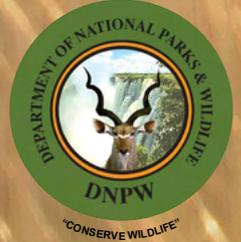




CARNIVORE PROGRAMME



Annual Report 2021





ANNA KUSLER

A lioness from the Kikuji Pride in the northeast of the Greater Kafue Ecosystem. Long-term intensive studies on the dynamics and threats to lions and other carnivores in the Kafue provide management and conservation guidance for the country and region.

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**Zambian
CARNIVORE PROGRAMME**

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



Cover: Spotted hyena cubs play on and around their mother as she sleeps at a communal den in Western Zambia’s Liuwa Plain. Long maligned as a dirty scavenger, hyenas are hopefully enjoying newfound support and recognition as Africa’s most widespread and successful large carnivore, and deserving of conservation attention as they decline across their range.
Photo by Sandra Martens



Zambian
CARNIVORE PROGRAMME

THE YEAR AT A GLANCE 2021

5
Ecosystems

7
Game
Management
Areas

4,053
Person Days In The Field

37,080km²
Covered

942 Large Carnivores
Intensively Monitored

7
National Parks

No Snared Wild Dogs
Detected In
The Luangwa
For First Time In Over

15
Years

405 Community Clean Sweeps Conducted,
Employing **1620** Community Members
And Pulling Over **200** Snares

Mapping Of Human Encroachment Patterns Completed
For All Of Zambia, ½ Angola And Portions Of
7 Bordering Countries



7
Large Carnivores
De-snared

7,539
Snare Checks Conducted On
Large Carnivores In The Field



2,788
Domestic Dogs
Vaccinated For Rabies

33
Educational Programmes To
252
Students Across
3
Ecosystems

31 Zambian Trainees In Women In Wildlife Conservation,
Conservation Biologist Training Programme
And Wildlife Vet Training Programme

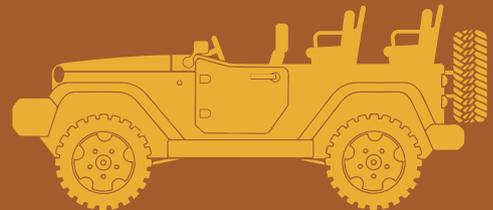
2
Zambian Students
Supported
For
Graduate Degrees
In
Wildlife Conservation

7 Zambian Students Supported
For University Degrees
In Wildlife Conservation



1,025
Livestock Owners Trained
On Carnivore Conflict Mitigation

335 Safari Drives For
2,458 Community Members,
Employing **100** Guides



9
Peer-reviewed
Scientific Studies
Published/in Review
For Policy And Management

202 Radio Shows, Conservation Football,
And Theatre Programs
Conducted To Over **800,000**
Community Members



Worked
With
23
Conservation
Partners



The Year in Review

Resilience and transition marked 2021 for our work conserving large carnivores and ecosystems through conservation science, action and local leadership. The global COVID-19 pandemic actually made its presence felt more this year than in 2020, with cases peaking mid-2021 in Zambia. The related economic impacts through loss of tourism, and ecological impacts through increased poaching, also continued, and pandemic fatigue was real.

Nevertheless, the commitment and determination of our teams and partners enabled us to once again endure a very challenging year and still celebrate some successes. We continued to log record field efforts across all sites--in the number of person days, carnivores intensively monitored, and area covered. Together with partners we conducted over 7,500 snare checks, and for the first time in over 15 years we recorded no snared wild dogs in the South Luangwa Valley.

We continued to upscale our community support work through Community Game Drives and Community Clean Sweeps, and our carnivore conflict mitigation work. We had a record number of trainees in 2021, with 31 aspiring Zambian conservation leaders through our Women in Wildlife Conservation, Conservation Biologist, and Wildlife Vet Training Programme. Strong partnerships continued to define our organization and we worked with nearly two dozen organizations across the country to collaboratively accomplish our objectives.

But 2021 was also a time of transition. Our average tenure for team members in the organization is over 8 years, and this year we had 7 team members—and a collective several decades of experience—transition into graduate, undergraduate, and more senior positions. Onboarding and training new team members in the complexities of our work presented no shortage of challenges, but we greatly benefitted from the outstanding enthusiasm and dedication of these new individuals.

One of the biggest bright spots of 2021 was the completion of our first ever Strategic Plan. As the organization has expanded dramatically over the last 14 years, we have a number of bottlenecks and growing pains that need to be addressed, and the resources and systems that got us here will not get us to where we want to go in the future. Thus, with the guidance and assistance of the amazing Maliasili organization, we were able to take a deep dive into who we were, what we stood for, and where we wanted to go as an organization. This has resulted in a comprehensive reorganization of our work and systems. We head into 2022 and beyond with a strength and confidence born of preparation and knowledge of our path. Maliasili continues to work closely with us, and in 2021 we also became part of the African Conservation Leadership Network as part of our increased Conservation Leadership focus.

In 2022 we now start our new chapter, with a new plan, and a new roadmap to reach the next level as an organization and meet the challenges ahead. And while lots has changed and it's a long road ahead, we continue to rely on the strengths of shared purpose and teamwork. Thanks again as always for your support and we hope you enjoy reading this report.



Matthew S. Becker

Dr. Matthew Becker
Chief Executive Officer

Our Approach



The **Zambian Carnivore Programme (ZCP)** follows a four-pillared interdisciplinary approach of Conservation Science, Action, Leadership, and Coexistence to fulfill our 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 and the region.

Why Carnivores?

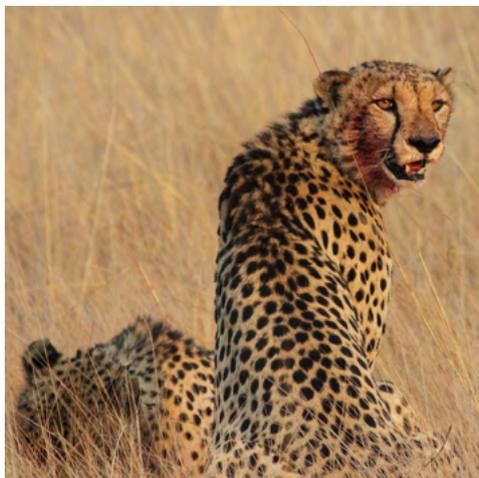
Umbrella species

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



Indicator species

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



Keystone species

Carnivores have an ecological influence disproportionate to their abundance.



Flagship species

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





Conservation Science

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

Conservation Action

Our conservation initiatives address the immediate threats to species and ecosystems as identified by our science, with the goal to reduce current, and help reverse past, negative impacts on large carnivore populations and ecosystems across Zambia. ZCP collaborates with local partners to ensure that threats are addressed in a timely manner, through initiatives ranging from combatting the illegal wildlife trade, supporting anti-poaching and land-use planning work to connectivity conservation and species restoration.



Conservation Leadership

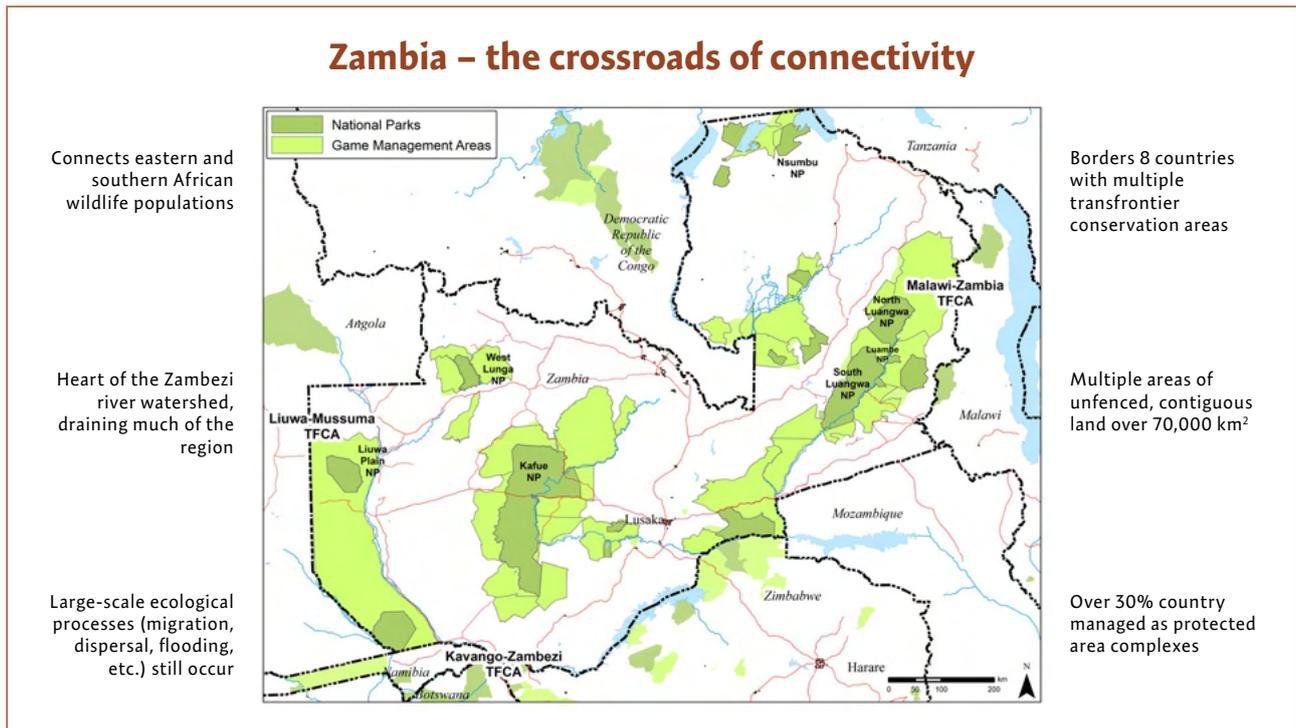
Too often the sustainability of research and conservation efforts are compromised because local communities are not effectively involved. We undertake a comprehensive multi-level approach to help ensure sustainability by training, educating, sponsoring, and employing young Zambian wildlife professionals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

Coexistence

There is currently a high 'cost of coexistence' for the people living in proximity with wildlife, greatly increasing threats to wildlife and people alike. Compounding this, there is often a lack of understanding of conservation work and its potential value. We help address these issues by decreasing the costs of living with wildlife through conflict mitigation techniques, reducing competition over resources between humans and wildlife through better land use planning and natural resource management, and increasing awareness and understanding of the value of conservation work.



Where we work



ZCP Field Ecologist Peter Musenge (R) conducts fieldwork with DNPW-African Parks Research Scout Given Kapawa.

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 and wild dog as well as Africa’s second-largest wildebeest migration.

Conservation Science: Field Reports

Key outputs 2021

- 336 lions in 58 groups intensively monitored across 3 ecosystems
- 380 wild dogs in 30 groups intensively monitored across 3 ecosystems
- 204 hyena in 14 clans intensively monitored across one ecosystem, photographic monitoring in three
- 32 cheetah intensively monitored across 2 ecosystems
- Photographic monitoring of leopards across 2 ecosystems
- Ten surveys of herbivore density and distribution across 5 ecosystems

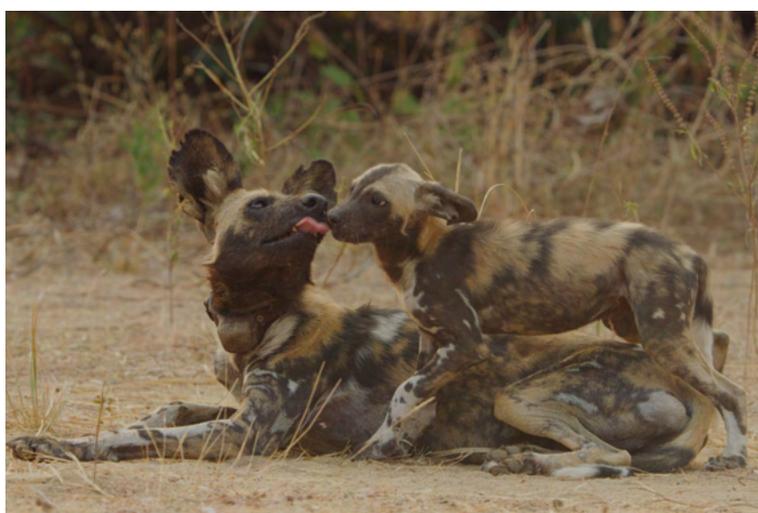
Luangwa Valley

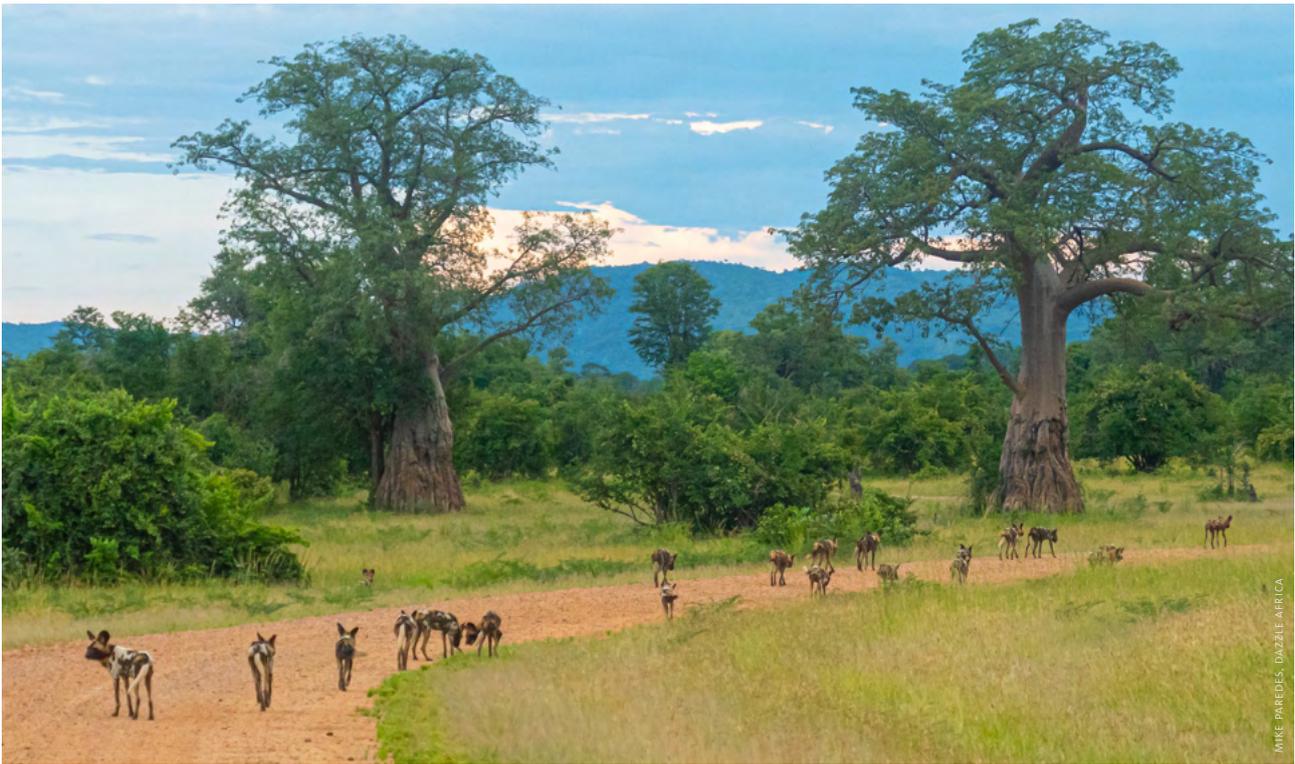
African Wild Dogs

We continued long-term work in Zambia's wild dog stronghold in the Luangwa Valley, the country's largest population. We recorded 287 individuals in 21 packs and dispersing groups, and together with the DNPW intensively monitored a record 224 dogs across 10,100 km² through ground-based field teams, GPS/satellite collars, and aerial tracking. Intensive monitoring work covered three national parks (South Luangwa, Luambe, North Luangwa) and six Game Management Areas (Munyamadazi, Luano, Lumimba, Sandwe, West Petauke and Lupande), encompassing much of the ecosystem.

Throughout the year we documented dispersal and subsequent pack takeover events across our study area, highlighting the importance of connectivity in the eastern Zambia protected area network. The Kakuli Pack experienced a takeover in the second half of 2021 by previously undocumented males. Dispersing males from the Chikwinda Pack took over the Mwasauka Pack, and in the southern part of our study area we documented a dispersing group of females that

headed south to settle in Luano GMA (see inset) as a start of the longest dispersal ever recorded for the species. There was also a small new pack recorded in the Lion Plain area composed of the Nsolo Mwamba Pack alpha male and new females.





