omega 111	0	0	0
Poca	0	0	0

Table 5: No of times CCC-9 has been located near human settlement areas in BNP out of 1085 locations

Locations of livestock CCC-9 Home Range

Livestock locations in proximity to villages and home range of CCC-9

Location times were examined for hyaena activity in order to guide livestock guarding vigilance. CCC-9 was active most of the time except for the very hot hours of the day from midday until 17:00.

Discussion

Spotted hyaena distribution, clans, density and population estimate for BNP.

Spotted hyaenas occupy areas with a high productivity of ungulate prey and at least some fresh water present (*Kruuk, 1998*). Spotted hyaena clans in BNP are restricted to the core conservation areas, adjacent to the perennial river systems. There are no permanently established clans within the multiple use area, which includes the two trophy hunting concessions. This is likely due to lack of permanent water in the late dry season resulting in the majority of wildlife congregating along the perennial rivers on the east and west boundaries. In dry habitats like semi-desert areas low densities of large carnivores has generally been associated with low prey densities (*Stander, 1991*) and hyaena density is strongly correlated with prey density (*Trinkel et al., 2009*). Although some wildlife species like kudu and steenbok occur in the multiple-use area even when there is no surface water (*pers. obs*.), it is unlikely that their numbers are sufficient to sustain the energy requirement of an entire clan/s of spotted hyaenas.

In addition Hyaenas breed throughout the year (*Boydston, et al. 2003*) and are limited in their movements by the lack of mobility of their young (*Hofer, et al 1993*). Hyaena dens are located close to permanent water systems (*Boydston, et al., 2003; Mills, 1990*), therefore lack of permanent water limits the possibility of spotted hyaena clans becoming established in the interior of BNP. There is no evidence of hyaenas based in the core areas commuting into the interior of BNP, such as has been observed in the Serengeti system (*Hofer, et al. 1993*).

There is anecdotal evidence to suggest that the interior of BNP is utilized by dispersing males. In addition to the presence of CCC-9, there is one photograph captured on remote camera of a sub-adult hyaena at Guixa Pan, which is situated 20 km west of the Kwando Core Area cutline and one set of male sub-adult spoor on the Mashambo core area cutline was recorded. Hyaena utilization of the multiple-use area of BNP could possibly adapt to changing conditions like increased water availability during very wet cycles when pans hold water throughout the dry season making water available throughout the year. This could explain the presence of hyaenas causing problems with livestock and attacking children around Chetto in the early nineties. They were eventually destroyed by MET (*S. Mayes, A. Tchadau, pers. comm*.). The interior of BNP will be monitored for hyaena activity during the current wet season and over the long-term for responses to environmental changes.

BNP contains one full clan and three partial clans of spotted hyaenas whose home ranges fall over the international borders shared with Botswana and Angola. All spotted hyaenas in BNP are dependent on trans-boundary movement to neighbouring countries for resources including the Kwando Clan whose entire home range falls within Namibia's borders.

Spotted hyaena clans range in size between four and 54 hyaenas with home ranges varying between 13 km^2 and 1250 km^2 depending mainly on availability of food (*Kruuk, 1972; Frank, 1986; Mills, 1984a, Tilson, et al. 1986*). Accordingly, hyaena densities vary largely with mean densities ranging from 0.6 hyaenas per 100 km^2 in the Kalahari Desert to 170 hyaenas per 100 km^2 in the Ngorongoro Crater (Kruuk, 1972, Mills, 1984a; Tilson, et al. 1986). BNP clans consist of five to eight adults and sub-adults, whose home ranges cover an area of approximately 500 to 600 km^2. The population estimate is based on density within the core areas, which range between 0.6 and 1.5 hyaenas per 100 km^2, which is similar to both the Kalahari (*Mills, 1984*) and Etosha National Park (*Trinkel*, *2004*) and in the multiple-use area which range between 0.001 and 0.1 hyaenas per 100 km^2 resulting in an estimate of 15 to 25 spotted hyaenas in BNP.

Human-wildlife conflict mitigation in BNP

In many instances predation of livestock may occur simply because there is nothing to prevent it (*Frank, et al., 2001*). Despite the lack of herding and guarding of small stock and donkeys in BNP, there appear to be some behavioural factors in both small stock and spotted hyaenas that play a role in preventing greater livestock losses to spotted hyaenas. Smallstock spend most of their time within the vicinity of human settlements and hyaenas appear to avoid villages despite CCC-9's home range and possibly those of other dispersing males encompassing the human settlement areas. Livestock is not targeted by spotted hyaenas, but frequency of encounters between hyaenas and livestock straying out of sight and sound of people play an important role in livestock depredation in the west Caprivi. Although the lack of herding or guarding of livestock within the study area is adequate for much of the time, vigilance by the community needs to be directed towards animals straying far from human activity. This is particularly relevant for Mashambo, Poca and Omega 111 that are close to the Kwando core area where spotted hyaena density is far higher. Kraaling of livestock in solid structures at night would provide adequate protection should a

