Zambian

CARNIVORE PROGRAMME

DEPARTMENT OF NATIONAL PARKS & WILDLIFE

DNPW

"CONSERVE WILDLIFE"

# 2017 Annual Report


Dogs from the Hot Springs pack--ZCP's longest running study pack--tend to their 2017 pups at the den. Despite severe snaring impacts, this pack has continued to breed and populate the Luangwa population (see Conservation Action section).

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Zambian
CARNIVORE PROGRAMME

Zambian Carnivore Programme
PO Box 80, Mfuwe, Eastern Province, Zambia
www.zambiacarnivores.org

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**Cover:** The iconic Lady Liuwa (circa 2000–2017) just prior to her passing away in 2017. Made famous in the "Last Lioness" film, Lady symbolized the plight of lions in Liuwa and throughout Africa, and in her twilight years was surrounded by the area's first lion pride in over a decade. *Photo: DaanSmit*

# The Year in Review

It was another busy year in 2017, with no shortage of work and challenges for conservation of large carnivores. As a field-based organization working across the country's major ecosystems, our teams logged over 2,700 person days in the field, drove over 66,105 kms in the bush to accomplish their work, and intensively monitored over 1400 animals this season through our long-term conservation projects across the country in collaboration with the Department of National Parks and Wildlife (DNPW) and an array of local and international partners. There is a lot of work covered in this report and hopefully we have done justice to the amount, diversity and effort this required.

Through work on all the large carnivore species and their prey in Zambia's major ecosystems we continued to provide high quality science-based policy and management guidance, not only on these species, their population sizes, trends and the threats facing them, but also on an array of conservation and management topics including bushmeat poaching, trafficking, trophy hunting management, connectivity, watersheds, and human encroachment. In the Luangwa we continued to see record numbers of African wild dogs for the fourth year in a row, while lion numbers also remained high. With collaborative work in Luambe and North Luangwa National Parks we documented one dog pack covering four national parks in their ranging, demonstrating the critical importance of connectivity and large landscapes. We also conducted the first carnivore and herbivore surveys in the Nsumbu ecosystem of Lake Tanganyika. In the Kafue we expanded our intensive work further into the GMAs and expanded collaborative monitoring of cheetah, lion and wild dog, assisted by new technology. In Liuwa cheetah populations continued to increase, with multiple litters growing to adulthood and dispersing, and long-term studies of wildebeest continued to provide insights for conservation of this keystone species.

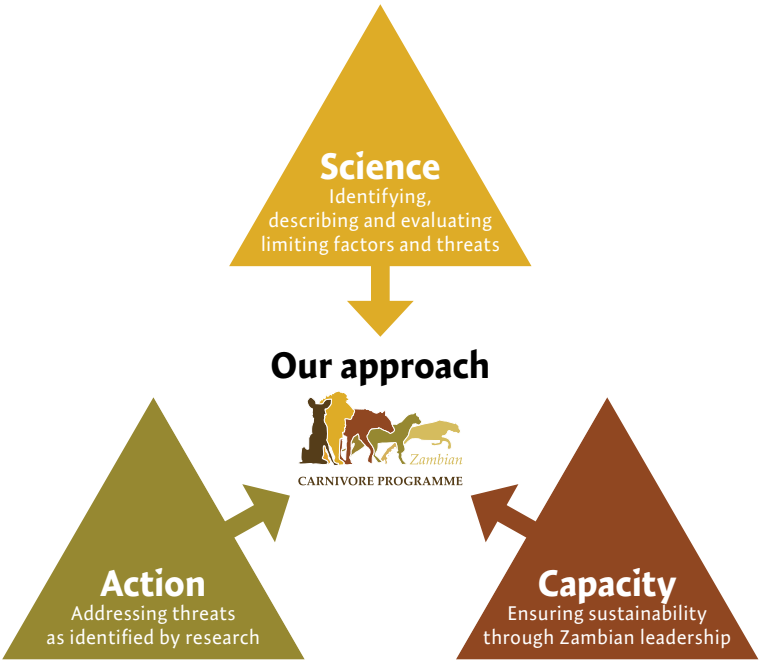
But despite these successes substantial threats continue to impact the viability of Zambia's wildlife, ecosystems and wildlife-based economies. Poaching of ivory and bushmeat remained high and snaring continued to threaten carnivores and their prey across all sites. In addition a worrisome trade in big cat skins and parts has emerged in country, and threats to Zambia's Luangwa and Zambezi watersheds require increased and immediate attention.

With our educational outreach and capacity development work we merged the Carnivore Cup with Conservation South Luangwa's Annual Fun Run and had the event hosted by Zambian football legend Kalusha Bwalya. We implemented programmes in Conservation Clubs in Liuwa and Kafue, and we trained another cohort of local students in our Conservation Biologist, Women in Wildlife and Wildlife Vet Programmes. Again the most promising result of our work was the continuing groundswell of interest among young Zambian students wanting to pursue careers in conservation. This was entirely due to the mentoring and leadership of the organization's Zambian team, three of whom who were recognized with prestigious awards and scholarships in 2017, namely the Wings Worldquest Women of Discovery Award, a Fulbright Scholarship, and a scholarship to the Oxford WildCRU Diploma in International Wildlife Conservation respectively.

The year was also poignant due to the loss of an iconic figure for carnivore conservation. After more than 17 years roaming the plains, Lady Liuwa (cover photo) sadly passed away in mid-2017 of natural causes. This was not unexpected, but after working with her for nearly a decade she leaves a permanent void in our hearts. Fortunately, due to the collaborative efforts of Liuwa's conservation partners, Lady spent her twilight years surrounded by lions and part of the first pride in over a decade. While significant challenges remain, the future of Zambia's carnivores looks promising with continued work. Thank you again for all your support and collaboration and we look forward to another productive year.

**Dr. Matthew Becker**
*Chief Executive Officer*

# Our Approach



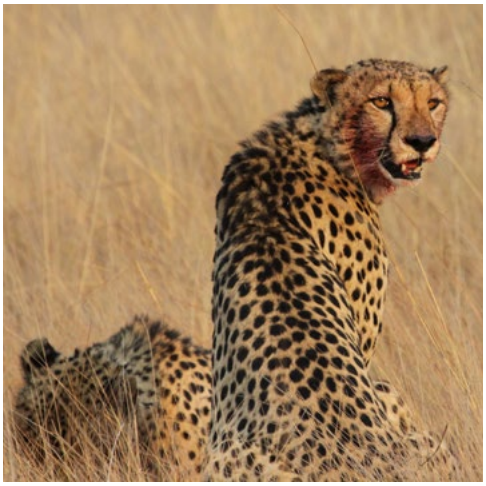

The Zambian Carnivore Programme follows a three-pronged interdisciplinary approach of Conservation Science, Conservation Action and Conservation Capacity to fulfill its goal of conserving large carnivores and the ecosystems on which they depend.

The success of this work fundamentally rests on our diverse and effective collaborations with local, national, and international partners, agencies, organizations and institutions that collectively provide the expertise, resources and energy to address the myriad conservation challenges facing Zambia.

## Why Carnivores?

**Umbrella species**
Carnivores need space, and lots of it; protecting them protects an array of other species in an ecosystem.

**Indicator species**
Carnivores are very sensitive to human impacts and are often some of the first to disappear from ecosystems.



**Keystone species**
Carnivores have an ecological influence disproportionate to their abundance.

**Flagship species**
Carnivores are charismatic and generate lots of public interest and support for conservation.

## Conservation Science

Fundamental to effective conservation is accurate and current information to guide actions and science-based management decisions. Given that very little is known about most of Zambia's wildlife species, long-term research and monitoring programmes are of paramount importance. Identifying, describing and evaluating dynamics, limiting factors and threats to species and ecosystems entails variable scientific investigations, ranging from metapopulation dynamics, genetics, and disease, to predator-prey dynamics, behavioral and landscape ecology.

## Conservation Action

Our conservation initiatives address the immediate threats to species and ecosystems as identified by research, with the goal to reduce current, and help reverse past, negative impacts on large carnivore populations across Zambia. ZCP collaborates with local partners to ensure that threats are addressed in a timely manner, through initiatives ranging from supporting anti-poaching and land-use planning work to species reintroductions, to mitigating human-wildlife conflict and reducing disease threats from domestic animals.

## Conservation Capacity

Too often the sustainability of research and conservation efforts is compromised because local communities are not effectively involved. We undertake a comprehensive multi-level approach to help ensure sustainability by training, educating, sponsoring, and employing current and aspiring Zambian wildlife professionals from the secondary school level through to international graduate programs. Collectively, this helps to ensure that Zambia's best and brightest have the opportunity to contribute their talents to wildlife conservation now and into the future.

