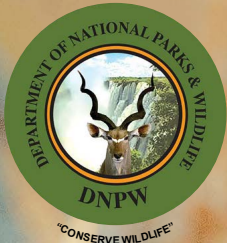




CARNIVORE PROGRAMME



Annual Report 2019





ANNA KUSLER

A cheetah cub eyes its surroundings in the Greater Liuwa Ecosystem of Western Zambia. A transboundary ecosystem with connectivity to Angola, Liuwa hosts Zambia’s second-largest cheetah population.

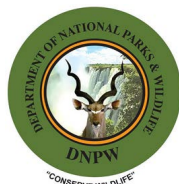
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**Zambian
CARNIVORE PROGRAMME**

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



Cover: Pups from the Luangwa’s Baobab Pack nuzzle their mother. One of the largest packs in the study, Baobab was the direct result of collaborative anti-snaring work by ZCP, DNPW and Conservation South Luangwa. Read their story on page 6.
Photo by Edward Selfe.

The Year in Review

We concluded another momentous year in 2019, working with the Department of National Parks and Wildlife (DNPW) and an array of partners to conserve large carnivores and ecosystems across Zambia. Our work extended across 7 national parks and seven Game Management Areas, as we logged over 2,700 person days in the field, and intensively monitored nearly 1,000 individual carnivores.

And the importance of these projects has never been greater. We are living in an era of rapid, human-induced environmental change, where current extinction rates are unprecedented in human history, and for the first time, humans are the primary driver of global environmental change. Particularly in the face of climate change, earth's ecosystems are experiencing rapid rates of transformation, and assessing the rates and consequences of this change makes long-term integrated ecological research and monitoring projects of key importance. Large mammals are among the most affected taxa, and large carnivores have experienced particularly large declines in numbers and geographic distribution.

We enter 2020 with all three of our long-term projects in the Luangwa Valley, Greater Kafue, and Greater Liuwa Ecosystems at a decade or longer of production, with new projects and collaborations on landscape levels in the Kabompo and Nsumbu Ecosystems beginning. A lot has changed over this time in the dynamics of people, wildlife, habitats, and climate, and together with our partners, we are positioned to continue addressing these issues.

And we have a number of conservation actions guided by science and aimed at combatting threats to species and ecosystems. We continued to provide significant support to anti-snaring

patrols by DNPW and partners to reduce snaring by-catch and prey depletion, we jointly developed human-carnivore conflict mitigation programmes in the Luangwa and Liuwa, we developed genetic tools for combatting trafficking of big cats and for evaluating connectivity between ecosystems; and we continued to evaluate human encroachment and provide science-based guidance for policy, land-use and species action plans, while continuing our emerging collaborations on watershed and climate change work.

And, as always, Zambian leadership was fundamental to all aspects of the work. Interest in carnivore conservation and our collaborative work continued to surge and we conducted an array of training and educational programmes across all sites, continued to support another cohort of outstanding young professionals in pursuit of advanced education and training, and collaborated on an assortment of community outreach and education programmes at a local, national and international level.

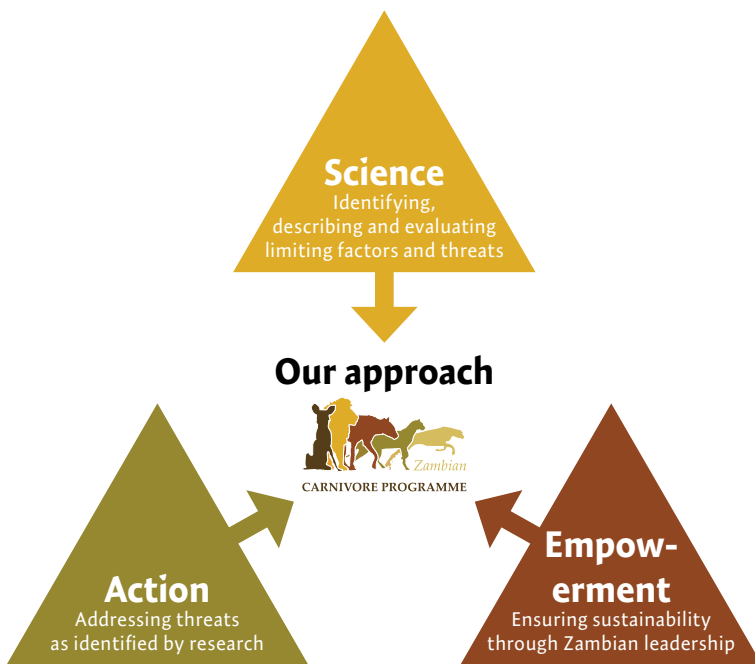
Addressing conservation challenges is a long-term endeavor, and a long-term commitment is therefore necessary. We can see positive results from this, perhaps best exemplified in 2019 by the appearance of the Baobab wild dog pack in South Luangwa. A new, large and previously unknown pack to our study, these dogs were the direct result of long-term collaborative anti-snaring work by DNPW, Conservation South Luangwa and ZCP, and a testament to the value of collaborations and commitment by all organizations. We hope you enjoy the Baobab pack's story and all the other information from 2019 enclosed in this report. On behalf of everyone in the organization, thank you again for your support.



Matthew S. Becker

Dr. Matthew Becker
Chief Executive Officer

Our Approach



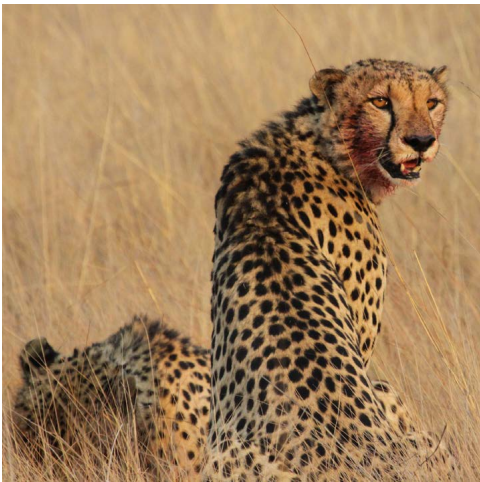
The Zambian Carnivore Programme (ZCP) follows a three-tiered interdisciplinary approach of Conservation Science, Conservation Action and Conservation Empowerment to fulfill its goal of conserving large carnivores and ecosystems.

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.



Keystone species

Carnivores have an ecological influence disproportionate to their abundance.

Indicator species

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

Flagship species

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



Conservation Science

In an era of rapid, human-induced ecological change, the importance of long-term projects to provide science-based assessments of the rates and consequences of these changes has never been more important to inform, guide and evaluate conservation, management and policy actions. Our integrated multi-site, multi-species, landscape scale work incorporates a holistic approach to understanding the trends, patterns, and dynamics of large carnivores, their prey, and the myriad human and ecological factors affecting them. In concert, this work provides accurate and current assessments of immediate, long-term and pending threats to these species and ecosystems, and the actions needed to address these impacts.

Conservation Action

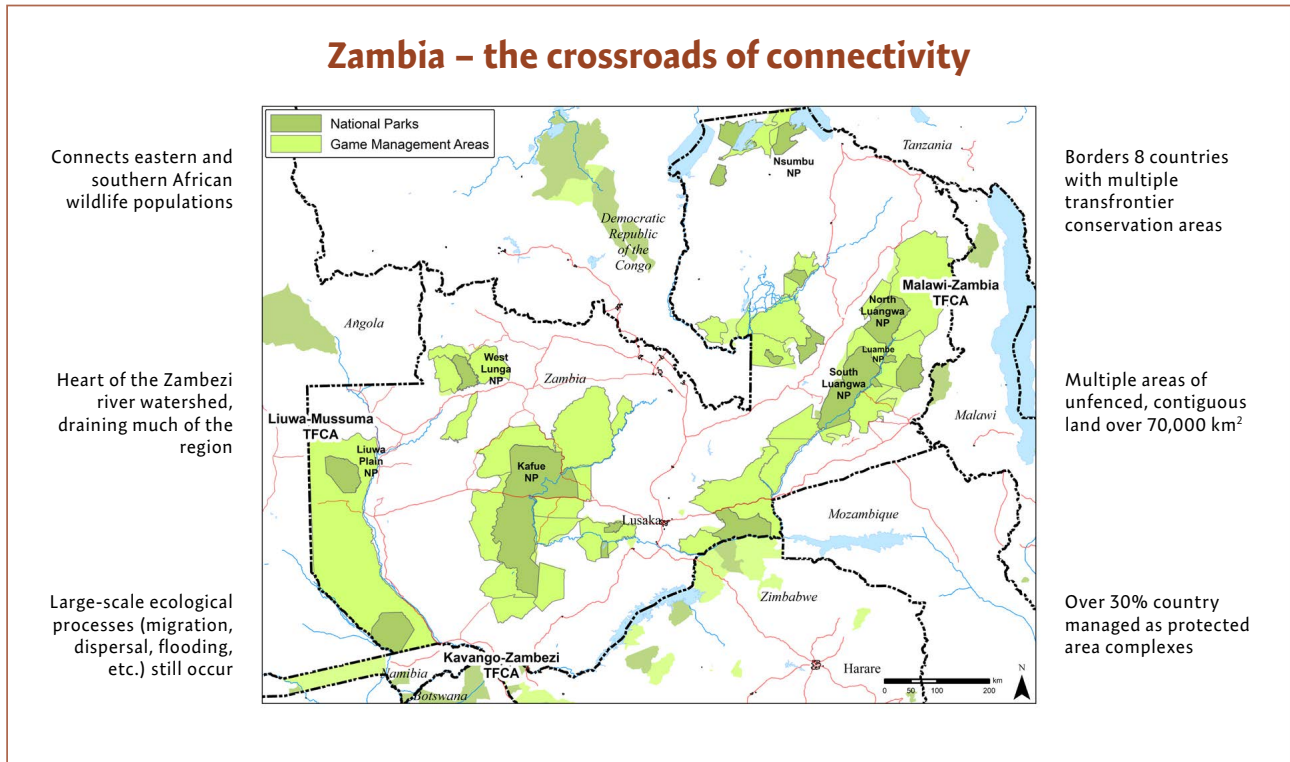
Guided by science, our conservation action initiatives help address the threats to species, ecosystems, and wildlife-based economies. We collaborate with a diverse array of partners on work ranging from supporting anti-poaching and combatting the bushmeat trade, to human-wildlife conflict mitigation, disease control, anti-trafficking, large landscape conservation and species reintroduction.



Conservation Empowerment

The sustainability of conservation efforts are often compromised because local communities are not effectively involved. We undertake a comprehensive approach to help develop local leadership and ensure sustainability through training, educating, sponsoring and employing current and aspiring Zambian conservation leaders in all aspects of the work, while conducting an array of community outreach and education work across the country.

Where we work



ZCP Ecologist and Luangwa Project Manager Thandiwe Mweetwa radio-tracks wild dogs in South Luangwa National Park.

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). We also work with partners in the recovering Kabompo and Nsumbu Ecosystems. The Luangwa Valley currently contains the country's largest carnivore populations; Greater Kafue contains Zambia's second-largest carnivore populations and its largest cheetah population as well as an incredible diversity of ungulates; and Greater Liuwa contains recovering populations of all carnivores and important populations of cheetah as well as Africa's second-largest wildebeest migration.

