- Black-footed Cat Working Group -

Report on surveying, catching and monitoring Black-footed cats (*Felis nigripes*) on Grünau Farms, Namibia and Benfontein Nature Reserve, South Africa in 2021

Alexander Sliwa, Beryl Wilson, Martina Küsters, Axel Hartmann,
Michelle Schroeder, Shipala Ndele, Heidi Fölscher & Morgan Hauptfleisch

Introduction:

The Black-footed Cat Working Group (BFCWG) aims to conserve this rare cat species by furthering awareness and conducting multidisciplinary research on the species' biology. The BFCWG owns a research vehicle (Ford Ranger 2.6 l) which is insured, and its running and maintenance costs are covered through a dedicated Non-Profit Company since 2019. The specialised equipment required for our research is stored at the McGregor Museum, Kimberley, Northern Cape Province.

This year we made several trips to exchange the radio collars of four females and capture new individual black-footed cats (BFC) in southern Namibia, on farmland in Grünau (GR) from 18 – 28 June 2021, and then to exchange the radio collars of the individuals in the current long-term study area, Benfontein Nature Reserve (BFN), near Kimberley in September 2021. We also report here, in abbreviated form, on the Black-Footed Cat Research Project Namibia which is managed locally by Martina Küsters (wildlife specialist) and Morgan Hauptfleisch (Namibia University of Science and Technology). This project used a vehicle (an Isuzu D-Max 4x4) on a short-term sponsorship agreement from Auas Motors loaned to the BFCWG and NUST from February 2020. The vehicle was administered through the NUST Biodiversity Research Centre but returned to Auas Motors in September 2021. Another vehicle (Toyota Hilux) was loaned from the Namibian Chamber of Environment (NCE) from September to December 2021 and again from January to April 2022. The project was able to purchase a dedicated field vehicle from funds received from Cat Life Foundation in April 2022.

Background and Study Areas

Background: This project is part of a multidisciplinary effort to study the distribution, ecology, health, and reproduction of *F. nigripes* to collect long-term data. The aims are repeated captures of BFCs for biological sampling and radio-collaring for subsequent observation. Several methods like camera trapping, den monitoring, and focal animal surveys, were employed to survey areas previously known to hold BFCs. From November 2005 until the present, annual capture operations are conducted on BFN. From 2009 to 2018, annual captures were also conducted on two additional properties in the Upper Karoo, Northern Cape, close to the town of De Aar, before research ended on these properties in November 2018. In February 2020 we started with a new study area in southern Namibia. Eighteen reports are available detailing previous fieldwork for download as PDF on the website www.black-footed-cat.wild-cat.org.

1 – Grünau (GR) study areas in Namibia:

Private farmland comprising an extensive area of 70.000 ha with Dwarf Shrub Savannah vegetation in typical Nama Karoo habitat. The area receives low rainfall of 80-120 mm on average and is lightly stocked with sheep (*Ovis aries*). We captured and radio-collared four female BFCs in February 2020 here (Sliwa et al. 2021) and one female dispersed 25 km to the north two months later. A well-maintained grid of sand and gravel roads traverses the property allowing good survey coverage.

2 - Benfontein Nature Reserve (BFN):

A private nature reserve owned by De Beers Consolidated Mines, located 10 km southeast of Kimberley on the border of the Northern Cape and Free State Provinces in central South Africa. The majority of the 11 400 ha consists of arid plant communities receiving an average annual precipitation of 450 mm. BFN has been the subject of the first field study on the species by A. Sliwa in the 1990s (1992-1998) (Sliwa 2004, 2006, Sliwa *et al.* 2010) and continues to be an important site for long-term monitoring.

Methods:

(A) Spot-lamp searching: For a total of 7 nights (all on GR, none on BFN) a 4x4 vehicle (Ford Ranger 2.6 l) drove a route of 20–80 km in length along dirt roads at a speed of 20–30 km/h whilst looking for the characteristic bright eye-shine of cats. A minimum of three people (three this trip) stood on the open back of the vehicle operating two spotlights (1 million candle power / Lightforce® SL240 mm) nets, while two were in the front.

(B) Catching via searching and pursuit: Once BFCs were located by their eye-shine in the spotlights, their species identity was swiftly confirmed, when necessary, using 10x42 binoculars. If positively identified, they were pursued quickly by vehicle for a short distance of between 100–600 m until the cat squatted low on the ground in front of the stopped vehicle (*n*=3). Two people with fish landing nets then netted the cats. On other occasions, during the last years, the cats found a den system (dug by aardvarks, ground squirrels, or springhares) and were either captured by exposing them after digging or were lost when escaping deeper into the den systems. We captured all new cats (n=4) this year (2021) directly in the nets.