# Where we work

## ZCP Study Areas

The Zambian Carnivore Programme's work centers primarily in three main ecosystems, namely the Luangwa Valley, Greater Kafue Ecosystem and Greater Liuwa Ecosystem.

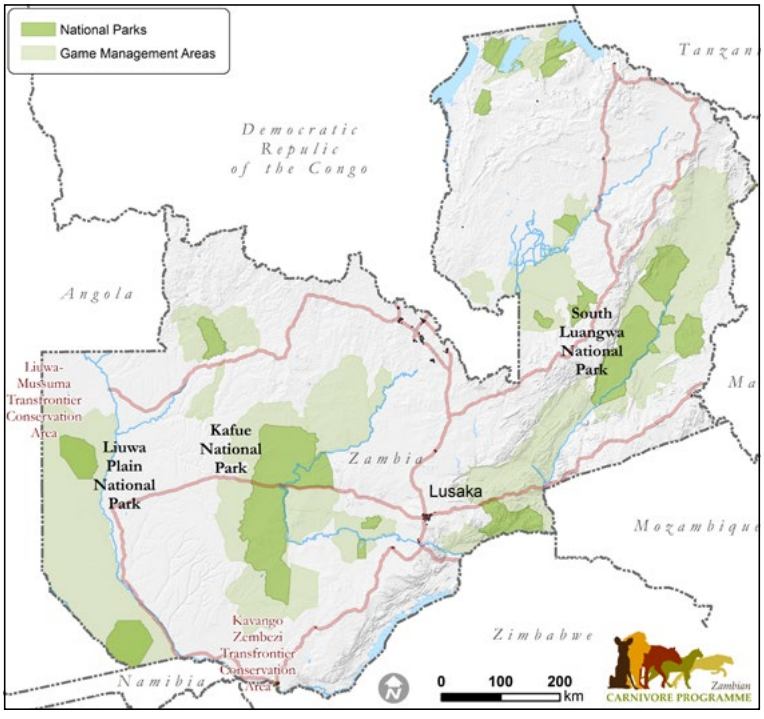
All of these areas consist of a matrix of national parks and Game Management Areas (GMAs), which collectively comprise the majority of Zambia's large carnivore populations and are part of three Transfrontier Conservation Areas (TFCAs). The Luangwa Valley contains the country's largest lion population and second-largest wild dog population; Greater Kafue contains Zambia's largest populations of wild dogs and cheetah and second largest lion populations; and Greater Liuwa contains recovering populations of all carnivores and important populations of cheetah and wild dog as well as Africa's second-largest wildebeest migration.

### Zambia – the crossroads of connectivity

Connects eastern and southern African wildlife populations

Heart of the Zambezi river watershed, draining much of the region

Large-scale ecological processes (migration, dispersal, flooding, etc.) still occur




Borders 8 countries with multiple transfrontier conservation areas

Multiple areas of unfenced, contiguous land over 70,000 km²

Over 30% country managed as protected area complexes

# Field Reports

## Luangwa Valley

### African Wild Dogs

In 2017 a record number of wild dogs were monitored in our intensive (~3000km$^2$) study area, with 180 dogs in 13 packs; in addition we recorded a total of 201 dogs across 15 packs in the Luangwa Valley. Given the difficulties in monitoring dogs across such a vast landscape this is certainly an underestimate of the population, however it is unclear as to what degree.

With the continued successful breeding and pup recruitment—particularly for large packs—in our study area over the last several years, 2017 had numerous dispersal groups forming new packs in and around the study area. Given snaring by-catch is considered to be one of the biggest threats to wild dogs in the Luangwa, being able to regularly locate, monitor and de-snare packs has been a key factor in the wild dog population's increase (see Conservation Action below).

Unfortunately wild dogs continue to be affected by detrimental impact of snares, with 3 confirmed snaring incidents in 2017. In the GMA areas in particular snaring bycatch mortality led to the fragmentation of at least one pack. Continued monitoring of these wide-ranging groups was greatly facilitated by the addition of satellite-GPS collars on four packs in high-snaring risk areas to complement

Pups from the Hot Springs pack at their den in Upper Lupande GMA.

A dog from the Manzi pack looks out for danger while other pack members feed on an impala. Dog numbers in the Luangwa have been at record levels for the last 4 years.

existing collaborative anti-snaring efforts and increase work in and around adjacent Luambe National Park. The newly formed Chakolwa Pack was equipped with a satellite collar that recorded the packs movements across 4 National Parks (NPs) and interconnecting Game Management Areas (GMAs) highlighting the importance of connectivity for low density and wide ranging species (see Conservation Action section).

Our intensive work continued to focus on the interaction between dogs and lions, and the impacts of human activities on these dynamics. Wild dog densities are negatively related to lion densities across most ecosystems, and similarly anthropogenic effects such as wire-snare poaching are a direct cause of dog mortality.

The Luangwa wild dog population overlaps areas of high lion density and high snaring risk, and an understanding of both natural and human-caused mortality is crucial in maintaining a strong wild dog population for generations to come.

The Chamilandu pride rests under the watchful eye of one of their three pride males. Adult and subadult male survival, as well as cub production and population size significantly increased during the moratorium.

## Lions

With improved management and protection the South Luangwa lion population continued to remain at high levels, with 221 individuals in 17 prides and 20 coalitions monitored across SLNP and the adjoining GMAs of our intensive study area. We completed our analysis of lion survival, reproduction and population trends from 2008–2015 and submitted it for publication.

The study—part of ZCP Ecologist Thandiwe Mweetwa's graduate research—evaluated the impact of a 3-year moratorium on trophy hunting of Luangwa lions intended to facilitate population recovery following overharvest. We identified and monitored 386 individual lions within and around SLNP for five years (2008–2012) with trophy hunting, and for three additional years (2013–2015) during the moratorium, and used these data to estimate the effects of hunting on lion survival, recruitment, and abundance. Hunting lowered subadult and adult male survival by 17.1 and 14.0 percent in subadult and adult males, respectively, with smaller effects on adult female and cub survival.

Large increases in lion abundance occurred during the hunting moratorium, with the study population approximately doubling by the last year of the moratorium. More cubs were produced each year of the moratorium than in any year with trophy hunting, and lion demographics shifted from a senescent and male-depleted population to a much younger population with >29% of all known adults being male.

These data support the moratorium decision by the DNPW and resulted in significant increases in lion survival and abundance. Continued monitoring coupled with changes in hunting


management to improve the viability of trophy hunting will be necessary, concurrent with continued anti-snaring efforts by Conservation South Luangwa, DNPW and ZCP, in order to maintain current population levels of lions.

Human impacts such as snaring are highest in the GMA buffer zones, and because 16 out of 17 of our study lion prides used the GMAs as part or all of their homerange, we continued to increase our efforts to protect lions from snaring by-catch mortality and other threats. We deployed satellite collars on two remote GMA prides particularly susceptible to snaring, and combined with aerial and ground-tracking and coordination with CSL-DNPW patrol teams we were able to reduce the threat of snares through this collaborative work. While snaring still remains a significant threat to most prides, this collaborative work continues to demonstrate a positive population impact for lions (see Conservation Action below).

## Leopard

We completed our sixth year of camera-trap based studies of leopard and their prey in 2017, evaluating factors affecting density and distribution within the SLNP and adjacent GMAs. Given the strong gradient of protection between the strictly protected park and surrounding buffer zones, there is an array of human impacts affecting leopards, including bushmeat poaching (resulting in prey depletion) and an emerging and increasing trade in leopard skins (see Conservation Action below).

The reporting period also marked the third year of leopard trophy hunting resumption in the valley. Consequently long-term evaulations of leopard dynamics are key to informing and evaluating conservation and management decisions. Additional analyses of these camera-trap data in the coming year will evaluate herbivores and other carnivore species such as hyena, which are currently very data-deficient.


## Herbivores

A giraffe herd in the Luangwa. As a small, geographically isolated population of Maasai giraffe, the Thornicroft's giraffe is vulnerable to an array of small population effects, and is monitored through photographic sight-resight techniques.

Given the ecological importance of herbivores and their importance as prey to carnivores, we continued our long-term evaluations of the human and ecological factors affecting herbivore density, distribution and abundance across gradients of protection in the Luangwa.

We conducted additional surveys of all species across SLNP and adjoining GMAs in 2017, and completed an analysis of impala, puku, zebra, and warthog populations from 2012–2015 and the various ecological and anthropogenic factors affecting them across space and time. All prey species occurred at their lowest densities in the GMA; however, there was no clear evidence that these dynamics were related to protection status or year of study across all species.


A herd of cape buffalo grazes in the dry season. Given different carnivores have evolved to predate different prey—in part to mitigate competition between carnivore species—understanding these patterns and the impact of human activities on them is of key importance.