Field Reports

Luangwa Valley

African Wild Dogs

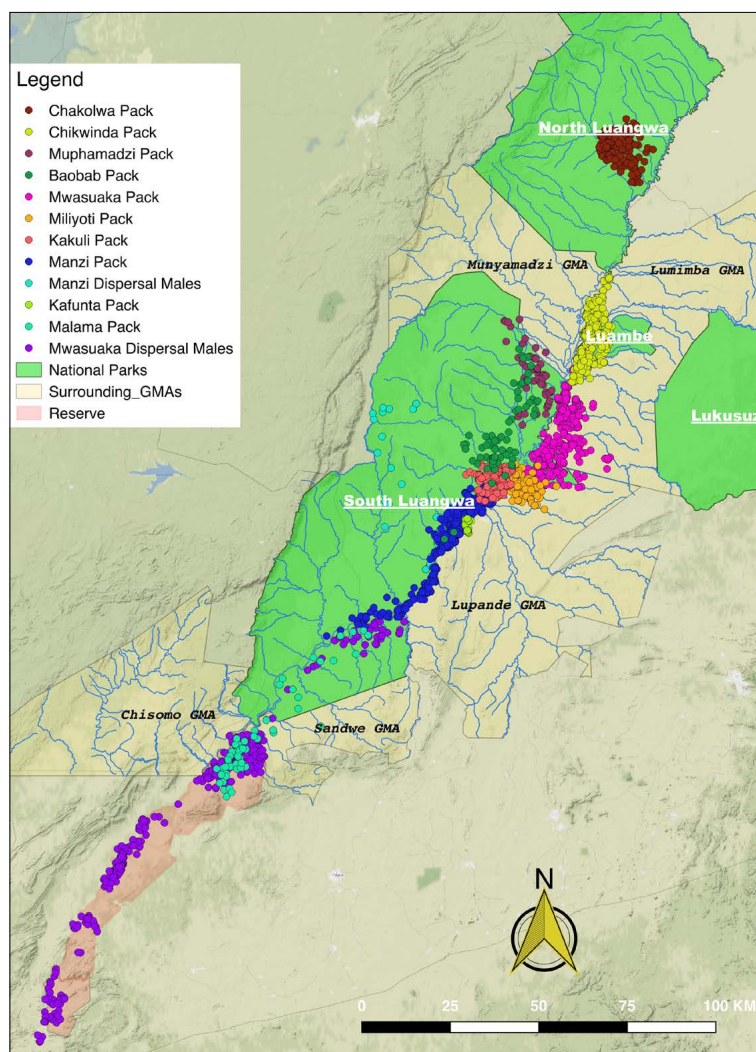
We continued the country's longest running wild dog conservation work in the Luangwa Valley in 2019, continuing work in and around South Luangwa National Park (SLNP) while also continuing and expanding work in Luambe National Park and North Luangwa National Park as well as the adjoining Game Management Areas (GMAs), and areas considerably further south of South Luangwa National Park. We monitored 181 dogs in 21 packs and dispersing groups across approximately 12,000 km². We intensively monitored 14 resident packs.

Owing to the dissolution of several long-standing packs in 2018-2019, such as the Hot Springs and Manzi packs, we documented numerous new packs in 2019. While wild dog numbers can fluctuate significantly, particularly due to human impacts, we again enjoyed high numbers of packs and dogs in 2019, owing in no small part to the extensive resource protection and collaborative anti-snaring work conducted with Conservation South Luangwa and DNPW (see Anti-Snaring).

We continued our work on human and ecological factors affecting wild dog demography and expect a first product from these analyses in 2020. The importance of connectivity was again documented by long-distance dispersals (both successful and unsuccessful). For example, subordinate dogs from the Manzi pack dispersed and comprised three new breeding packs from North Luangwa to Lower Lupande GMA.

In late 2018, a group of three males dispersed from Mwasuaka pack, moving south from the SLNP's Nsefu sector passing through 3 game management areas and 7 game reserves along the Luangwa River, and covering more than 230 kms straight line. The dispersal group continued to head south in 2019, towards Lower Zambezi National Park and Mozambique, making it 62 km outside of the park before the collared male

was killed in a snare. While extremely unfortunate it highlights both the threats facing wild dogs and the connectivity of the Luangwa Valley. We also produced our first analysis of genetic connectivity of Zambian wild dog populations and the effects of competition and human impacts (See Large Landscape Conservation).



Space use of wild dogs across the Luangwa Valley in 2019 illustrates the crucial importance of connectivity as well as the dependence on the free-flowing Luangwa River.



Pups from the new Baobab Pack are doted over by the adults. One of the largest packs currently in the Luangwa, the pups' father and pack's alpha male was dying from a snare in 2014 but rescued through collaborative anti-snaring work.

Tails of Hope and Resilience: The Baobab Pack

Snared and dying as a pup in 2014, this rescued dog had returned in 2019, now as the alpha male of a new 16-strong pack.

The pup's future was looking bleak: with a snare cutting deep through the back of his mouth that prohibited him from eating, it was only a matter of time before he would die. Fortunately for Wild Dog 635, several of his aunts and uncles wore radio-collars, enabling our teams to locate the pack, detect his injury, and rescue him. Together with the DNPW and Conservation South Luangwa, we darted the dog and treated his wounds, and while he was forever left with a deep 'Joker Smile' scar, he made a full and fast recovery.



The Baobab Pack's Alpha Male as a pup in 2014 getting rescued from a deadly snare lodged through his mouth.

Wild Dog 635 grew into a yearling and in 2015, together with one of his brothers (which we also de-snared in a separate incident), he dispersed from their natal pack. For several years 635 had to roam the vast expanse of the Luangwa Valley to form his own pack with the perfect female.

This August we were treated to a great surprise when the rescued pup 635 reappeared as the alpha male of a 16-dog pack in South Luangwa National Park's Baobab Forest! This new pack ranged widely before denning late and raising four new pups, becoming mobile with them just as the rains arrived.

Like many wild dogs in the Luangwa, the Baobab Pack would not have existed without over a decade of intensive anti-snaring work on wild dogs by ZCP, DNPW, and CSL (See Anti-Snaring). Today, the Luangwa holds the country's largest dog population and is one of Africa's premiere places to view this endangered species.

We hope Wild Dog 635 follows in the footsteps of his father, an alpha male who lived to a record 12+ years and sired over a dozen packs and 170 pups, grandpups and great-grandpups, and was also rescued from a lethal snare. With our conservation work ongoing, the Baobab Pack and its new pups are in the running for the Luangwa's next wild dog dynasty.

Lion

In 2019, DNPW-ZCP field teams monitored 201 lions across 19 prides and 18 coalitions ranging from Luambe National Park down south to the Luamfwa area of South Luangwa National Park and the adjacent Game Management Areas (GMAs).

Almost every pride and coalition ranged both in the National Park and outside in the GMAs, making them susceptible to an array of human impacts across these dramatically different protection gradients. The illegal bushmeat trade, heavily fueled by wire-snare poaching, continued to have significant impacts on lion preybases as well as lion mortalities and injuries from snaring by-catch (see Anti-Snaring), and snaring activity again was concentrated in the GMAs and park boundaries.

While lion conflict with livestock in the Luangwa was historically not a common problem due to low human densities and the presence of tsetse fly-borne sleeping sickness that discouraged livestock herding, changes in human demographics and livestock have seriously increased lion conflict with livestock and people. Consequently, our newly-implemented lion conflict mitigation programme in the Luangwa with the DNPW and CSL assumed even more



importance in 2019, and we conducted an array of conflict mitigation work (see Human-Carnivore Conflict). Using GPS/Satellite collar technology, we continued to intensively monitor boundary prides in the GMA particularly susceptible to conflict and snaring, and collaborated with our partners and communities on mitigating these threats.

We also published our first genetic analysis of Luangwa lion genetics in 2019, evaluating connectivity of populations between Kafue and Selous ecosystems as part of our ongoing connectivity work (see Large Landscape Conservation).

ZCP-DNPW collect data on the Nsefu pride of South Luangwa as part of the country's longest-running lion conservation project.





A leopard and her cubs rest in the middle of a camera trap array. Data from camera trap studies provides key information on leopard demographics, as well as prey, competitors and smaller carnivores.

Leopard

We completed our eighth year of camera-trap based studies in the Luangwa's leopard stronghold, conducting work on leopards, their prey and competitors across the gradient of protection between South Luangwa National Park and the adjacent Game Management Areas.

In 2019, we expanded the camera trap study to Luambe National Park to conduct similar work in concert with our ongoing intensive carnivore work and herbivore surveys. Unfortunately, a myriad of human impacts on leopard exist in the

Luangwa Valley and rangewide, yet are poorly understood. These include encroachment, prey depletion and bycatch from poaching, an emerging illegal trade in leopard skins and parts (see Wildlife Crime section), conflict with livestock and legal offtake from trophy hunting. Consequently, an understanding of leopard populations and dynamics is ever more important. In addition, ZCP is working with DNPW Ecologists (see Conservation Capacity) to begin evaluating leopard dynamics in Zambia and the factors affecting them.

Herbivores

The global decline of large herbivores is one of the most pervasive anthropogenic impacts given the significant influence of these species on ecosystem functioning. Understanding their dynamics, particularly across gradients of protection from strictly protected into human-modified landscapes, is critical for conservation and management.

In 2019 we completed our eighth year of bi-annual herbivore surveys across South Luangwa National Park (SLNP) and the adjacent Game Management Areas (GMAs), as well as our second year of similar surveys in Luambe National Park. These surveys provided estimates of density, distribution, and the human and ecological factors affecting them for numerous species and across the strong gradients of protection between national parks and GMA buffer zones where human habitation occurs.



A male puku keeps a close eye on a leopard in South Luangwa. Recent studies of herbivores indicate substantial differences in densities between park and Game Management Areas. These contrasts were best explained by differences in habitats and poaching intensity.



We published our first analysis of the impacts of human and ecological factors on herbivore densities and distribution in a study entitled “Do protection gradients alone explain changes in herbivore densities? An example with four ungulate species in Zambia’s Luangwa Valley.” Using survey data from 2012-2015 we evaluated population densities of four important ungulates species (impala, puku, zebra and warthog) across the gradient between national park and GMA, while accounting for the role of various ecological and anthropogenic variables that could affect densities. Our primary goal was to assess whether protection status explained differences, and whether there were any trends over time and across management regimes. All four species occurred at substantially lower densities in the GMA buffer zones compared to the park (ranging from 4.5-fold to 13.2-fold lower), even in areas with no physical boundary such as the Luangwa river between park and GMA. Density trends through the study were species-specific and not consistent across time or areas. These differences surprisingly were not found to be due to levels of protection or year, nor was there a detectable decline during the hunting moratorium of 2012-2014 in the areas of survey. Instead, these differences were due to differences in vegetation composition and water availability. Our findings indicate that habitat conditions

play a major role in the distribution of these ungulate species, in addition to differences in poaching intensity between the national park and GMA. This study highlights the importance of accounting for variables beyond the strata of interest in evaluating the effectiveness of a protected area and the importance of continued long-term assessments across protection gradients given the rapidly-changing human impacts and resultant prey depletion in protected area buffer zones.

We continued our long-term demographic studies of the geographically-isolated Luangwa giraffe population in 2019, co-authoring a paper on giraffe populations continent-wide entitled “An update of the geographical distribution of giraffe, *Giraffa* spp., throughout sub-Saharan Africa and its implications for conservation.” The paper indicated several areas of range loss for giraffe, including the Luangwa Valley, but these differences are unlikely to reflect true occupied range that has been lost versus a more concise range estimation with long-term sightings data. We continued to work on demographic evaluations of the giraffe population using photographic mark resight techniques on a study population of over 400 individually-identifiable animals, and initial products are expected in the coming year.

Giraffe drink from the Luangwa river in the dry season. Long-term studies on giraffe demography and spatial dynamics have been ongoing since 2008 and helped inform a reassessment of giraffe range across Africa in 2019.



The Lwengu female of Greater Kafue rests with her female cub. A successful disperser, the Lwengu female and her cub face an array of human and ecological threats.

Greater Kafue

Cheetah

Long-term conservation work on Zambia’s largest cheetah population continued in the Greater Kafue ecosystem as we completed our ninth year of work in 2019, with 31 individual cheetah monitored through a combination of intensive fieldwork and collaborative citizen science programmes (see Citizen Science p31). In prior years we documented cheetah cubs successfully dispersing and establishing new home-ranges, and this year we documented successful reproduction in several of these young females.