particular hyaena develop into a problem animal through learnt behaviour. It is worth mentioning that hyaenas could be blamed for livestock kills made by other predators due to their scavenging nature (*Kruuk, 1998*) and HWC incidences related to other predator species needs further study. Although livestock deaths to domestic dogs are not recorded in the Event Book, this phenomenon is highly likely, as domestic dogs form packs and roam within BNP far from human habitation *(pers. obs.).*

Spotted hyaena conservation in BNP.

More myths have arisen in regard to hyaenas than perhaps any other animal in Africa (*Glickman, 1995).* Public ignorance regarding spotted hyaenas currently represents one of the most serious obstacles to the conservation of spotted and other hyaenas and misconception is considered one of the most serious threats to the survival of spotted hyaenas (*Mill & Hofer 1998*). Although spotted hyaenas are perceived to be the most abundant large carnivore in BNP, they are the least observed. It is likely that spotted hyaenas number less than wild dogs in the west Caprivi. Spotted hyaenas are considered conservation dependent and are classified as Threatened – increasingly dependent on protected areas (*IUCN, 2000*), but gaps in knowledge, poor species management, indiscriminate killing and constraints on conservation measures are listed as problems in hyaena conservation plans.

With the rapid decline of spotted hyaena populations outside PA's due to persecution and habitat loss, the species is increasingly dependent on the continued existence of PA's (*Mills, 1998*). Lethal off take within PA's is considered a conservation threat to the spotted hyaena and should be taken seriously *(Hofer, 1998)*. Once a spotted hyaena social group (clan) has disappeared it is difficult to repopulate the area *(Kruuk, 1998).*

In Namibia, there appears to be a lack of knowledge regarding spotted hyaenas and their need for conservation particularly within PA's. With regards to utilization of this species, their population dynamics and strict dominance hierarchy along with complex intraspecific relationships makes them a poor candidate for trophy hunting. It is these factors rather than hyaena population numbers that contribute to the sustainability of this practice. Their reproduction is so slow that they struggle to recover their numbers even under natural systems. The Kwando Clan has increased in size by only two members over a period of three years.

Low fertility is a cost of female virilization and female hyaenas struggle to conceive (*Szykman, et al. 2007*) and to give birth (*Frank & Glickman, 1994*). A female hyaena may produce only ten offspring in her entire life (*Hofer, 1998*) and possibly 50% of hyaena cubs survive to one year, (*Mills, 1990*). Hyaena offspring require an unusually long period of nutritional dependence on the mother, which can be up to 24 months. (*Boydston et al., 2007, Holecamp et al, 2007*), but is usually between 14 and 18 months. Hyaena milk has the highest protein content of all terrestrial mammals. (*Mills & Hofer, 1998).*

Trophy hunting of spotted hyaenas is unsustainable throughout the Caprivi and Kavango Regions and is particularly destructive within BNP where clans are small and density is exceptionally low throughout the majority of the park. Occasional incidences of HWC do not justify the hunting of this species inside a PA particularly when HWC can be minimized by increased vigilance of livestock by the community.

Baiting on the periphery of core areas to attract hyaenas for trophy hunting is likely to draw key clan members out of the core area and possibly from further afield such as Angola. Copious baiting and scent trails in west Caprivi core areas have been known to attract up to 20 hyaenas (*A. Cilliers, pers. comm*). The destruction of key clan members could well mean the permanent destruction of the entire clan due to their complex social structure and population dynamics. Complexity of spotted hyaena societies far exceeds that found in the social lives of any other terrestrial carnivore (*Holecamp, et al. 2000*). Small clans such as those that occur in the Caprivi and Kavango Regions are particularly vulnerable to persecution. The loss of the dominant female could well mean the loss of even quite large cubs. Unlike lions, there is no communal care of young (*Maddox, 2003*). In the case of the Kwando Clan, the three large cubs/sub-adults are important individuals which have tentatively contributed to the slight increase in clan size. The loss of their dominant female would most certainly lead to the fragmenting of the clan.

Targeting dispersing males in the multiple-use areas could be equally destructive as immigrant males are important for reproduction as they sire all cubs within a clan (*Van Horn, 2003*). Nearly all spotted hyaenas are the offspring of males born elsewhere (*Engh, et al. 2002*). Building relationships with new clans takes years and immigrant males must remain within a new clan for at least two years before he sires his first offspring (East *et al. 2003; Engh et al., 2002).*

Trophy hunting as a means of alleviating HWC is indiscriminate therefore ineffective in dealing with an actual problem animal. In addition, hyaenas in BNP do not cross major river systems and therefore play no role in HWC in east Caprivi. The BNP hyaena population is entirely separate to the east Caprivi hyaena population and should be managed as such.