Wild dogs from the Manzi pack hunting in South Luangwa National Park. ZCP-DNPW teams intensively monitored a record 224 wild dogs in 2021 across the parks and Game Management Areas.

Lower Lupande’s year of the dog

As a naturally rare, wide-ranging and subordinate competitor in the large carnivore community, African wild dogs can be impacted by a multitude of human and ecological impacts, which can interact to drive declines and even local extinctions. The Luangwa’s Lower Lupande Game Management Area (GMA) exemplifies many of the conservation challenges wild dogs face. Incorporating the gateway town of Mfuwe and other villages, and a wide range of legal and illegal consumptive activities, Lower Lupande has struggled to maintain resident packs during the many years we have been conducting intensive wild dog work here. Wire snare poaching in particular has had a noticeable impact on dogs in this area, both through direct mortality and injury. Consequently, we believe snaring is why the area has been unable to sustain a resident pack of dogs for any extended period of time, and has historically been subject to continual turnover of packs.

This year capped a historic time for the area, and 2021 could be considered Lower Lupande’s Year of the Dog. The area has potential to be a great area for wild dogs and we worked closely with our partners to improve resource protection in the area and limit the impact of wire snaring. On a weekly basis, we continued to share information regarding high priority areas for patrols with Zambia’s Department of National Parks and Wildlife (DNPW) and Conservation South Luangwa (CSL) based on the spatial data from satellite collared packs. We also continually conducted snare checks on all dog packs and dispersing groups, with heightened checks during the peak of snaring



Historically a demographic sink for wild dogs due to snaring risk, 2021 saw a resurgence of dogs in Lower Lupande Game Management Area thanks to collaborative anti-snaring efforts from DNPW-CSL patrols (see Conservation Action) and Community Clean Sweeps (see Coexistence).

in the hot dry season. The results of this improved protection in the area have been quite remarkable. In 2021, Lower Lupande was utilised by three breeding packs of wild dogs and 1 dispersal group.

We also documented one pack of 4 dogs east of our intensive study area, and there were reports of another bigger pack which were unverified. The Stork Colony pack denned within a kilometer of DNPW’s South Luangwa Head Office and were frequently observed terrorizing the local bushbuck frequenting Flatdogs Camp, Robin Pope Safaris, and other camps nearby, as well as the outskirts of Mfuwe town itself. When compared to recent years, this is unprecedented and would not have happened without intensive collaborative monitoring and resource protection work.

From Lupande to Luano – The importance of large, connected landscapes

Our prior work has highlighted that wild dogs are more adept at traversing human-impacted landscapes than their larger competitors such as lions; dogs are highly mobile and wide-ranging, perhaps as an adaptation to avoid predation by lions. This idea was exemplified in November 2021 in the Luangwa Valley when four dispersing female dogs left the resident Luamfwa Pack and headed south in search of unrelated dispersing males or an existing pack to takeover. The dispersers traversed different types of protected areas including one national park, five GMAs and eight private game reserves. Despite this 250km journey, the females did not appear to find a suitable area and suitable dogs with which to form a pack, and the story continues into 2022.

However, it does highlight the importance of Zambia's large landscapes that allow for large-scale movements of wildlife such as wild dogs throughout an immense network of parks and GMAs that is responsible for the Luangwa Valley continuing to be one of the last large areas of conservation connectivity remaining.

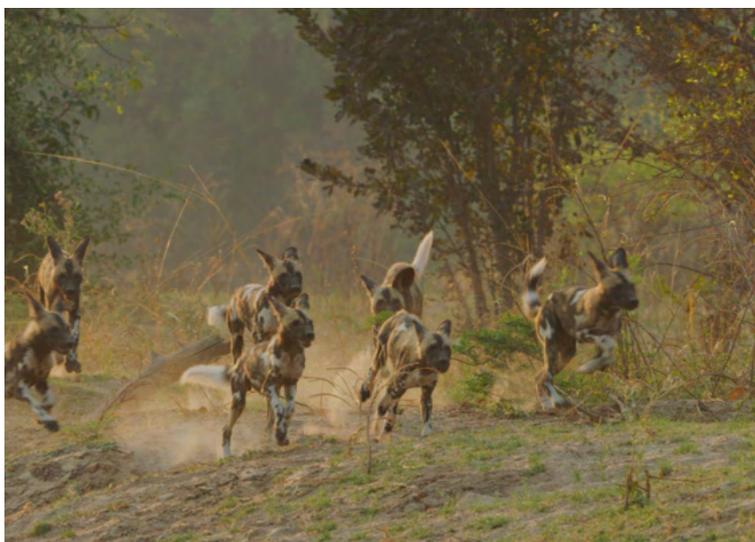


Wild dogs are naturally limited by competition with lions, and lions have a strong positive relationship with prey density. Consequently, wild dog demography can be impacted by changes in prey density and lion density, and both of these variables can be significantly altered by human impacts such as bushmeat poaching. While wild dogs were generally thought not to be heavily influenced by prey depletion (compared to dominant competitors such as lions and hyenas), evidence from our work continues to indicate otherwise (see Kafue Wild Dogs).

In coordination with ongoing studies of wild dog dynamics in the Greater Kafue and Greater Liuwa Ecosystems we completed the first analyses of Luangwa wild dog demography in 2021, evaluating across gradients of protection, lion density and prey density in the National Park and GMA complexes comprising our study area. The first products from this work are expected to be completed in 2022.

Wire-snare poaching for the illegal bushmeat trade continues to be a threat for wild dogs in our area, both in terms of dog mortality from snaring by-catch, and from prey depletion. However, we are proud to report that in 2021 we did not record any snared wild dogs in the Luangwa for the first time in over 15 years. This is testament to the impact of the long-term, collaborative work conducted with our partners DNPW, CSL, and North Luangwa Conservation Programme.

The increased and sustained resource protection throughout the COVID-19 pandemic consisted of directed anti-snare patrols in areas of high snare risk for wild dogs and intensive field monitoring and de-snaring. When the COVID-19 pandemic devastated the tourism industry in our area, we expected the worst. We strengthened our collaboration with law enforcement partners to secure and protect areas frequently used by known wild dog packs and these great results are the fruits of that hard work. Going forward we plan to keep this up as snaring patterns are dynamic.





Lions

We continued our intensive lion work across two national parks, three GMAs and approximately 13,000km² in 2021. Twenty prides and 18 coalitions, comprising 183 lions, were intensively monitored throughout the year. The number of animals monitored was lower than in prior years likely due to a decrease in effort coincident with a record number of wild dogs monitored. Given nearly all the study prides traversed gradients of protection between strictly protected national

parks and GMAs, lions continued to experience an array of human impacts, ranging from legal harvest from trophy hunting to snaring by-catch, and increasingly, human-lion conflict as a result of numerous dynamics in the GMAs (see Human-Carnivore Conflict Mitigation).

Findings and recommendations from our long-term ZCP-DNPW lion work helped guide Zambia's Lion Conservation Strategy and Action Plan in late 2021. The strategy and action plan was the first since 2009, which coincided with the initiation of long-term intensive studies in the Luangwa. The three-day workshop highlighted the way forward in lion management and conservation for the next five years, but also provided a chance to highlight how much progress has been made since 2009 in understanding of lion dynamics and providing science-based management for what are now some of the most well-described and studied populations in the region.

Led by ZCP Luangwa Assistant Manager Henry Mwape, we also continued analyses of lion movement and space use across gradients of protection in the Luangwa, with completion expected in 2022.



Leopard

We continued to conduct studies of leopard, their competitors, and prey in 2021, using camera-trap based methods and photographic monitoring across South Luangwa National Park and adjoining GMAs, and Luambe National Park. Similar to lion, we also contributed the findings from this work to the DNPW's first Leopard Conservation Strategy and Action Plan for Zambia in 2021, to help guide leopard conservation and management across the country for years to come.

Herbivores

One unique and important aspect of our long-term work is to study carnivores concurrently with studies of herbivores, given their importance as prey, as key drivers of ecosystem dynamics, and their sensitivity to human impacts.

We completed our tenth year of bi-annual, ground-based herbivore transects across South Luangwa National Park and Lupande Game Management Area, as well as our fourth year of surveys in Luambe National Park. Given the pervasive impacts of the illegal bushmeat trade (see Conservation Action) across Africa's ecosystems, evaluating herbivore dynamics across gradients of protection provides key insights into the human and ecological factors driving both carnivores and their prey. Studies of these dynamics continue to demonstrate the importance of prey depletion from poaching in impacting the demography and carrying capacity of carnivores.

We continued long-term demographic studies of the geographically-isolated Luangwa giraffe population. Using photographic monitoring with mark-recapture techniques we were able to cover the core range for this population and completed the first rigorous estimates of survival and population size from these data, with publication slated for 2022.

We also continued to expand collaboration with Giraffe Conservation Foundation and collaborators throughout the valley to assist in conservation of this unique population.



Long-term camera trap-based studies of Luangwa leopards across gradients of protection between national parks and adjacent Game Management Areas are conducted in South Luangwa and Luambe.



As a small, geographically isolated population, the Luangwa giraffe have been studied by ZCP-DNPW teams since 2008 with the support and collaboration of Giraffe Conservation Foundation.



Cheetah cubs feed on a fresh impala kill from their mother in Kafue National Park. Long-term studies of cheetah and competing carnivores continue to provide insights on the impacts of bushmeat poaching and prey depletion in particular, and its complex impacts on the large carnivore guild in the Kafue, and rangewide.

Greater Kafue

Cheetah

This year we completed our 11th year of cheetah monitoring in the Greater Kafue Ecosystem (GKE). In 2021 we monitored 55 individual cheetahs through a combination of intensive fieldwork and collaborative citizen science through the Kafue Carnivore Coalition. We intensively monitored 11 individuals across Northern and Central Greater Kafue through the deployment of GPS-satellite tracking collars.

Similar to our findings on wild dogs, our ongoing work suggests that Kafue's resident cheetah population is also likely to be heavily impacted by bushmeat poaching and subsequent prey depletion. While prey depletion reduces the density of dominant competitors such as lions, the benefit is likely to be offset by reductions in prey density, increases in snaring by-catch mortality, and increases in competition with lions and hyenas due to the loss of their preferred larger prey. Consequently, it is possible that cheetah can be existing at or near a carrying capacity set by availability of prey.

From similar demographic studies across other carnivore species both in the Kafue and the Luangwa these dynamics often result in low juvenile survival but good adult survival for the core population, and low survival for dispersing individuals as a result of an array of human impacts. Ongoing analyses of Kafue cheetah demography across multiple years of study will provide insights into these dynamics.

Wild Dog

This year we completed our 11th year of wild dog monitoring in the Greater Kafue Ecosystem. We intensively monitored 145 dogs in eight collared resident packs within our core study area in northern and central Kafue. Collectively we monitored 253 individuals in 20 packs and dispersing groups throughout the Greater Kafue as part of a collaborative citizen science program with DNPW, Panthera and Musekese Conservation, and various safari operators and guides. Intensive monitoring over 16,000 km² utilizing ground-based teams, aerial support from African Parks, and GPS-satellite collars enabled us to effectively monitor packs and dispersing groups, direct anti-poaching patrols, and document multiple large-scale dispersal events (see Large Landscape Conservation). Dispersal is naturally a high-risk undertaking, and was met with mixed success due to an array of human impacts such as snaring by-catch and roadkills, particularly for dispersers ranging out of the core population in the GKE.

In 2021 we published our first demographic analysis of Kafue wild dogs and the human and ecological factors affecting them. The study, entitled "Low apex carnivore density does not release a subordinate competitor when driven by prey depletion," appeared in *Biological Conservation* and evaluated the respective impacts of prey depletion from bushmeat poaching and subsequent reductions in lion density on wild dog demography. Our prior work on Kafue

herbivores demonstrated significant prey depletion, particularly amongst the larger species preferred by lions such as buffalo (see Kafue herbivores). This dynamic has resulted in low lion densities that could potentially benefit wild dog populations given that dogs are naturally limited by lion predation.

Using long-term data from 425 individual wild dogs from 2012–2019, we evaluated demography and dynamics for the Kafue population, and found that Kafue wild dog populations were characterized by very low densities, large home ranges and small pack sizes. Similar to studies on lions and leopards in the Kafue and elsewhere however, survival was comparable to stronghold populations not affected by bushmeat poaching.

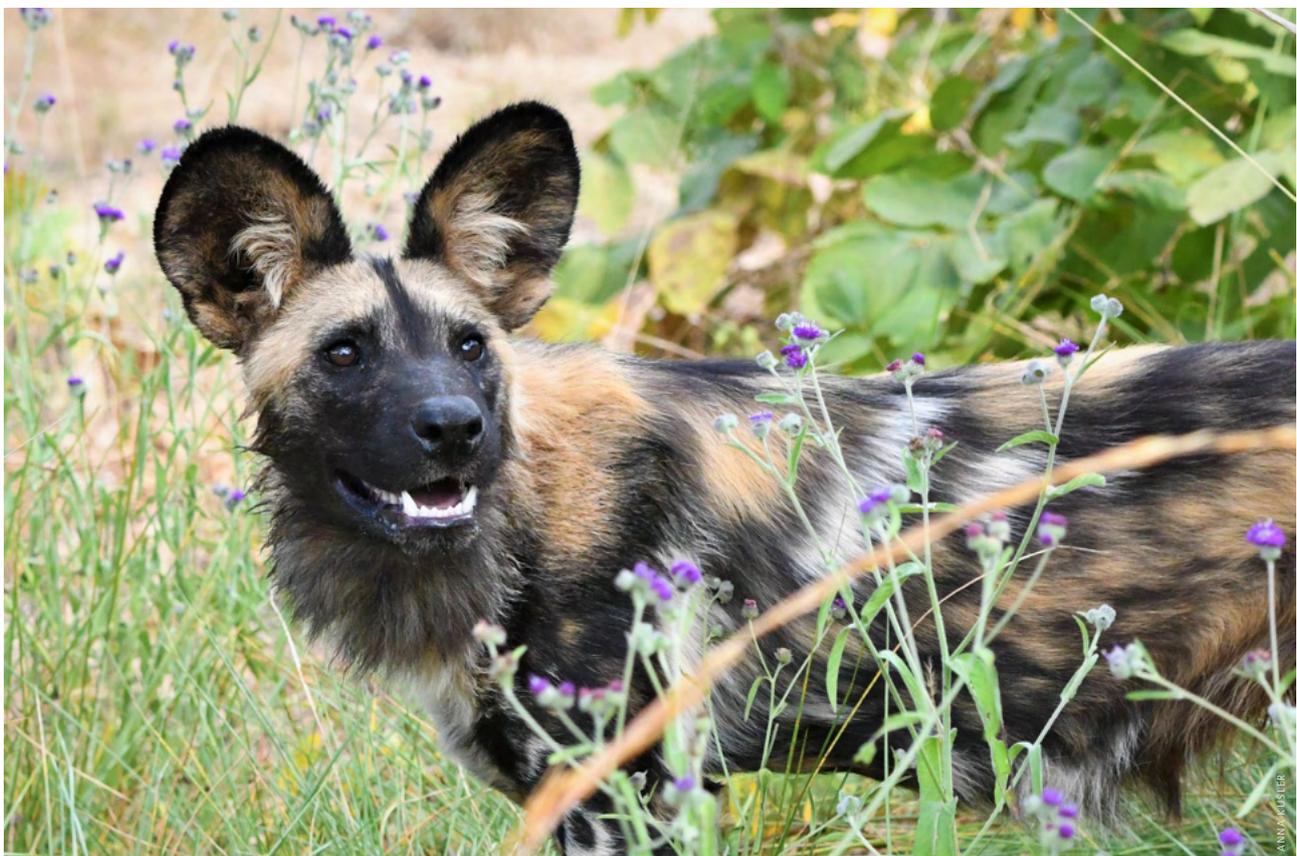
These patterns likely indicate that core populations are likely at carrying capacities set by limited prey availability, and subjected to an array of negative human impacts most pronounced on the boundaries of the protected areas and beyond which strongly limit dispersal success. These dynamics, and their consistency across species and populations, further highlight the importance of illegal bushmeat poaching on all species of large carnivores rangewide.