Satellite/GPS collars continue to give us crucial information on dispersal, spatial dynamics, and connectivity for cheetah in the GKE and KAZA Transfrontier Conservation Area and analyses of genetic connectivity for cheetah and other carnivores are ongoing as part of our African Carnivore Connectivity Project (see Large Landscape Conservation). In addition, the first demographic analyses of human and ecological factors affecting cheetah survival and reproduction are ongoing, as are evaluations of how these same factors affect cheetah usage of natural and human-modified landscapes. As part of this work we successfully collared a new dispersal group that was ranging far from the protected core areas of the park and toward heavily human-encroached areas in the GMA. Young dispersing animals are particularly vulnerable as they traverse human-modified landscapes, and collectively this work will continue to improve

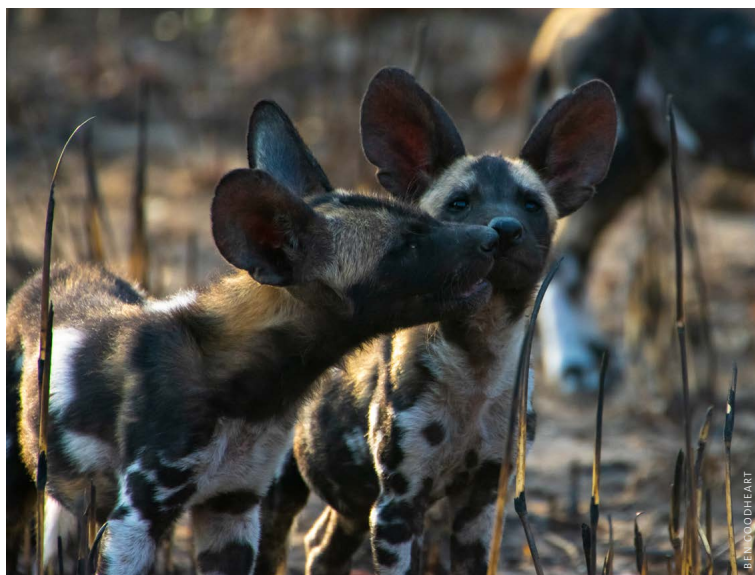
our understanding of the dynamics, requirements, threats and actions needed to protect this key population. In comparison to other carnivores, snared cheetah are not typically detected, perhaps owing to their low-density, wide-ranging and elusive behavior, as there is no reason to believe cheetah are not heavily impacted by snaring bycatch like other carnivores. We detected our first snared cheetah in 2019, ranging in an area of high-snare risk (See Anti-Snaring). Given this animal was in a remote area and his death would have remained undetected if not for Satellite/GPS collar technology, the impacts of snaring are likely severe if not addressed.

Wild Dog

We completed our ninth year of intensive wild dog conservation work in 2019, monitoring 89 dogs in seven packs in our intensive study area of Northern and Central Kafue, and 119 in 21 throughout the Greater Kafue as part of a collaborative citizen science programme (see Citizen Science) with DNPW, Panthera, safari operators and guides. Pup recruitment in resident packs was good, likely owing to a combination of low lion densities (a strong natural limiting factor in most ecosystems) and collaborative anti-snaring work (see anti-snaring) through much of their range which helped protect dogs from snaring bycatch and mitigate prey depletion. The largest pack,

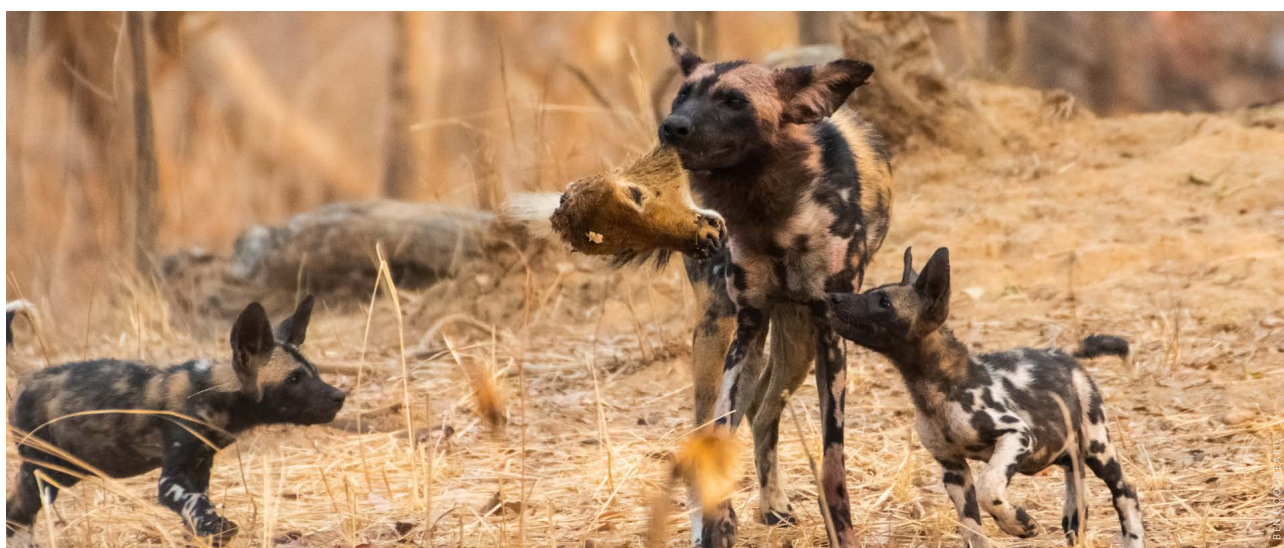
Twin Palm, grew to 21 dogs and, like all packs with pups in the study, could continue to grow with good wet season survival, which in turn would provide more helpers for the coming year's denning effort and produce more dispersers to form additional packs. We added three new packs to our study, two of which formed from successful dispersals from known packs, again demonstrating the importance of large landscape connectivity, and satellite/GPS collar technology enabled monitoring and protection across approximately 12,000 km². We began analysis of Kafue wild dog demography and the human and ecological factors affecting them, with the first results from this population stronghold expected in 2020.

Unfortunately Kafue dog populations were still subject to an array of negative human impacts. While snaring bycatch was again reduced in 2019, with one snared dog detected and de-snared, we continued to lose dogs from roadkills along the high-speed routes of the M9 (see roads) and the year ended on a down note in December with the detection of rabies in a rarely-seen 17-dog pack frequenting the boundary areas between Kafue National Park and the West Mumbwa GMA. The dogs were detected along the M9 with several animals already showing signs; despite efforts to control the disease within the pack by the DNPW and ZCP, the pack was lost. While we did not have data on their homerange the pack likely frequented human-impacted areas in the GMAs where contact with unvaccinated domestic dogs was likely, and contact with poachers' dogs was also possible in much of their range. To date, perhaps owing to the low densities of carnivores in the GKE limiting transmission, further spread of the disease has not been documented. Nevertheless, given the reservoir for rabies is typically



unvaccinated domestic dogs, continued anti-poaching efforts coupled with domestic dog vaccination programmes are of critical importance to avoid more catastrophic outbreaks in the future (see Disease p29).

We continued to document large-scale dispersals and movements of wild dogs in 2019, with the most dramatic being a group of three dispersing females that moved west toward Liuwa Plain, making it approximately 115 km before turning back. We produced our first genetic analysis of Kafue wild dogs in 2019 (see Large Landscape Conservation), finding that perhaps owing to the mobility evolved to cope with lions that wild dogs are able to still retain genetic connectivity between Kafue, Liuwa and Luangwa populations, though this ability to move through human-impacted landscapes may also put them more at risk for snaring by-catch and disease.



Pups chase after an adult carrying the remains of a puku kill. Likely owing to low densities of competitors such as lion and hyena, pup survival for most Kafue study packs was high in 2019.



A lioness and her cub from the Kasonso Pride in the Greater Kafue. Ranging widely across a protection gradient between Kafue National Park, the Kasonso-Busanga GMA and beyond, this pride is exposed to substantial risks from humans and both the cub and a subadult male from this pride were de-snared in 2019 (See Conservation Action).

Lions and Hyena

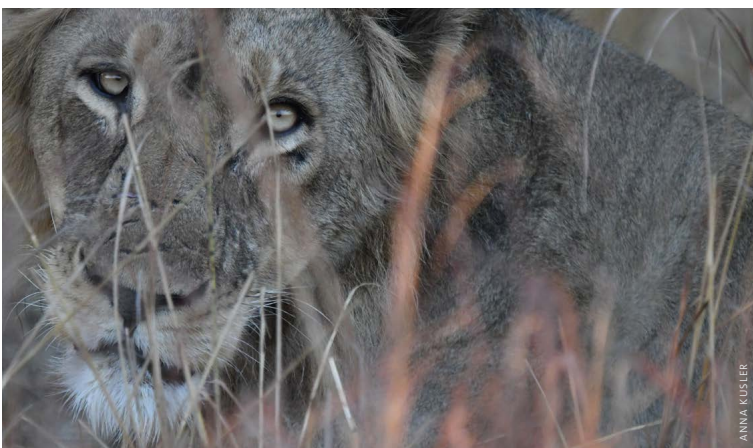
We completed our eighth year of long-term lion conservation in the Greater Kafue in 2019, continuing work begun by the Kafue Lion Project in 2010. We intensively monitored 110 lions in 17 prides and 18 coalitions across Northern and Central Kafue and expanded work in the Game Management Areas (GMAs) bordering the park.

While prior collaborative work in the Kafue had highlighted the potential impacts of prey depletion from poaching on lions and other carnivores, the impacts are not well-understood. Building on our published work from 2018 evaluating the impacts of diet changes with prey depletion, we completed the first study of these impacts on lion demography. In concert with additional studies of the herbivore community that demonstrated significant prey depletion (see Herbivores p14), we completed our first analysis of Kafue lion population dynamics and submitted it for publi-

cation. The study, entitled “Demographic response of an apex predator in response to long-term declines in prey abundance,” utilized intensive studies of 170 lions in 16 prides and 16 coalitions from 2013-2018 in order to estimate survival, reproduction and population density, and evaluate whether the factors affecting herbivore densities also affected lion demography. Average lion density in the study area was approximately 1/3 that of populations in similar ecosystems without significant prey depletion, while adult female and older male survival was similar to rates in high density, stable populations. In contrast, survival for young males was relatively lower, indicating prey depletion could play a significant role in dispersal success. The proportion of the population comprising 2nd year cubs was also low, indicating that recruitment is more sensitive than adult survival, and in accordance with life history theory predictions that lions would prioritize survival over reproduction when resources are limiting. Given that prey depletion impacts are occurring throughout the range of lions and other carnivores in Africa, these impacts should be evaluated in other systems and increasing resource protection and reducing the underlying drivers of prey depletion are urgent conservation needs for lions in sub-Saharan Africa and other large carnivores.

Population sizes and trends of lions and other carnivores are of fundamental importance in assessing the status and threats to these species, as well as in identifying the appropriate conservation actions needed and in evaluating the success of this work. Unfortunately, large carnivores are low density, wide-ranging, elusive, and often declining, making estimating population

The fight-scarred face of a male lion in Kafue. Concurrent ZCP-DNPW studies of lions and herbivores indicate that densities of lions in this ecosystem are considerably lower than comparable miombo ecosystems elsewhere in Africa, likely as a result of a diminishing preybase from poaching.



ANNA KUSLEER



The Papyrus Pride’s cubs tussle over the remains of a lechwe kill in Kafue’s Busanga Plains. While prey depletion is known to be a threat to lions and other carnivores, the impacts are poorly understood. Lion demography studies produced in 2019 indicate that prey depletion is likely driving low cub recruitment in the ecosystem. Fortunately Papyrus had a total of 9 cubs in 2019, owing to effective anti-snaring work in the area, which included de-snaring of a sub-adult male in the pride (See Conservation Action).

Leopard

status and trends extremely difficult. Thus, there is an urgent need to identify effective and standardized methods for population monitoring. Index-calibrated survey methods such as track counts and call-ups are widely employed for lions and other carnivores given they can rapidly cover large areas at substantially lower costs; however prior work has raised concerns on the ability of these methods to detect declines in populations.

In collaboration with the Trans-Kalahari Predator Conservation Project, we evaluated the effectiveness of track count surveys using GPS movement data from lion populations of known size in the Kafue and Hwange ecosystems. Entitled “Assessing the performance of rapid and inexpensive methods to monitor populations of imperiled apex carnivores,” the study was accepted for publication in *Ecology and Evolution*, and found that track counts did not effectively estimate these populations of known size due to several issues underlying the method itself and index-calibrated methods as a whole. These methods also were unable to detect population declines that would trigger IUCN uplistings. Consequently, there is a clear need for additional and improved methods for population monitoring beyond long-term intensive studies and index-calibrated surveys, with a number of camera-trap and genetic based methods showing promise.

Hyena numbers continued to be the lowest of the carnivores we monitored in the GKE, but we continued to amass data from photographic-based monitoring, with 26 hyena over six clans monitored in our intensive study area in 2019 and over 80 to date.

The Greater Kafue comprises one of Zambia’s two largest populations of this threatened cat, yet very little is known about the population and its threats, though many of the same factors influencing other carnivores are likely impacting leopards (see Herbivores p14, Wildlife Crime p25, and Anti-Snaring p23).

We completed eight seasons of camera-trap based work on leopard in Northern and Central KNP, while also collecting data on competing predators, prey and mesocarnivores. We completed a preliminary analysis of leopard densities and an evaluation of ecological and anthropogenic factors affecting them and will be finalizing this work in the coming year. We currently have 93 individual leopards in our databases and continue to expand this long-term monitoring work in collaboration with partners and other initiatives.