With regards to financial benefits to the community through trophy hunting of this species, the total amount contributed per annum is minimal, unsustainable and would be short-lived. The average trophy fee for spotted hyaenas is US$700 (N$5250) (at a current rate of US$1 = N$7.5; www.xe.com) per animal of which the community would receive US$300 (N$2250) (*A. Cillier, W. Cillier, pers.comm*.) per trophy. This brings the total financial benefit to the community from spotted hyaena trophy hunting within BNP to N$6750 (approx. US$900) per annum. Additional benefits like bed night levies, length of safari, etc. are not factored in, as it is assumed that spotted hyaenas are not the main attraction for hunting clients.

In November 2011, a letter from the KA committee was sent to MET requesting that spotted hyaenas be removed from the hunting quota for BNP. This is a positive step for spotted hyaena conservation in the Caprivi Region. The results of this study support the recommendation for the

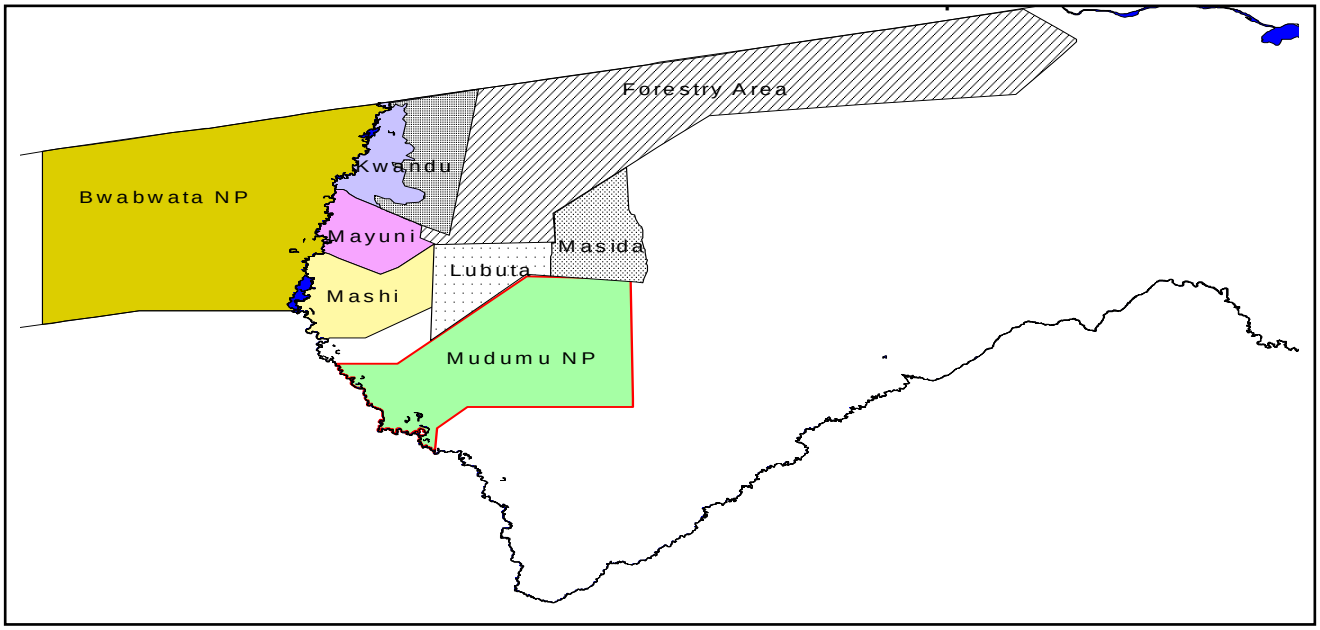
permanent removal of spotted hyaenas from the hunting quota for BNP as this practice has no community benefit and is destructive to the conservation of this keystone predator.

Resource availability and distribution of permanent water are the limiting factors of spotted hyaenas in BNP. If it were not for the trans-boundary movement across the international borders of Angola and Botswana, then the BNP hyaena population could not persist.

Spotted hyaenas are keystone predators and their presence is a useful indicator of ecosystem health (*Mills, 1998*). It would be worthwhile developing a species management plan that is relevant for all PA's that fall over international borders such as within the KAZA TFCA.