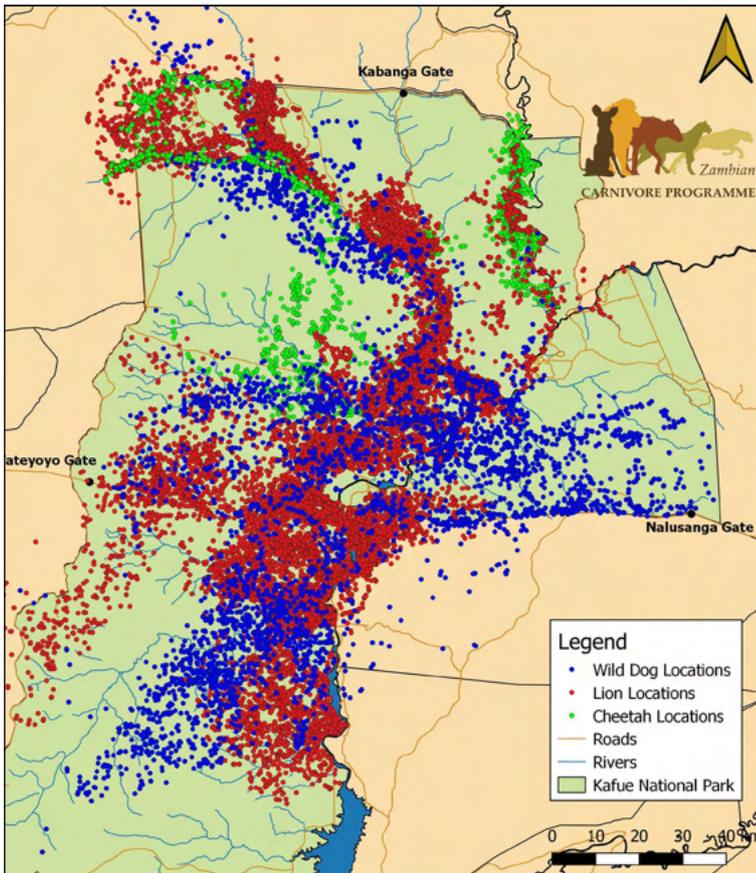
Building upon our demographic analyses in 2021 that highlighted the impacts of prey density, lion

density, and the human impacts affecting them, we also completed a study of wild dog movements in relation to ecological and anthropogenic factors. It is well-established that wild dogs exhibit spatial avoidance of lions. However, how wild dogs adjust their movements and space use in relation to all these factors is not well understood, and has significant conservation implications given dog populations typically exist across gradients of protection between national parks and community areas.

Utilizing data from ten wild dog packs in the Northern and Central Greater Kafue from 2017–2020, we evaluated the impacts of lions, prey density, seasons, and other factors on wild dog movements. While demographic analyses clearly highlighted the impacts of prey depletion, the drivers behind the dynamics observed are more complex than simply low food availability. Analyses indicated that even despite low lion densities, wild dogs still must adjust their movements to the long-term and immediate risk of lion predation.

These changes in movements can have energetic costs that can affect survival and recruitment and support our findings indicating that competitive interactions remain strong in ecosystems where densities of both lions and wild dogs are low as a result of human-driven prey depletion.





Locations from collared carnivore groups throughout Northern and Central Kafue. A core focus of the long-term work is to understand dynamics of populations across gradients of protection and inform conservation efforts.



A Kafue lion with a bushpig piglet kill. Long-term studies in the Greater Kafue indicates that prey depletion has significantly more complex and important impacts on the large carnivore community than previously understood.

In addition, the findings reinforced an emerging pattern across both carnivores and herbivores that movement patterns often show contrasting responses to short and long-term predation risk, which has important implications for predator-prey dynamics, competition, and human predation in ecosystems continent-wide.

Near the end of the dry season, as part of an initiative led by African Parks and DNPW to restore Liuwa wild dog populations as per the Liuwa Predator Management Plan (see Conservation Action), we assisted with the translocation of three dispersal-aged females from the remote Katinti pack to Liuwa Plain National Park, to serve as breeding females for the restored population.

Lions

In 2021 we completed our 9th year of long-term lion conservation in the Greater Kafue, continuing work begun by the Kafue Lion Project in 2010. We intensively monitored 131 lions in 18 prides and coalitions in our intensive study area across Central and Northern Kafue, and collectively monitored 161 individuals in 38 prides and coalitions throughout the Greater Kafue as part of a collaborative citizen science program with DNPW, partners Panthera and Musekese conservation, and various safari operators and guides (see Citizen Science). We added multiple new prides into the study and significantly expanded our coverage in the GKE while continuing work on the dynamics of dispersing subadult male lions in the ecosystem.

Small prey items such as warthog continued to predominate in lion diets, further corroborating our findings that prey depletion from bushmeat poaching—particularly of large bodied species such as buffalo—was the primary driver of the lion dynamics we observe. Our first analysis of Kafue lion demography, published in 2021, entitled “Response of lion demography and dynamics to the loss of preferred larger prey” indicated that lions are at a low density in the GKE relative to what would be expected in similar miombo woodland systems, pride sizes are generally small, and cub recruitment is low. As more resources have been invested in the Kafue’s protection over the last several years, it is likely that these trends can be reversed and recruitment will improve. A revisit of lion demography during this period will be completed in 2022. Given prey depletion is recognized as the largest threat to lions rangewide, continued insights and evaluations of these dynamics will assist in addressing the impacts of the illegal bushmeat trade rangewide.



Leopard and Hyena

Multiple new prides were added to our intensive monitoring in 2021, as part of expanding efforts in the Northern, Eastern, and Central Greater Kafue, and collaborative work with Panthera, Musekese Conservation and African Parks. Using genetic samples from monitored lions we also finalized an important new genetic tool—a lion single nucleotide polymorphisms (SNP) Chip. This tool enables high-quality genetic data to be obtained from low quality samples such as trafficked skins and parts (see Anti-Trafficking) and scat. The tool will greatly assist in tracing trafficked lion skins and parts back to their populations of origin, assessing connectivity, and estimating population sizes.

In late 2021 ZCP-DNPW data from this long-term study and our other sites helped guide the development of Zambia's first Lion Conservation Strategy and Action Plan since the original was developed in 2009, which coincided with the initiation of long-term intensive studies of lion.

The three-day workshop highlighted the way forward in lion management and conservation for the next five years, but also provided a chance to acknowledge how much progress has been made since 2009 in understanding of lion dynamics and providing science-based management for what are now some of the most well-described and studied populations in the region.

We published our first analysis of Kafue leopard density and survival in 2021, evaluating the impacts of low lion density and prey depletion from bushmeat poaching. The study, entitled “Leopard *Panthera pardus* density and survival in an ecosystem with depressed abundance of prey and dominant competitors” was based on long-term camera trapping data in what is likely to be a core population area for leopards in Northern Kafue. These analyses incorporated the impacts of low lion density and low prey density to evaluate how prey depletion from poaching can have variable impacts on different carnivore species as a result of changes in competition and prey density. Similar to our other studies in Kafue and in Luangwa, we found survival to be high despite these human impacts, but in contrast to lions and wild dogs in Kafue, density of leopards in this core area were high. This likely is the result of prey depletion primarily impacting larger ungulate species, while reducing dominant lion competitors, and highlights the complexities of bushmeat poaching impacts that we are only beginning to understand.

We also completed a key genetic tool in 2021 that will greatly assist in anti-trafficking, connectivity, and population estimation work. A leopard SNP Chip was completed with ongoing collaborations from DNPW, Wildlife Crime Prevention, and ZCP, and allows for high quality genetics information from low quality samples such as



A female puku in the Greater Kafue Ecosystem. Prey depletion is generally not considered a primary human impact on large carnivore populations range-wide in Africa, but increasing evidence from long-term studies such as the Kafue indicates it may be the biggest threat to large carnivore populations.

trafficked skins and parts, and scat (see Anti-trafficking Section). We also assisted in publishing the full genome for leopard in 2021 across their range in Africa and Asia, which found significant differences between the populations. These data will be utilized as baselines.

Despite typically being a dominant competitor behind the lion, spotted hyena dynamics are poorly understood in the Kafue, but populations are thought to be low. In addition to continuing photographic monitoring, intensive long-term hyena studies were planned in 2021 and will be rolled out in 2022 to provide more management and conservation guidance for what is likely to be a key population for this misunderstood and little-supported species.

Herbivores

Given the influence of large herbivores on ecosystem structure and functioning, and that they are the primary prey of large carnivores, our long-term work has always included strong components to evaluate the density, distribution, and trends of ungulate populations, and the human and ecological factors driving them. We completed our tenth year of large herbivore surveys in 2021, building on recent analyses of these data and large carnivore diets that indicated strong depletion of most species, particularly large-bodied ungulates such as buffalo. With increased investment in resource protection these trends will be reversed.

In 2021, together with DNPW and African Parks, we also launched our first intensive studies of buffalo, collaring two herds in Central Kafue and the Busanga Plains with GPS-satellite collars. These data will be utilized to direct anti-poaching patrols toward these highly-prized bushmeat species, and will provide insights into seasonal movements and the ecological and human factors driving them.

Greater Liuwa

Spotted Hyena

The 2021 season marked the 12th year of our work on Greater Liuwa's apex predator, the spotted hyena, in what is to our knowledge the largest, and one of the longest-running, studies of the species. We intensively monitored 204 individuals throughout approximately 6,500 km² of Liuwa Plain National Park and the adjacent Upper West Zambezi Game Management Area. We monitored a record number of clans in the ecosystem in 2021, utilizing satellite-GPS collars on 14 clans across both the park and GMA, as well as gradients of prey density and human impacts.

The total number of hyenas monitored was lower than in prior years, likely owing to a number of factors in this recovering ecosystem. Firstly, one clan in particular (the North Clan) continued to decline, likely due to being in a high snaring risk area. Secondly, field effort decreased slightly in 2021 as a result of experienced team members transitioning out of the field and a new team beginning. And thirdly, there are likely some demographic changes from the continued recovery of the hyena population. In the early years of our work the Liuwa hyena population exhibited very high survival rates, very large clan sizes, and likely was a growing population. This was due to the recovery of the wildebeest, zebra

and other key herbivores in Liuwa under the long-term African Parks-DNPW management, as well as low levels of livestock conflict, and low lion densities. However, given that hyenas are territorial, continued high survival rates and growth of the population may mean that density-dependent impacts are beginning to act on the Liuwa population, particularly in the high-density southern part of the park. Cub recruitment in particular was lower this year, and has been lower since 2020. Analyses of data from the last 12 years are ongoing in 2021, and will provide key insights on hyena demography in Liuwa and for the species.

Perhaps because there are few long-term demographic studies on hyena, we also documented a number of novel dynamics in 2021. While hyena males are typically considered to be the dispersing sex in a population, we documented four females dispersing from four different natal clans into others. This was highlighted by a dispersing female hyena that crossed into and settled in Angola. A collared member of the Mabula Hyena Clan, female Hyena 828 left her natal clan in June and moved in a northwesterly direction over 70km into Angola. In the recent years with the continued improvement of satellite-GPS collar technology we have increasingly

A Liuwa hyena mother rests with her cubs. Large carnivores such as hyena have benefitted strongly from Liuwa's abundant preybase, low competition from lions, and minimal conflict with humans. However, recent findings indicate significant changes in the hyena population that may indicate a leveling off of the population after a period of high survival and reproduction.





A hyena with a freshly-killed wildebeest calf in Liuwa Plain. Long-term studies indicate that predation by hyenas and other carnivores is likely to be the biggest driver of wildebeest population dynamics, as carnivores continue to recover. Continued changes in carnivore and herbivore populations as the ecosystem recovers are expected and will continue to provide insights and guidance for conservation of this unique system.

Locations from 14 hyena clans across Liuwa Plain National Park, the Game Management corridor, and into Angola demonstrate that hyena are also a transboundary population. These findings further support the proposed Liuwa-Mussuma Transboundary Conservation Area between Zambia and Angola.

recorded transboundary carnivore movements into Angola. This is promising for the proposed Liuwa-Mussuma Transfrontier Conservation Area, and we continued to work with partners on the Angolan side to collaboratively monitor carnivores in this area.

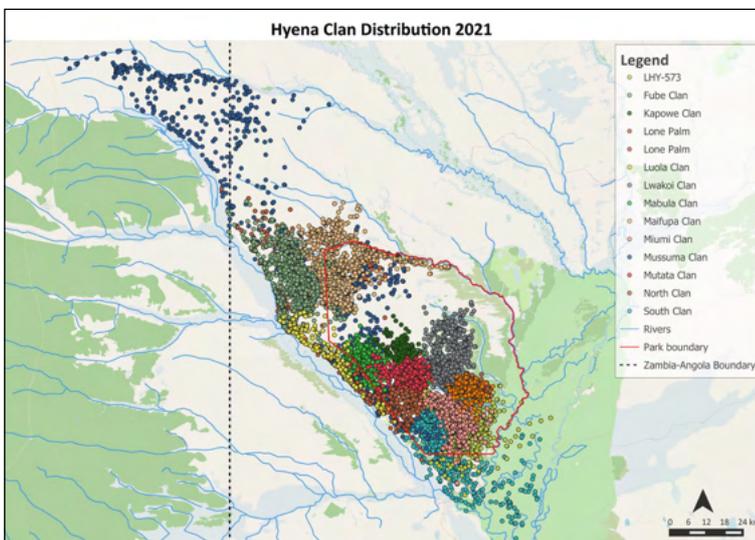
Continued work in 2022 will focus on clans in the corridor areas between the park and Angolan border, where human impacts are likely to be strongest. Illegal wire-snare poaching continued to pose a serious threat (see Conservation Action) and we documented direct killings of hyena and destruction of dens by people in 2021. While the Greater Liuwa Ecosystem (GLE) population

remains stable, it is still at risk from a number of human impacts threatening populations rangewide, including habitat loss, prey depletion, and conflict. Using our Liuwa studies and work from elsewhere in Zambia, we continue to work with partners to advocate stronger protection and uplisting of spotted hyena on the IUCN Red List (where it is currently a Species of Least Concern).

Cheetah

In the 12th year of cheetah conservation work we intensively monitored 17 different animals across the Greater Liuwa Ecosystem. The GLE is home to Zambia's second largest cheetah population and is the only one confirmed to be transboundary. For the second straight year we documented cheetah movement between Zambia and Angola, within the proposed Liuwa-Mussuma Transboundary Conservation Area. Given the wide-ranging nature of the species, and the ability of Liuwa cheetah to move across human-impacted landscapes, the risk of snaring is also quite high, particularly for dispersing animals. Human impacts such as snaring continue to be the primary cause of death for adult cheetah, and this year we again documented the illegal killing of a young adult female.

We continued to collect survival, reproduction and spatial data to understand the dynamics of Liuwa's population, intensively monitoring 4

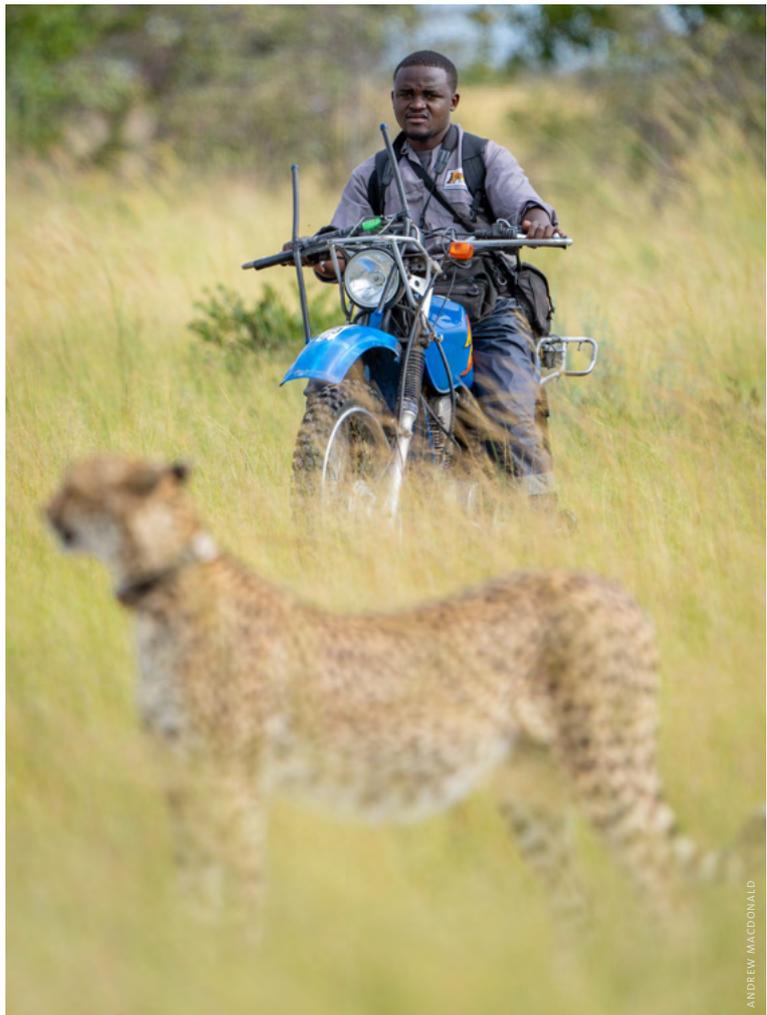




Liyuwa Cheetah 180, the star of BBC's *Dynasties II*, continues to play a matriarchal role in Zambia's second-largest cheetah population.

adult females and 2 adult males with satellite-GPS collars and a year-round field effort. Cub survival continued to be highly variable, and dependent on a variety of ecological and human factors. Cheetah cubs are most vulnerable when they are still very young and confined to a den, and these dens are typically situated in tall grass. We documented natural litter failures, due to flooding and predation, but also documented the loss of 5 cheetah cubs from a human-caused bushfire. Continued investigations into climate change, fire, and flooding (see Large Landscape Conservation) will provide insights as to the dynamics of humans and ecological change in the ecosystem, and its impacts on cheetah and other species.