A leopard in Kafue National Park. Very little is known about leopard dynamics in the Kafue and ZCP-DNPW have been conducting camera trap-based work since 2012, with the first evaluation of leopard density and factors affecting them to be completed in 2020.





A puku grazes across the Busanga Plains in Kafue. Long-term studies conducted since 2012 indicate significant depletion in the Kafue's herbivore community, particularly with the larger species such as buffalo.

Herbivores

The diversity of large herbivores in the GKE is one of the highest in Africa, but owing to its large size and lack of resources has long been thought to be threatened by depletion from poaching and the illegal bushmeat trade, which has an array of negative impacts on ecosystems and wildlife-based economies.

We continued to conduct ground-based surveys for all herbivore species in the early and late dry season in 2019. Building on our prior Kafue herbivore dynamics and bushmeat impacts work, we published a second analysis on the ecological and anthropogenic factors affecting large herbivore densities entitled “Testing the effects of anthropogenic pressures on a diverse African herbivore community.” Using survey data from 2012–2018, we were able to estimate the density and distribution of 10 large herbivore species (puku, impala, warthog, common duiker, reedbuck, Lichtenstein’s hartebeest, blue wildebeest, roan antelope, zebra, and waterbuck), while accounting for the potential effects of important ecological and anthropogenic variables on these two measures.

An underlying goal of the study was to rigorously determine if large herbivore densities are indeed as low as has been previously suggested for this system. Our findings suggest that this is indeed the case, and more importantly they suggest that the densities of larger-bodied herbivores are greatly depressed relative to smaller species. This pattern could have direct and indirect effects on large carnivore populations, with broader implications for the ecotourism and trophy hunting industries. Our findings highlight that the Greater Kafue Ecosystem will require continued increases in resource protection to facilitate the recovery of an economically and ecologically important large herbivore guild.

More broadly, our results confirm that anthropogenic effects on large herbivore distribution and abundance can be strong over wide areas for all species (particularly the larger members of the guild), even in very large protected areas. This study was also closely linked with our lion study to determine the impacts of prey depletion on lion demography (see Lions p12).

Greater Liuwa

Spotted Hyena

We completed a decade of work on Liuwa's apex predator, the spotted hyena, in 2019. We intensively studied 284 hyena in 11 clans across approximately 6,000 km² of Liuwa Plain National Park and the Upper West Zambezi Game Management Area (GMA). In the absence of a large competing lion population, and with abundant prey and minimal livestock conflict, the hyena population continued to exhibit high adult survival, but a preliminary assessment of recent demographic data indicated juvenile (cub) survival has been lower in recent years. While more analyses are ongoing, one of the biggest factors likely to be affecting cub survival is the extreme climatic conditions Liuwa has experienced, with the year being one of the driest on record. The weak rainy season and accompanying floods resulted in early drying of the water pans throughout the southern portion of the park that comprises the homeranges of the densest hyena populations. The drying down in turn resulted in resident wildebeest bulls and zebra—core components of the dry season diets for these clans—to migrate north to more permanent water sources, which in turn resulted in hyenas traveling very long distances to hunt and provision cubs. This long-distance commuting resulted in cubs being left alone at the den for long periods of time and exposed to predators

and malnutrition. These changes reflect a key question of how long-term changes in precipitation, flooding and fire will affect the dynamics of both hyena and their prey, and is the focus of current work on climate change (see Large Landscape Conservation).

An increased emphasis on the hyena dynamics across the wildebeest winter range in the northern portion of the park and GMA continued in 2019, with our seasonal North Camp base at Salwela Scout Camp. We monitored several new clans in this area, with one residing fully outside of the park, in the area that forms the critical connectivity for the Liuwa-Mussuma Transfrontier Conservation Area with Angola. These clans were smaller than those of the park's southern portion, likely reflecting both the differences in prey density but also the increased human impacts in the GMAs. Given the long-distance commuting and large spatial scales that hyenas cover, the work was greatly assisted by the deployment of Satellite/GPS collars into three clans, which allowed us to effectively monitor long-distance movements. In addition to changes in range resulting from the drought, we documented a rise in the incidences of wire-snare poaching in and around Liuwa in 2019, with 10 hyenas detected carrying snares.

Cubs from the Mutata Clan interact with an adult visiting the communal den. Hyena survival and reproduction in Liuwa continues to be high, owing to the abundant preybase, low lion numbers, and minimal conflict with humans. Some clans, however, have experienced reduced cub survival as a result of drought and consequent changes in the distribution of prey.





A herd of zebra ambles past a sleeping hyena. With their major prey species strongly migratory, there is increasing evidence of long-distance commuting by hyenas into other clan territories.

We were able to effectively rescue three (see Anti-Snaring) but the impact of such snaring by-catch on hyenas, other carnivores, and their prey remains a serious concern.

Of the five large African carnivores (lion, cheetah, wild dog, leopard, hyena) all except the spotted hyena are species of concern due to increasing human impacts on their habitats and populations. Despite being as susceptible or more to the array of human threats facing the continent's big cats and wild dogs, hyena are currently listed by the IUCN as a species of Least Concern, likely due to lack of public interest and support for hyena conservation and a lack of data on hyena dynamics. Utilizing data from Liuwa and our other sites we hope to contribute to current efforts to bring attention and support to the plight of this unique and important top carnivore.

Hyenas relax in and around a pan in Liuwa Plain. With 284 hyenas monitored in 11 clans, the Liuwa study is one of the longest-running hyena projects in the region.

Cheetah

Greater Liuwa's cheetah population is Zambia's second largest and is likely to be transboundary with Angola's Mussuma Ecosystem; however, like many species cheetah are experiencing unprecedented rates of human impacts. We continued our 10th year of cheetah conservation work in the GLE, intensively monitoring 19 cheetah across both the national park and the Upper Western Zambezi Game Management Area (GMA) corridor between Liuwa and Angola. We collected survival, reproduction, and spatial data to understand the dynamics of this population. This work was greatly facilitated by satellite/GPS collar technology and a year-round field effort that logged 1138 person days in 2019.

Overall it was a positive year for Liuwa cheetah, with five female cubs successfully surviving to dispersal age and splitting off to seek out homeranges and mating opportunities. While the park population is well-described, earlier in the year we detected an unknown female with three young cubs in the GMA corridor. This area also serves as the homerange for one of the adult study males, indicating that additional animals are in the corridor area breeding. In addition, an unknown group of dispersal-aged cheetahs, consisting of one female and two males, were also first seen together at the start of the year before subsequently splitting and being regularly observed throughout the year.

Liuwa's only 3-male strong cheetah coalition was also only seen on camera trap photos until they were found at the end of the reporting year and one of the males fitted with a satellite/GPS collar.





Male cheetah 438 kills a duiker. Small antelope such as duiker and oribi form the primary prey items for cheetah in the ecosystem, and the presence of these small resident herbivores is important for cheetah population growth throughout Greater Liuwa, particularly in areas where wildebeest are not present seasonally or permanently.

These data will continue to help evaluate the dynamics of this population and the importance of increasing protection for the GMA corridor, both for cheetah and other species.

While the wildebeest population's range is well-studied (see Herbivores p19), populations of oribi and duiker are much wider distributed throughout the GLE, likely enabling cheetah to persist throughout much of the GMA and mitigate competition with larger competitors such as spotted hyena through dietary niche partitioning (i.e. eating different prey). We documented over 250 hunts and over 100 kills by cheetah groups in 2019, as small-sized antelope continued to be the primary prey items, as well as reedbuck, wildebeest calves and scrub hare. Females continued to hunt primarily in daytime, while males were also active at night. Given the potential for the GMA to support significantly more cheetah than currently documented we have planned additional surveys in 2020 throughout the area for carnivores and herbivores in order to document the status of these species and assist with documentation of these resources to support greater protection of these key areas.

While cheetah generally fared well in 2019, human impacts, particularly on a small low-density population, can quickly have severe consequences. For the third-straight year we lost a cheetah to poaching, with a prime-age adult



female monitored since birth succumbing to probable snaring by-catch. The cheetah had two female cubs of dispersal age, which have fortunately been able to survive. Nevertheless, snaring remains a serious threat to cheetah and Liuwa's recovering carnivores in general (see Anti-Snaring p23).

Female Cheetah 439 and her cubs in early 2019. Late in the year the female died from probable snaring by-catch but her cubs—near dispersal age at the time--have been able to survive and fend for themselves.



The increase in lions, particularly in subadult and adult males which are more prone to roam and get into conflict with livestock, has necessitated Liuwa's first Predator Management Plan to help restore predators while ensuring communities are protected and benefitting from restoration.

Lion

It was again a tumultuous year for Liuwa lions in 2019. In the late rainy season the pride's two breeding females died of an apparent hunting injury from a zebra, leaving behind three approximately 1.5 year old cubs. In addition, the adult male lion translocated to Liuwa in 2016 continued to roam throughout Liuwa and beyond and was eventually euthanized after repeatedly attacking cattle. The Liuwa pride consisted of one breeding female, two subadult males, and four subadult females for most of the dry season, with the remaining pride male spending most of his time with the pride but also with his two subadult sons. During the dry

season the pride largely frequented the scattered woodlands of the park's northeast sector, while during the wet season all lions primarily resided in the center of the park. As expected, the two subadult males and pride male also roamed widely in and around the park, and in August entered Angola briefly. These dynamics continued to reflect the challenges of having lions in a heavily human-impacted landscape with livestock, and precipitated the first Predator Management Plan for Liuwa in 2019. The DNPW, African Parks, the Barotse Royal Establishment, WWF, ZCP and other stakeholders met for two days to start the process of a plan that lays out clear objectives and actions for restoring carnivore species in Liuwa. This meeting was preceded by a lengthy sensitization and survey by APN, DNPW and ZCP throughout Liuwa to gather baseline information, attitudes and opinions on predator management that will help guide this work (see Human Wildlife Conflict Mitigation).

A lion cub watches vultures while feeding on a wildebeest kill. Liuwa's lion population has continued to increase with the establishment of a breeding pride in 2013.



Wild Dogs

Similar to prior years, wild dogs continued to remain absent from the southern portion of the Greater Liuwa Ecosystem in 2019, though unconfirmed reports of dogs, particularly in the northern sector of the Upper West Zambezi GMA that connects Liuwa Plain National Park



Wildebeest group together tightly after being tested by predators. Long-term wildebeest studies indicate predation is the major driver of survival, and potentially the tendency for migration.

with Angola's Mussuma area, persisted. In some good news however, our Angolan partners conducting carnivore surveys in the Mussuma area verified a population of dogs persisting in the Liuwa-Mussuma Transfrontier Conservation Area.

Adding to this, in 2019 we published our first analysis of wild dog genetics and connectivity work (see Large Landscape Conservation), which indicated Liuwa wild dogs still retained high genetic connectivity with other Zambian populations in the Kafue and Luangwa, and thus connectivity with Angola is also highly likely. Thus natural recolonization of southern Liuwa by wild dogs is promising, but these findings highlight the need to maintain connectivity between Zambia and Angola, particularly through increased protection of the Upper West Zambezi GMA, and to make conditions for wild dogs in Liuwa more amenable through domestic dog disease control. As a small grassland ecosystem population that competes with a large population of superior competitors in the spotted hyena and lion, wild dogs are already likely to be heavily limited by competition. However, with the continued threat of rabies from a largely unvaccinated population of village dogs of potentially as many as 7,500 animals in and around Liuwa, as well as from snaring by-catch threats, much remains to be done to help ensure the viability of wild dogs in Liuwa.

In 2019, together with African Parks, DNPW, the Barotse Royal Establishment, and WWF-Zambia we launched the first Predator Management Plan for the Liuwa Plain, which helps guide restoration objectives and actions for wild dogs and other species. In mid-2020, as a companion study to the Angolan Mussuma work, we will also be undertaking an additional carnivore and herbivore survey far into the Upper West Zambezi GMA to assess the status of the area for these species.