Section 2 – East Caprivi (Mudumu National Park and Mudumu North Complex*)

Study site



Mudumu North Complex in the East Caprivi (Adapted from Peggy Poncelet Report). Source: www.nnf.org.na

**The Mudumu North Complex is a cluster of conservancies, community forests and state protected areas in eastern Caprivi that co-operate in the management of wildlife, forests and other natural resources. The MNC aims to accomplish goals greater than any smaller unit could achieve on its own. (NRWG, NACSO, 2009)*

Although the Kwando core conservation area within BNP is considered part of the MNC, for the purposes of this study, activities within MNC were confined to the east Caprivi within the state forest area where the East Caprivi borders on Zambia, the four conservancies of Kwandu, Mayuni, Mashi and Sobbe that fall between the northern border with Zambia and the boundary of MNP and within MNP itself. Approximately 13 000 people and their livestock reside in villages within the conservancies of MNC, which cover an area of 1042 km^2 (*NACSO, 2006*).

Methods

Monitoring of changes within the Lwazaze Clan was carried out by placing an infra-red camera at the Lwazaze Waterhole that was established in the state forest through the ICEMA project under MET. The clan was photographed 422 times in just over one month.

In MNP, baiting was briefly carried out at a sight close to the Lianshulu Lodge airstrip. This bait site turned out to be unnecessary for the capture of hyaenas as they readily responded to sound playbacks of spotted hyaena vocalization and were calm enough to be immobilized close to vehicles.

All field activities taking place in the state forest and MNP included the training of CGG from both Mashi and Kwandu conservancies. All activities within MNP were carried out with the permission of MET park staff.

Study animals were immobilized examined and marked using the same techniques as those described for BNP. Sera and whole blood from both east and west Caprivi have been frozen and sera have also been contributed to the CVL in Windhoek. Two satellite collars from AWT were also used in the East Caprivi. One GSM collar deployed on CCC-7 captured at Njalingombe Waterhole during 2010, was still active until January 2012, but did not transmit data due to the poor cellphone network coverage. The collar was programmed to take a location every hour throughout the night for just over one year until the battery life ran out. This hyaena will be captured to retrieve the collar and the data will be downloaded from the onboard memory card. Capture work took place between 19h00 and 02h00.

The MNC was monitored constantly for hyaena spoor and scat and/or latrines to establish whether clans are present within the conservancies. Scat was collected when found and analyzed for prey species using the same method as for BNP.

HWC work was carried out by recording the position of unguarded/unherded livestock observed at night on a GPS while driving along roads throughout the MNC. The possibility of livestock encounters with hyaenas can be established by comparing livestock locations to hyaena home range use. Hyaena locations outside MNP were examined in order to establish whether hyaena movement in conservancies is part of their home range extending outside the boundaries or the park or whether hyaenas are only exiting MNP to target livestock in the conservancies. Attacks of livestock inside kraals at night are rare (*B. Bennety, B. Munali, D. Mwema; pers.comm; HACCSIS, unpubl.data*) so kraals were not included in the study. Hyaena locations occurring within a radius of 2 km of each village were compared to the total number of locations to assess whether hyaenas were targeting areas of frequent livestock occurrence. Hyaena location data was examined for times of activity in order to guide livestock guarding vigilance efforts.

Results

Hyaena distribution in MNC

There are no permanent clans established within the high density human settlement and livestock farming areas. Hyaena clans are restricted to MNP and the state forest in the north, but home ranges do extend over their boundaries into conservancies.

During 2010, a male hyaena (CCC-7) was captured and collared at Njalingombe waterhole on the border of Mayuni and Mashi Conservancies, which is approximately 20 km north of MNP. The GSM collar did not transmit locations, but using the VHF facility on the collar, he was tracked using MET's aircraft and was located 8 km into MNP, within the same home range of the newly collared Mudumu Clan. As he was two to three years old, it is highly likely that he was in the process of

dispersing, which would explain moving distances of up to 20 km away from the clan home range boundary.

On one occasion, bait was stolen by a hyaena in the Ngonga area, which is approximately 15 km north of the MNP, but the hyaena identity is unknown.

No latrines were located within the conservancies of the MNC although occasional scat was found near Lwazaze waterhole, Njalingombe waterhole, the Sijwa Wildlife Corridor and Mavunje Camp. Latrines were located inside MNP, but none in the area surrounding Lwazaze Waterhole in the state forest, despite a permanent clan being established there.

Spoor that was found in the conservancies of MNC were restricted to that of CCC-7 visiting bait near Njalingombe and occasional spoor in the wildlife corridors. Spoor was found near Sijwa Environmental Centre and around Kapako Village in the Mayuni Conservancy on only two occasions in three years.

Clan size structure and home range size

State forest – Lwazaze Clan

The Lwazaze Clan was identified during 2010 when an infra-red camera was placed at the newly established Lwazaze waterhole in order to monitor visiting wildlife species on behalf of ICEMA and IRDNC.