Cheetah diets in 2021 continued to be comprised mostly of small antelope such as oribi and duiker, that are widely distributed and resident throughout the ecosystem, in contrast to the migratory wildebeest, zebra and lechwe that comprise the diets of dominant, competing carnivore species such as spotted hyena and lion. Thus, dietary niche partitioning (i.e. eating different things to reduce competition) continues to help facilitate cheetahs being widespread throughout the ecosystem. As most remaining populations of cheetah are under 100 individuals, it is important to understand the dynamics of these small populations now characteristic of the species, and together with data from the Greater Kafue, we will be finalizing analyses on Liyuwa cheetah demography in 2022.



ZCP Liyuwa Field Ecologist Peter Musenge checking on Liyuwa's cheetahs. Teams from ZCP-DNPW-AP logged over 1100 person days in the field intensively monitoring and providing field-based protection for the area's carnivores.



A lioness from the Liuwa pride rests next to her zebra kill. As lion pride numbers increase, and hyenas show signs of resource limitation, the abundant zebra population may be of increasing importance for carnivores in the system.

Lion

The lion population continued to slowly increase over the reporting period, with one new litter born to the resident pride in September, and a total population of 15 lions. The single pride consisted of 4 adult females and 4 cubs, as well as 5 subadult and adult males and a single female.

The year was marked by coalition changes, with the 8-year old resident male being evicted in a coalition takeover during the rains. Amazingly, the evicted male then undertook an over 640km journey into Angola before unfortunately getting killed along the Kwando River in the Cangombe region. The pride continued to frequent the central portion of the park in and around the woodlands, and preyed primarily on wildebeest, with some zebra increasingly found in their diet. The year also marked the first full implemen-

tation year of the Liuwa Predator Management Plan (see Coexistence) which for lions focused heavily on conflict mitigation between lions, people and livestock in and around the park.

Wild Dogs

The 2021-2026 Liuwa Predator Management Plan (see Coexistence) made restoration of wild dogs in the Greater Liuwa one of the top priorities, given that wild dogs have not been verified in the ecosystem since 2014, following a rabies outbreak combined with small population effects. Restoration plans were designed either to occur by natural recolonization, translocation, or a combination of both.

Given the strong support and urgency on wild dog restoration from the Barotse Royal Establishment, the Zambian Government, and African Parks, it was agreed that translocation was the preferred option. To prepare for this, a large-scale domestic dog rabies vaccination programme was undertaken, with more than 3000 village dogs vaccinated by African Parks, the local governmental veterinary department, ZCP and the DNPW. The annual vaccination programme will be repeated annually to help protect communities and wildlife from the threat of rabies in the ecosystem. The Greater Kafue Ecosystem was selected as a source for Zambian wild dogs, given it was the nearest viable population with similar genetics and potential connectivity between ecosystems (see Large Landscape Conservation). Three dispersal-aged females were translocated

The wild dog boma in Liuwa Plain National Park, designed to bond male and female groups into a pack prior to their release in 2022. Restoration of wild dogs into Liuwa is one of the core components of the Liuwa Predator Management Plan.



from the Kafue National Park's remote Katinti pack by a specialised translocation team from Endangered Wildlife Trust, ZCP, DNPW and African Parks in late 2021 and placed in a boma with eight free-ranging males of similar age translocated from South Africa's Limpopo area. All were vaccinated and release planned for 2022.

As part of the Liuwa Predator Management Plan (PMP) an assessment of the status of large carnivores and their prey in the northern portion of the GLE was planned in 2021 using detection dog surveys, but was delayed due to COVID-19 issues. The survey will take place in form of a camera trap survey in 2022.

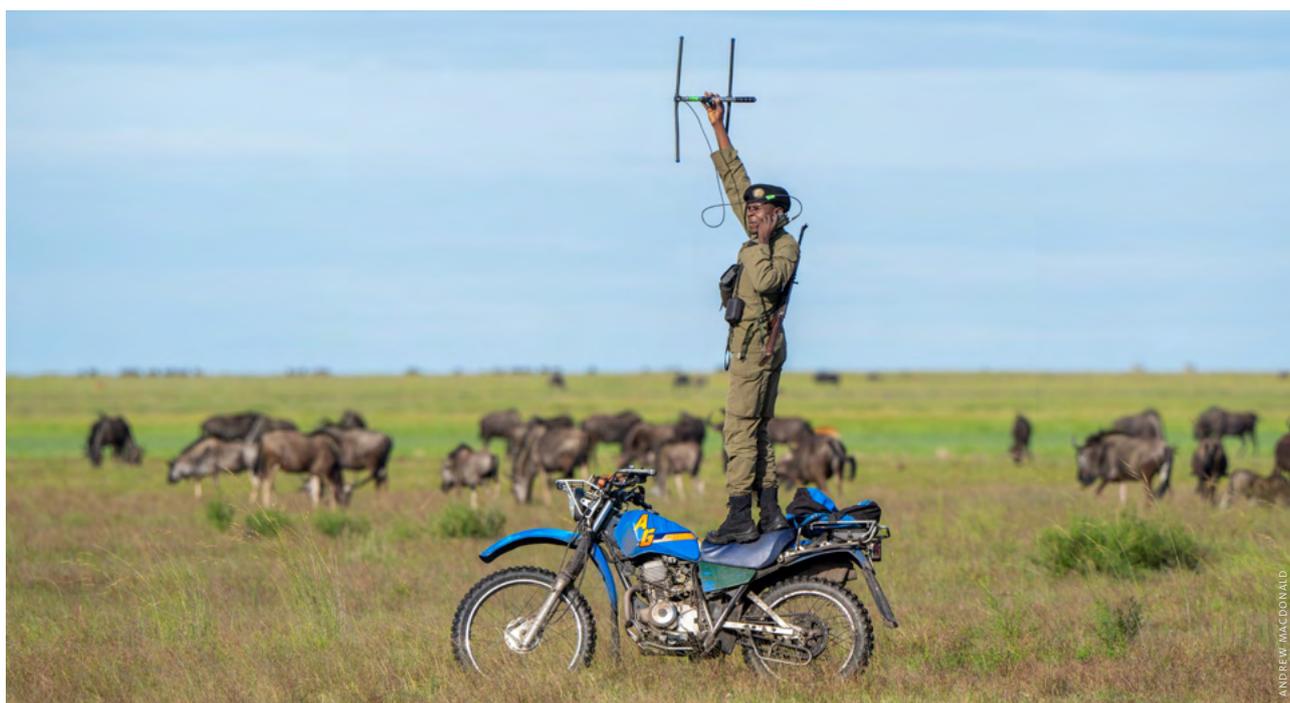
Herbivores

We completed our 10th year of work in 2021 on the GLE's keystone herbivore, the blue wildebeest, and this project comprised the longest-running individual-based demographic study of the species. We intensively monitoring 38 adult cows, their calves, and their accompanying herds throughout the year to collect survival, reproduction, habitat selection and migration data for this recovering population. This work was greatly facilitated by VHF collar technology and a year-round field effort, logging 1145 person days in the field in 2021. The GLE experienced above average rainfall for the 2020–2021 season, resulting in a resumption of typical migration patterns that had been altered somewhat by prior years' droughts. The first herds moved outside the park to the Upper West Zambezi GMA in February, at the peak of flooding, and the

remaining herds followed in May and June, at the end of rain season. The majority of the bulls also migrated north with the females, but returned south during the dry season. The majority of the wildebeest calved in their wet season range, the southern portion of the GLE. Our prior work demonstrated that wildebeest were strongly limited by predation from a recovering carnivore population, and that this predation was clearly most intense in the southern portion of the park and during the rainy season, when wildebeest herds were largely in the high density predator areas. Migration and spatial dynamics in general are thus strongly influenced by predation risk, flooding and fire, amongst other factors, and this is the current focus of our work. How climate change and other human impacts will influence wildebeest dynamics (and subsequently that of carnivores) is also a concurrent line of investigation as part of our watershed conservation work (see Large Landscape Conservation). To enhance the protection of the keystone herbivore species, we also shared wildebeest location data and herd sizes with the DNPW and African Parks to facilitate law enforcement and plan anti-poaching patrols (see Conservation Action).

Concurrent with intensive wildebeest work we continued to conduct thrice-annual surveys of all large herbivore species in Liuwa to evaluate changes in density, distribution and the human and ecological factors affecting these. Given the significant differences between the northern and southern areas of the ecosystem we have added additional survey areas in the northern corridor in 2022.

DNPW-AP Research Scout Given Kapawa tracks wildebeest as part of the region's longest-running collaborative study. Well-designed research and monitoring concurrent with restoration efforts provide important guidance for conservation given how rapidly ecosystems can change with improved management resources.





Team members from DNPW, West Lunga Conservation Project, WWF, and ZCP conducting surveys in West Lunga as part of collaborative ecosystem restoration efforts.

Greater Kabompo and Greater Nsumbu

In addition to our three long-term study sites across the country, we continued to upscale collaborations with partners working in potential carnivore strongholds, as well as working to protect the connectivity between them (see Large Landscape Conservation).

The Greater Kabompo and Greater Nsumbu Ecosystems were historically wildlife-rich areas that have been severely depleted due to human impacts, and the herbivore and carnivore commu-

nities have been reduced, and in many cases locally extirpated, particularly the big cats and wild dog populations. Fortunately, they are now the focus of intensive restoration efforts, with the DNPW working with West Lunga Conservation Project (WLCP) and WWF-Zambia in the Kabompo, and with Frankfurt Zoological Society (FSZ) in Nsumbu.

In the Kabompo we continued to make progress in assisting with the development of long-term ecological research and monitoring in the ecosystem, working together with DNPW, WLCP and WWF.

The year also marked the establishment of our fourth long-term study site, as a full-time, year-round field team took up residence in the ecosystem to conduct the increasing scope of work activities. Our collaborations formed part of WWF-Zambia's integrated programme in the Upper Zambezi Landscape and Watershed that aims to provide key guidance toward ensuring sustainable natural resource use and biodiversity conservation management within the broader landscapes of the Zambezi headwaters, formed by the Greater Liuwa Ecosystem and Kabompo.

ZCP team members Emmanuel Chibusa (R) and Salia Phiri (M) pose with DNPW scout Boyd Kakoma at the project headquarters in Jivundu, West Lunga.



We completed a fourth year of bi-annual ground-based surveys in and around West Lunga National Park and a camera-trap based survey was implemented to better evaluate the dynamics of the recovering ecosystem. Our completed analyses of human encroachment and habitat connectivity demonstrated that the connectivity between the Kabompo and Greater Kafue Ecosystems comprises perhaps the largest unrecognized habitat corridor remaining in Zambia. We thus expanded collaborations in 2021, working with The Nature Conservancy and partners to increase evaluations and protections of this and other remaining corridors in the region. Given the importance of these ecosystems, as well as the Greater Liuwa Ecosystem, and their potential susceptibility to climate change, we also continued work on a Climate Change Barometer for the area to assist in evaluating and predicting the impacts of climate change for the region's communities and wildlife.

In the Greater Nsumbu Ecosystem we continued working with FZS and the DNPW on long-term research and monitoring programmes with which to provide evaluations and adaptive management for their ecosystem recovery efforts. The work was in collaboration with Oxford University's WildCRU through ZCP collaborator Dr. Egil Droge and focused on Nsumbu National Park and the adjacent Tondwa Game Management Area, building on surveys initiated in 2017. Preliminary results indicate a significant increase in wildlife sightings on these surveys in 2021, both through camera trapping and direct observations. The biggest increases in sightings were also in the GMA, a promising result for restoration of this key buffer zone to the national park.



ZCP Field Ecologists Salia Phiri (M) and Emmanuel Chibusa (R) work with DNPW scout Boyd Kakoma to set a camera trap for wildlife surveys in the Kabompo Ecosystem's West Lunga National Park.

While big cats continued to not be detected in the ecosystem through these efforts, promising patrol reports indicated that leopard may still be resident in the system. In 2022 we will continue to assist FZS in upscaling monitoring and restoration efforts for this important ecosystem.



Sitatunga and roan antelope. Long-term camera trap surveys conducted by DNPW-FZS-ZCP teams in the Greater Nsumbu Ecosystem continue to document the potential for Nsumbu to become a wildlife stronghold under long-term recovery efforts.

Conservation Action

Key outputs 2021

- Conducted intensive anti-snaring work across 3 ecosystems to help protect 945 large carnivores across 37,500 km²
- De-snared 7 large carnivores and conducted over 7,500 snare checks on carnivores
- Successfully developed and applied the first SNP Chip for African lions, leopards, African wild dogs and spotted hyena to further facilitate anti-trafficking work
- Worked with partners to create lion genetics database for anti-trafficking intelligence and forensics work
- No snared Wild Dogs detected in the Luangwa for first time in over 15 years
- Continued developing Climate Change Barometer to predict and adapt to changes for communities and wildlife
- Sponsored three DNPW Ecologists to enroll in University of Edinburgh's Applied Conservation Genetics and Forensics programme to build capacity to use genetics, forensics and intelligence to combat carnivore trafficking
- Continued Human Encroachment and Land Use Change assessments, and Corridor Protection plans across the country and portions of the 8 neighboring nations

Combatting the Illegal Wildlife Trade: Anti-Snaring and Bushmeat Work

The illegal bushmeat trade has increasingly been recognized as one of the most serious—if not the most serious—threats to large carnivores rangewide in Africa. Given that bushmeat poaching results in severe declines and even extirpations of herbivore populations, prey depletion is the most serious impact on carnivores. However, wire-snare poaching is likely the most widespread method of obtaining bushmeat,

and, given snares are non-selective, wire-snaring by-catch—i.e. non-target species caught in snares—can also have severe impacts on carnivores. In addition, while bushmeat poaching, prey depletion, and snaring by-catch are viewed as serious threats, little is known about the complexity of impacts on species, populations and ecosystems in regard to large carnivores (see Kafue field reports). Consequently, combatting the impacts of bushmeat poaching and snaring on carnivores is a fundamental objective of our conservation actions.

With the economic impacts of the COVID-19 pandemic dramatically reducing tourism revenue and food security, and straining law enforcement resources, there were spikes in bushmeat poaching across many of our study systems. However, owing to long-term, effective collaborations and support amongst partners and donors we were again able to mitigate snaring impacts across all sites in 2021.

How Much Is One Dog's Life Worth?



WILD DOG 73

Rescued from a lethal snare in 2014



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.



CSL-ZCP Vet Dr. Mwamba Sichande treats a Luangwa lion snared through the mouth.

Our methodology—collaborative field-based protection work, or the “Halo Effect”—was developed by ZCP with Conservation South Luangwa (CSL) and the DNPW, and expanded throughout our long-term sites in the Greater Kafue and Greater Liuwa Ecosystems. The collaborative work consists of:

1. Intensive field monitoring and snare checking by ground and aerial crews of nearly 1,000 individual carnivores.
2. Spatial data from these carnivore groups provided to DNPW and partners to guide patrols to areas of high snaring risk for carnivores.
3. Field-based vet teams able to rapidly respond to snared carnivores.

In 2021 we conducted 7,539 snare checks, detected 3 lions, 1 leopard, 1 cheetah, 4 wild dogs, 5 hyenas snared and successfully treated 2 lions, 2 wild dogs, and 3 hyenas respectively. The untreatable animals were either not in our collared groups, outside our study area, or both.