Consequently, in addition to the growing evidence of herbivore depletion in the buffer zones around national parks, we must consider both direct sources of mortality and the manipulation of habitat and environmental conditions by an expanding human population. The results improve our understanding of the impacts of protection gradients, human encroachment, bushmeat poaching, and hunting moratoria, and provide baseline estimates of density for important prey populations that face increasing anthropogenic pressures.

In addition to this we continued our long-term demographic studies of the Thornicroft's giraffe, completing our tenth year of photographic mark-resight studies to estimate population size, composition, survival and reproduction for this geographically isolated population. With an expanded collaboration to better evaluate these data we expect to produce our first rigorous demographic analysis in the coming year.


Subordinate dogs play box following a kill. Most subordinate dogs disperse from their natal pack between 1-2 years of age and data from these dispersers indicates a connected population throughout the Luangwa and potentially beyond.


Detecting lion spoor on transects. Survey results indicated abundant carnivore populations in North Luangwa and significant restoration potential in Nsumbu.

## Carnivore and Herbivore Surveys in the Greater Nsumbu and North Luangwa National Park

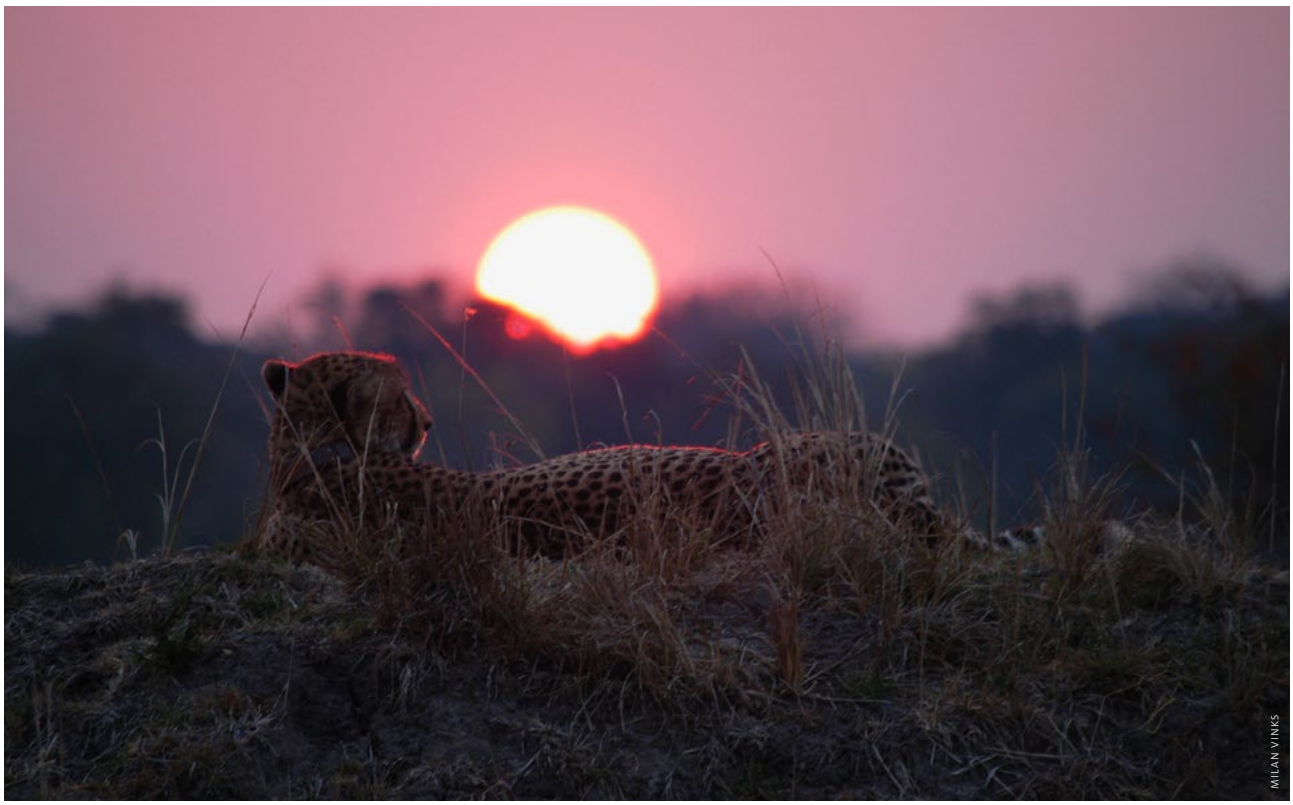
A month-long survey to provide baseline information about large carnivore and herbivore populations—with an emphasis on lions—was conducted in the North Luangwa and Nsumbu ecosystems in October 2017 by the Zambian Carnivore Programme (ZCP), Frankfurt Zoological Society (FZS) and Department of National Parks and Wildlife (DNPW) through the support of the Lion Recovery Fund. Using a combination of spoor counts, call-ins and line transects, the intent of the work was to provide baseline presence/absence and population estimates from which concurrent recovery efforts can be evaluated. In addition the survey provided training and field experience in all research and monitoring techniques to three early career DNPW Ecologists.

Preliminary results indicate North Luangwa has healthy prey and predator populations as expected, and the presence of lions was observed throughout, as well as spotted hyena, leopard and wild dog. While survey techniques were challenging in the substrate conditions, the observed track density suggests a density comparable to lions in ZCP's South Luangwa study area.

Surveys in the Nsumbu ecosystem indicate a sufficient prey base to potentially sustain a viable lion population, though it is patchily distributed and large prey are at low densities. Lions were not detected on surveys but reported to be present at very low numbers and the population in the Nsumbu system might not be currently viable. Additional carnivores, including hyena, leopard and jackal were detected.

Overall the recovery potential for lion and other carnivores in Nsumbu is high and the significant carnivore populations in North Luangwa further emphasize its key importance for the Luangwa population.


ZCP, FZS and DNPW survey crews in North Luangwa National Park.




# Greater Kafue

## Cheetah

We continued long-term studies of Zambia's largest cheetah population in the Greater Kafue in 2017, collaborating with the DNPW and Panthera by intensively studying cheetah populations in the north and central GKE and collaboratively monitoring them elsewhere in the ecosystem through sightings and photographs from tourists and operators as part of our joint Citizen Science initiative. In 2017, we collectively monitored 19 cheetahs in the Greater Kafue, of which 11 were new to the study. Two cohorts of 3 young dispersing cheetahs each were identified this season, likely indicating that females are successfully rearing large cohorts of cubs with the potential of augmenting the population. We successfully collared two of these dispersers, enabling monitoring of their dispersing movements. Cheetahs extensively utilized portions of the GMAs surrounding Kafue National Park, as well as the park. With the assistance of our collaborative Citizen Science programme involving guides, operators, and tourist photos, new cheetah continue to be detected across the system. To date we have amassed 102 cheetah in our database with 75 animals seen in the last three years. Given the size and inaccessibility of the Kafue, successful monitoring of individuals is extremely difficult, and we were able to greatly improve our ability to find and monitor cheetah through the deployment of Iridium Satellite-GPS collars. This enables us to document long-distance movements out of the park and in the GMAs, as well as provide valuable data on the factors influencing movements and habitat selection.

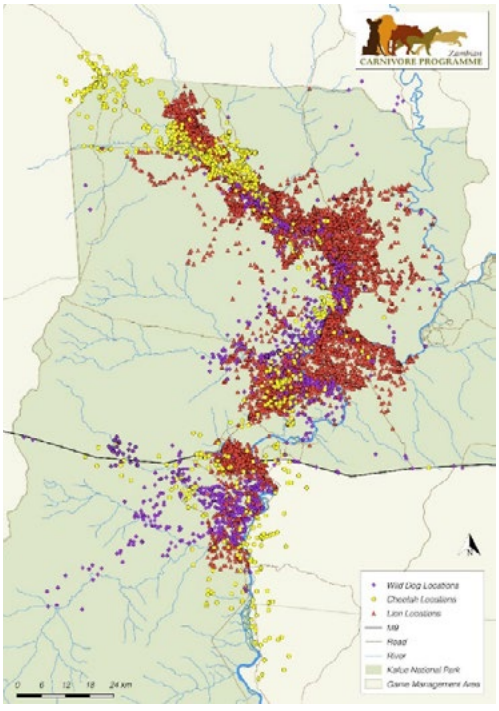

## Wild dog

The Greater Kafue is likely Zambia's largest wild dog population, and we continued our long-term intensive work on dogs in 2017, greatly assisted by newly deployed satellite-GPS collars, communications and collaborations with lodges, guides and a continuing partnership with DNPW and Panthera.