None of this clan was captured at the time as the focus of the study during 2010 was examining HWC in the MNC closer to the boundaries of MNP. However, individuals were identified through natural markings, one eye injury and age classes that were recorded by remote camera. Clan association was established by the number of times individuals were observed together. During 2010 it could only be established that the clan were using the Lwazaze waterhole, but during 2011 it was confirmed that this waterhole is well within their home range as they are denning close by.

Two small cubs of approximately four months old were photographed during August 2011. This confirms that the den must be reasonably close to the waterhole as young cubs would still be den bound and far too young to accompany adults on foraging expeditions.

It appears that the Lwazaze Clan has not expanded during two years of monitoring as the adult/sub-adult age classes remain at four individuals.

Age classes	2010	2011
Adult	2	4
Sub-adult	2	0
Cubs	?	2
Total clan size (adults/sub-adults)	4	4

Table 6: Clan size and structure over a period of two years

MNP – Mudumu Clan

Work on the Mudumu Clan is recent and there is relatively little information on the size and structure of the clan. On one occasion, seven hyaenas responded to sound call ups of which the two known collared individuals were not present. Currently the Mudumu Clan is known to consist of a minimum of eight adults and sub-adults. Three clan members are currently marked and collared and have been examined. Details on age and sex are presented below.

Hyaena ID	Sex	Age class
CCC-7 (Dispersed?)	Male	Adult
CCC-8	Female (has lactated)	Adult
CCC-11	Male	Sub-adult

Table 7: Age and sex of collared members of the Mudumu Clan

The Mudumu Clan are making use of an area that measures approximately 600 km^2, but the area continues to expand and the home range of the entire Mudumu Clan is likely to be larger as this figure is based on data from only two satellite collars.

Home range use

The highest frequency of locations are clustered around a den which lies only 1.2 km south of the northern boundary of MNP and 2.2 km east of the main gravel road. The hyaenas use the main gravel road to travel through their home range, but spend more time away from the river to the east of the main road. The northern part of their home range alongside the border of MNP is by far the most used area. There are surprisingly few locations close to Lianshulu lodge, Ngenda and Nakatwa Ranger Stations where one would expect hyaenas to look for scraps of food. The majority

of their time is spent inside MNP, but they have been located in Mashi and Sobbe Conservancies in the north and in Balyerwa Conservancy to the south. On one occasion, CCC-8 travelled as far as 8 km into the Mashi Conservancy. The Mudumu clan is using about half of MNP as their home range. The far eastern side of the park appears not to be utilized at all by the Mudumu Clan, but some scat has been collected there. The collar data was examined for movement across the park boundaries. The Mudumu Clan spend time within the neighbouring conservancies rather than making sporadic trips out of the park so it is assumed that the southern parts of Mashi and Sobbe conservancies fall within their home range.

Density, sex ratio and population estimate for MNP

It appears that there is only one clan of spotted hyaenas within MNP, but this needs further research. It is not possible to establish sex ratio as the majority of the clan members are not known. The Mudumu Clan size appears to be between 5 and 8 individuals, which is similar to hyaenas in BNP. Using the known home range of approximately 600 km^2, the density of this one clan is tentatively estimated at 1.5 hyaenas per 100 km^2, although it is not yet clear whether this figure applies to the whole of MNP. Based on the above results, there appears to be less than ten spotted hyaenas in MNP, with a total of 15 for the whole of MNC. Research on the MNP hyaenas will continue during 2012.

Prey species and food items of MNC hyaenas

Prey species of MNC hyaenas have been identified through scat (n = 6) and the stomach contents of one female hyaena that was killed by a vehicle near the Mavunje Community Campsite in the Mashi Conservancy. All the scat in MNC was collected in the conservancies and the state forest around Lwazaze waterhole. Eleven species were identified. No latrines were found. No scat has been collected from within MNP although it is likely that some of the prey species identified in the scat originated from the park. No livestock was identified in any of the scat samples.