Herbivores

The longest-running intensive study of migratory herbivores in the region is the Liuwa wildebeest study, and large herbivores play critical ecological roles through their impacts on vegetation structure, diversity, nutrient cycling, and as prey for carnivores. We completed our 8th year of wildebeest work, intensively monitoring 43 collared adult cows and their calves throughout the year to collect survival, reproduction, habitat selection and migration data on this keystone species of the Liuwa-Mussuma Transfrontier Conservation Area. In addition to fine-scale GPS collar data, over 900 ground-based sightings and 1100 herd composition counts over approximately 6000 km² were collected concurrent with work on large carnivores, flooding, fire and vegetation dynamics (see Large Landscape Conservation). With the poor rains (approximately 400mm



A large migratory population of zebra also resides in Greater Liuwa, likely with increasing importance for a growing carnivore population.

The success of predator restoration has ensured that predation and predation risk effects continue to exert strong influences on wildebeest demography and behavior and spatial dynamics in Liuwa.

relative to annual average of 1000 mm) and subsequent extreme drying down of pans in the dry season, the herds shifted the timing of migration to their winter range, leaving earlier than normal. In addition, given that numerous traditional water points had dried up and were no longer available, and limited flooding and subsequent fire likely changed forage availability, wildebeest spent more time outside of the park in the Upper West Zambezi GMA. Given the lower protection status of the GMA, wildebeest were more prone to be poached for bushmeat, and indeed an increase in poaching was documented in comparison to prior years.

As a continuing result of carnivore recovery in Liuwa, the wildebeest population continued to be strongly limited by the growing predator populations with very high survival and reproduction and a high kill rate. Demographic analyses of wildebeest survival and reproduction indicated age as the best predictor of survival, typical of long-lived age-structured mammals, but also of herbivores that are preyed by coursing predators such as spotted hyena (which would be more likely to take older animals in a chase relative to ambush predators like lions). In addition spatial dynamics affected survival, with mortality higher in the high predator density area of Southern Liuwa NP, where most wildebeest concentrated for the rains and endured high predation from spotted hyena and lion. Current analyses now incorporate spatial dynamics of wildebeest movements and migration with ecological factors such as flooding and fire and human impacts.

While wildebeest were intensively studied, we also continued to conduct tri-annual surveys of all large herbivores in the southern area of Liuwa Plain NP, to evaluate the changes in densities and distributions due to drying down, fires and vegetation changes. This in turn was reflected in the migrations of wildebeest, zebra and lechwe. With the expansion of our field effort in the north, similar surveys will also be undertaken in the northern sector of the park and GMA that comprises the wildebeest winter range.





The Upper Zambezi watershed depends heavily on the areas in and around West Lungu National Park in the Greater Kabompo Ecosystem. Under new collaborations between DNPW, the Trident Foundation, and WWF-Zambia, restoration efforts are underway for this little known ecosystem. ZCP is assisting in evaluating connectivity, encroachment, developing a research and monitoring programme, and assisting in assessing and responding to the impacts of climate change.

Greater Kabompo and Greater Nsumbu

In 2019 we continued to work with partners to upscale work across Zambia's current and potential carnivore strongholds, working with partners to implement research and monitoring programmes in the Kabompo and Nsumbu ecosystems—two spectacular but depleted ecosystems with great potential for wildlife and wildlife-based economies.

Our long-term partner WWF Zambia recently initiated an integrated programme in the Upper Zambezi Landscape that seeks to provide key information towards ensuring sustainable natural resource use and biodiversity conservation management within the broader landscapes of Greater Liuwa and North-Western Zambia's Greater Kabompo Ecosystem (GKBE). The GKBE includes a well-developed protected area network consisting of West Lungu National Park, and adjacent Game Management Areas and Forest Reserves. Historically rich in the diversity and abundance of wildlife, the ecosystem has long been severely depleted by poaching or persecution as a result of human wildlife conflicts, and the impacts on these species and the extent of connectivity remaining between these areas and other ecosystems in Zambia and Angola is unknown.

Together with DNPW, WWF, and the Trident Foundation we undertook work in 2019 to provide a better understanding of the threats to Kabompo wildlife populations, and the opportunities to restore this ecosystem. Utilizing our well-developed techniques for evaluating the extent, trends and patterns of human encroachment, and rates of population change in the focal area, we began assessments of the extent of existing land still possible for inclusion into corridor conservation efforts, the state of the potential corridors from Kabompo to each corridor destination, and the actions needed to protect them (see Large Landscape Conservation). Concurrently, we also helped implement a long-term research and monitoring programme and restoration plan into and around the core Kabompo wildlife area of West Lungu, while beginning development of a Climate Change Barometer for the landscape to assist in adaptation for communities and wildlife.

Collectively, these assessments comprise a crucial aspect that will feed into a comprehensive Kabompo landscape zoning plan by providing a clear delineation of where efforts should focus in corridor conservation, by implementing



The Greater Nsumbu Ecosystem consists of Nsumbu National Park and the surrounding GMAs. Under a public-private partnership between DNPW and Frankfurt Zoological Society the area is receiving substantial resources for restoration, and ZCP is assisting with long-term research and monitoring of large carnivores and herbivores.



long-term research and monitoring programmes for adaptive management and science-based restoration, and by providing predictive tools for human land-use change dynamics to allow for adaptive management.

In the Greater Nsumbu Ecosystem we continued working with our partners Frankfurt Zoological Society (FZS) and DNPW to assist in implementation of a long-term research and monitoring plan concurrent with FZS-DNPW restoration efforts focused on Nsumbu National Park and the surrounding GMAs. This work built on prior 2017 surveys for carnivores and herbivores that provided a baseline and recommendations for future work, while also training DNPW Ecologists and scouts on large mammal monitoring techniques.



In 2019 Dr. Egil Droge of Oxford University's WildCRU/ZCP worked with FZS Ecological Monitoring and SMART supervisor (and former ZCP sponsored university graduate) George Phiri, along with DNPW and community scout teams, to design and implement survey methods in the ecosystem, including transects and camera trapping grids. As the ecosystem recovers with the substantial investments from FZS, DNPW and partners, these monitoring programmes will increasingly inform, evaluate and guide conservation efforts in this ecosystem.

Middle: ZCP Ecologist Daan Smit (R) helps conduct training in wildlife survey techniques for DNPW and WWF-Zambia teams as part of the West Lunga ground transect survey for wildlife. Surveys were conducted twice in 2019, with access both by boat, vehicle and foot (below). Implementing a monitoring programme in concert with restoration efforts will help provide guidance for and evaluation of management and conservation actions.

Conservation Action

Anti-Snaring

Bushmeat poaching with wire snares continues to pose one of the greatest threats to large carnivores in Zambia, both in its impacts on prey populations, and in snaring bycatch deaths and injuries of wild dogs, big cats and hyenas.

An extremely dry rainy season coupled with a drier than normal dry season and increases in maize prices likely drove an increase in snaring in 2019. We detected 4 wild dogs, 5 lions, 11 hyena, 1 cheetah and 1 leopard carrying snares or recent snare injuries and successfully treated 2, 4, 3, 1 and 1 respectively. This work consisted of intensive monitoring of carnivore groups utilizing radio collars, GPS/Satellite technology, and ground and aerial monitoring. Locational data from this work was provided to anti-snaring patrols in the Luangwa (DNPW-Conservation South Luangwa), Kafue (DNPW-Panthera, Musekese Conservation, Ntengu Safaris), and Liuwa (DNPW-African Parks) to direct efforts toward areas of high risk and high use for carnivores.

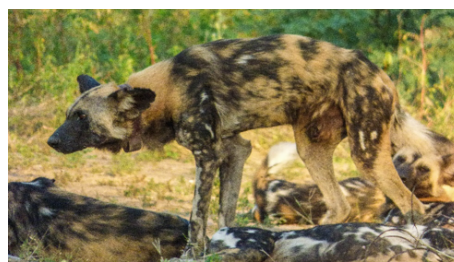
In addition, full-time, field-based local wildlife vets enabled us to effectively rescue snared carnivores and keep them on the landscape. At the close of 2019 we had provided over \$100,000 to anti-snaring patrols for this work.

In the Luangwa Valley we continued the successful anti-snaring collaborations with Conservation South Luangwa and the DNPW to mitigate snaring by-catch on carnivores through intensive monitoring nearly 400 wild dogs and lions in 32 collared groups. The work was facilitated by intensive monitoring of these groups through ground, aerial and satellite/GPS tracking, coupled with data-directed anti-snaring patrols, and the presence of field-based Zambian wildlife veterinarians through CSL/ZCP and DNPW. ZCP-DNPW teams logged over 1200 person days in the field and the data collected through monitoring was also continuously provided to anti-snaring teams which targeted



An immobilized male cheetah in Kafue after being rescued from a snare on its front leg. Ranging widely in remote areas of the park and GMA, the animal would never have been detected without intensive monitoring from ZCP-DNPW teams aided by GPS/satellite collars.

How Much Is One Dog's Life Worth?



WILD DOG 73

Rescued from a lethal snare in 2014

At Least 13
Additional Packs
formed from
Dispersing
Offspring

At least 171 pups,
grand-pups and
great-grand pups



Packs have
populated
throughout the
Luangwa Valley

The oldest known dog in the wild was 12 years of age. The Hot Springs Pack's alpha male was born in 2006 at the latest, making him over 12 years old when he died in 2018. 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.



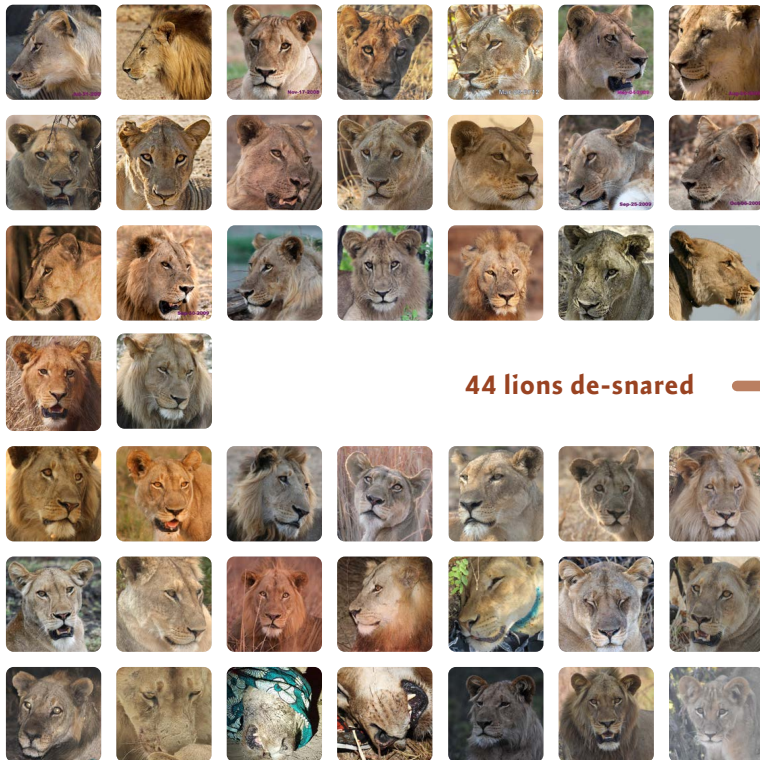
Dr. Kambwiri Banda de-snaring and treating a hyena in Liywa (L) and a cheetah in Kafue.

The Importance of Field-Based Wildlife Veterinarians

The 2019 season was a very busy one for ZCP Vet Dr. Kambwiri Banda, even by his own high standards. The Kafue ZCP-DNPW field teams covered approximately 12,000 km², and Dr. Banda frequently traveled to our Liywa project to respond to snared hyenas. In a remote wilderness area like Kafue it can take hours, or even days, to get anywhere, making rapid response of the utmost importance, particularly for species like cheetah and wild dog that are wide-ranging and unpredictable in their movements; a snared animal may never be seen again if the opportunity to rescue them is missed. In addition to de-snaring three lions

in Northern Kafue, Dr. Banda and teams de-snared an adult male cheetah, an adult male leopard, and a wild dog, while de-snaring three hyena in Liywa. For most of these animals they never would have been found without the aid of GPS/Satellite/GPS collars and an intensive field monitoring presence, as well as the commitment and dedication of Dr. Banda and the DNPW-ZCP teams. Like CSL/ZCP vet Dr. Mwamba Sichande and DNPW Vet Lengwe Bwalya in the Luangwa, the collective work of these individuals and partners makes the prospects for large carnivores in Zambia considerably brighter.