This season, we were able to successfully monitor 14 packs and 135 dogs, with 37 pups recorded. A new pack also established itself in the core of the study area and included dogs that were last sighted as pups in 2013, emphasizing the large landscape connectivity that currently exists in the Kafue. Overall, the use of satellite collars has greatly benefited our monitoring efforts of the species across the system, and the ZCP team currently has 4 packs fitted with satellite collars, with plans to deploy more this coming season.

We continued to document large dispersal events, most notably a small group of former Tateyoyo pack members that dispersed over 90 kms from the central Kafue National Park to the Kasonso Busanga Game Management Area (GMA), where they managed to den successfully and raise 8 pups. The pack also utilizes much of the Kasonso Busanga GMA, an area severely impacted by illegal bushmeat poaching but the focus of restoration efforts through Ntengu Safaris and DNPW. We are now working closely with DNPW and Ntengu Safaris to effectively monitor and conserve this pack and other carnivores in the area.

Unfortunately, snaring by-catch and traffic-induced mortalities continue to pose two of the most severe threats for dogs in the Kafue system. By working closely with DNPW and partners and having a full-time field-based vet able to monitor and treat snared animals in the course of our work (see Conservation Action below), such immediate threats can hopefully be mitigated in concert with longer-term solutions for protection of the Greater Kafue.




Locations from collared cheetah, wild dog and lion across the Kafue landscape demonstrates the large-scale movements across gradients of protection between national park and GMA.


ZCP Vet Dr. Kambwiri Banda (R) and ZCP Researcher Caz Sanguinetti fit a satellite-GPS collar to a lioness in Kafue. Given the size and seasonal inaccessibility of the Kafue collars are critical to the success of this work.

## Lions and Hyena

Continuing the intensive research and monitoring work begun by the Kafue Lion Project in 2011, we followed 11 prides and 13 coalitions comprising 100 individuals in the Northern and Central Kafue. Pride sizes continued to be small but slightly higher from prior years, with an average of approximately five adults and subadults per pride, while mean coalition size was 1.7 males. Mukambi River pride in Central Kafue was the largest pride with 12 animals and multiple breeding females.

Prey selection continued to consist primarily of mid-sized antelope such as puku, warthog and lechwe, potentially contributing to the small pride sizes observed. While hyena numbers continue to appear to be the lowest of all the carnivores we nevertheless have identified and monitored 36 individual hyenas from multiple clans to date. The impacts of prey depletion from the commercial bushmeat trade on big cats and other carnivores is widely recognized as a serious threat in Kafue and savannah Africa. However the effects of prey depletion can also be amplified by changes in the composition of the large herbivore community that comprises carnivore diets. The GKE has one of the most diverse prey populations on the continent, and the density and distribution of the respective species are strongly affected by human impacts.

We completed a study in 2017 using our long-term data on cheetah, lion, wild dog and leopard diets, and comparing them to data from a study by Mitchell et al. 1965 revealed concerning shifts in the diets of big cats indicative of prey depletion, with 71% of the changes supporting the hypothesis that large prey have become less important and small prey have become more important as diet breadth has narrowed. The conservation implications of these diet changes have potentially significant impacts on intra-guild competition, group size, hunting energetics and the vulnerability of carnivores to snaring.

## Leopard

We continued individual monitoring and camera-trap based work on leopard in Northern KNP, identifying and monitoring 36 leopards to date. In addition to the collection of data on other large and mid-sized carnivores and prey species, we collected an additional season worth of data for estimation of leopard density and for evaluation of the effects of environmental and anthropogenic variables on leopards, their competitors and prey.

We will utilize continuing collaborative work with Panthera and DNPW in the coming seasons to evaluate herbivore and carnivore densities across protection gradients in the Greater Kafue using these techniques.


## Herbivores

Given very little is known about herbivore populations and the factors affecting them, ZCP's Kafue conservation work has always made prey dynamics a high priority. In 2017 a collaborative paper with the DNPW on prey surveys entitled "Boots on the Ground: In defense of low-tech, inexpensive, and robust survey methods for Africa's under-funded protected areas" was accepted for publication in the scientific journal Biodiversity and Conservation. The study found strikingly different patterns of density—and the human and ecological factors affecting density—across Kafue National Park.

The impacts of prey depletion from the commercial bushmeat trade on big cats and other carnivores is widely recognized as a serious threat in Kafue and savannah Africa.


Lions from the Moshi pride fight over a freshly-killed impala. Lion diets have shifted over time to smaller prey species, reflecting changes in herbivore abundance and diversity and also posing potential impacts from increased competition with smaller species such as cheetah and wild dog.



Abundant prey, low levels of livestock conflict and small populations of lions have allowed other carnivores such as hyenas and cheetahs to proliferate under Liuwa's ecosystem recovery efforts.

# Greater Liuwa

## Spotted Hyena

We completed the 8th year of our long-term studies of Liuwa's most significant large carnivore population—the spotted hyena. Prior results from our work indicated the population was experiencing unprecedented survival and reproduction due to the low numbers of lions, abundant prey and minimal human-wildlife conflict.

During the reporting period we collected data on 201 animals in 6 clans and again documented high adult and cub survival, as well as a strong limiting impact of predation on wildebeest. Clan sizes were suprisingly similar compared to prior years (mean 33.5) and a new clan was formed in 2017 within the ranges of existing clans. With a solid understanding of the demography and impacts of the southern hyena population, we expanded focus in 2017 up into the north and Upper West Zambezi GMA where we only had survey data. This expanded focus will help quantify the respective impacts of predation, poaching and encroachment/barriers to wildebeest migration and carnivore dynamics in this key unprotected area.

An adult female cheetah and her four dispersal aged cubs hunt in Liuwa Plain.

## Cheetah

The 2017 year was good for the recovering cheetah population in Liuwa, as we continued to collect demographic, spatial and ecological data through monitoring of twelve cheetah in seven different groups. The cubs from the three breeding females that were born in 2016 all dispersed in 2017, and two of the three female cheetah were confirmed to be denning at the end of 2017, though unfortunately the new litters did not survive the early flooding of the plains.

The dispersing cheetahs are in good health and are currently monitored through VHF and satellite-GPS telemetry. Cheetah diets continued to consist primarily of small antelope such as oribi and duiker, with wildebeest calves and scrub hare continuing to be important as well.

## Lions (Lady Liuwa 2000–2017, Sepo 2010–2017)

It was a turbulent year for the lions in Liuwa, particularly with the loss of the iconic Lady Liuwa, who was at least 17 years old when she died of natural causes in August 2017.

Given her age and deteriorating condition this was not unexpected, and thanks to restoration efforts by African Parks, DNPW, the Barotse Royal Establishment and ZCP, Lady lived out her twilight years surrounded by a pride, in stark contrast to her early years of roaming Liuwa alone as the famous Last Lioness. Unfortunately her death may have also led to the loss of her pride mate Sepo, who was brought in from Kafue to bond with Lady in 2011 and likely died defending her cubs from the introduced Kafue male, who was not the father of the cubs. Lionesses dying while defending their cubs from males is not uncommon in lion populations but obviously was a significant loss for a small recovering population.

Fortunately the cubs survived and the dynamics have stabilized for the time being at a population of 4 adult lions and 6 cubs, while plans are underway for the next step in Liuwa's lion recovery.



One of Liuwa's male lions feeds on a wildebeest calf kill. The increase in lions is expected to increase predation impacts on wildebeest, and potentially on zebra.

## Wild Dogs

Wild dogs continued to be absent from the intensive study area during 2017, though sightings continued to be reported in more outlying areas but were unable to be verified. Vaccination programmes for domestic dogs were unfortunately still unable to be enacted but a disease mitigation programme is under development with African Parks and ZCP. While reintroduction of wild dogs is a possibility, ZCP is currently not in support of reintroductions unless suitable vaccination programmes on domestic dog populations in and around the park are effectively implemented and naturally occurring Greater Liuwa wild dog populations have been given an opportunity to recover. At present it is not certain recovery can occur without proper domestic dog disease control.

In the upcoming reporting period ZCP teams will make a concerted effort to document wild dogs or lack thereof in the more remote areas of the ecosystem, particularly during the denning season.

## Wildebeest

Given that wildebeest are the keystone species for the Liuwa-Mussuma Transfrontier Conservation Area (LMTFCA) and their historical range helps delimit the boundaries of the TFCA, the overall intent of ZCP's long-term wildebeest work is to determine the factors limiting wildebeest recovery, as well as to guide and evaluate changes in management, ecological factors and human factors, and their impacts, coincident with ecosystem recovery efforts. Under African Parks Zambia (APZ) management, the wildebeest population has increased significantly from an original estimate of 15,000 animals.