Food items are listed in the table below in descending order

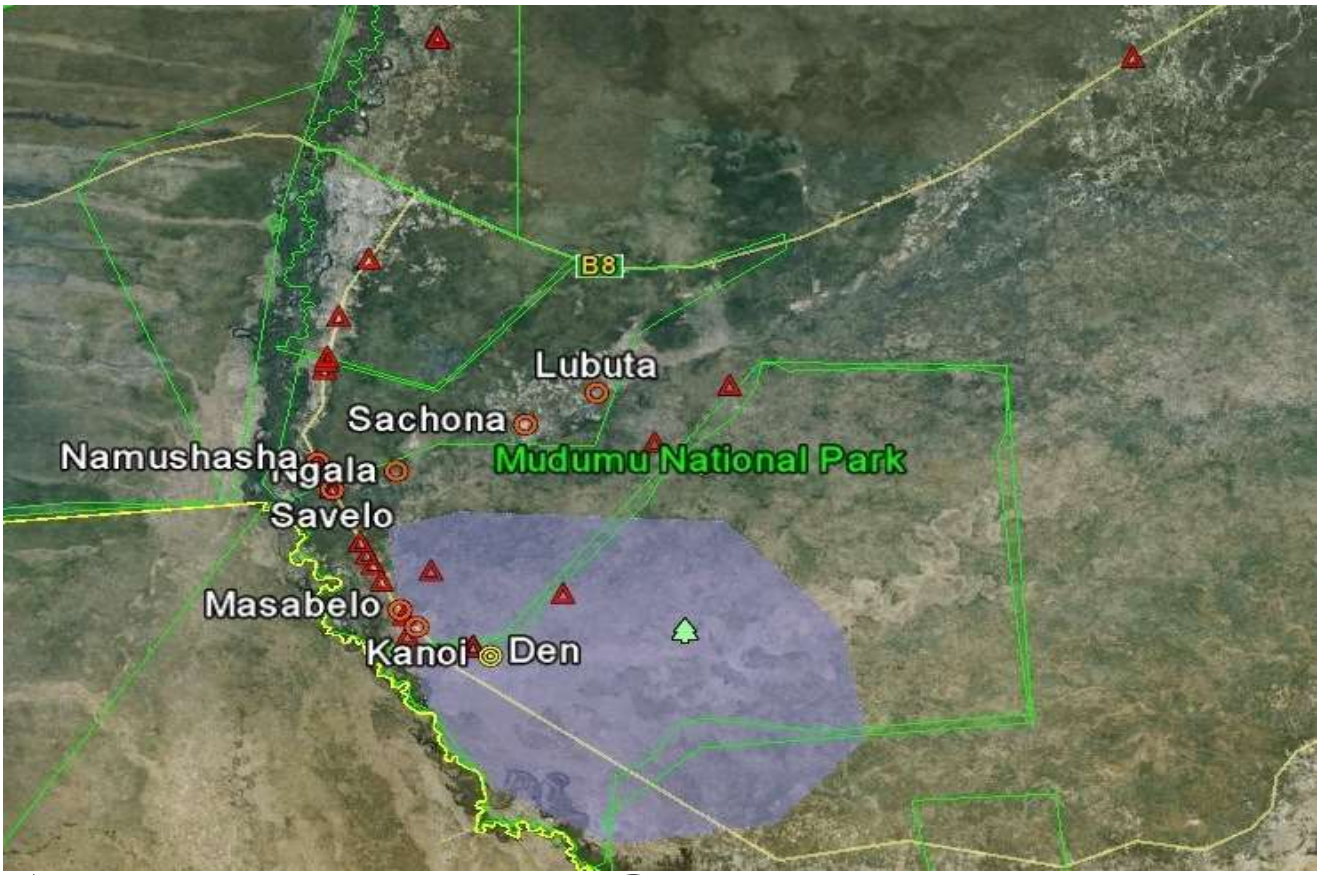
Food items	No of times identified
Kudu	5
Scrub Hare	3
Scavenge	3
Springhare	2
Duiker	2
Impala	1
Steenbok	1
Vervet monkey	1
Bat-eared fox	1
Aardwolf	1
Bird	1
Vegetation	1

Table 8: Food items of MNC and MNP spotted hyaenas

Human-Wildlife Conflict

The highest incidences of livestock predation in the MNC occur within Mashi Conservancy, which borders on MNP. The area that lies south east of the conservancy on the border of MNP close to the Kwando River and the area between Sachona and MNP are considered hotspots (*Rostant, 2010*). It is assumed that spotted hyaenas and other predators leave the park at night, kill livestock then return to the safety of the PA. Between ten and sixty tons of livestock can be found unherded and unguarded on any one night within the whole of the MNC (*Hanssen, unpubl.data*), which is easily killed by any number of large carnivores. More unguarded livestock have been observed at night in Mashi Conservancy than any other Conservancy although this is likely due to there being more livestock in the Mashi Conservancy. Three observations of unherded cattle took place on the cutline between MNP and Mashi Conservancy. Large herds of cattle unaccompanied by a herder were photographed by remote camera grazing on the boundary of MNP during the day. Herds of up to fifteen cattle are regularly observed by tourists on game drives up to 2 km inside MNP boundary (*A. Soja. pers. comm).* During the wet season, cattle are often not kraaled at night, but left to graze unaccompanied by a herder for weeks or months at a time to take advantage of the green grass and the availability of water in pans and gravel pits (*V. Tetuka*, *D. Chelezo, pers.comm*).