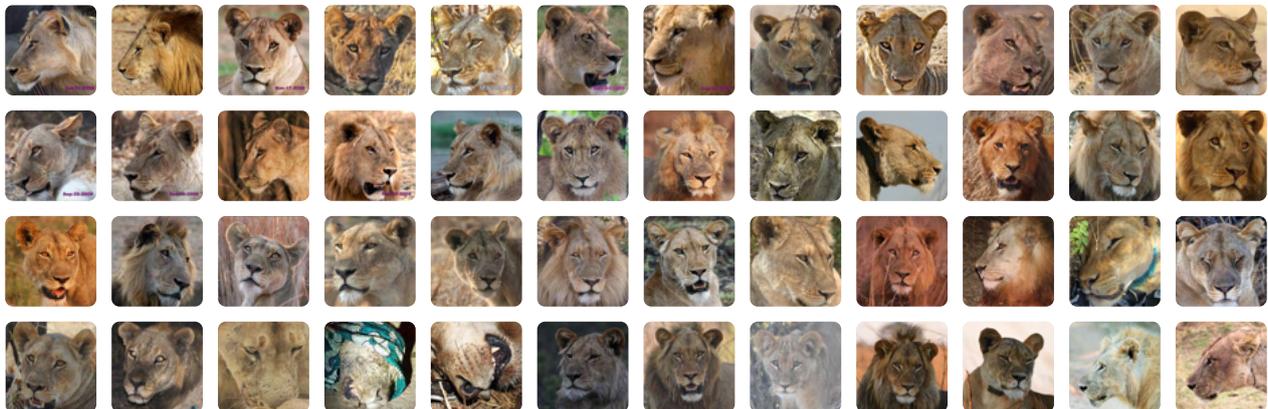
In the Luangwa, long-standing collaborative work with the DNPW and CSL continued to be successful even in the face of the pandemic impacts. Reports of snared animals steadily



decreased and in 2021, we recorded the lowest numbers of snared animals detected in any year. Only 12 snared animals were detected, of which 6 were successfully de-snared. In 2020 no snared lions were detected, and in 2021 no snared wild dogs, giraffes or buffalo for the first time in 15 years. This is remarkable, given our normal experiences with snaring in the main area, and is in stark contrast to what we expected during a second year of COVID-19 impacts on people living in South Luangwa. Although we have witnessed an increase in overall poaching using firearms, we did not observe any increase detection of snared animals. This is likely due to

DNPW-ZCP team members (L-R, Anna Kusler, Clement Mtonga, Stephi Matsushima) led by Dr. Brian Musalo (R) de-snare the alpha male of Kafue’s Chunga Pack. Intensive monitoring and snare checks, facilitated by over 1100 person days in the field, allowed teams to detect and rescue this important individual and pack.

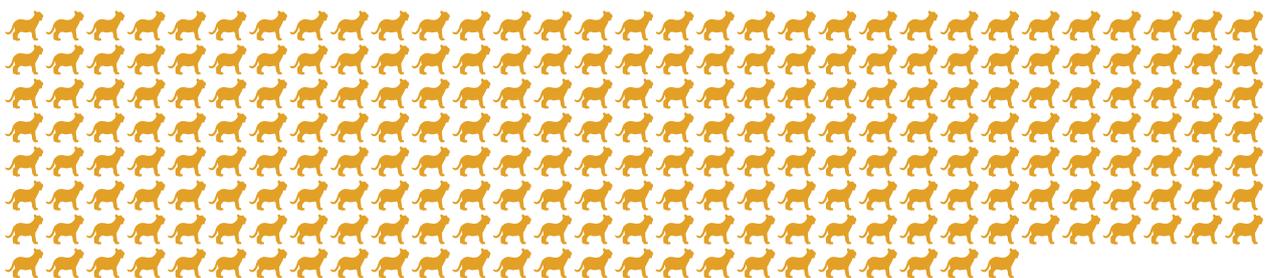
Population effects from snared lion rescues



48 lions de-snared



242 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.



DNPW-ZCP Field Ecologist Reuben Kabungo (R) and ZCP Conservation Biologist Trainee Franklin Sakala sort carnivore tissue samples as part of collaborative anti-trafficking work with the DNPW, Wildlife Crime Prevention, TRACE, the US Fish and Wildlife Service, and the Lion Recovery Fund. Long-term genetic sampling from intensively monitored carnivore populations across the region, combined with illegally trafficked skin samples help provide key tools and information to fight the illegal trade in big cat skins and parts.



Senior Kafue Ecologist Kachama Banda (L) explains genetic sample collection techniques from lion scat to Conservation Biologist Trainee Emmanuel Chibusu. The development of a SNP Chip for lion, leopard, wild dog and hyena helps provide high-quality DNA for low-quality samples such as scats and skins.

the ongoing efforts of local people engaged in our Community Clean Sweeps Program, and increased patrol effort and coverage.

In the Greater Kafue we continued to work with DNPW, Panthera and Musekese Conservation (MC) on collaborative anti-snaring work, while also working closely with new Kafue partner African Parks Network (APN). Collectively, these organizations contributed significant amounts of resources into resource protection in the Kafue, and the presence of an APN aircraft and helicopter also assisted greatly in tracking carnivore groups and providing patrol access to areas of high snaring risk for the many remote carnivore groups, particularly during the wet season. Our intensive lion work was also supported by Panthera's Lion Monitoring Team, which assisted in intensive monitoring and snare checking of lions and other focal carnivore groups, and we worked closely with MC to mitigate snaring risk on the carnivores in the Musekese-Lumbeya area. Collectively, these efforts continue to mitigate bushmeat poaching impacts on both the carnivores and their preybase throughout much of the Kafue.

In Liuwa snaring continued to be high but localised in several key areas throughout the ecosystem, and overall snaring impacts were lower than in 2020. Working with DNPW and APN we detected three snared hyenas and were able to successfully rescue all of them, thanks in large part to the presence of a full-time, field-based vet, Dr. Musalo, who together with our teams was able to rapidly respond.

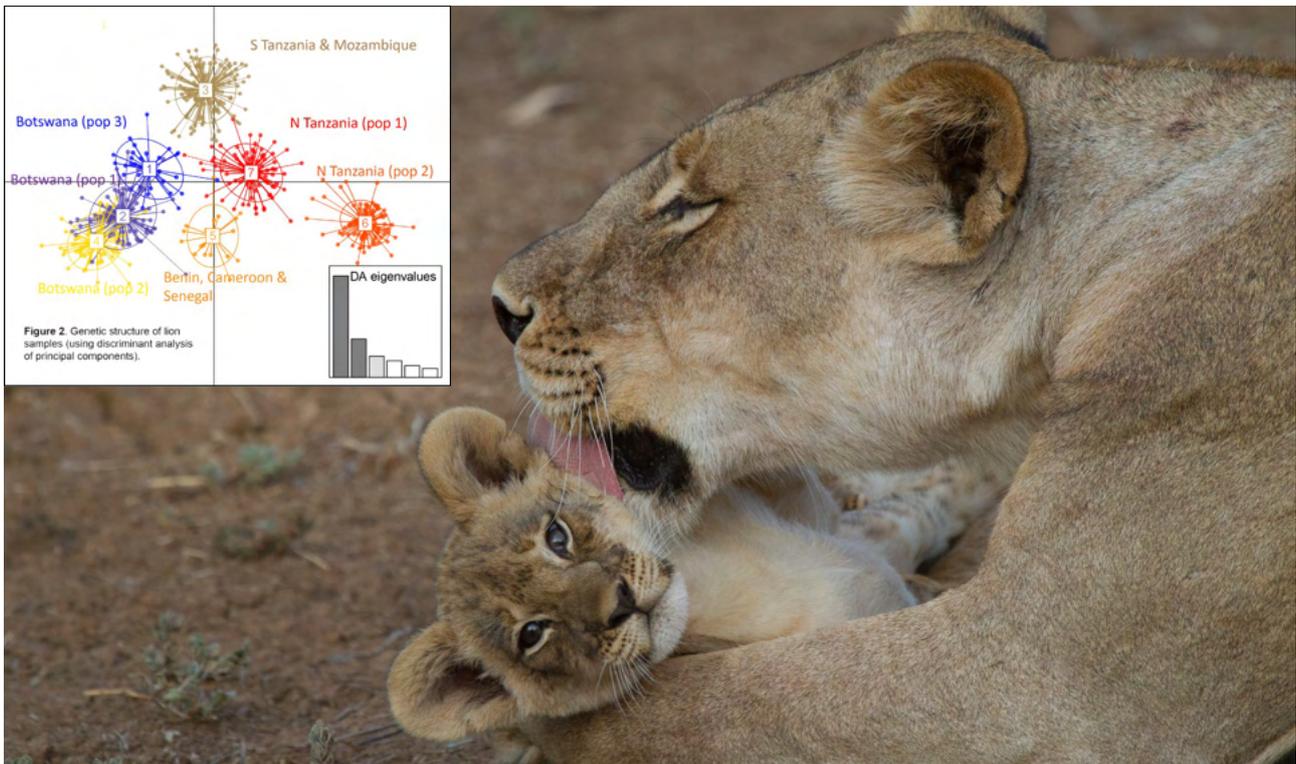


Figure 2. Genetic structure of lion samples (using discriminant analysis of principal components). Inset: Baseline genetic data from lions across Africa demonstrate clear distinctions across regions and populations.

Combating the Illegal Wildlife Trade: Anti-Trafficking Work on Big Cat Skins and Parts

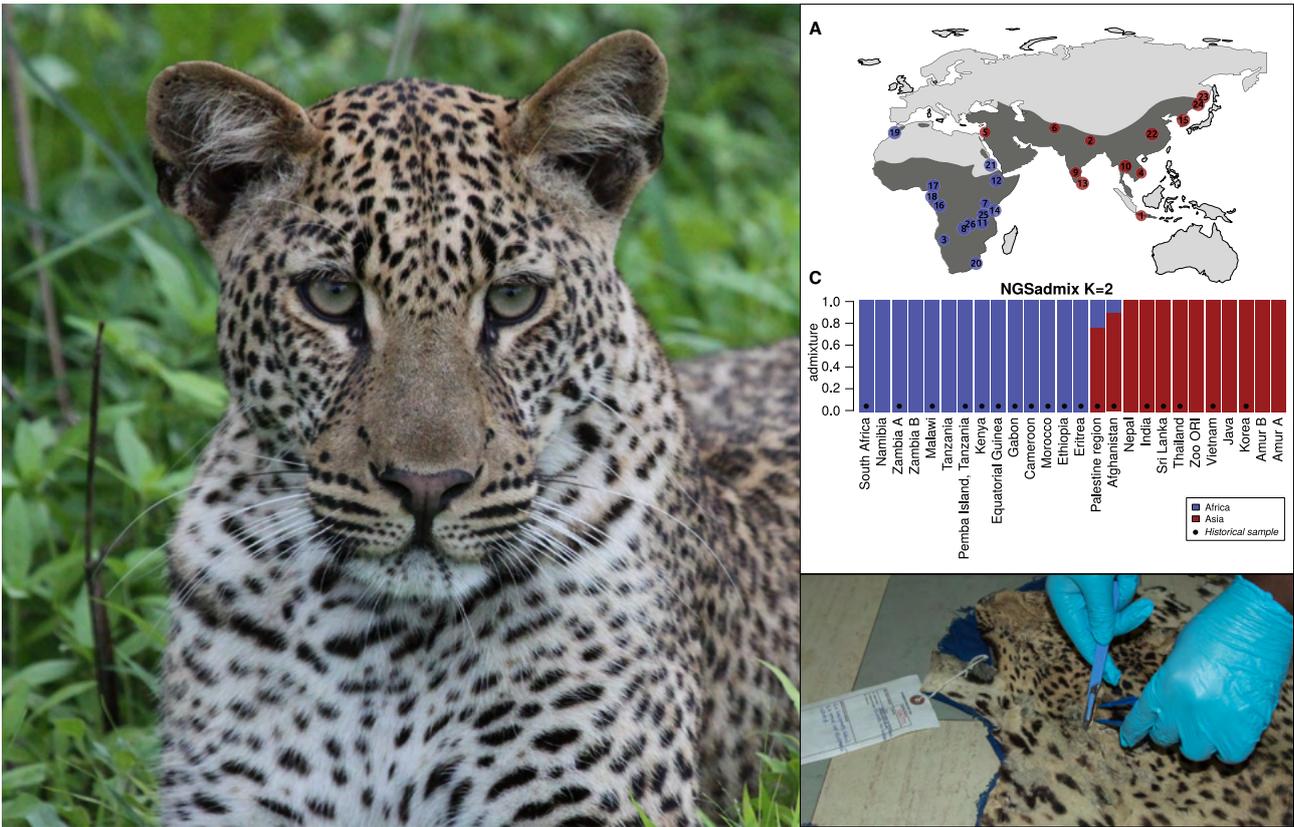
Working with DNPW, Wildlife Crime Prevention, TRACE and dozens of other partners rangewide, we continued to make significant progress in 2021 on long-term anti-trafficking work on lions and leopards in Zambia and the region. Our work could be classified into five main categories, namely: 1) Creating genetic tools for intelligence and forensics work 2) Expanding collaborations and baseline sampling rangewide 3) Building anti-trafficking capacity rangewide 4) Providing conservation science on the impacts of bushmeat on big cats and the carnivore guild.

1) Creating genetic tools for intelligence and forensics work

Our collaborative work has now ultimately transformed a situation where there was no scientific means of obtaining information from big cat skin seizures, to where a key tool has now been created for both lion and leopard (with cheetah in progress) that can effectively trace seizures to their population of origin (provided there is adequate genetic sampling of available source populations).

Using cutting-edge genetic technology with single nucleotide polymorphisms (SNPs) we were able to develop the means for tracing. However, one key challenge that required addressing was that despite SNPs being highly effective, they

required high-quality genetic samples (such as tissue). While samples were obtained from seizures of trafficked skins, many of the skins held DNA degraded to the point that bead based chip technologies would perform poorly. To address this, we have developed a fluid based SNP chip for lions and leopards respectively. While SNPs produce hundreds to thousands of markers (compared to traditional mitochondrial DNA techniques that typically generate a dozen or so), the lion and leopard SNP chips select the most effective markers that best explain provenance and individual identity, as well as accurate genotyping on samples with minute quantities of DNA. The SNP chip thus allows for deriving high quality genetic data from low quality samples, and we are currently re-running trafficked samples that were unable to provide genetics data from traditional SNP analyses. The development of the SNP Chip for both species is a game-changer given that now poor-quality trafficked samples can be assessed, but equally we can get more baseline samples from lion populations range wide through non-invasive means such as scat samples. In addition to lions and leopards we also completed SNP Chips for African wild dogs and spotted hyena, which will greatly improve the ability to collect high quality data from these low-density, wide-ranging species.



Similar to lions, new genetic tools developed from Zambian leopard work combined with genomic information on leopards rangewide (see Scientific Publications Pajmans et al. 2021) will greatly assist anti-trafficking efforts by providing intelligence and forensics information.

2) Expanding collaborations and baseline sampling rangewide

We continued to work with partners rangewide to expand the baseline of genetic samples from lion and leopard populations, and collaborators now number several dozen and reflect all the lion strongholds on the continent. In addition, we continued to analyse all lion and leopard tissue samples from hunted males across the Luangwa and Kafue in 2021, and continued to collect samples from seizures through DNPW, WCP and other law enforcement partners. This work will also comprise much of DNPW Ecologist Clive Chifunte’s Master’s Degree (see Grad Students). Perhaps the biggest development in this work was; 1) for lions, our expanded collaboration with Dr. Laura Bertola and TRACE, merging our collective data to expand coverage. Through this collaboration we have merged our genetics data with the lion genetics data from Bertola et al. 2019 so that the lion chip now hold markers that are variable across the entire African range, and 2) for leopards, we have intersected SNP information from whole genome sequencing across the global range with our RAD sequencing effort to extract a set of markers that are now validated on a range of sample types, including low quality samples. This set of markers now allow us to reliably identify individuals and their provenance from any leopard sample.

3) Building anti-trafficking capacity rangewide

In addition to developing these tools we were able to leverage the impact of this work to establish additional complementary initiatives. We continued to work on a USFWS anti-trafficking grant that supported the above-mentioned work but also supported TRACE and The University of Zambia (UNZA) work developing in-country capacity in Zambia for forensics and chain of custody work. Given the increasing sophistication of criminals in the illegal wildlife trade, forensics work confirming the identity of trafficked species is increasingly necessary (compared to expert opinion traditionally used). In addition, we sponsored three DNPW Ecologists from three Area Management Units in the Luangwa and Kafue to enroll in the University of Edinburgh’s Applied Conservation Genetics and Forensics programme (see Professional Training and Advanced Education). Collectively, this will build the capacity for the DNPW to effectively address the ever-increasing complexity of genetics, forensics, intelligence and trafficking. In addition our work has assisted in rangewide development of anti-trafficking capacity, the most recent being the Lion Recovery Fund supported Victoria Falls Wildlife Trust, and partners in South Africa, as they use our data from this work to develop in-country capacity.