It was unclear however whether the population would be expected to continue to grow, what sort of carrying capacity could be expected, what limiting factors and threats there were and of those, which could be managed, and what factors determined wildebeest movements and migration, or lack thereof. This collaborative study was therefore launched to address the near complete absence of any demographic or spatial data on the second largest wildebeest migration in Africa in order to inform and guide recovery efforts for this keystone species and the ecosystem at large.

We continued our long-term collaborative wildebeest work in 2017, completing our 5$^{th}$ season of intensive work with the monitoring of 33 radio-collared adult female wildebeest and their calves. and replacing and deploying nearly 20 collars in November for continuation of the work. Population and spatial data was collected through intensive monitoring of collared females tracked throughout the year, with 900 locations and over 1100 herd composition counts conducted in addition to fine-scale spatial data from GPS

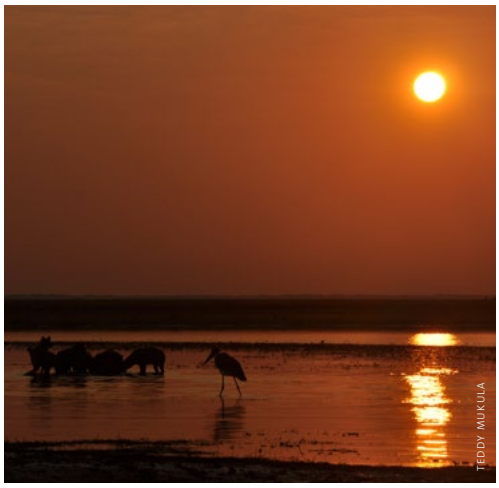

Hyenas hunting wildebeest during peak calving. While predation is a significant limiting factor for wildebeest populations, migration likely enables these herbivores to escape the carrying capacity constraints of resident populations, further emphasizing the importance of protecting wildebeest migratory range outside the national park.


collars. Eleven new wildebeest were collared, with 3 GPS collars and 8 VHF collars deployed in addition to replacing collars from the original 2012 study animals.

Migratory populations are typically more abundant than resident ones as they can likely avoid the carry-capacity restraints imposed on residents by tracking resources and avoiding predation through movement. However when constraints or barriers to migration occur, dramatic declines and even collapses in populations occur. This is exemplified throughout Southern and Eastern African wildebeest populations. Increasingly it appears that wildebeest are strongly limited by predation—primarily through an abundant and increasing hyena population as well as a recovering carnivore guild (see above), but this predation occurs primarily in their summer range. Additional constraints in their winter range are poaching and spatial constraints in the form of agriculture and other human activity, particularly in the Upper West GMA where most wildebeest migrate to following the rains. Loss of this key area could decouple the migration and result in wildebeest spending more time in the high predator density areas of the southern park, likely with population declines as a consequence. In addition flooding appears to have strong impacts on wildebeest movements in the wet season, as well as for carnivores; thus climate change and alterations to watersheds are likely to have serious cascading impacts on these species and their recovery.

We finalized nearly five years of wildebeest demography data in 2017 and will be integrating analyses of the impacts of ecological and human factors affecting migration and movement. We also continued to evaluate factors affecting density and distribution of all herbivores with three additional surveys conducted in 2017.

ZCP Liuwa Manager Daan Smit (L) and APN/DNPW Scout Mboo Masilokwa take measurements on an immobilized cow wildebeest to determine age. Wildebeest survival and reproduction is often age-dependent and subject to an array of ecological and anthropogenic variables. At present however wildebeest are primarily limited by top-down influences such as predation.




A hyena clan feeds on a freshly-killed wildebeest in the rains. Wildebeest summer primarily in carnivore-rich areas of southern Liuwa, where predation is higher relative to their northern winter range.


## Predation Risk Effects

Zebra intently watch a group of hunting cheetah. New studies indicate that the amount of anti-predator behavior such as vigilance that prey can exhibit depends on both the short-term and long-term risk of predation in an area.

While the act of a predator killing and eating a prey animal has always been recognized as one of the most fundamental interactions in ecosystems, the mere presence of a predator on the landscape—and its impacts on prey behavior, habitat selection, nutrition, reproduction and ultimately fitness—has received far less attention. These predation risk effects, as they are known, have been shown to be increasingly important by an array of scientific studies, but given the complexity of these interactions it is extremely difficult to evaluate in natural settings, particularly with multiple predators and prey species characteristic of most ecosystems.

In 2017 we produced two risk effects studies from long-term carnivore and herbivore work in Liuwa. The first, entitled "The relationship between direct predation and anti-predator responses: a test with multiple predators and multiple prey" evaluated the relationship between direct predation and the strength of anti-predator responses in an entire large carnivore community (spotted hyena, African wild dog, cheetah and lion)—as well as the three primary prey species of wildebeest, zebra and oribi. No detectable relationship was found between the amount of direct predation a prey species experienced and the amount of anti-predator behavior they exhibited. Consequently this indicates a potential trade-off for species in the cost of predation; in other words the cost comes from either getting eaten, or in avoiding getting eaten.

A hyena defends its kill from vultures in Liuwa. New studies indicate no detectable relationship between the amount of direct predation on an herbivore species and the amount of anti-predator behavior exhibited.


The second study entitled "Risky times and risky places interact to affect prey behavior," evaluated the response of wildebeest to spotted hyena, cheetah, wild dog and lion, both in the immediate response to the presence of a predator, and to the long-term risk of predation on the landscape. The conclusions of this study indicate neither risk should be evaluated in isolation and both must be considered. Understanding risk effects and how they impact ecosystems, particularly in large mammal communities, has considerable conservation and management significance.

At the same time a global carnivore decline is occurring we are continuing to learn just how much of an impact these species—and their loss—have on ecosystems. Understanding the importance of risk effects not only demonstrates how carnivores are much more important to ecosystems than we previously thought, but also that losing these species will have a far greater impact than we know.

# Conservation Action

## Anti-Snaring

Our collaborative research and monitoring work has demonstrated severe impacts of snaring on carnivores and their prey, both through prey depletion and through snaring bycatch on the carnivores themselves.

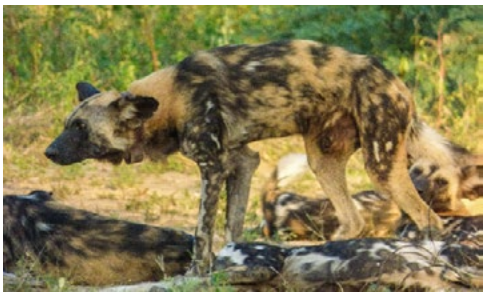
Fundamental to addressing snaring bycatch impacts on carnivores, particularly wild dogs and lions, is the ability to monitor populations of resident packs, prides and dispersers. Regularly locating animals that can range over thousands of square kilometers requires a full-time, year-round field effort and an intensive collaring effort to ensure that groups have individuals with a radio- collar to enable effective relocation and tracking.

Snaring continued to be a serious problem for carnivores and their prey across all three ecosystems, but particularly in the Kafue during the reporting period, with multiple snarings of carnivores.

We de-snared 6 lions, 4 hyena and 2 wild dogs and were able to mitigate snaring mortalities through the presence of a field-based vet, aerial