All captured cats were subsequently anaesthetised with an intramuscular injection of medetomidine, midazolam, and butorphanol and covered with a blanket to shield them from lights and sounds. During this Namibian trip, we processed the seven captured cats in the field. All animals were given complete physical examinations, had biological samples collected for disease and genetic studies, morphometric measurements obtained and all but one (too small) radio collars fitted. The anaesthetic drugs were reversed with an intramuscular injection of atipamezole, flumazenil, and naltrexone. The cats were then placed in a small plastic crate for awaiting full recovery (Eggers et al. 2020).

All BFCs were released back into a den close to their capture locations. A blanket was used to cover the den entrance, keeping them inside until they were fit to leave on their own accord. One or two digital camera traps were set close to the den entrance to record the cat leaving the den. There were no complications associated with these procedures and all radio-collared cats (*n*=6 GR and *n*=4 BFN) were confirmed alive and well on subsequent nights using telemetry and visual verification.

(C) "Digging" of previously radio-collared cats: This method was employed eight times this year. The entrance of the den system, in which the radio-collared BFC was resting during the daytime, was quickly draped with a net and the cat either ran into the net or was extracted after only slight and careful digging. The still-functioning radio collars of the females *Prima*, *Kara*, *Auas*, and *Lace* in Namibia were exchanged with slight digging or modification on their current dens being necessary, while the repeated capture of females *Kazi* and *Durga* as well the males *Hamba* and *Phusa* on BFN made extended but highly careful excavation necessary for want of another opportunity to apply other methods.

(D) Live trapping: no trapping was performed on this field trip.

The capture vehicle in Namibia was staffed in June 2021 by:

Ms. Beryl Wilson, zoologist, McGregor Museum, Kimberley, South Africa (berylwa@gmail.com)
Ms. Martina Küsters, field researcher BFCWG, Black-footed Cat Research Project Namibia, Swakopmund, Namibia (kusters.m@hotmail.com).
Dr. Alexander Sliwa, behavioural ecologist and zoo curator, Cologne (Kölner) Zoo, Germany (sliwa@koelnerzoo.de)
Dr. Axel Hartmann, veterinarian, Ministry of Environment, Forestry and Tourism, Etosha Ecological Institute, Okaukuejo, Namibia (axel.hartmann@meft.gov.na)
Mr. Shipala Ndele, field technician and NUST student, Windhoek, Namibia

The capture on BFN (South Africa) was staffed in September 2021 by:

Ms. Beryl Wilson, zoologist, McGregor Museum, Kimberley, South Africa (berylwa@gmail.com)
Ms. Michelle Schroeder, field technician, BFCWG, Kimberley, South Africa (MustelaMichellea@gmail.com)
Dr. Axel Hartmann, veterinarian, Ministry of Environment, Forestry and Tourism, Etosha Ecological Institute, Okaukuejo, Namibia (axel.hartmann@meft.gov.na)
Mrs. Heidi Fölscher, zoology collections manager, McGregor Museum, Kimberley (heidi.folscher@gmail.com)

Results:

Trapping: no trapping with cage traps was performed on this field trip.

Spot-lamp searching and catching/exchanging of radio collars:

***GR*, Namibia:** Total distance searched was 521.8 km (average 74.5 km/night) and the total time spent searching was 25 hrs 19 min (Küsters et al. 2021b). We saw nine BFCs during seven nights of searching (129% chance of sighting a BFC/night) and caught four of them (100% capture success of those we attempted for) – all of them female. We collared the older adult *Nama* and the young adult *Zola*. We didn't collar the two juvenile females, since they were with 910g and 850g below our 1 kg cut-off to radio collar but microchipped them for recognition if re-captured later and took hair samples for genetics. We also captured an African wildcat (*Felis lybica cafra*) kitten, another one ran away and we also spotted the likely mother of these kittens on one of the consecutive nights. During these night drives combined we observed other carnivore species such as aardwolves (*Proteles cristatus*), bat-eared foxes (*Otocyon megalotis*), and several Cape foxes (*Vulpes cana*), common (small-spotted) genets (*Genetta genetta*) and striped polecats (*Ictonyx striatus*). We also observed aardvarks (*Orycteropus afer*), porcupines (*Hystrix africaeaustralis*), and spotted eagle-owls (*Bubo africanus*). We didn't spot any black-backed jackals (*Lupulella mesomelas*) or caracals (*Caracal caracal*) in the area of GR.