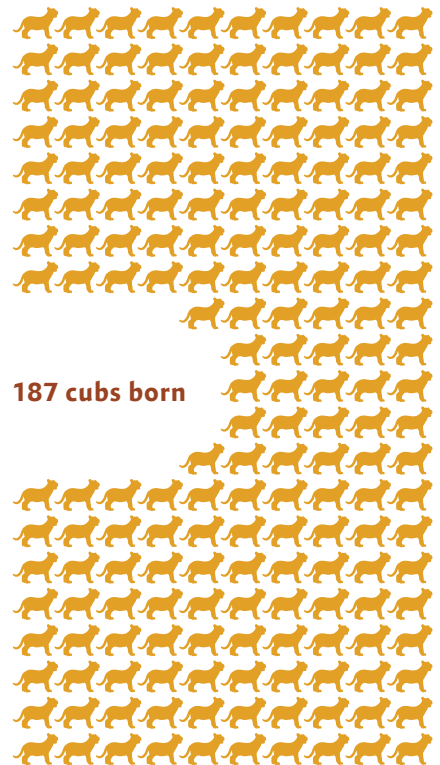
Population effects from snared lion rescues



44 lions de-snared



187 cubs born



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 de-snaring.

areas of high risk and high use by large carnivores, and this support assisted in the removal of 478 snares. We detected 9 snared carnivores, successfully treating 5 for snares and snare injuries, and having one wild dog lose a neck snare by itself.

In the Kafue we continued working with the DNPW, Panthera, Musekese Conservation and Ntengu Safaris to conduct collaborative anti-snaring units. We saw a spike in snaring by-catch of carnivores in 2019 but it was primarily outside of the directed patrol areas, in and around the GMAs. Similar to the Luangwa, field teams intensively monitored satellite collared groups of wild dogs, cheetah and lions across northern and central GKE, and provided these data to the anti-poaching units that would then target these areas of high risk and high use for snare removal and other anti-poaching work.

In Liuwa we experienced one of the driest seasons on record, which corresponded to a spike in poaching. We recorded 11 hyenas snared, successfully de-snaring 3, and hindered by the lack of a field-based vet, for which we are addressing in 2020. We also lost one of the most productive breeding female cheetah to poaching, though unknown if it was by-catch or directed, making this the leading cause of death for adult cheetah.

Road Impacts

Our prior and ongoing work on human encroachment continues to highlight the impacts of road development on wildlife in general and carnivores in particular. We lost 3 wild dogs, a cheetah, 2 lion and a hyena to roadkill in 2019, with most of these deaths coming from the highspeed M9 highway in Kafue, which runs parallel to and then bisects nearly 200km of the Kafue National Park and also bisects a significant proportion of our wild dog, cheetah and lion study population homeranges.

While a number of mitigation initiatives are needed, the complexities of implementation are challenging; nevertheless in 2019 with partners we successfully designed and constructed signage to be placed in strategic areas of high wildlife use throughout the M9 in Kafue that alerts and urges drivers to exercise caution when using the road.

Wildlife Crime and Trafficking

Because Zambia borders eight countries and has multiple transfrontier ecosystems and carnivore strongholds, it is subject to the increasing threat of illegal trafficking in big cat skins, bones and



Dispersers from the Mwasauke pack detected from aerial tracking. Dogs from this group made it 62km from Lower Zambezi before the collared dog died in a snare.

Living on the Edge: The Mwasauka Pack

The majority of wild dog packs in the Luangwa have their homeranges partly or completely outside national parks, frequenting the lower lion density Game Management Areas (GMAs) where they are at much higher risk of encountering snares.

The Mwasauka Pack has been one of the largest and second-longest running packs in our study, ranging from the vast Lumimba Game Management Area in the north down through the South Luangwa National Park's Nsefu Sector and routinely running the gauntlet through some of the highest snare risk areas in South Luangwa Valley. The pack's history epitomizes the threat that bushmeat poaching and snares pose to wild dogs and other carnivores, as in each of the past five years at least one wild dog in the pack has been snared. Nevertheless, the pack has persisted thanks to having radio-collars on several pack members that have allowed ZCP-DNPW and CSL teams to find and rescue snared dogs.

In 2019, we again de-snared dogs in the Mwasauke pack; just before the rains cut off access we tracked in on the pack in the north of their range and found them with a badly snared pup which we were able to rescue. While de-snaring individuals may seem futile in the face of the complexities of the bushmeat trade, these individuals can have significant population impacts, as evidenced by the Hot Springs (see *How Much Is One Dog's Life Worth?*) and Baobab Pack (see *Luangwa Wild Dogs*).

parts, both within its own populations of lions, leopard and cheetah, and as a trafficking route to other destinations. Very little is known about the dynamics of the trade, including routes, drivers, and impacts on already imperiled big cat populations. We continued to make progress in 2019 on our collaborative work with DNPW and Wildlife Crime Prevention to understand and address the origins and impacts of big cat trafficking. Building upon our Lion Recovery Fund-supported training of 39 Intelligence and Investigations Units to collect samples from seizures, we successfully developed a cutting edge genetic tool

to trace trafficked lion skins and parts. We completed our first analysis of trafficked lion skins, and have completed the first round of analyses on leopard and cheetah to finalize the development of similar genetic tools for these species.

We broadened this work in 2019 with new partners TRACE and the University of Zambia, and through a grant from the United States Fish and Wildlife Service's Combat Wildlife Trafficking programme. We began work with DNPW and all partners on three main objectives of 1) Developing and applying a genetic tool to identify source populations of trafficked big cats 2) Building in-country capacity for forensics and prosecutions of wildlife crimes, and 3) Utilizing this tool to direct law enforcement efforts to protect at-risk populations. This work has broadened into a rangewide initiative with over 2 dozen ecosystems and projects across Africa and also trains a number of DNPW and UNZA personnel in genetics, forensics and anti-trafficking. Given how rapidly the field of conservation genetics is developing and the large combined ZCP-DNPW datasets for big cats in Zambia, we are currently training a DNPW Ecologist, Clive Chifunte (see Graduate Students p36), to serve as a genetics specialist for the Department. Clive is conducting his Master's Degree research on leopard and lion genetics in Zambia with ZCP, looking at an array of questions on both species relevant to their conservation.

Big cats, particularly leopards, are increasingly trafficked illegally in Zambia, with unknown source populations and impacts.

Inset: A trafficked lion skin sampled for genetics. Working with DNPW and Wildlife Crime Prevention we have developed genetic tools to trace seizures of big cats to their origin in an effort to combat this trade rangewide.



Large Landscape Conservation

Zambia's natural areas are largely characterized as dryland ecosystems, extremely seasonal areas with dramatic fluctuations in rainfall, water and resource availability. Consequently, both wildlife and people are dependent on mobility, both to adapt to these seasonal fluctuations, and to adapt to ever-increasing human impacts, particularly climate change. Large landscapes are becoming increasingly fragmented worldwide, making connectivity of critical importance. In addition to supporting numerous large carnivore strongholds, Zambia lies between Eastern and Southern Africa, borders 8 countries, has large tracts of connected and unfenced protected area networks, and is the source of some of the region's major watersheds such as the Zambezi and Luangwa. We significantly upscaled our large landscape conservation work in 2019, working with an array of partners on initiatives across all our study sites and beyond.

We made substantial progress on collaborative watershed conservation efforts, working with WWF-Zambia and array of partners on the Upper Zambezi Landscape initiative, aimed at ensuring sustainability and biodiversity across the Greater Liuwa and North-Western Zambia's Greater Kabompo Ecosystem (see Greater Kabompo p21). In addition to our wildlife-related work we also conducted analyses on the patterns and trends of human encroachment in and around these areas in order to identify and evaluate the status and distribution of wildlife corridors between both systems, as well as to the Greater Kafue and Angolan ecosystems. This work was part of a broader ongoing effort to evaluate human encroachment across all Zambia's protected area networks. Building upon this work, we continued collaborative evaluations of flooding and fire across both ecosystems to determine the relationships between wildlife and fisheries.

Given climate change is expected to significantly alter ecosystems throughout Southern Africa, there has been considerable interest and investment in developing strategies for communities and wildlife to adapt to climate change, particularly in the dryland ecosystems characterizing much of the Upper Zambezi, where strong seasonality makes mobility critical for adaptation. In order to develop strategies for climate change adaptation, in 2019 we began construction of a Climate Change Barometer. This barometer would identify and standardize data inputs and sources for precipitation, temperature, flow, flooding, and fire in both the Liuwa and Kabompo Ecosystems, eventually allowing for forecasting and evaluations of climate change impacts while improving preparedness for communities and managers.



Lastly in 2019 we made significant progress on understanding and protecting genetic connectivity of carnivore populations with the launch of the African Carnivore Connectivity Project, a collaboration between institutions, departments and carnivore conservation projects and organizations across Southern and Eastern Africa. The project has three main objectives, namely 1) Developing genetic tools to combat wildlife trafficking (see Wildlife Crime), 2) Evaluating and conserving genetic connectivity between carnivore populations, and 3) Improving the means of population monitoring through genetic tools. Led by Dr. Scott Creel and Dr. Goran Spong, together with DNPW researchers we published a concept paper on this connectivity work in 2019 in Nature Scientific Reports entitled “Carnivores, Competition and Genetic Connectivity in the Anthropocene.” Using cutting-edge genetic techniques, the study evaluated how well-connected wild dogs and lion are in several ecosystem across Zambia and Tanzania. Under the idea that well-connected populations remain genetically similar, but poorly-connected populations become genetically distinct from one another, the study hypothesized that adaptations of wild dogs allowing them to move through a landscape dominated by lions and hyenas might also help them move through landscape altered by humans.

Under this hypothesis genetic data would show that wild dogs have stronger connections between ecosystems than lions, and that their connections are less affected by humans. There

was strong support for this hypothesis, with wild dog populations in Liuwa, Kafue and Luangwa exhibiting much more genetic connectivity than lions in the Kafue, Luangwa and Selous ecosystems.

How general this hypothesis may be is yet to be explored by collaborations across the wide array of species, populations, and ecosystems, but the assessment of connectivity in light of competition and human impacts is likely to yield an array of important insights for conservation.

An approaching storm in the Greater Liuwa Ecosystem. Particularly with climate change, large connected landscapes are critical for mobility and adaptation by wildlife and people.



Wild Dogs from the Chikwinda Pack at a stream crossing in Luambe National Park. Recent ZCP-DNPW studies of genetic connectivity indicate that the superior movement and dispersal capabilities of wild dogs – evolved from being subordinate competitors to lions and hyenas – has resulted in Zambian dog populations in the Luangwa, Kafue and Liuwa still retaining good genetic connectivity.



ZCP Ecologist Teddy Mukula works with members of the Barotse Royal Establishment to explain the survey and sensitisation work conducted as part of the Liuwa Predator Management Plan development.



African Parks and ZCP present on carnivore ecology and the structure and need for a Predator Management Plan.

and expert advice and design and implementation of these programmes and their adaptability to Zambian communities and ecosystems. In the Luangwa we formed a working group comprised of DNPW, Conservation South Luangwa, and ZCP which met bi-weekly to discuss issues related to human-wildlife conflict (HWC). Livestock predation and human-carnivore conflict is one of the areas of focus because incidents were recorded in different chiefdoms throughout the year. This included two human deaths from lions in Msoro and Mnkhangya chiefdoms respectively. Led by the DNPW HWC department, we are in the process of jointly developing an HWC Mitigation Plan for the district. ZCP will be working on conflict related to carnivores and will help develop protocols for reporting and problem animal control.

Because lion conflict is relatively new to South Luangwa, it is important to have data about trends and patterns of the problem. Early in 2019, we carried out a household survey in one of the most affected chiefdoms to evaluate trends and patterns of conflict. Throughout the year, we worked with our partners to improve the collection and organization conflict data, simplify conflict assessment and ensure that all data are recorded in the SMART database. Furthermore, we held a collaborative training session for Wildlife Police Officers from six chiefdoms, wherein conflict assessment protocols were discussed.

Mitigation measures included an early warning system aimed at reducing livestock predation by staying in communication with owners about the movements of known prides of lions. We satellite collared three prides in one chiefdom but the full implementation of the program was limited by the lack of cell reception in the area. We conducted village visits and radio programs to promote better herding practices and in 2020 are piloting predator proof enclosures to reduce livestock losses.