### How Much Is One Dog's Life Worth?

**At Least 8 Additional Packs formed from Dispersing Offspring**



**Packs have populated throughout the Luangwa Valley**

**WILD DOG 73**
Rescued from a lethal snare in 2014

**At least 129 pups, grand-pups and great-grand pups**

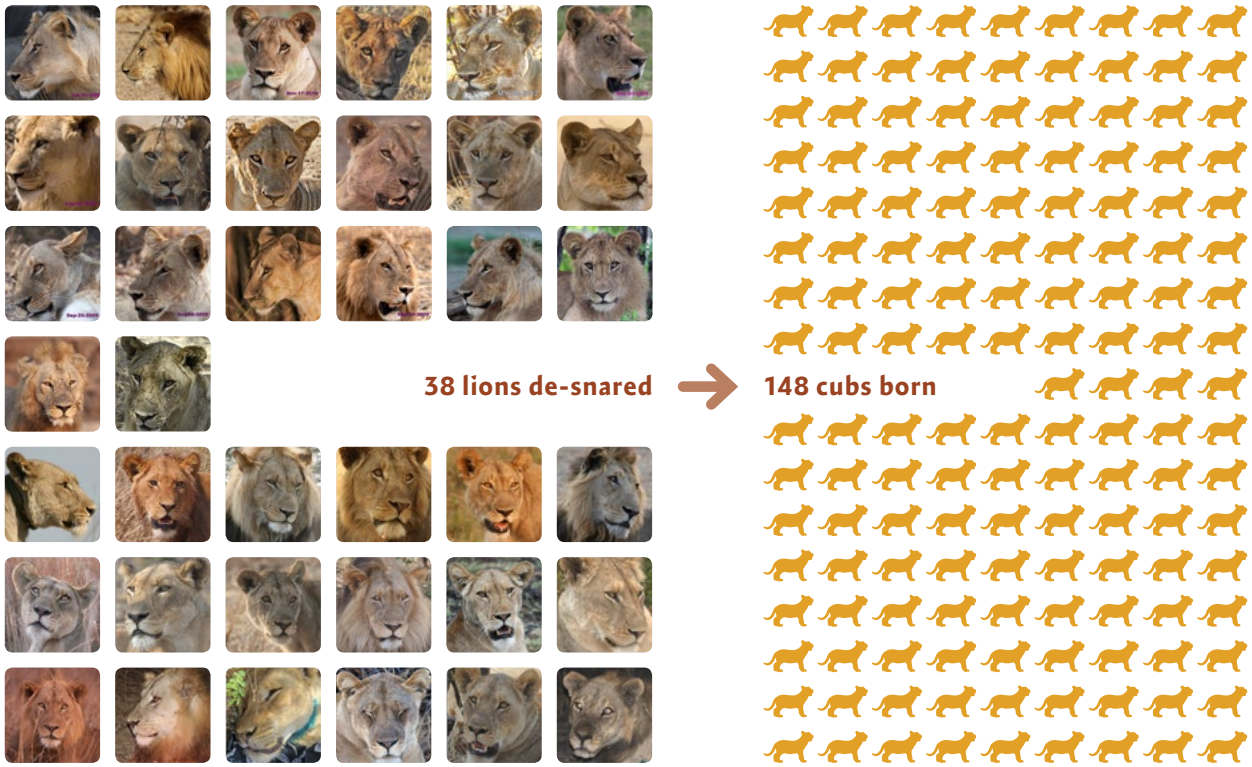
The oldest known wild dog was 12 years old. The alpha male of Luangwa's Hot Springs Pack was born in 2006 at the latest, making him at least 11.5 years old. As alpha male his pack endured severe snaring impacts and he was dying from a snare himself but was rescued by the collaborative work of ZCP, CSL and DNPW. His legacy is found in all the dogs populating the Luangwa with ties to the Hot Springs pack, and his life is a testimony to the value of this work.

Dr. Kambwiri Banda (R) and teams from ZCP, APN and DNPW treat a badly snared hyena in Liuwa.

support and satellite collars but it continues to pose a serious problem. Given the low density of carnivores in most ecosystems, loss of any animals can have negative demographic impacts; thus continued collaborative anti-snaring work is essential.

We continue to quantify the impacts of our collaborative de-snaring efforts in the Luangwa using our long- term data, with products set for 2018.

## Population effects from snared lion rescues




Demographic impacts of de-snaring on lions in the Luangwa and Kafue projects. Such collaborative work is greatly facilitated by radio collars allowing for frequent detection and monitoring of prides and desnaring.

## Disease Control and Mitigation with Domestic Animals

Domestic dogs are often the primary source of disease transmission to wild carnivores, and also pose human health threats from rabies and other diseases when not vaccinated. We continued our vaccinations, spaying and neutering programmes of domestic dogs and cats in Mfuwe through CSL/ZCP Vet Dr. Sichande's office while also working with African Parks to develop a rabies mitigation programme in Liuwa to help promote recovery of African wild dogs. Under the guidance of Dr. Sichande, ZCP assisted in the vaccination of nearly 200 domestic dogs in Mfuwe from Kakumbi, Nsefu, and Mnkhanya Chiefdoms.


A domestic dog vaccination clinic run by ZCP/CSL Vet Dr. Mwamba Sichande and the Department of Veterinary and Livestock Development.

## Poisoning

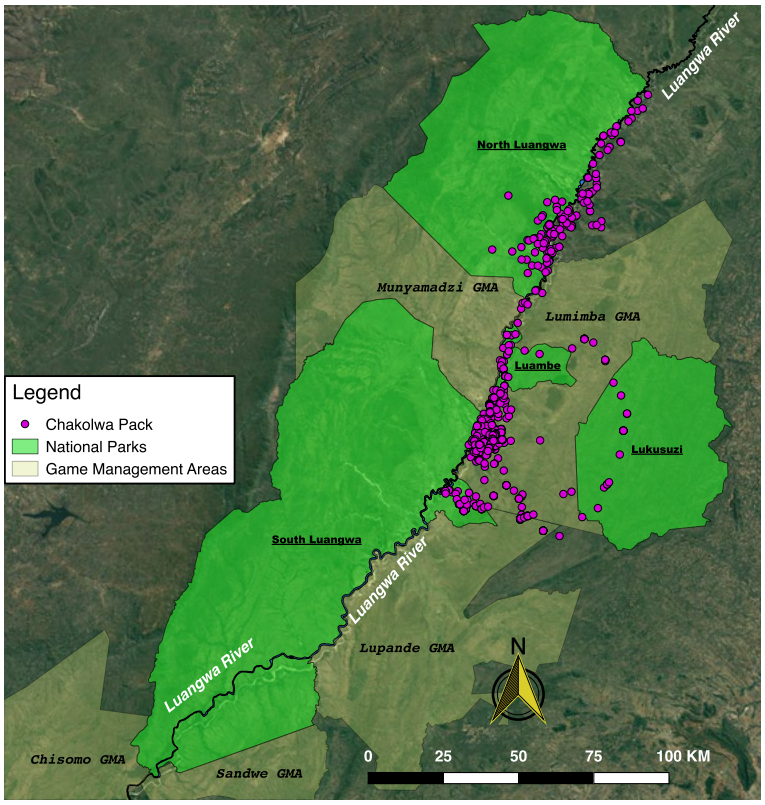
Given the elevated threat of poisoning—both as part of wildlife trafficking and as part of human-wildlife conflict—we worked with Endangered Wildlife Trust's Andre Botha to facilitate Poisons Response Training across the Luangwa, Kafue and Liuwa Projects in 2017. The intensive three-day course provided an overview of poisons and impacts as well as the development of response protocols, and additional work to build upon this foundation is currently in progress.


Andre Botha (right) demonstrates poison response techniques at a workshop for ZCP, African Parks and DNPW in Liuwa Plain.

## Wildlife Crime

While much of the current wildlife crime in Zambia focuses on ivory and bushmeat, there is increasing evidence across our study sites of a trade in big cat skins and other parts. Trafficking in leopard, lion and cheetah skins and parts occurs in Zambia, but very little is known about the extent and severity of it. We continued a partnership with Conservation South Luangwa to address these impacts in the Luangwa and also began a new initiative with Wildlife Crime Prevention (WCP) and DNPW aimed at determining the origins and impacts of the trade across the country and region. With the support of the Wildlife Conservation Network's Lion Recovery Fund, ZCP and partners will be utilizing genetic data from long-term studies of big cats to compare and trace seized skins and parts from traffickers in order to determine the patterns of illegal trade. With collaborators we also added samples from Tanzania, Zimbabwe and Mozambique to determine regional patterns. As part of the project in 2017, WCP and ZCP held nation-wide training workshops at 39 investigations and intelligence units (IIUs) to 163 DNPW personnel from law enforcement, anti-poaching, research and veterinary departments. These workshops demonstrated how to safely and effectively collect DNA samples from confiscated big cat skins and parts, and provided DNPW staff with manuals and sample kits and identification guides. Given that carnivore populations are wide-ranging and low-density to begin with, impacts from emerging carnivore trades may not be detected without intensive ongoing monitoring, further emphasizing the importance of ZCP's long-term carnivore projects in addressing the impacts of illegal wildlife trade in these species. We will continue to work together with partners to better understand and address this threat.


Training on sample collection from illegally trafficked big cats.


GPS locations from the Luangwa Valley's newly-formed Chakolwa Pack document their visiting four national parks before finally settling in North Luangwa. Such large-scale movements demonstrate the importance of connecitivty and preservation of the Luangwa river corridor.


The Luangwa river in the dry season. Zambia is characterized by dryland ecosystems with severe variability in rainfall and water availability, making connectivity and protection of land and watersheds criticial—particularly in the face of climate change.

## Large Landscape Conservation

Zambia and the region are characterized by dryland ecosystems that are highly seasonal in the extent and amount of water available, and require mobility for both wildlife and people to respond to these changes in rainfall and flooding patterns, particularly in the face of climate change. Consequently large landscape connectivity is of critical importance and can be compromised by an array of human activities, including encroachment, poorly planned roads, dams, fencing, and lack of land-use planning. We worked closely with a number of partners in 2017 to help address these issues.

Our encroachment analyses continued with a completion of Northern Kafue National Park and GMAs, and an updating of encroachment in the GMA and conservancy areas in the southern Kafue KAZA connection. These data continue to be utilized for land-use planning and assessments of connectivity/lack thereof, most recently used by partner Panthera at a conservancy meeting for chiefs in southern Kafue.