Wildebeest migrating in the Greater Liuwa Ecosystem. Liuwa and the Greater Kabompo Ecosystem form important components of the upper Zambezi watershed and are the focus of large landscape conservation and connectivity efforts.

Large Landscape Conservation

Zambia—and much of the region and continent—is characterized by dryland ecosystems. These seasonal systems have severe and dramatic fluctuations in rainfall, flooding, water and resource availability during the wet and dry seasons. Consequently, mobility is crucial for both wildlife and people in order to adapt to seasonal fluctuations and access variable resources. And mobility requires connectivity within and between ecosystems, particularly in an era of rapid, human-induced ecological change, most evidenced by changing climates.

Habitat fragmentation from human activities continues to degrade and diminish large landscapes worldwide, making connectivity of ever-increasing importance. In addition to supporting strongholds for large carnivores, Zambia borders eight countries, has large tracts of over 70,000 km² of connected, unfenced protected area networks, provides connectivity between Eastern and Southern Africa, and is the headwaters of the region's major watersheds in the Zambezi and Luangwa Rivers. Large landscape conservation is therefore a key component of our work, and utilizing strong, diverse collaborations, integrated approaches, and cutting-edge methodology, we collectively made significant progress on this work in 2021.

Climate Change

Ecosystems throughout Southern Africa are expected to be considerably altered by human-driven changes in climate, and considerable attention and resources have been invested in developing strategies for communities and ecosystems to adapt and buffer the impacts of climate change. The Upper Zambezi headwaters in the Kabompo and Liuwa Ecosystems make it of considerable importance given the Zambezi River drains much of the region in Southern Africa will likely have significant impacts on climate trends going forward.

We continued work on a Climate Change Barometer in 2021 using data from these ecosystems. The Barometer identifies and standardizes data inputs and sources for precipitation, temperature, flooding, fire and vegetation change for both ecosystems. With these data, forecasting and evaluations of potential climate change impacts can be conducted, and the effects on communities and wildlife can then be mitigated by improving preparedness.

Given the complexity involved in construction of climate change tools, we spent 2021 continuing to synthesise these data, with first products expected in 2022.



ZCP-DNPW teams de-snare wild dog 1049 outside the park.

There and back again: the dispersal story of Kafue Wild Dog 1049

Some consider life to be one long journey... but some legs of the trip are certainly more dangerous than others. Among most animal species, possibly the most perilous time in life is a process called “dispersal”. This is the time when an animal leaves its natal family group to find and establish a home of its own. In 2021, we were able to document four dispersal events by wild dogs in the Greater Kafue Ecosystem. The satellite GPS tracking collars on these individuals allowed us to observe their movements and to better understand wild dog connectivity both within Kafue and across the greater region. Some stayed close to home, setting up a territory immediately adjacent to their natal range. But others ranged far, on average covering hundreds of kilometers.

In late July 2021, a group of siblings from the iconic Chunga Pack set out from central Kafue. The pack had swollen in size to over 23 dogs, and with 10 hungry puppies dominating mom and dad’s attention at the dinner table, there weren’t many scraps left for the eldest siblings. So a group of three brothers and two sisters left the pack, ready to forge their futures. Though this group was initially mixed-sex, we knew that ultimately the brothers and

sisters would part ways to find mates and form families of their own. So within the group were two satellite GPS collars: one on a young male Wild Dog 1047 and one on his sister Wild Dog 1049.

Initially the group ventured far to the south, sometimes covering dozens of kilometers in a day. But upon reaching the southwestern corner of the park, they seemed to change their minds. South was not the way to go! Why? We don’t know; perhaps they ran into a big pride of lions, or perhaps encountered a well-established pack of wild dogs



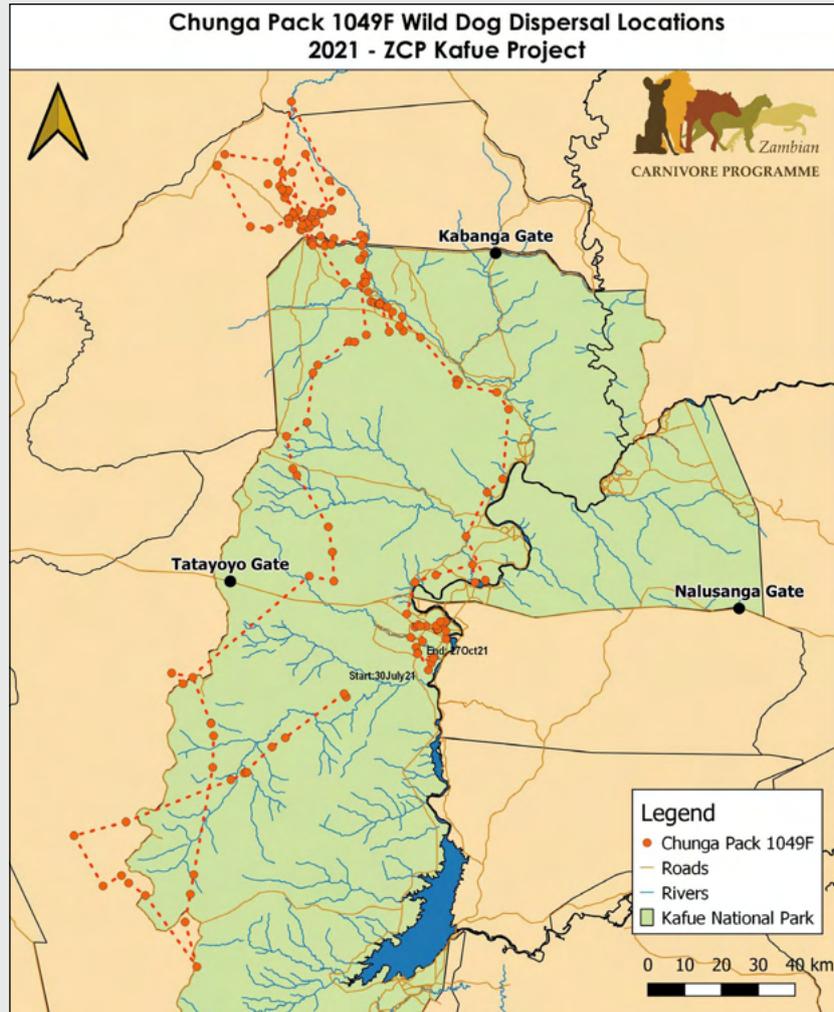
Wild dog 1047 dead in a snare outside the park after dispersing into a remote, high-risk area where teams were unable to rescue him in time.

defending their range from intruders. Regardless of the reason, the dispersers made a U-turn and abruptly headed north. They traversed hundreds of kilometers, exiting the northwestern park boundary and entering the Kasonso-Busanga GMA beyond. It was there, north of the park, that the group ran into bad luck...

On 10 September 2021, satellite locations from the collar revealed potentially concerning movement. At this point the dispersers had already traveled over 500km, but the dog’s locations became clustered within an area less than 100m for over two days. Such sedentary behavior was ominous, so a ZCP team rushed into the field to assess the situation. But the journey was far, and sadly upon arrival, the team discovered the young male – KWD-1047M – already dead in a snare. The snare was one of many, set up in a deadly row along a game trail hidden inside an extremely thick woodland. Poor 1047 had been caught by two whip snares: one entrapping his front leg, and one on his hind. Within a few meters of his body, the team found additional snares and fresh signs of poachers. Both snares were removed and destroyed by our Wildlife Police Officer (WPO), and we immediately



Clockwise from top left: a) ZCP-DNPW teams de-snare wild dog 1049 outside the park b) The dispersal path of 1049 and littermates is one of the longest recorded for the species. Limited dispersal opportunities combined with strong human impacts make dispersal highly risky and often unsuccessful. c) 1049 reunites with her pack after her long dispersal ordeal.



alerted the department who sent in an entire patrol team to sweep the area.

The patrolling officers found and removed an additional dozen snares from the woodland – some with wire thick enough to catch a buffalo or elephant! Due to the fate of her brother and presence of poaching activities in the area, our ZCP ground teams initiated emergency efforts to find and monitor the remaining dispersers through the collar on the female KWD-1049. We found her the next day, 5 kilometers from where her brother had died. She was alone, injured, and also carrying two snares. She also had acquired puncture wounds on her rump, likely from an attack by an unknown animal. ZCP's veterinarian Dr. Emmanuel Kaseketi immobilized and de-snared 1049F and managed to treat her injuries. Based on the condition/age of her injuries and her movements subsequent to her brother's death, we determined it was

likely that 1049F likely was caught in the same set of snares that her brother died in.

The ZCP-DNPW ground team monitored and stood vigil with 1049F for three days post de-snaring. During this time the team had one brief sighting of her remaining siblings, but they were over 1 km away and did not appear to find or visit 1049F as she recovered from her injuries. We suspect they may have been chased away by the area's resident uncollared wild dog pack, which may have also been responsible for the bites and wounds on her rump.

After three days of rest, 1049 recovered enough strength to move again. Amazingly, despite her injuries, she managed to move 30km south into the central Busanga Plains. There she scavenged and ate small game to regain some condition. After two weeks in the plains, she began slowly wandering

east, deeper into the heart of the park. At this point, 1049 had been alone and injured for nearly three weeks. Though in pain and likely very hungry, she was a fighter... and she knew what she needed to do to survive. Within the course of one week, 1049 traveled over 200km south to return to the range of her mother, father, and siblings. By mid-October she had reunited with her family, resting and recovering from her journey. Now healthy and fully recovered, she is helping ensure that the next generation of Chunga's puppies survive to have their own chance at dispersal.

There and back again, 1049's epic journey exceeded 800km of travel. This is the longest known dispersal event by a wild dog. Though she was unable in this time to find mates and establish a new pack or territory of her own, 1049 fought hard to survive and live another day. And who knows... maybe she'll try again next year!



EGIL DRØGE

Utilizing movement and dispersal data, genetics, and land use change patterns from long-term work across four ecosystems, ZCP and partners are conducting important connectivity conservation work across Zambia and the region.

Human Encroachment, Land Use Change, and Corridor Protection

Given the rapid fragmentation of remaining ecosystems and erosion of connectivity between them, understanding how trends and patterns of human encroachment and land-use change impact carnivores is a primary focus of large landscape conservation.

In 2020 we completed a preliminary assessment of encroachment across all of Zambia, and assessed connectivity and the status of the Upper Zambezi Watershed between Angola and the Democratic Republic of Congo. Several important and unrecognized corridors were highlighted from this work, and we continued assessments and corridor protection plans in 2021. We worked with DNPW, WWF, The Nature Conservancy and West Lunga Conservation Project on corridor and connectivity conservation efforts between the Kabompo and Kafue Ecosystems and beyond. Encroachment data and summaries were provided to stakeholders for land-use planning and other work as they were finalized and will be available large-scale in 2022.

Large Carnivore Connectivity and Dispersal

In addition to looking at watershed and landscape level environmental and human dynamics to understand and protect connectivity, we also continued to look at connectivity through movements and dispersals of our study animals, as well as the genetic connectivity between populations and individuals.

Our genetic work was conducted through the collaborations of the African Carnivore Connectivity Project, a collaboration between partner institutions, departments and carnivore conservation projects across the continent. The Project's three main goals are:

1. Developing genetic tools to combat trafficking (see Anti-trafficking)
2. Evaluating and conserving genetic connectivity between carnivore populations, and
3. Improving the population monitoring methods through genetic tools.

With cutting-edge SNP Chips developed through our work for lions, leopards, wild dogs and spotted hyena in 2021, we continued to make progress across all three objectives.

Concurrent with the genetic connectivity work, we continued to collect movement data from resident and dispersing carnivore groups across all three ecosystems continued to provide further insights into connectivity dynamics. In 2021 we completed a study in the Greater Kafue on wild dog movements in relation to human and ecological drivers (see Kafue Wild Dogs), and we documented multiple large scale and trans-boundary dispersals of carnivores into Angola from Greater Liuwa.

Multiple analyses of movement and connectivity are ongoing with expected results in 2022.



LAUREL REISMAN



Conservation Leadership

Key outputs 2021

- Developed ZCP's first five year strategic plan
- 33 Conservation Club Programmes to 252 students across 3 ecosystems
- 31 Zambian trainees in Women in Wildlife Conservation, Conservation Biologist Training Programme and Wildlife Vet Training Programme – Double the number from 2020
- 7 Zambian students supported for university degrees in wildlife conservation
- 2 Zambian students supported for graduate degrees in wildlife conservation
- Selected for the African Conservation Leadership Network

Primary and Secondary School Programmes

Our primary and secondary school programmes were once again affected by disruptions to the academic calendar linked to the COVID-19 pandemic. The government of Zambia continued to close schools a number of times to limit the spread of the disease, and this made it difficult to complete activities in a timely and safe manner. This was a challenge that we faced the previous year as well. We adjusted to the school closures as necessary, conducting school programmes whenever possible. In 2021 we conducted 33 programmes to 252 students across three ecosystems.

In the Luangwa Valley we continued to run adventure-based learning projects through comprehensive programmes in collaboration with our long-term partner, Chipembele Wildlife Education Trust. These programmes were conducted through a weekly Field Ecology Club, wherein students learned about protected area management and reserve design, the importance of land use planning and about how to safely

coexist with wildlife. This year's project goals were designed to allow students to further develop their field research, spoor identification techniques, as well as their computer and public speaking skills. One of the highlights of the project was a field trip to the far southern section of Lupande GMA's Malama Chiefdom to learn about the impact of human land use change on loss and restoration of wildlife corridors.

Pandemic-driven school closures also greatly constricted primary and secondary school programmes in the Greater Kafue Ecosystem in 2021. Our longstanding partnership with Treetops Schools was again on hiatus this year, as school visitations to the remote camp were severely reduced. In order to adapt to these new challenges and still maintain some portion of our programmes, a new Conservation Club programme at Mukambi Community School was developed by ZCP Kafue's Senior Ecologist and Education Coordinator Kachama Banda. Given the proximity to our base camp we were able to



Conservation Club students from Mfuwe Secondary School conduct research on the importance of wildlife corridors in the Lupande Game Management Area.



Conservation Club students on a field trip as part of ZCP-Chipembele's weekly programmes with students. The adventure-based learning programme helps provide skills and experience for post-graduate education and employment, in addition to teaching about conservation.



Conservation Club students in Liuwa Plain National Park's Mishulundu School work on a wildlife conservation project with ZCP-DNPW-APN teams.

conduct 7 classes for an average of 25 students, with plans for expanding programmes across our three schools in Treetops, Chunga and Mukambi upon resumption of regular school schedules.

Also in Liuwa we experienced delays and restrictions on our educational programmes from COVID-19. Nevertheless, we managed to conduct programmes at two of the schools inside the park, with 47 students attending the Conservation Clubs at Sibemi School and Mishulundu Schools. These conservation clubs were started in 2016 by Senior Ecologist and Conservation Educator Bridget Mayani, and in 2021 she trained Women in Wildlife Conservation Trainee Salia Phiri and Conservation Biologist Trainee Emmanuel Chibusa to carry on the work. The Grade 6-9 pupils attended different activities ranging from lectures on ecosystems and Liuwa wildlife, as well as more informal activities such as conservation related quizzes, games and treasure hunts.

We had planned to involve Kalabo based schools in the programme and to once again run the "Introduction to Conservation Internship Programme" that was initiated in 2020, but due to COVID-19 we were unable to make this happen.

Additionally, we welcomed Muyenga Muyenga as a student intern within our conservation intern programme. Muyenga is from the Mishulundu village inside the park. He joined us at the start of the dry season to gain some field experience. As one of the top students of the conservation club in 2018, Muyenga finished grade 12 in December and will be welcomed back as an intern with our field team again in 2022.



Women in Wildlife Conservation Mentors (L-R) Kachama Banda and Anna Kusler with ZCP-Musekese Conservation's Ruth Kabwe conduct a cheetah immobilization and collaring in the Kafue.



Women in Wildlife Conservation Trainee Salia Phiri radio-tracks carnivores in the Greater Liuwa Plain. A graduate of Copperbelt University, Salia worked across both Liuwa and Kabompo on an array of conservation programmes as part of her training.

Women in Wildlife Conservation Programme

Despite the challenges of the pandemic, we continued to make great strides in 2021 with our Women in Wildlife Conservation Training Programme (WIWC), intensively mentoring six trainees across three ecosystems. Given the underrepresentation of women in field-based conservation, and the challenges of breaking into the profession, the WIWC programme encourages the entry and retention of women into this sector by pairing trainees with female mentors that are ZCP Ecologists and Managers. As part of the larger ZCP teams, trainees receive instruction and experience in all aspects of the work and are often employed and supported for university degrees following completion of the programme. Through the generous support of partners, in 2021 we were able to place two WIWC graduates in 4-year university degree programmes with institutions in the United States and Zambia respectively.