As the first step for the Liuwa Predator Management Plan (PMP), together with African Parks and DNPW we spent September 2019 conducting sensitization surveys across the Greater Liuwa Ecosystem, explaining the concept of the PMP, gathering information on attitudes, incidences, trends and patterns of conflict, and documenting community ideas on future management. We conducted this work across all 10 chiefdoms (silalos) using Village Action Group (VAG) catchment areas as delineations. Sensitization surveys were conducted at the main centres of VAG areas and from village to village in areas far from the main centres, and data from

Human-Carnivore Conflict Mitigation

While in the past human-carnivore conflict was minimal due to the low numbers of livestock and effective husbandry in the Luangwa and Liuwa respectively, the rapid changes in human demographics coupled with increases in livestock have led to growing human-carnivore conflict issues in the two ecosystems. In 2019 we significantly upscaled our conflict mitigation work, developing and implementing a comprehensive carnivore conflict mitigation programme in the Luangwa and a Predator Management Plan in Liuwa.

Given carnivore conflict mitigation has been ongoing long-term work for many carnivore conservationists throughout Africa, we utilized these resources by having ZCP Ecologists visit award-winning conservation organizations in Tanzania and Kenya who specialized in lion conflict mitigation. Thandiwe Mweetwa and Teddy Mukula visited the Ruaha Carnivore Project in Tanzania to learn firsthand with their team about conflict mitigation strategies, and Thandiwe then also visited the Ewaso Lions team in Kenya to conduct similar work. Collectively we were able to gain a lot of firsthand knowledge



ZCP Ecologists Thandiwe Mweetwa and Teddy Mukula visit the Ruaha Carnivore Project team in Tanzania to learn about lion conflict mitigation work as part of the development of Human-Carnivore Conflict Mitigation Programmes in the Luangwa and Liuwa ecosystems to addressing growing conflict issues with lions.

each Silalo and VAG were compiled and shared with Silalo chiefs and VAG chairpersons prior to the PMP Workshop. In total 774 community members (344 males, 430 females) were interviewed for this work.

The two-day workshop for the PMP was held in Kalabo on the 25-26th of September, 2019 and hosted 45 participants from 11 stakeholder groups. These groups included the Barotse Royal Establishment, Community Resources Board, Department of National Parks and Wildlife, African Parks Liuwa and Head Office, WWF, the Zambia National Assembly, Zambian Carnivore Programme, and Ministry of Livestock and Fisheries, TLC and Zambia National Information Services. The workshop provided the background and justification for a PMP, and an overview into the biology and management challenges of particular predator species before presenting the results of the system wide sensitization work. The same surveys were then conducted for all workshop participants and responses used as focal points of discussion with lessons learned from PMP plans implemented elsewhere in Africa. The AP Head Office then led the discussion and development of plan components. Overall it was a very productive and positive workshop with strong support from all stakeholders. African Parks, DNPW and ZCP are currently finalizing the draft PMP, which will then be circulated back to communities in the Silalos and to stakeholders, before finalization in early 2020.

Given that poisoning is an increasing threat for carnivores across Africa, both as retaliation in conflict incidents, and for poaching to fuel the illegal trade in big cat skins and parts (see Wildlife Crime), we had Poisons Response Trainings for both Liuwa and Kafue project teams led by Andre Botha of Endangered Wildlife Trust. The training prepared team members to safely recognize and act on poisoning incidences when they occur.

Disease Control and Mitigation

As ecosystems worldwide are increasingly impacted by people, the risk of disease transmission between domestic and wild animals as well as humans continues to increase. Given that people and domestic animals inhabit Zambia's Game Management Areas (GMAs) both legally and illegally, and in some cases even national parks such as Liuwa (legally), disease risk is an ever-increasing concern for small and often declining populations of threatened large carnivores. In the Luangwa we continued with vaccination, spaying and neutering work through CSL/ZCP vet Dr. Mwamba Sichande, who operates a clinic at the CSL base and works with DNPW and Veterinary Department vets and personnel to conduct vaccinations across much of the South Luangwa area. For the second straight year in Kafue we documented a wild dog pack that inhabited the boundary of Kafue National Park and adjoining GMA contract disease. The Nangoma pack was not part of our intensive studies and therefore we did not have good data on their ranging, but we knew they frequented the GMA and park boundary along the M9, where substantial encroachment is occurring and the chances of disease transmission from domestic village dogs and poachers' dogs was high. We detected them in these areas in late 2019, with several dogs exhibiting symptoms consistent with rabies, and subsequent tests confirmed this. Unfortunately most of the pack perished from rabies, highlighting the need to implement disease mitigation programmes focusing on domestic dog vaccinations and rabies education and awareness in the surrounding communities. In Liuwa we continued to work with African Parks, DNPW, and the Barotse Royal Establishment to implement a Predator Management Plan (see Human-Carnivore Conflict) that also addresses wild dog recovery by mitigating the ever-increasing threat of rabies from unvaccinated domestic dogs throughout Greater Liuwa.



ZCP Ecologist and Luangwa Project Manager Thandiwe Mweetwa, also a product of Chipembele's Conservation Club programme, explains to students how to set camera traps for data collection as part of the Chipembele-ZCP Field Ecology Club.

Empowerment

Primary and Secondary School Programmes

Chipembele Wildlife Education Trust and ZCP teams take students out on research trips in the park as part of the Field Ecology Club, where students conduct independent research projects to acquire skills needed for advanced education and employment post graduation.

We continued our primary and secondary school programmes across Zambia's carnivore strongholds in 2019, with the work collectively emphasizing the core objectives of our work, specifically: 1) Student engagement and education in conservation issues 2) 'Adventure-based Learning' that capitalized on the students living with wildlife in and around protected area networks and enabled independent field research projects that empha-

sized key skills in computer literacy, technology, critical thinking, writing and public speaking. Collectively these objectives advanced our overall goal to prepare students for advanced education and employment following graduation. In 2019 we conducted 56 programmes to 285 students across all three sites.

In the Luangwa we continued and expanded our long-running collaboration with Chipembele Wildlife Education Trust, conducting intensive work with 35 students from Mfuwe Day Secondary School's Field Ecology Club, an offshoot of the popular Student Conservation Club. Due to increased student demand we also included students from neighboring Yosefe Secondary School as part of the programme. With these students we developed field research projects, utilizing science as a means of generating interest in conservation and acquiring key vocational skills. This year's studies focused on large mammal behaviors and the potential influence of vehicles in the Main Game Area of South Luangwa National Park. After designing their studies to address these questions students began fieldwork and data collection, completing



the field component of it just prior to the rainy season, with data analysis slated for Term 1 of 2020 before writing up their results and presenting their projects. During both the field-based component and the classroom sessions, students had the opportunity to learn more about the relationship of wildlife with their environment and think critically about issues pertaining to eco-tourism and responsible human-wildlife interaction. This project will also allow them to further develop their data collection, computer and public speaking skills.

Conservation Club programme development is much more recent in Liuwa, and we continued to build upon prior years' work in 2019, working closely with Mishilundu School inside Liuwa Plain National Park, and conducting eight programmes to an average of 28 people while continuing to have good attendance and support from both the school and community. Activities ranged from educational talks and activities about our work and the species we study, to drawing competitions for World Lion Day, to debates on topics such as human-carnivore conflict, and video showings of natural history films featuring ZCP and Liuwa which were attended by over 200 students and community members. In 2020 we will be expanding the Liuwa Conservation Club programme.

In the Kafue in 2019 we conducted eight programmes to 190 students visiting our educational partner Treetops School, while conducting nine programmes to 32 students at Chunga School in Central Kafue for more intensive work similar to our Luangwa site. Programmes focused on teaching students the value of conservation in general, carnivore conservation in particular, and the impacts of humans on ecosystems. In addition we provided a variety of activities and lessons focused on conservation biology and field methods such as radio-tracking, tracks and signs, counting and identifying animals, and doing carnivore monitoring. With a year-round base camp now in the central Kafue we hope to expand programmes with local schools in this area in the coming years.

Citizen Science

Large carnivore strongholds are also typically wildlife-based economies with safari tourism, and given that all large carnivore species are identifiable by their coat patterns and markings substantial opportunities exist for citizen science to contribute significantly to monitoring and conservation efforts. We continued our long-standing Citizen Science programmes in the Luangwa, Kafue and Liuwa in 2019, working



closely with safari guides from over 14 companies and 20 lodges as part of the Luangwa Valley Carnivore Monitoring Programme (LVCMP), the Kafue Carnivore Coalition, and Liuwa Carnivore Monitoring Programme. In the Luangwa we had guides from every lodge participating in the programme and submitting photos and sightings as well as reports of snared animals, both in the parks and GMAs. Similar work was conducted in the Kafue, with guides submitting data to either ZCP or our project partner Panthera, and in Liuwa with guides operating from the lodge and community campsites. Award ceremonies for outstanding contributors were again held at both the Luangwa and Kafue sites, with continued and expanded work planned for 2020.

ZCP Researchers Kings Chiimungu (R) and Bridget Mayani (L) along with DNPW-AP Wildlife Police Officer Chisola Sibemi (Front) pose with the Mishilundu School Conservation Club in Liuwa.

Community-Based Education

Throughout the year ZCP conducted a variety of community conservation activities to share information on the threats carnivores face and the needs for protection. These activities were targeted at local, district, provincial, national and international audiences.

Local drama club SEKA performs a play explaining the importance of ZCP's work to local communities in the South Luangwa on World Lion Day.





The championship game of the fourth annual Carnivore Conservation Cup, held in conjunction with the Conservation South Luangwa Fun Run and attended by over 6,000 people.



A variety of activities and musical performances also accompanied the race and football match.



Players from the finalists of the Carnivore Cup are treated to a game drive in South Luangwa National Park where they saw two dog packs and a male lion coalition amongst many other animals.

ZCP Carnivore Conservation Cup and CSL Community Fun Run

In collaboration with the Community Resource Boards in Nsefu, Kakumbi, Mnkhanya and Jumbe Chiefdoms we held the fourth-annual Carnivore Conservation Cup football tournament. The tournament is aimed at raising awareness about carnivores and gaining local support for their protection, and games occurred for six weeks prior to the championship match, held on the same day as Conservation South Luangwa's annual Fun Run and attended by over 6,000 people. Concurrently with the tournament we worked with the local theatre group SEKA (Sensitisation and Education with the Kunda Arts) to develop and present plays highlighting ZCP-DNPW-CSL collaborative conservation work, as well as various issues regarding carnivore conservation. These plays were performed throughout the events at the chiefdom level and during the championship.

Part of the prize package for the top two teams, which came from Jumbe and Nsefu Chiefdoms respectively, was a game drive into the South Luangwa National Park. Tour operators Flatdogs, Marula Lodge and Robin Pope Safaris all offered vehicles and guides to facilitate the outing. The game drive went very well with amazing sightings of elephants, giraffes and impala nurseries. The group also saw two packs of wild dogs in the main game viewing area and this provided an opportunity for them to learn more about the ecology, social behaviour and conservation issues affecting the endangered

species. Another highlight of the trip was a sighting of one of the Chipela coalition males who form the current resident coalition in the Big and Chipela Prides. This allowed the teams a rare opportunity to see the King of the Jungle and learn more about social behaviour of the species and their conservation status. For many team members, this was their first trip into the park and the first time to see rare carnivores in the wild. All of them agreed the outing was one of the highlights of 2019!

We also participated in various outreach events throughout the year to share information about ZCP's work with the wider Mambwe district community. We took part in the International Women's and Youth Day celebrations as well as the District and Provincial Commercial and Agricultural Show. We also conducted regular radio shows at both Radio Breeze and Mnkhanya FM focused on increasing awareness about carnivores, reducing human-carnivore conflict and promoting human co-existence. Furthermore, ZCP staff held joint radio sessions with our partners CSL and DNPW targeted at reducing livestock predation in the GMAs surrounding SLNP.

Later in the year, we held a music contest where local musicians were asked to compose and perform conservation-themed songs and a drama contests for youths talking about various issues affecting carnivores. The drama groups came up with interesting topics ranging from the challenges of living with predators to the illegal trade in lion parts. In partnership with Mfuwe Sports Association and our partner Wildlife Crime Prevention, we also sponsored the Independence Cup whose theme was encouraging people to report wildlife crime. Twenty-six teams from four chiefdoms participated and the final event attracted nearly 1500 people. We also continued the Mimbulu Boys Football Club, a team formed by ZCP's Henry Mwape and continued by ZCP's Benny Mwila that regularly participated in local league games and conservation-themed tournaments and used these opportunities to raise awareness about carnivore conservation in particular and conservation in general throughout the chiefdoms. Collectively throughout the year, we engaged face to face with over 8000 people.