We exchanged the still-functioning radio collars of the four females *Prima*, *Kara*, *Auas,* and *Lace* with new collars, by locating them in their dens. Particularly with *Lace,* we made sure to not disturb her remaining small kitten too much when working on her and placed her back in her den with the kitten when finished. Thus, we had six radio-collared BFCs on GR when the BFCWG left on 27 June 2021.

BFN: no spot-lamp searching was performed here in 2021. We exchanged the still-functioning radio collar of the males *Hamba* and *Phusa*, as well as those of the females *Kazi* and *Durga* with new collars, by locating them in their dens. Careful extraction via slow digging exposed them for an anaesthetic injection and all four individuals were fit and showed no obvious aversive reaction when checked over the consecutive days. Thus, we had four radio-collared BFCs on BFN by late September 2021.

Monitoring radio-collared cats on GR and BFN*:*

GR: The field technician, Shipala Ndele, was able to complete three tracking periods. Initially from 20.2.-18.3.21; then again from 20.5. and continued tracking all six females directly after their capture and re-capture in late June up until 20.7., after a break, he then returned to the study site from 5.9.- 29.11.21. All females maintained relatively stable and mostly smaller than last year's annual home ranges.

Altogether 1 177 waypoints were collected for the six females, while the two newly radio-collared females *Nama* and *Zola* were only tracked for the period of five months and thus probably didn't display the full extent of annual home ranges, while the females we had already captured in 2020 were tracked for a whole year's cycle. This is a very solid foundation for defining their annual home ranges and will serve as highly interesting comparisons between years and study sites. Home range size estimates incorporating all collected waypoints for all the individual cats tracked in 2021 are provided in Table 1 and Minimum Convey Polygon (MCP100%) outlines are shown on Map 3.

BFN: Field technician Michelle Schroeder tracked the four radio-collared cats in their dens during daylight and at night. Enough waypoints were acquired to determine the full sizes of their annual ranges. She was assisted on occasions during the day by Heidi Fölscher with the McGregor Museum's Toyota Hilux Legend when the project vehicle was undergoing repairs. Overall, 1 221 waypoints were collected up until 31 December 2021. Home range size estimates incorporating all collected waypoints for all the individual cats tracked in 2021 are provided in Table 1 and Minimum Convey Polygon (MCP100%) outlines are shown in Map 1.

Black-footed cats in 2021:

GR area:

Female *Prima*: After her shift north onto the Mickberg Farm in April 2020 she has remained there with a stable smallish 2021 annual home range (9.4 km², 230 waypoints), where she also gave birth to two litters in 2021.

Female *Lace*: Adult female in good body condition. She had a large but stable home range in 2021 (19.3 km², 217 points). She is still the shiest of the Namibian females. She had a litter of three born in early May and another one in November 2021.

Female *Kara*: Adult female in good body condition, highly gravid when we caught her in late June 2021 for radio collar replacement. She is still the best-habituated female with a medium-sized and stable home range of 13.4 km² (252 points) for 2021. She gave birth at least once, but kittens were never recorded.

Female *Auas*: Older adult female; she was very thin when first caught in March 2020 but had gained condition and weight upon re-capture in June 2021. In 2021 she again shifted her home range across the B1 road from north of the Gamkab River to south of the B1 road (Map 3). She has habituated well to being tracked. Her total range in 2021, with the renewed range shifts was 82.8 km² (266 waypoints), however, it is actually two core home ranges with a 10 km distance between them, still very large for a female BFC. She had two litters in 2021.

Female *Nama*: Adult female in good condition who had kittens before, captured for first time on 21.6.21 in an area used by the two females *Kara* and *Auas* and could be related to them. *Nama* and *Kara*'s home ranges are currently overlapping, *Auas* dispersed from that area in May 2021. *Nama* is still fairly shy and used shrubs for cover to move around in her home range, when tracked, and covered an average-sized home range of 17.6 km² (101 waypoints) in comparison to the other females during 2020 and 2021. She had two litters in 2021.

Female *Zola*: A young adult female in good condition caught on 23.6.21, which by then didn't have kittens. She used a strongly overlapping home range of 13.5 km² (112 waypoints) with female *Lace*. She had two kittens in November 2021.