The home range of the Mudumu clan falls over the northern boundary of MNP and a significant portion falls within the same area that livestock graze. In addition, livestock inside the park were found close to areas of hyaena frequency including one den site.



Locations of livestock in MNC Home range of the Mudumu Clan

Spotted hyaena locations and livestock locations in MNC

The collar data was examined to establish whether the Mudumu clan were targeting kraals in villages. Out of 1534 locations from two collars, the monitored hyaenas were located within a distance of 2 km from all villages only 12 times in five and a half months and none within half a kilometre during the same period. However, there remain at least six hyaenas within the Mudumu Clan that are not collared and whose movements have not been monitored to date.

The collar data was examined for times of activity. Mudumu hyaenas are active at all times of day, but this could be influenced by cooler temperatures during the peak wet season.

During 2011, nine head of cattle were killed by spotted hyaenas in Mashi Conservancy (*N. Le Roux, J. Muchaka, pers. comm*)

Discussion

Spotted hyaena distribution, clans, density and population estimate for BNP.

Spotted hyaenas in the MNC are mostly restricted to areas with protection status such as the state forest and MNP, however their home ranges do slightly overlap with human settlement areas and associated livestock farming. Clans are similar in size to BNP, between 5 and 8 individuals, but density and population estimate is unknown. There is anecdotal evidence to suggest that density might be slightly higher in MNP compared to BNP, but this needs further research. As hyaenas are restricted by water distribution, until recently this would have limited the east Caprivi hyaena population. However, with developments of waterholes, i.e. Lwazaze bordering on Kwandu Conservancy, Njalingombe on the border of Mashi and Mayuni and more recently, within Sobbe Conservancy, the furthest from the Kwando River, this is likely to affect the home range use of the Mudumu Clan and could possibly lead to an increase in the spotted hyaena population within MNC as clans are able to establish themselves close to permanent water. This appears to already have taken place near Lwazaze waterhole and is a good possibility for the Sobbe Conservancy due to its proximity to the protection of MNP. The increase in hyaena activity within the conservancies according to the Event Book is likely to be due to hyaenas changing their land use strategy in response to water availability rather than an increase in the population size at this point. Increased water availability is likely to lead to increased HWC or the perception thereof.

Hyaenas occurring as far north as Mayuni conservancy from MNP could possibly be dispersing males from the park or small foraging groups, but further research is needed.

MNC contains no more than two partial clans, one near Lwazaze waterhole which is shared with Zambia and possibly even their PA of Sioma Ngwezi National Park to the north and the Mudumu Clan which is shared by conservancies as far south as the MSC.

With limited protected areas and high density of people and livestock in the MNC, hyaena numbers are unlikely to exceed fifteen individuals.

Human-Wildlife Conflict mitigation

More livestock is lost to predators in Mashi Conservancy due to a number of factors. With a human population of nearly 4000 people, the second highest in the MNC, Mashi contains more cattle than any other conservancy (*NACSO, 2009*). Although the home range of the Mudumu Clan falls within a small portion of the Mashi Conservancy, it appears that this is not due to hyaenas making short trips out of the park and rapidly returning to it after targeting livestock, but rather spending time foraging in the areas close to their den which is near the northern border of the park. There is no evidence from both collar data and Event Book data to suggest that hyaenas target livestock in kraals in villages as carnivores display both spatial and temporal avoidance in response to increased human activity (*Boydston, et al. 2003*). Livestock losses are likely due to the frequency of encounters between cattle and hyaenas. The encounters are opportunistic where cattle are left unguarded close to and within the borders of MNP where their grazing overlaps with the Mudumu

Clan home range. This becomes apparent when one considers that Mashi Conservancy has the highest loss of cattle to hyaenas, which can be calculated at approximately one head of cattle per hyaena for 2011.

The hotspots of livestock losses to hyaenas can be attributed to cattle congregating near the river to drink which overlaps with the northern boundary of Mudumu Clan as well as the settlements of Sachona and Lubuta having more livestock that any other settlement in the Mashi Conservancy. This along with the practice of allowing cattle to graze unattended for extended periods of time without supervision while water and grazing is abundant then unaccounted for livestock losses are blamed on hyaenas due to the presence of their spoor. Out of ten insurance claims to HACCIS, eight were not paid out due to circumstances similar to the above. (*D. Mwema, pers. comm*.).