On a national level ZCP again attended the second-annual conservation careers fair in Lusaka and we reached over 500 students from universities and colleges across Zambia. We also shared our work through presentations and talks to diverse audiences which included primary school pupils, the general public, tourists, safari guides, government officials, traditional leaders, journalists and international conservation organizations.



ZCP Conservation Biologist Trainee and Educational Coordinator Lameck Sakala at the Lusaka Conservation Careers Fair.



ZCP Liuwa mechanic Eugene Silumessi instructs Dean Banda on bike maintenance as part of the Conservation Biologist Training Programme.

Conservation Biologist Training Programme

With three year-round field-based projects, our work continues to provide some of the premiere opportunities for aspiring local conservationists recently graduated from university or secondary school and looking to acquire practical field experience for their career development.

We expanded our Conservation Biologist Training Programme in 2019, aimed at equipping incoming students with the theory and practice behind research as well as with practical field skills. Students underwent intensive training in the theory and practice of ecological research, as well as hands-on training in Land Rover and motorbike servicing, repair, recovery and 4x4 driving skills, and experience in community outreach and environmental education.

In 2020 we attached four trainees in the Luangwa, along with two in the Kafue and two in Liuwa.



Women in Wildlife Conservation Trainee Margret Mwale (L) utilizes her training on field vehicle repair from ZCP Ecologist mentor Thandiwe Mweetwa.



Conservation Biologist Trainee Peter Musenge (L) fits a radio collar to a Liuwa wildebeest with the assistance of Women in Wildlife Conservation Trainee Bridget Mayani.



Women in Wildlife Conservation Trainee Kachama Banda gets instruction on radio-tracking from ZCP Ecologist mentor Anna Kusler.

Women in Wildlife Conservation Programme

Given the under-representation of women in field-based conservation projects on carnivores and other species, our Women in Wildlife Conservation Programme seeks to provide training and mentoring of aspiring conservation biologists through intensive work with female ZCP Ecologists. We greatly expanded our programme in 2019 across all three sites. In the Luangwa we attached Nomsa Kamanga, Margret Mwale, and Ruth Daka, who received intensive mentoring from ZCP Ecologist and Education Manager Thandiwe Mweetwa in all aspects of field-based conservation, including field research and monitoring, as well as educational and outreach work with student Conservation Clubs and communities. In Liuwa we attached Copperbelt University (CBU) graduate Bridget Mayani to be similarly mentored by Ecologist Sandra Martens, and in the Kafue we attached CBU graduate Kachama Banda to be trained and mentored by Ecologist Anna Kusler.

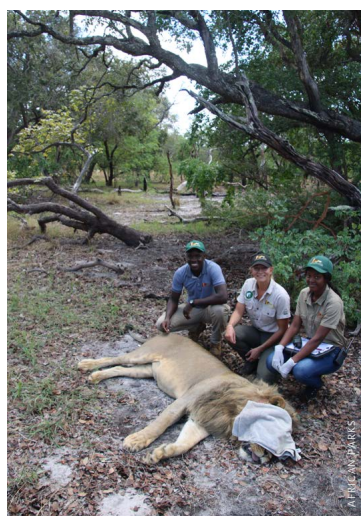
These projects will be continued in 2020 with additional trainees, as several current trainees are now full-time members of the field teams and others will be pursuing advanced educational opportunities as a result of their work.

Wildlife Vet Training Programme

While becoming a wildlife vet is an increasingly popular profession in Zambia, opportunities for gaining practical field experience is very limited.



Wildlife Vet Trainee Johane Njobvu (L) gets more than vet training with ZCP vet Dr. Kambwiri Banda, who instructs him on how to patch tires for field vehicles.



Women in Wildlife Conservation trainee Bridget Mayani gets instruction on lion immobilization and collaring from ZCP vet Dr. Kambwiri Banda and ZCP Ecologist and mentor Sandra Martens.



Wildlife Vet trainee Johane Njobvu (L) receives instruction on lion immobilization from ZCP Vet Dr. Kambwiri Banda (2nd from left), and Kafue Manager Ben Goodheart (3rd from left).

We continued our training programme for aspiring Zambian wildlife veterinarians and vet nurses across all sites, with 2 vet students, 2 vet nurse students, and 3 aspiring students obtaining mentoring from ZCP, CSL and DNPW wildlife vets and field staff on wildlife immobilization techniques as well as fundamental information on each species' ecology, physiology and behavior and key field skills for bush-based work. Kings Chimungu, started working with us in 2016 when he was 17. After three years of studying Animal and Crop Sciences at NRDC to become a veterinary technician, Kings has rejoined the field team in Liuwa as a full-time member.

Professional Training and Advanced Education

As a joint DNPW-ZCP project we not only worked closely together but we also continued to support professional training and advancement of DNPW personnel involved. We sponsored the education and training of four DNPW Wildlife Police Officers (WPOs) in 2019.

In the Luangwa we supported the education of DNPW WPO Lackson Mbewe to attend the Southern Africa Wildlife College's Advanced Certificate in Transfrontier Conservation Area Management in 2020, after which he hopes to continue his career trajectory in large carnivore research with the DNPW.



DNPW Wildlife Police Officer Clement Mutanga radio tracks for carnivores in the Greater Kafue. In addition to working on ZCP-DNPW's Kafue Project, Clement is one of two officers sponsored by ZCP to attending university in Livingstone for a degree in Wildlife and Resource Management



DNPW-AP Wildlife Police Officer Mbo Masilokwa collects data on carnivores and wildebeest. Attached to the Liuwa Project, Mbo has rapidly acquired skills in field research and monitoring and is sponsored by ZCP to receive additional training and education.

Similarly in the Kafue we supported long-time project member and DNPW WPO Charles Kalambata's continued studies in Wildlife and Natural Resource Management at Livingstone International University. Charles is expected to graduate in 2020 and also will continue conducting large carnivore research. In the Kafue we also supported another team member to begin the same programme in 2020, sponsoring



ZCP Ecologist Shadrach Mwaba meets Sir David Attenborough at a science fair in Cambridge, where Shadrach presented his independent study on hyena demography.

DNPW WPO Clement Mutanga's studies at Livingstone International University.

In Liuwa we taught DNPW/AP WPO Mboob Masilokwa how to drive and sponsored his driver's license in 2019, enabling him to lead vehicle-based work initiatives. We also sponsored Mboob to attend an intensive computer training course in 2020 to increase his skills in data management and writing. We continued to have attached or seconded at least one scout on each project who worked as a full time field team member.

In 2019 ZCP Liuwa Ecologist Shadrach Mwaba successfully graduated from his Postgraduate Diploma in International Wildlife Conservation

Practice at Oxford University's Wildlife Conservation Research Unit (WildCRU). Shadrach was one of 12 students selected worldwide for the programme and received intensive instruction over the 10-month course while also completing an independent study on hyena demography in Liuwa (see Liuwa Hyena p15). Shadrach returns to Zambia in 2020 with a broad array of field experience and quantitative skills.

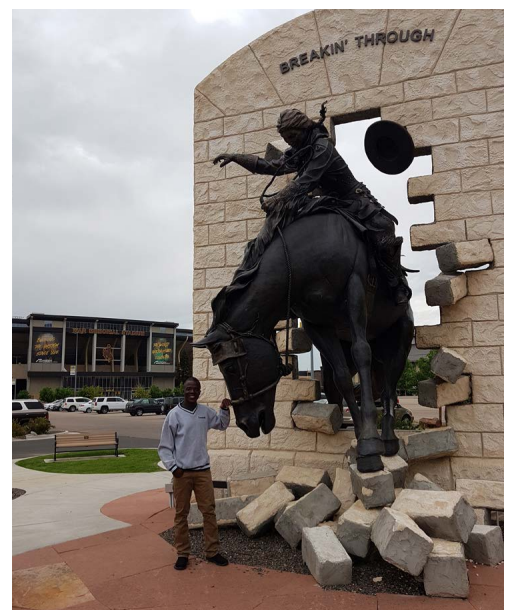
Graduate Students

Opportunities for graduate research on large carnivores in Zambia are limited, yet at the same time highly-skilled Zambian conservation biologists with extensive field experience and education are extremely important in driving science-based conservation in the country and region. We therefore invest heavily in graduate education. In 2019 Luangwa Ecologist and Education Coordinator Henry Mwape continued his Fulbright Scholarship-supported Master's research at the University of Wyoming. Working with ZCP Researcher and graduate advisor Dr. David Christianson, Henry is evaluating Luangwa lion spatial dynamics, and the ecological and anthropogenic factors affecting them.

We also continued working with DNPW Ecologist Clive Chifunte to develop his Master's research with Dr. Goran Spong and Dr. Scott Creel at the Swedish Agricultural University, where Clive will be evaluating lion and leopard genetics in Zambia and the impacts of the illegal trafficking. ZCP's Kafue wildlife vet, Dr.



DNPW Assistant Director of Research Chuma Simukonda (second from right) conducts fieldwork in Kafue with Dr. Scott Creel (R), ZCP-DNPW graduate student and DNPW Ecologist Clive Chifunte (L) and Dr. Matt Becker. Dr. Creel and Dr. Goran Spong will be advising Mr. Chifunte for his Masters on lion and leopard genetics.



ZCP Ecologist and Fulbright Scholar Henry Mwape at the University of Wyoming, where he is finishing his Master's degree studying Luangwa lion spatial dynamics with Dr. David Christianson.



ZCP Ecologist Thandiwe Mweetwa speaks at National Geographic's education summit in Washington, D.C.

Kambwiri Banda, is also slated to conduct his Master's research in Sweden with ZCP, evaluating the impacts of de-snaring efforts on large carnivores.

Lastly, former ZCP Ecologist Teddy Mukula also received a Fulbright Scholarship in 2019 to pursue graduate research on cheetah at Montana State University, but unfortunately was unable to attend. Fortunately, Teddy has brought his skills to a new position as Sustainable Development Projects Manager in Liuwa with African Parks, conducting community outreach work and helping implement the Predator Management Plan. In 2020 we are working with Copperbelt University to also increase the number of in-country Zambian graduate students involved in our collaborative work.

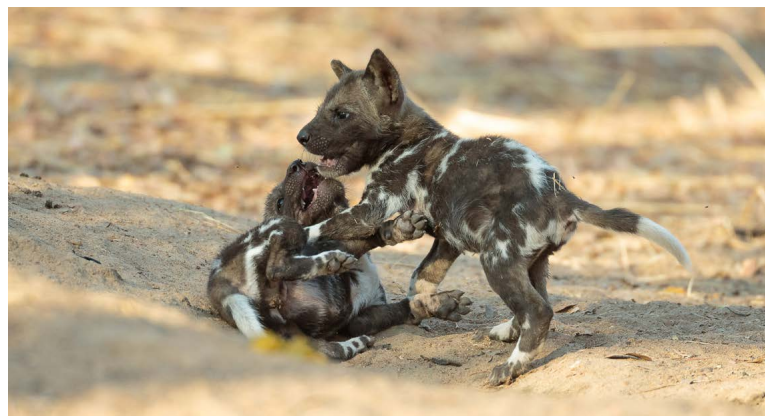
Media and Special Events

We conducted an array of media work and participated in a variety of special events in 2019, both internationally and within Zambia.

We continued to collaborate on a number of natural history films. We continued work on a major landmark television series with the BBC, and saw the release in Zambia of National Geographic's 2018 Explorer feature on Thandiwe

Mweetwa and our Luangwa project. We were invited by the Lion Recovery Fund to attend the Lion Footprint Forum in Disney World as part of the launch of the new "Lion King" film and Thandiwe also helped promote its launch with Disney. We assisted with a National Geographic film on lions, and Thandiwe was an invited guest to the launch of National Geographic's Education Summit in Washington, D.C. as well as to the African Film Makers Conference in South Africa.

We were also thrilled to be invited to Tusk's 2019 Conservation Symposium held in Kenya in October, where we were able to meet, discuss and network with 45 Tusk-supported projects from over 14 countries across Africa.



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, demography, and predator-prey dynamics, to large landscape conservation, genetics, disease, trophy hunting, fencing, community conservancies, land-use planning and human encroachment.

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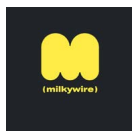
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Back cover: A cheetah cub in the Greater Kafue Ecosystem, which holds Zambia's largest cheetah population and is part of the KAZA Transfrontier Conservation Area. *Photo: Anna Kusler*



CARNIVORE PROGRAMME