BFN

On a positive note, all the four BFCs monitored in 2021 survived, so we can report on their activities throughout this year**:**

Male *Hamba*: An adult male with a stable home range in west-central BFN, where we first captured him in November 2018. He was well-habituated. Surprisingly he didn't gain in weight or size since the last capture, so this seems to be his final size as a resident male. He didn't reach or surpass the >2 kg body mass of a dominant resident male with a broad head and shoulders, whilst observed mating and

frequently spray marking his range, a sign of residency. He had a slightly smaller home range for an adult resident male on BFN (18.3 km², 272 waypoints) in 2021 than previously published (Sliwa 2004).
Male *Putter*: An adult male in good condition, first captured in March 2020, likewise relatively small-bodied for an adult male. He was mainly roaming in the southwest and central area of BFN, even sometimes leaving the property for excursions to the adjacent southern neighbouring farm Melrose. In 2021, he maintained a home range of 18.96 km² (280 waypoints), like *Hamba*.
Female *Kazi*: A large adult female, tracked since November 2018, always seeming restless and often shy. She maintained a remarkably small home range of only 5.8 km² (305 waypoints) in 2021, even smaller than the 7.2 km² in 2020, however in prey-rich "pan veld" habitat. She bore kittens on two occasions in 2021, but none survived.
Female *Durga*: An adult female first captured in March 2020. In 2021 she maintained a similarly small home range (6.5 km²; 364 waypoints) as in 2020. She had two litters in early and mid-summer 2021. She is often in long grass and shy.

Despite their small home range sizes females *Durga* and *Kazi*, had, in addition, overlapping home ranges (~20-25%) while male *Putter* overlapped *Durga* entirely (100%) and to a large part (~70%) that of *Kazi*. Male *Hamba* stayed in the eastern section of BFN, and thus had no overlap with the other three monitored cats.

Fire: An exceptional environmental incident happened on Benfontein when, on the night of 27 September, a fire came through from the west and burned about 50% of the reserve (Map 2). This included parts of the home ranges of all four monitored cats. In all the years since the initiation of the black-footed cat field studies in December 1992 Benfontein has never burned this extensively. All four cats were luckily confirmed alive and well the next night through tracking. Over the following days and weeks, they shifted to the unburned parts of their so-far used home ranges, no significant long-distance movements were recorded due to the fire. Two of the cats (*Hamba* and *Durga*) were in their dens when the fire burned the grass above them. *Durga* even reused a large aardvark burrow in the burned area for five days in early October after having her kittens merely a week after the fire.

Observations of Black-footed Cats: A total of 10 cats were monitored via telemetry during 2021. Most were well-habituated through the field technicians and provided valuable insights into the killing of various prey species. A new prey species was confirmed when following female *Kazi* on BFN, of the killing and eating of a lesser red musk shrew (*Crocidura hirta*) (Fig. 27). Additional information on spray-marking, courting during the mating seasons and the birth of kittens was recorded. These excellent data sets will allow meaningful comparison of annual home range sizes between years and between study areas in future analyses.

Reproduction on GR: Of the six females tracked in 2021, we have confirmed reproduction in the following females (Küsters et al. 2021a & b).
Auas: Camera trap footage revealed that she had two kittens on 1 June 2021, estimated then at 2-2.5 months old. By 18 June, only one kitten, estimated at 3-4 months old, had survived. It was rarely seen with *Auas* afterwards (Fig. 10), probably hunting independently but still within her home range. Auas was observed on 11 October 2021, when she moved very close to the tracking vehicle and three little kittens following her. By 19 November only two had survived identified from camera trap photos. They hopefully survived to independence as they were not recorded beyond 9 weeks of age, too early for independence.
Kara: Highly gravid when we captured her on 22 June, she must have given birth between 23-27 June. Her kittens were never seen/recorded, also not in September and we fear they may have not survived for long.
Lace: Three kittens were recorded on a camera trap set at her den on 11 June 2021, estimated at 4 (Alex's current estimate from pictures) weeks old. A week later (19 June) only one remained. The male

kitten was seen by Shipala until 20 July, then about 9 weeks old. Thereafter we have no information about its survival as the kitten was not seen again in early September. Two more kittens were born around 12 November 2021 in a deep den and were observed playing on 21 December 2021. They were both seen last on 26 January 2022, at about 2.5 months of age. Tracking stopped on 30.1.22, so we don't know if they survived to independence.

Nama: She had a single kitten, estimated at about 2 months old at the end of June 2021, detected via camera trap after we captured her. The kitten was regularly seen at the den and with *Nama* at night. As kittens get older, female and kittens often do not sleep in the same den, so capturing them on camera traps is challenging and doesn't allow conclusions about their survival. Another single kitten was seen in the entrance chamber to *Nama*'s den on 1 November 2021. Its eyes were still closed, so was estimated at less than a week. Unfortunately, the fate of the kitten is not known as it was never seen after that, including at a den Nama used in January 2022, when the kittens would be estimated at nearly two months old and still dependent on their mother.