We also continued to provide data and evaluations to Transfrontier Conservation Efforts in the Liuwa-Mussuma TFCA as well as for land-use planning in the GMAs in the Luangwa. We worked with WWF to help evaluate the impact of water diversion/damming of the Luangwa river on wildlife, communities and wildlife-based economies and will be undertaking additional collaborative wildlife and watersheds work in 2018. Our collaborative work continues to highlight the importance of Zambia's connectivity, both on a national and regional scale and satellite collar data on dogs in particular showcased this, with a single pack traversing 4 national parks in 2017.

# Capacity-Building and Education Reports

*We continued to build and expand our education and capacity-building programmes during the reporting period, making significant strides across all sectors and adding strong new programmes in community and secondary education in particular.*

## Secondary Education

We continued and expanded our secondary school programmes in 2017; collectively the work emphasized engaging secondary school students in conservation issues, conducting research in collaboration with ZCP, continuing to provide students with key skills in computer software, technology, and critical thinking, writing and public speaking skills essential for advanced education and employment opportunities, as well as providing tutorials and additional assistance in preparation for final exams used in evaluations of university applications. We conducted 57 school programmes to over 350 students across three ecosystems. In the Luangwa, in collaboration with Chipembele Wildlife Education Trust, we continued

Students from Liuwa Plain's Mishilundu School participate in an activity on wildlife research techniques as part of ZCP's newly-implemented Conservation Club programmes in the park.

ZCP Researcher Benny Mwila (Right) helps conservation club students to set up camera traps for their research projects.

ZCP Researcher Lameck Sakala—a graduate of ZCP's Conservation Club Programmes himself—teaches DNPW's Chunga School students as part of Kafue's educational initiatives.

intensive work with 30 students from Mfuwe Day Secondary School's Conservation Club, conducting 33 programmes using science as a means to acquire and improve key skills in computer literacy, technology, writing, public speaking and critical thinking. The students designed and conducted a study evaluating prey species richness in open grassland and closed woodland habitats in South Luangwa National Park as part of a broad focus on predator-prey dynamics and conservation. Students conducted their own research with camera traps, and by making weekly site visits and collecting data on prey distribution in the main park wildlife areas. Data were then analyzed and a report and presentation was prepared summarizing their findings which will be presented to additional schools in 2018. In addition, to further prepare students for their exams and for admission into tertiary academic institutions following graduation, we continued to provide weekly academic tutoring for students across all subjects.

In the Kafue we continued our work with Treetop's School camp by conducting 15 weekly educational programmes to approximately 360 students. We also expanded work with DNPW's Chunga School, initiating a Conservation Club programme and agenda with the students which will significantly expand in 2018.

In Liuwa we conducted 8 programs to an estimated 358 people, primarily at Mishelundu High School , where we also initiated student Conservation Club programmes. We also added our fourth and fifth trainees from these secondary school programmes into our Conservation Biologist Training Programme (see below).

## Citizen Science

Given that safari guides are out every day observing carnivores we continued our long-term collaborative monitoring with guides in the Luangwa Valley Carnivore Monitoring Project (LVCMP) and with the Kafue Carnivore Coalition (KCC). The KCC, a carnivore monitoring group set up by ZCP and Panthera, is a collaboration of partners, lodges, and guides across the Greater Kafue that submit carnivore photos and locations on a daily basis either through whatsapp/phone calls or by alerting the research teams directly. These data have greatly improved and expanded our knowledge of Kafue's carnivore populations and allowed us to monitor an area much bigger than our research teams could do alone.

Similarly the LVCMP continued to provide key data on carnivores throughout the Luangwa study area and the annual awards banquet will be held in March 2018. In addition local ZCP Ecologists assisted with various carnivore-related programmes for 92 local guides enrolled in Guides Training in collaboration with DNPW in 2017.

A safari guide in South Luangwa shows clients wild dogs. Data collected through safari guides participating in Citizen Science programmes is of key importance.

## Community Conservation

As part of our community conservation initiatives in 2017, we undertook a variety of outreach programs and events that were targeted at district, provincial, national and international audiences.

In the Luangwa, led by our educational team, we had meetings with community resource boards in Jumbe, Nsefu, Kakumbi and Mnkanya chiefdoms to discuss how we can collaborate on various community engagement projects. We partnered with the CRBs to organize the chiefdom level marches of the carnivore conservation clubs, and we participated in the annual district and provincial Agricultural and Commercial Shows, where we came 1st and 3rd place respectively in the NGO category. Our work was featured by different Zambian media outlets, namely the Zambia Daily Mail, Travel and Leisure Zambia magazine, Radio Breeze and Q TV, all of which provided a platform for us to reach a wider audience.

We also worked with local theatre group SEKA (Sensitisation and Education through the Kunda Arts) to develop a play on ZCP's collaborative carnivore conservation work which was peformed across 6 chiefdoms to an estimated 7000 people. Through presentations and talks, we directly reached nearly 5000 people both in Zambia and abroad. The audiences were diverse and included primary school pupils, the general public, tourists, safari guides, government officials, traditional leaders, journalists and international conservation organizations.

Henry Mwape, an Ecologist and Education Coordinator for ZCP, also expanded his work with his boys football team—the Mimbulu Academy (Mimbulu is the local word for wild dogs). The team competed in football tournaments while also serving as ambassadors for conservation, playing throughout the Mambwe District and in Lusaka for numerous tournaments. The biggest community event of 2017 was the second Annual Carnivore Cup in the Luangwa. This year we merged the championship day with Conservation South Luangwa's (CSL) Annual Fun Run. Numerous Guests of Honor, including Zambian football legend Kalusha Bwalya attended and over 5,000 people were in attendance. Winning teams were treated to a game drive in collaboration with multiple safari lodges in the valley; for many players it was their first time in the park and they were treated to great sightings of two wild dogs packs and a lion pride among others.


Zambian football legend Kalusha Bwalya plays with ZCP's Mimbulu (local word for wild dog) Academy at the Carnivore Cup.


Theatre troup SEKA performs a play explaining the work of ZCP to several hundred community members.


ZCP Researcher, Educator and Mimubulu Academy Director Henry Mwape (top left) poses with Kalusha Bwalya (middle) and the Mimbulu Boys.


ZCP Researcher Thandiwe Mweetwa (L) instructs trainee Mercy Njovu in lion collaring, field vehicle maintenance, and data management.

## Women in Wildlife Conservation Programme

Our training programme for Zambian women interested in pursuing careers in field-based conservation continued under the direction of Ecologist and Education Manager Thandiwe Mweetwa. Local Mfuwe trainee Mercy Njobvu completed her training and entered Vet School at the University of Zambia as a trained field biologist with extensive experience in wildlife immobilization. Additional candidates Margaret Mwale and Christine Njobvu have now been selected for the 2018 programme.

Pending funding we would like to expand the programme significantly to include all three sites and include a secondary school programme to help prepare and identify aspiring conservationists, given the increase in interest among young women in the programme.


## Conservation Biologist Training Programme

With long-term projects across the country, ZCP's field sites offer unique opportunities for Zambian University students pursuing degrees in the sciences to gain much-needed practical field experience in ecological research, particularly given that Zambian universities are rarely able to offer field-based courses and training to students majoring in the biological sciences. However given that a large array of skills are needed to effectively function as a field team member, intensive training is required. Consequently ZCP expanded its ongoing Conservation Biologist Training Programme aimed at equipping incoming students with the theory and practice behind research as well as with practical field skills. Students underwent intensive training in ecological research, as well as hands-on training in Land Rover and motorbike servicing, repair, recovery and 4x4 driving skills.

In addition to training recently graduated university students, increasingly we are finding strong motivated candidates from our Luangwa Conservation Club work, selected and trained by Thandiwe Mweetwa and Henry Mwape. In 2017 we continued this work by intensively training University of British Columbia undergraduate Joseph Banda and Southern Africa Wildlife College student George Phiri (see below), and adding former Conservation Club graduates Dean Banda and Peter Musenge to the Liuwa Project. All excelled and Peter and Dean will be full-time members of the team in 2018.

## Wildlife Vet Training Programme

Training continued for aspiring Zambian wildlife vets on all sites, with students Fitzgerald Mukumbi, Kings Chimungu, Johanne Mayem and Mercy Njobvu all receiving intensive instruction from ZCP and CSL's wildlife vets and field staff on wildlife immobilization techniques as well as fundamental information on each species' biology and behavior. Currently, trainees are now at school for veterinary medicine and veterinary nursing and assist with ZCP's work during term breaks. In addition we assisted three newly-hired DNPW veterinarians in obtaining more field experience in large carnivore immobilizations through the course of our collaborative ZCP-DNPW work.