2021 was a great year for Luangwa's (WIWC) Training Programme. Mercy Njobvu, a graduate of the program and a wildlife veterinary student at the University of Zambia, was selected in 2020 as a National Geographic Young Explorer in recognition of her work as young conservation leader. In 2021 she used her Young Explorer funds to begin her project activities aimed at reducing the prevalence of rabies in the Luangwa Valley (see Disease Mitigation).

Another WIWC graduate Margaret Mwale successfully completed her first year of university while still assisting with research and data management work during her holidays. And our third graduate, Nomsa Kamanga, was selected as one of 17 extraordinary young conservation leaders from around the world by the European Development Days initiative.

In 2021, Kafue's WIWC initiative was small but mighty and demonstrated the strength of the programme's philosophy of paying it forward. Kafue's first WIWC trainee Kachama Banda, originally mentored by ZCP's site manager Anna Kusler, officially became a mentor herself. As Kafue's Senior Ecologist and Education Coordinator, Kachama began mentoring our newest team member, Ruth Kabwe. Ruth joined the team as an intern and WIWC mentee at the end of 2020, and in 2021 she was offered her a full-time position as a Field Ecologist, working with ZCP and partner Musekese Conservation (MC). Ruth has been mentored by ZCP and MC in all aspects of field ecology and conservation, from data collection and database management, to field mechanics, project logistics, and law enforcement support. In Liuwa, Salia Phiri joined Liuwa as a WIWC trainee in 2021. She earned a Bachelor's degree in Biology from the Copperbelt University in 2020 and joined the Greater Liuwa team in 2021. She is also involved in the work in the Kabompo Ecosystem.



With their extensive lion conservation experience ZCP Ecologists (L to R) Thandiwe Mweetwa, Kachama Banda and Bridget Mayani Nkoma hosted a special session on Facebook Live with Lion Recovery Fund Director Dr. Peter Lindsey about women in lion conservation.

Conservation Biologist Training Programme

While we continued to see a surge in interest in young people for careers in conservation, there is still a lack of opportunities for aspiring conservation biologists to gain field experience. With four long-term study sites across the country, we are able to provide this through our Conservation Biologist Training Programme (CBTP).

While other programmes suffered from COVID-19 restrictions and impacts, we were actually able to increase participation in this programme, hosting 20 trainees across four ecosystems in 2021. Trainees ranged from gap year students to recent university or Grade 12 graduates, and all were embedded and trained in all aspects of the research, education and conservation work that ZCP does. They were trained on how to collect large carnivore monitoring data, use telemetry to track elusive carnivores, navigate remote environments, and provide assistance during animal immobilization for collaring and de-snaring purposes. Trainees were also given opportunities to develop soft skills essential for conservation practice such as communication and interpersonal skills, and to learn fundamental field skills such as 4x4 driving, and automotive repair. We also were able to find additional funding to support two CBTP graduates of this program for 4-year degree programmes at Zambian universities in 2021.

In the Luangwa we hosted multiple trainees with the assistance of long-term partners. Together with DNPW's South Luangwa Research Unit we provided training and field experience to Copperbelt, Mulungushi University, and Livingstone International University of Tourism Excellence and Business Management (LIUTEBM) students, and trained a Copperbelt University

graduate specifically for African Park's wild dog monitoring in Liuwa.

Our partner organization Chipembele Wildlife Education Trust was also running a gap year conservation and leadership training initiative called Aspiring Conservation Leaders' Program (ACLP). Throughout 2021, we were pleased to host five of their students for work placements. The students spent time assisting with various tasks at our camp and shadowing our Human Wildlife Conflict Officer to learn about conflict mitigation. We are committed to providing learning opportunities for future conservationists and we look forward to hosting more ACLP students in the future.

In 2021, ZCP's Greater Kafue team had five participants in its CBTP. Recent Copperbelt and University of Zambia graduates university graduates Lucky Chama and Kabwe Chanda each joined the Kafue project placements, along with current university students Lameck Sakala and Johanne Meyams. In December, the ZCP Greater Kafue project welcomed our newest team member, DNPW Community Wildlife Police officer Clement Kauseni. Clement joined ZCP as a CBTP trainee and looks forward to becoming a highly experienced ZCP/DNPW field ecologist.

Liuwa welcomed three CBTP trainees in 2021 – Lucky Chama, Allan Banda and Emmanuel Chibusa. Lucky was selected this year to join both the Greater Kafue Ecosystem as well as the Greater Liuwa Ecosystem projects. He spent a few months in Kafue for the first part of his field-based training on the various aspects of our work, followed by a long-term placement in Liuwa.

Conservation Biologist Trainees Clement Kauseni (a Community Wildlife Police Officer) and Lucky Chama (R) assist with a wild dog immobilization in Kafue.



Conservation Biologist Trainee Johanne Meyams radio tracks collared carnivore groups as part of his training.



Kafue Project vet Dr. Emmanuel Kaseketi immobilizes a lion as part of his training.

Wildlife Vet Training Programme

Interest in wildlife veterinary work continued to increase in 2021, and together with the DNPW and partners we provided opportunities for aspiring wildlife veterinarians and veterinary technicians to obtain field experience in this work which would otherwise not be possible. With intensive wildlife monitoring and wildlife rescue work being conducted year-round across the long-term sites, our Wildlife Vet Training Programme allowed for the attachment of four trainees in 2021 across three ecosystems. In the Luangwa, under the mentoring of Conservation South Luangwa (CSL)-ZCP vet Dr. Mwamba Sichande and DNPW Vet Dr. Lengwe Bwalya, we were able to attach three trainees to gain extensive experience in wildlife vet work, as well as community vet work through CSL's domestic animal clinic and National Geographic Young Explorer Mercy Njobvu's rabies mitigation campaign (see Disease Control).

In the Kafue, our long-standing wildlife vet, Dr. Kambwiri Banda, left in 2021 to begin his Master's degree (see Graduate Students, p. X) at Montana State University with ZCP's Dr. Scott Creel. We thus brought on Dr. Emmanuel Kaseketi as our new vet in Kafue, working in partnership with DNPW to conduct the work. Dr Kaseketi earned his degree in veterinary medicine from the University of Zambia in 2019 and is currently pursuing a master's degree in Project Management with Copperbelt University and Astria Learning. Dr. Kaseketi spent the first several months of his tenure receiving intensive

training on all aspects of wildlife veterinary work with Dr. Sichande and Dr. Bwalya in the Luangwa, before moving to the Kafue. Because the success of veterinary interventions with carnivores requires a solid knowledge of the behavior and ecology of each species and to managing the many aspects of the darting environment, a high premium is placed on understanding all aspects of carnivore ecology and bush knowledge, in addition to veterinary knowledge. Dr. Kaseketi had no shortage of work and quickly became experienced in all aspects of the work, and will be mentoring students in the coming year as part of the programme.

Professional Training and Advanced Education

Developing local leadership in science-based conservation is critical for ensuring the sustainability of conservation efforts, but obtaining support for professional training and advanced education of current and future conservation professionals is often extremely difficult. We continued our comprehensive, multi-tiered approach addressing this challenge by working with partners to provide training and educational opportunities for outstanding team members and collaborators in 2021.

One primary component of this work was assisting in the training and advanced education of DNPW Research through our collaborative work. DNPW-ZCP teams across all sites provide extensive training to members throughout the year, but also assist in leveraging training to other areas of the country. As part of the continued implementation of the National Conservation Action Plan for Cheetah and Wild Dogs in Zambia aimed at increasing carnivore monitoring capacity within the DNPW we

Conservation Biologist Trainee Lucky Chama collects carnivore data out in the field on Liuwa Plain.





hosted DNPW ecologist for Chama, Benson Silweya. Benson spent time with our ZCP-DNPW Luangwa team to learn more about the carnivore monitoring techniques we use. The training included intensive field-based components, overviews of the theories and questions around techniques, and online mentoring by ZCP-affiliated scientist Dr. Paul Schuette.



In addition to field-based training, we supported advanced education for three DNPW Ecologists and three DNPW Wildlife Police Officers in 2021. As part of our anti-trafficking work we supported three DNPW ecologists – Clive Chifunte (see Graduate Students), Benson Silweya, and Howard Maimbo – to pursue studies at the University of Edinburgh’s online Applied Conservation Genetics with Wildlife Forensics Programme in partnership with TRACE and the USFWS. Given the rapid advancements in genetic techniques for anti-trafficking, connectivity (see Large Landscape Conservation), and population estimation, having personnel well-versed in genetic techniques is critical.

DNPW Ecologist Benson Silweya (top) underwent intensive training on carnivore monitoring techniques with ZCP Luangwa teams in 2021, enabling him to initiate this work in the Chama area of the Luangwa Valley. Below: Benson works with DNPW-ZCP Field Ecologist Reuben Kabungo to deploy camera traps as part of long-term leopard monitoring.

DNPW Wildlife Police Officer (WPO), Lackson Mbewe, a long-term team member of the Luangwa Project, began a distance learning programme towards obtaining a BSc degree in Wildlife and Natural Resources Management at the LIUTEBM in Lusaka. He is currently in his 2nd year of study, receiving credit for his 17 years as a WPO as well as some of the courses he successfully completed while attending Southern Africa Wildlife College on support from ZCP and partners. Long-term Luangwa Project team member and DNPW WPO, Reuben Kabungo, was also awarded support by Dazzle Africa to



(L): DNPW Wildlife Police Officer Lackson Mbewe attends his residential learning component required for his BSc in Wildlife and Natural Resources Management. (M): Conservation Biologist Training Programme Graduate and long-time ZCP Field Ecologist Dean Banda beginning his wildlife management studies at Copperbelt University. (R): Women in Wildlife Conservation Training Programme Graduate Nomsa Kamanga arrives at Catabwa College in the United States to begin her university studies in conservation.

begin his studies in a Bachelor's degree program in Environmental Studies at Mulungushi University. Reuben's programme complements the extensive training and experience he has received through intensive field work on carnivores. In the Kafue we also supported Senior DNPW WPO Mathews Mumbi to pursue a degree at Zambian Open University in Development Studies to further his conservation career goals.

In addition to DNPW support, with the sponsorship of partners we were able to support four ZCP team members to pursue advanced educational opportunities. ZCP Luangwa Project's Margaret Mwale (a graduate of the Women in Wildlife Conservation Training Programme) continued her studies at the Copperbelt University pursuing a Bachelor's degree in Wildlife Management. ZCP Kafue Conservation Biologist Conservation Training Programme graduate Lameck Sakala continued his studies at Mulungushi University. In Liuwa, Senior Ecologist Dean Banda was accepted into the prestigious Wildlife Management Programme at Copperbelt University (CBU). Dean began his career with us as a trainee in our Conservation Biologist Training Programme and has been a core member of the Liuwa team since 2017. At CBU, Dean will acquire the skill set he needs to become one of Zambia's future conservation leaders. Finally, at the end of 2021, WIWC graduate and ZCP Luangwa team member Nomsa Kamanga was awarded a scholarship by Catawba College, in the United States to study for a Bachelor's degree in Environmental Science.

Graduate Students

Starting as a wildlife vet trainee under former DNPW Head of Vet/ZCP Ph.D. student Dr. Wigganson Matandiko, Dr. Kambwiri Banda spent 5 years working on the Kafue project as a field-based wildlife veterinarian and co-manager. As part of his ambition to also get formal education in ecology in addition to his field experience, Kambwiri embarked on a new challenge in 2021: enrolling as a graduate student at Montana State University. Working with ZCP's Dr. Scott Creel, Kambwiri's research evaluates the demographic impacts of de-snaring work (see Anti-snaring) on wild dog and lion populations in our study areas. With a Wildlife Conservation Network scholarship, Kambwiri is making good progress on his work and we are looking forward to his findings.

As a DNPW Ecologist in the Kafue, Clive Chifunte's Masters degree enrollment at Swedish Agricultural University (SLU) was delayed in 2021; however, in preparation for a 2022 start he

enrolled in University of Edinburgh's online Applied Conservation Genetics with Wildlife Forensics Programme in partnership with TRACE and the USFWS, as part of our collaborative anti-trafficking work (see Anti-trafficking). Clive will be working with ZCP's Dr. Goran Spong on genetics of big cats and anti-trafficking, using an array of data from DNPW, ZCP, Wildlife Crime Prevention, and others in order to become a genetics specialist in the Department.

Professional Development Training

To conduct field-based conservation science requires a wide variety of skills and experience that is often difficult to integrate fully into training programmes. Consequently, with the onset of the rainy season and subsequent reductions in fieldwork we were able to launch an ambitious new online programme: Professional Development Training (PDT).

The PDT, developed by ZCP Kafue Project Manager Anna Kusler and Patty Riexinger (former Director of the New York State Department of Fish and Wildlife), provided a comprehensive overview of skills needed to work as a professional teammate and leader in conservation.

Because the dry season necessarily was focused on skills needed to conduct fieldwork, and academic training provides understanding of conservation principles, the PDT focused on the "people" side of things: such as how to work in a team, how to lead and manage others, how to set goals/objectives, and how to communicate effectively. This also included a number of key professional skills, including public speaking, the nuances of professional writing, and navigating the interface of science and the media.

ZCP Graduate student Dr. Kambwiri Banda on the MSU campus. Working with Dr. Scott Creel and supported by a WCN Veterinary Scholarship, Dr. Banda is evaluating the impact of de-snaring work in the Kafue and Luangwa Ecosystems.



ZCP Strategic Plan 2022–2026

Over the last 13 years ZCP has grown dramatically, and is currently at 57 team members working across five ecosystems, seven national parks and 7 Game Management Areas across Zambia. As with most small conservation organizations, success and expansion has come with growing pains, as the scope and breadth of the work has not been matched by organizational transitions in administrative capacity, funding and operational systems. Consequently, in 2021, with the support of WWF, we began an intensive collaboration with Maliasili to develop a Strategic Plan for ZCP to chart the next five years.

This integrated and comprehensive process was over a yearlong and engaged nearly all of our team members and partners to collectively develop a vision and strategy and reflect on our core strengths and needs. From this we developed two new organizational pillars, Conservation Leadership and Coexistence respectively, and move forward into 2022 and beyond with a clear purpose and vision to increase our impact. In addition to developing the Strategic Plan, we also signed an MOU with Maliasili to assist us in implementing the plan's components and in improving our overall functioning and effectiveness as an organization.



For two months of the rainy season team members from across all ZCP's sites, as well as members of partner organizations attended the PDT, learning from expert presentations from specialists around the world. The PDT's first iteration was a massive success, with over 28 attendants, and the program included nine lecturers from three different countries. The programme is now a mainstay for our wet season training and a key component of our organization's Conservation Leadership pillar.

African Conservation Leadership Network

The development of our 2022–2027 Strategic Plan (See Strategic Plan) with Maliasili highlighted the current and potential leadership

programmes of ZCP as a key area of focus going forward. As a result, we created a new organizational pillar of Conservation Leadership, aimed at developing current and future leadership in Zambia and the region. We were thus very fortunate to be selected by the African Conservation Leadership Network (ACLN) as their 2021–2022 cohort.

The ACLN programme is a year-long training developed and sponsored by Maliasili and The Nature Conservancy in Africa aimed at achieving greater conservation impact in Africa by improving the quality and effectiveness of leaders of local organizations that work with communities to protect their land, natural resources and livelihoods.

The ACLN programme selected two senior members from eight non-governmental conservation organizations across Africa, including the CEO of each. Given her work, experience and demonstrated potential as a leader, we were proud to select ZCP Kafue Senior Ecologist, Education Coordinator and Women in Wildlife Conservation Mentor Kachama Banda for this outstanding programme. In 2021 Kachama and ZCP CEO Matt Becker began intensive leadership training, mentorship, and peer-to-peer learning through a curriculum that integrates personal, organizational, and systems-levels approaches to leadership development. The programme continues into 2022 and beyond as ZCP team members gain valuable training, experience, and collaborations with similar conservation organizations across the region.

ZCP Senior Ecologist, Education Coordinator, and Women in Wildlife Conservation Mentor Kachama Banda was selected in 2021 to be part of the African Conservation Leadership Network's (ACLN) Cohort 4. The ACLN works to strengthen and develop a rising generation of African conservation leaders and their organizations.