Due to cattle grazing overlapping with the northern part of the Mudumu Clan home range, losses of livestock would be reduced if vigilance in the form of herding were markedly improved within 5 km of the boundary of MNP. Hyaenas have been known to be wary and show avoidance behaviour around livestock accompanied by herders (*Boydston, 2003; Pangle, et al, 2010*). This would also reduce the number of cattle roaming into the park and into the core area of the Mudumu Clan's home range. Villages within this zone also need to take particular care that their cattle are safely kraaled at night.

There are no records of livestock losses due to domestic dogs or diseases in the Event Book. However a number of livestock losses in the village of Kapako, which were blamed on hyaenas were found to be due to a pack of five domestic dogs (*N. Le Roux, pers. comm.).* Perception of impact of spotted hyaenas on domestic stock differ from reality and a regularly scavenging species such as spotted hyaenas may often be blamed for killing livestock when it has merely scavenged a carcass of an animal that died from disease (*Mills & Hofer. 1998*). .). A number of cattle have been observed overcome with external parasites in the east Caprivi (*F. Chitate, D. Stephens, D. Ward, pers. comm.*). These would readily be scavenged on by hyaenas. In some of these cases claims have been laid with HACCIS, but have been denied.

Suggested management of spotted hyaenas in MNC

Spotted hyaenas are currently still on the trophy hunting quota for some of the conservancies in the MNC. This measure is due to a number of reasons. The frequent observations of their spoor which is recorded in the Event Book, results in the calculation of a high sightings index, which is misinterpreted. Spoor frequency is not a reflection of abundance of spotted hyaenas in the conservancies, but rather behaviour of the species. Hyaena spoor has been used reliably in population estimates in some studies (*Gusset, et al. 2005*). It would be valuable to link Event Book data to true density of spotted hyaenas in the Caprivi as an indirect monitoring system. Another reason, is their perceived role in HWC as well as intolerance and dislike of the species. Studies in Kenya have shown that hyaenas are disliked in great disproportion to the relative damage they caused when compared to cats (*Frank, 1998).* Reports of hyaenas bothering cattle in the MNC have come about merely from people hearing hyaenas vocalising in livestock areas (D. Chelezo, pers.

comm.). Although trophy hunting within PA's and conservancies is based on sustainable utilization, it has already been shown that this is not possible with spotted hyaenas. Hyaenas tend to have an unpopular image (*Kruuk, 1998*), which plays a greater role in their quota setting than any conservation consideration. There is a valid argument that trophy hunting of spotted hyaenas need not be sustainable in the east Caprivi as killing them would reduce the number of livestock killed as well as appease the community. However it has already been shown that livestock losses to spotted hyaenas are far lower than perceived or even proved and trophy hunting is unlikely to affect hyaena related HWC unless spotted hyaenas are eliminated from the east Caprivi entirely.

The financial benefits to the conservancies from their research through this project alone have far exceeded any benefits from trophy hunting hyaenas in the MNC. This has taken the form of S and T to CGGs, purchase of meat from the community for baiting as well as training and research opportunities and capacity building for some community members.

Based on this, it would be worth considering promoting hyaenas to the local tourism industry, which is a suggestion in the Hyaena Conservation Action Plan (*Mills & Hofer, 1998*) for the conservation of spotted hyaenas living outside PA's. Conservancies could receive income from taking tourists to view hyaenas at a bait site. This could easily be carried out by CGG or specially trained guides that could work with local lodges and their guests. Not only would this improve the community perception of this species, but it would raise the profile of the spotted hyaena, which is sorely needed for their long-term conservation. It is possible that tourism benefits could exceed anything received through trophy hunting and this income would be sustainable. Aside from income, this venture would provide some job opportunities and could be initiated by the community and maintained by them.

Future research and conservation on spotted hyaenas in the Caprivi and Kavango Regions

Spotted hyaenas have only recently been studied in MNP, but information on the clan structure, reproduction and even the numbers of clans are unknown. A study of the population within MMNP has never taken place. It is likely that the MNP and MMNP populations are connected through the conservancies in the MSC, but this is unknown. As MSC is an area of high HWC incidences, it is important to understand how these populations interact, their dependence on the conservancies within the MSC, current hyaena management within the MSC as well as factors driving HWC. This information would result in maximising efforts in HWC mitigation as well as understanding conservation needs for spotted hyaenas in these two PA's.

The BNP population needs continued monitoring particularly with regards to factors affecting density and trans-boundary movement. Hyaenas within the Buffalo Core Area and their role in HWC within the western settlements of BNP need intensive research. Tracking skills provided by the KA community within BNP will provide the necessary insight into spotted hyaena behaviour. These individuals will receive training on in depth wildlife monitoring at the same time, which contributes to their capacity to jointly manage resources within BNP in partnership with MET.

Follow up ground work in Kaudom Game Reserve in Kavango needs to take place following the collaring of a female spotted hyaena by MET during 2011.

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