We also funded our Kafue vet, Dr. Kambwiri Banda, to successfully complete the wildlife capture course in Zimbabwe in early 2017.


ZCP Luangwa Project's Benny Mwila (R) services his field vehicle with the skills acquired from his Conservation Biologist training.

ZCP Liuwa Ecologist Shadrach Mwaba (L), a graduate of the Conservation Biologist Training Programme, conducts field work with APN/DNPW Scout Mboo Masilokwa.


ZCP Liuwa Manager Daan Smit (L) and ZCP Wildlife Vet Dr. Kambwiri Banda (second from right) instruct Dean and Peter on wildebeest collaring and data collection.


Zambian student George Phiri poses with one of several top student honors he earned from his ZCP sponsorship to the Southern African Wildlife College.


Henry Mwape (L) and Thandiwe Mweetwa working in the field. Both local Mfuwe secondary students, Henry is now a Fulbright Scholar and Thandiwe a National Geographic Explorer.

With curious subadults looking on, Teddy Mukula (L) works with ZCP/CSL Vet Dr. Mwamba Sichande to collar a hyena as part of Teddy's slated graduate research.

## Professional Training and Support

We continued to support professional training within DNPW by supporting Kafue Wildlife Police Officer Charles Kalambata and Victor Salamu's extended studies in wildlife and natural resources management through the Livingstone International University. We trained three DNPW Ecologists on carnivore and herbivore survey methods and three DNPW wildlife vets on wildlife immobilization techniques. With collaborators we also continued support to scout families through educational funding, supporting nursing school for the daughter of DNPW's Gibson Banda. We continued to have at least one scout attached or seconded to each project and working as a full-time field team member. We also supported local Mfuwe student George Phiri to complete his Higher Certificate in Nature Conservation at the Southern Africa Wildlife College during the reporting period. George not only completed the programme but earned Top Student honors in all courses, earning him a full scholarship to the College's year-long Advanced Certificate in Transfrontier Conservation Area Management in 2018. ZCP will be supporting his travel and visa fees as well as attaching him to the Luangwa Project as part of the course's required work experience.

## Graduate Students

The year was a transition period for Zambian graduate students, with our first cohort of students finishing in 2016; thus 2017 was spent preparing students for graduate entrance exams, seeking funds for their programmes, and assisting with project preparation. The year ended on a high note when Henry Mwape, a long-time ZCP Ecologist and Educational Coordinator in the Luangwa, was awarded a prestigious Fulbright Scholarship to the University of Arizona to pursue his Master's Degree in 2018 with Professor and ZCP Researcher Dr. David Christianson on big cat dynamics in the Luangwa. In preparation for his eventual Master's Degree at Montana State University, Liuwa Ecologist Teddy Mukula was one of 12 students selected worldwide to attend a 10 month course in 2018 at the University of Oxford's Wildlife Conservation Research Unit (WildCRU) in International Conservation Practice. In addition Dr. Kambwiri Banda, our wildlife vet and Ecologist on ZCP's Kafue Project, has committed to pursuing a Master's Degree with ZCP's partner institutions and will be preparing for this in 2018.


Thandiwe Mweetwa speaks on her community conservation work in Zambia to an audience in New York City. Thandiwe will be returning to New York in 2018 as a WINGS Worldquest Women of Discovery Award Recipient for her research and conservation work on lions.

## Media and Special Events

We continued to increase our media output during the reporting period with the construction of a website due to be released in 2018, as well as the production of two more natural history films—one on ZCP's Kafue Project and the other on Liuwa wildebeest, both set to air in 2018 in the USA and UK respectively.

We worked with National Geographic to produce a short impact film on Thandiwe Mweetwa and Henry Mwape's conservation and education work and worked with Plimsoll Films to translate their film on ZCP Luangwa Project's work into Nyanja for local showings. Episode 7 of the BBC's The Hunt, "Living with Predators," earned Best Conservation Film at the Jackson Hole Film Festival and featured ZCP's collaborative anti-snaring work on wild dogs. Thandiwe Mweetwa worked with National Geographic on a short film showcasing her lion work for Big Cat Week and was funded by the Wildlife Conservation Network to attend a Big Cat Conservation Summit in Jackson Hole, Wyoming in September as a guest speaker on Community Conservation. Thandiwe also conducted multiple Facebook Live interviews for National Geographic and Wildlife Conservation Network's Lion Recovery Fund. Thandiwe and Henry Mwape also finalized an agreement with Radio Breeze to provide 13 one-hour radio shows on ZCP's conservation work for airing in Eastern Province in 2018. At the end of 2017 Thandiwe Mweetwa was one of five women to be named a 2018 Wings World of Discovery Awardee by Wings WorldQuest. The awards "recognize the extraordinary women around the world contributing to world knowledge and science through exploration." Thandiwe will attend the awards in New York City in April 2018.

Thandiwe with renowned conservationist Dr. George Schaller at the Cat Conservation Summit in Jackson Hole, Wyoming.

Dr. Kambwiri Banda (L) and ZCP Researcher Milan Vinks work to treat a badly snared lion as part of a Plimsoll film documenting collaborative ZCP-DNPW conservation work.

# The Science of Conservation

## ZCP Scientific Publications for Policy and Management

Given that the strongest measure of the validity of science-based management and conservation recommendations is publication in peer-reviewed scientific journals, ZCP endeavors to ensure that findings and recommendations undergo this process as much as possible. We work with a variety of collaborating agencies, organizations, and institutions to accomplish this, and to ensure that these findings and recommendations are provided to managers and policy makers to help drive science-based conservation outcomes. To date ZCP has contributed to an array of scientific papers to provide science-based guidance on topics ranging from poaching, carnivore and herbivore demographics and survey techniques to genetics, disease, poaching, trophy hunting, fencing, community conservancies, land-use planning and human encroachment.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Christianson, D., M.S.Becker, S. Creel, A.Brennan, E.Droge, J.M'soka, T.Mukula, P.Schuette, D.Smit, and F.Watson. In Review. **Interactions between foraging investment and predation risk in a long-lived herbivore.** Ecology and Evolution.

Droge, E., S.Creel, M.S. Becker, D. Christianson, J. M'soka and F. Watson. In Review. **Response of wildebeests (Connochaetes taurinus) movements to spatial variation in long term risks from a complete predator guild.** Biological Conservation.

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Rosenblatt, E., S.Creel, P.A. Schuette, M.S.Becker, D.Christianson, E.Droge, and J.M'soka. In Review. **Do protection gradients alone explain changes in herbivore densities? An example with four ungulate species in Zambia's Luangwa Valley.** Biological Conservation.

Schuette, P., N. Namukonde, M.S.Becker, F.Watson, S.Creel, C. Chifunte, W. Matandiko, P. Millhouser, E.Rosenblatt, and C. Sanguinetti. 2018. **Boots on the ground: In defense of low-tech, inexpensive, and robust survey methods for Africa's under-funded protected areas.** Biodiversity and Conservation. https://link.springer.com/article/10.1007/s10531-018-1529-7

Becker, M.S., S.M. Durant, F.G.R. Watson, M. Parker, D. Gottelli, J. M'soka, E.Droge, M. Nyirenda, P. Schuette, S.Dunkley and R. Brummer. 2017. **Using dogs to find cats: detection dogs as a survey method for wide-ranging cheetah.** Journal of Zoology http://onlinelibrary.wiley.com/doi/10.1111/jzo.12445/full

Creel, S., E.Droge, J.M'soka, D.Smit, M.S.Becker, D.Christianson, and P.Schuette. 2017. **The relationship between direct predation and antipredator responses: a test with multiple predators and multiple prey.** Ecology. http://onlinelibrary.wiley.com/doi/10.1002/ecy.1885/full

Droge, E., S. Creel, M.S. Becker, and J. M'soka. 2017. **Measuring the 'landscape of fear': risky times and risky places interact to affect response of prey.** Nature Ecology and Evolution. https://www.nature.com/articles/s41559-017-0220-9

Droge, E., S. Creel, M.S. Becker, and J. M'soka. 2017. **Spatial and temporal avoidance of risk within a large carnivore guild.** Ecology and Evolution: 7: 189–199. doi: 10.1002/ece3.2616 http://onlinelibrary.wiley.com/doi/10.1002/ece3.2616/full

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**Back cover:** A hyena mother grooms her young cub in Liuwa Plain. Despite being impacted by all the same factors causing declines in big cats and wild dogs, hyenas have generated little concern as to their conservation status, largely owing to a lack of interest and support by the public and conservation organizations relative to the other species in the large carnivore guild. *Photo: Daan Smit*

Zambian

CARNIVORE PROGRAMME

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