Coexistence

Key outputs 2021

- 335 safari drives for 2,458 community members, employing 100 guides
- 405 Community Clean Sweeps conducted, employing 1620 community members and pulling over 200 snares
- 1025 livestock owners trained on carnivore conflict mitigation
- Two human-carnivore conflict mitigation plans developed for two ecosystems
- 2788 domestic dogs vaccinated for rabies
- 202 radio shows, conservation football, and theatre programs conducted to over 800,000 community members

Community Support in the COVID-19 Pandemic

Community Game Drives

The economic impacts of the COVID-19 pandemic continued to negatively influence wildlife tourism economies in 2021, particularly the country's premiere safari destination, the Luangwa Valley. An estimated 1,000 safari industry workers were unemployed or on reduced wages during the pandemic and had large numbers of dependent family members to support.

As part of our COVID-19 community support we continued and expanded our Community Game Drives throughout the year. Given over 20 lodges and several dozen bushcamps are typically operating in South Luangwa, the area's safari guides were largely out of work or on reduced wages. At the same time, communities living on the edge of South Luangwa National Park often rarely get to experience or understand the wildlife safari industry. Consequently, the

pandemic created a unique opportunity to help address these issues. Together with Conservation South Luangwa, the Luangwa Safari Guides Association, and numerous lodges, we employed guides to take members of the community on game drives in the national park, provide them a safari experience and teach about conservation efforts in the area. We hired 100 guides to conduct 335 Community Game Drives to 2,458 community members in 2021. For 57% of the community, it was their first time on a game drive, and participants ranged from 3 to 90 years of age. For 26% of the people, it was their first time seeing a lion. The success of this endeavor, and the economic and educational support it provides, have ensured that CSL and ZCP will continue this work with partners long-term, and this initiative was one of the few positives resulting from the pandemic.

A Community Game Drive watches a lion on a kill in South Luangwa National Park. Originally designed as a COVID relief initiative for the South Luangwa communities, this CSL-ZCP initiative has now become a long-term coexistence programme.



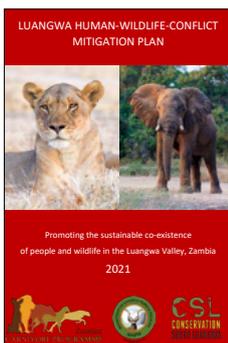


Community Clean Sweeps employ community members to pick up litter and snares in the areas surrounding South Luangwa National Park as part of COVID relief for communities. Similar to Community Game Drives, this initiative is now a long-term programme by CSL and ZCP.

Community Clean Sweeps

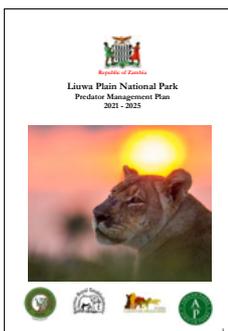
The pandemic impacts on wildlife tourism in South Luangwa also resulted in the loss or reduction of wages for the many employees working in lodges and bushcamps. At the same time, the economic downturn resulted in increases in poaching throughout much of Zambia's protected area network, and at a time when a presence from the safari industry was at its lowest. Consequently, we partnered with CSL to continue our Community Clean Sweeps programme, paying local community members for conservation services, picking up litter and removing deadly wire snares in the Game Management Areas surrounding South Luangwa National Park.

In 2021 we employed 1,620 community members to conduct 405 Community Clean Sweeps across Lupande GMA. These programmes were highly successful in providing immediate income to community members, and resulted in over 200 snares being confiscated across areas of high risk for carnivores. Like Community Game Drives these programmes will be continued long-term despite originally being designed for pandemic relief.



Human-Carnivore Conflict

Human-carnivore conflict (HCC) is a growing threat across the continent, with rapidly increasing human populations requiring more resources. In many areas of Zambia, conflict with livestock was historically minimal, due to tsetse fly-borne disease that limited the success of livestock. However, increases in tsetse control effectiveness, alterations in habitats, and rapid human demographic changes in and around protected area networks have resulted in significant increases in livestock, and subsequent HCC, particularly with lions.



We continued to expand the country's first Human-Lion Conflict Mitigation Programme in South Luangwa, working as a collaborative team with the DNPW and CSL, local communities, traditional leaders and Community Resource Boards (CRBs). With escalated HCC in prior years and a number of challenges, we answered the call to action by enhancing our mitigation strategies across five chiefdoms working with 525 livestock owners.

We began our work in the communities with conflict assessment and have added an array of mitigation activities that include boma trials, livestock cataloguing, aversive conditioning, early warning system and community outreach. For this mandate to be executed efficiently, we welcomed two additional HCC assistants to our team. They were instrumental in helping to roll out and monitor the different conflict mitigation activities in the Nsefu, Kakumbi and Mnkhanya Chiefdoms.

We encountered many challenges this year but we persevered – the future is bright, we have unprecedented support from local traditional leadership, the communities we work with and the CRBs. As part of this work we finalized the Luangwa Human-Wildlife Conflict Mitigation Plan. The plan, developed by all partners, provides a strategy and action plan to promote the sustainable coexistence of people and wildlife in the Luangwa Valley.

In Liuwa we successfully completed a year-long process of developing a five-year Predator Management Plan (PMP) for Liuwa Plain National Park, through a participatory approach led by African Parks, DNPW and ZCP and including traditional leaders, communities, and other stakeholders. Human-carnivore conflict mitigation work played a central role in the PMP, particularly with lions, and as part of the implementation of the plan a conflict mitigation team was developed that worked across 11 Silalo Induna chiefdoms with over 500 livestock owners, ranging on topics from lion predation to disease prevention.

Poisoning incidences were surprisingly non-existent; nevertheless, we conducted Poisons Response Training programmes for ZCP and partners in the Luangwa in 2021. The training was aimed at capacitating our teams to train others on poisons response, and to develop Poisons Response teams in each of the three sites, led by our wildlife vets stationed at each project.



Dennis Zimba, HCC Mitigation/Research Officer, uses an aversive conditioning technique on a boma.



ZCPs HCC officer and ZCPs CBU student Margret Mwale (L) and CSL HCC Officer doing a conflict assessment using a SMART installed device.



Kabwe Chanda (R), Luangwa's Outreach Officer, distributes posters and brochures on how to coexist with wildlife in Jembe.



DNPW-CSL-ZCP teams conducting assessments and sensitisation work with livestock owners.



ZCP HWC Officers Sandram Mwale (L) and Charles Njobvu distribute equipment to livestock owners as part of aversive conditioning and early warning systems to mitigate lion conflict with livestock.



National Geographic Explorer and ZCP Women in Wildlife Conservation graduate Mercy Njovu. Mercy received funding from National Geographic to conduct this work in order to protect communities, domestic dogs and wildlife from rabies.



Mercy Njovu (center) works with DNPW's Gibson Banda to vaccinate dogs as part of a CSL-ZCP-DNPW disease control initiative.



ZCP-APN Vet Dr. Brian Musalo vaccinates a domestic dog in Liuwa as part of the Liuwa Predator Management Plan's disease control strategy.

Disease Control and Mitigation

Zambia's protected area networks are largely characterized by unfenced, connected tracks of strictly protected national parks (with notable exceptions such as Liuwa Plain) surrounded by Game Management Area (GMA) buffer zones in which communities reside. Domestic dogs also reside in GMAs, and are often unvaccinated against diseases such as rabies, despite Zambian law requiring vaccinations. Across Africa and the world unvaccinated domestic dogs serve as primary sources of rabies outbreaks that threaten people and wildlife alike, and thus disease control and mitigation work forms a significant component of our work. In 2021, in collaboration with the DNPW, the Vet Department, African Parks and Conservation South Luangwa we assisted in vaccinating 2,758 domestic dogs across the Luangwa and Liuwa Ecosystems.

In the Luangwa, vaccination programmes continued to be led by CSL-ZCP veterinarian Dr. Mwamba Sichande, and were greatly assisted by the work of ZCP's Mercy Njovu. A vet school student at the University of Zambia, Mercy received a National Geographic Young Explorer grant in 2020 to conduct rabies vaccination programmes with domestic dogs in communities across the South Luangwa Valley. Together the teams vaccinated 477 domestic dogs across 6 chiefdoms.

In Liuwa, as part of the newly-implemented Liuwa Predator Management Plan, ZCP-African Parks vet Dr. Brian Musalo led the vaccination of 2,381 domestic dogs and 115 domestic cats across the National Park and Game Management area as part of a programme to reduce disease threats in the area and facilitate the restoration of African wild dogs (see Liuwa wild dogs). In addition, Dr. Musalo utilized his expertise in veterinary diseases to serve as an extension specialist for the communities within Liuwa Plain, assisting in maintaining healthy livestock to reduce disease risks in livestock, communities and wildlife.

Community Outreach and Education

Community Radio

Despite the challenges and restrictions posed by the COVID-19 pandemic, we still managed to conduct a variety of community outreach work in 2021, with the pandemic forcing us to be innovative in getting work conducted safely and effectively. One of the primary avenues for this work was community radio. Together with partners DNPW, CSL, Chipembele Wildlife Education Trust and Wildlife Crime Prevention we conducted 24 broadcasts to an estimated audience of over 50,000 community members. We continued co-hosting the Conservation Hour Radio Programme at Mnkhangya FM with partners, and covered a wide range of topics, including the history of conservation in Zambia, conservation challenges and field research techniques.

Human-carnivore conflict (HCC) continued to be one of the major topics of our radio programmes and we shared information on personal safety around predators and carnivore conflict mitigation methods. We also continued partnering with CSL on a radio program recorded in the field aimed at bringing out community perspectives on HCC mitigation. We premiered a new radio programme at Three FM in Chipata called Samalani Chilengedwe (Conserve Nature) in order to reach a wider audience. Finally, we expanded our radio programming to include wildlife story-telling for kids with Book Buddies Library, a local organisation that targets primary school children.

Conservation Ambassadors through Sports

Another unfortunate impact of the pandemic was the continued cancellation of the annual Carnivore Conservation Cup and Fun Run, hosted by CSL and ZCP. Thanks to the initiative of Luangwa Project Manager Henry Mwape, our community engagement through sports continued to grow, primarily through the Mimbulu Football Academy (MFA) conceived and developed by Henry. The word Mimbulu means wild dog in Nyanja, and the programme consisted of a local team playing in tournaments throughout the district while promoting carnivore conservation themes with their play.

Mimbulu Academy played in 40 tournaments in 2021 to an estimated 20,000 attendees. Acting as conservation ambassadors, the Academy invited key stakeholders to some of their events such as His Royal Highness Chief Kakumbi.



Community radio programming covers an array of conservation topics including Human-Carnivore Conflict to an audience across Eastern Zambia.



Conservation Ambassadors, the Mimbulu Academy, plays in football tournaments throughout Eastern Zambia while spreading a conservation message focused on carnivores.



Community theater group SEKA conducted conservation-themed plays (such as this one on human-wildlife conflict) in collaboration with sporting events and on community radio.

Community Theatre

In addition, SEKA group, a popular theater group in the Luangwa Valley accompanied the Mimbulu Academy and conducted 15 conservation shows highlighting trends of Human Carnivore Conflict and how to mitigate them. These plays were combined with Mimbulu tournaments and were recorded such that 24 performances were broadcast on community radio across six chiefdoms.



Safari guides from the Luangwa Valley Carnivore Monitoring Programme attend the annual awards ceremony with ZCP and DNPW. Sightings from these collaborations provide key information on carnivores across all study sites.

Citizen Science

Tourism continued to be significantly reduced with the pandemic, limiting the amount of citizen science possible through safari tourism. Nevertheless, we continued to operate these collaborative programmes with 65 guides across three ecosystems. In the Luangwa Valley work was conducted through the Luangwa Valley Carnivore Monitoring Program in partnership with the South Luangwa Professional Guides Association. Beginning in 2020 and continuing on in 2021, the program was negatively affected by an abrupt decrease in tourism linked to the COVID-19 pandemic. International travel restrictions significantly reduced the volume of tourists coming to the Valley, leaving a large number of lodge staff without consistent employment.

We worked hard to maintain our relationship with different tour operators throughout the Luangwa Valley during this difficult period. Of great mutual benefit during this time was our Community Game Drives in collaboration with CSL, which hired unemployed safari guides to

take community members on safari, and enabled us to continue receiving carnivore sightings data. At the end of the year, we held an event honoring the Community Game Drive guides who submitted the most reports. Ten guides received an award in 2021.

Despite the impacts of COVID-19 on the tourism sector, ZCP continued its longstanding partnership with Panthera to co-manage the Kafue Carnivore Coalition (KCC), compiling and identifying citizen science data from partners across the vast Kafue ecosystem. This citizen science programme, initiated by ZCP in 2012 and utilizing over a decade of data from our long-term intensive demography studies into the shared database, enabled the collection of substantially more sightings across the park, particularly those areas not covered by intensive monitoring efforts. Citizen science work in Liuwa was significantly curtailed through much of the year with limited tourism but we still continued to work with operators and tourists to collect sightings data.

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 a multitude 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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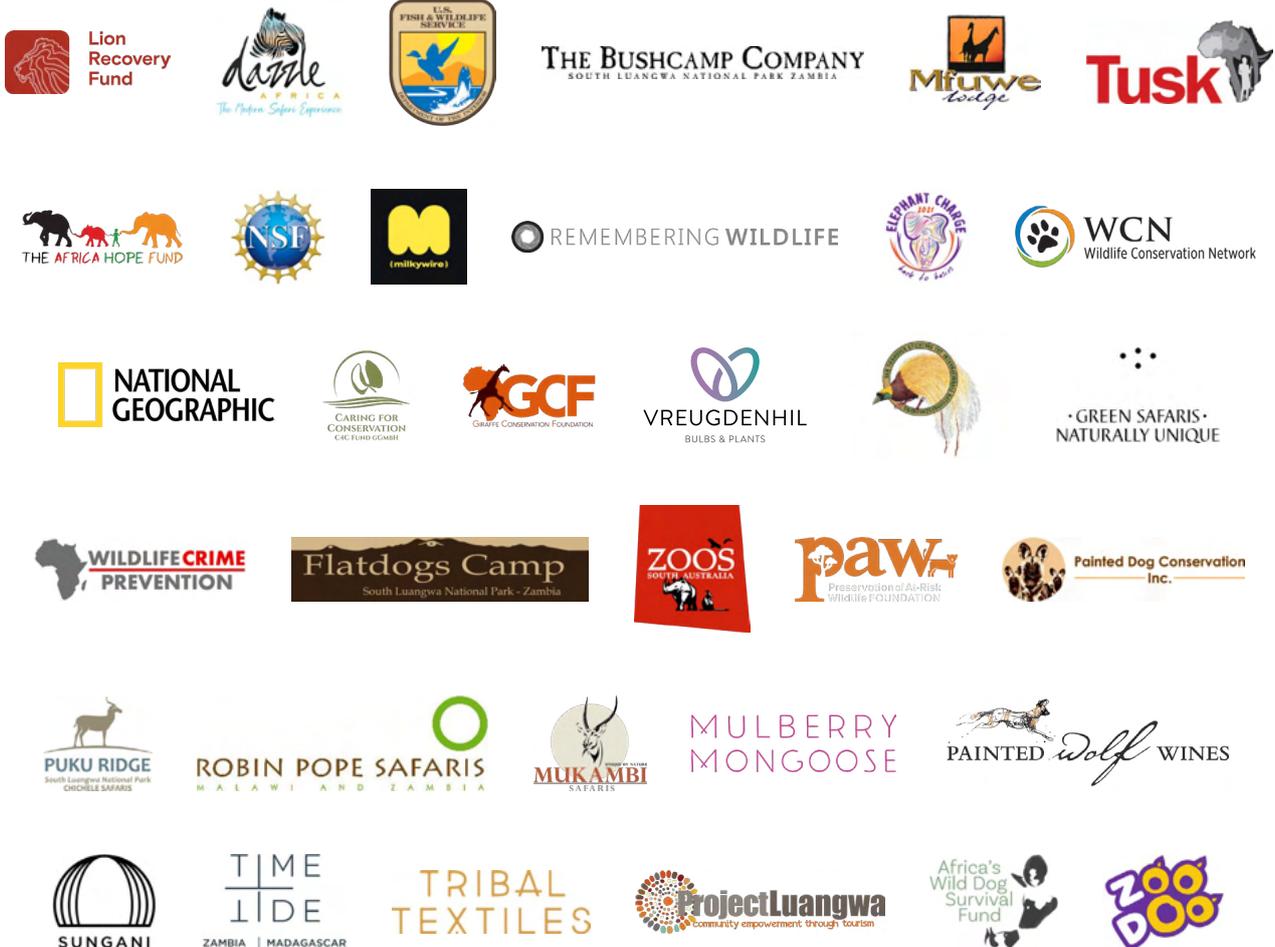




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Back cover: A hyena cub in the Greater Liuwa Ecosystem, the site of the country’s longest-running hyena conservation project as part of collaborative ZCP-DNPW and African Parks work. *Photo: Sandra Martens*



CARNIVORE PROGRAMME