Prima: She gave birth to two kittens between 22-26 June 2021. Shipala confirmed one of the kittens with estimated 82 days of age (~3 months), last on 12 September. Thereafter we have no more records of its survival. An estimated one-month-old kitten was seen peering out of a den on 19 November. This kitten was again recorded on camera at a den, much older and stronger on 21 December 2021. It was not recorded again since, no tracking and or camera trapping took place between 30.12.22 - 13.1.22.

Zola: On 1 November 2021 two very young kittens, with eyes still closed (< 5 days], were seen lying huddled up together in the entrance chamber of the den. It's very unfortunate that we did not obtain further footage of her kittens on camera traps and they must not have survived, as *Zola* was captured on camera moving a young kitten (~10-14 days old) on 26 January 2022. The interval between the two litters is too short for the litter born at the end of October 2021 to have survived to independence as she must have been mated in mid-November 2021 again. This kitten was last recorded on 27.3.22, so at 2.5 months old.

Two juvenile female kittens (*JuvF1* & *JuvF2*, Tab. 1) were caught in late June (Table 1). When considering their body weight of 830 g and 920 g they were probably four to five months old, on the verge of independence. We didn't anesthetise them so could not accurately check their dentition. They were born probably in late February 2021 and were still living close to or within their mothers' home ranges.

Reproduction on BFN:

Kazi: Her single male kitten of early October 2020 was last seen on 13 January 2021, thus disappearing at about 2.5 months of age, too young to have become independent. She was observed breeding with an uncollared male already on 6 Dec 2020 while the October 2020 kitten was still dependent. Subsequently, she gave birth to two kittens first observed on 15 Feb 2021 (estimated 1 week old). They were last observed on 2 March 2021, and later presumed dead. *Kazi* was using shallow old aardvark burrows and thus kittens would have been vulnerable to predation. She was suspected of having given birth in October 2021 based on proximity of day locations after being palpated gravid with two kittens upon her capture in late September. However, kittens were not observed (heard, seen, captured on camera trap, or observed in the burrow using a probe after *Kazi* left her den). No subsequent reproductive behaviour was observed during the 2021 early summer months.

Durga: She had a single male kitten in October 2020, which was last on 5 Feb 2021. On 24 September 2021 for the radio collar exchange, *Durga* was pregnant with two young estimated due in a fortnight. *Durga* reused a large aardvark burrow in the burned area for five days with repeated visits at night to the den (4-9 Oct 21). We suspected she had kittens in this burrow, but they did not survive. She was observed mating with *Putter* on 13 Oct 2021. Gave birth in mid-December and one kitten at two weeks of age was first observed on 1 Jan 2022. It was last observed on 14 Feb 2022, so not presumed to have survived to dispersal and thus dead.

In summary, although there were four litters in 2021 born by the two females on BFN and they were in good body condition, no kitten born survived for long and certainly not to dispersal. Thus, the year 2021 was really not successful, despite proper rains.

Camera Trapping: The field technicians deployed digital camera traps (Bushnell Trophy Cam HD Nature View with close focus lens, Browning Strike Force Pro XD, Secacam Pro, SpyPoint Force-11D) to acquire regular pictorial material of all the monitored cats and to check for the presence of kittens (Sliwa *et al*. 2018) (Küsters et al. 2021a & b) at their subterranean dens (Figs.12, 16, & 24, 25, 27).

Scat Dog work: While the 2020 pilot study revealed that detection dogs can effectively find BFC scat (i.e. faeces), it fell short of meeting specific population metrics. Thus 2021 efforts expanded scat detection dog surveys across the entire BFN study area. This year, Michelle Schroeder trained "Lyka" a female German short-haired pointer (Fig. 22.; Fig.23) owned by the BFCWG project manager Beryl Wilson. Following four months of training, they completed 97 km of systematic transect surveys on foot (Lyka covered 2.7 times the distance) between July and October 2021. The dog found 61 samples suspected to belong to the target species. Further DNA analysis will confirm donor species and individual identity to derive estimates using a 'mark-recapture' framework. The effectiveness of this non-invasive technique (detection dogs and genetic analysis of scat) will hopefully open the doors for additional BFC studies across their distribution, filling existing data gaps to inform the magnitude of threats facing the species. Scat detection surveys are planned on the Grünau farmlands in July 2022.

Conservation Genomics: Through a collaboration with Stanford University's Program for Conservation Genomics, South African BFC samples that were previously stored at the San Diego Zoo Wildlife Alliance have been sequenced for their whole genome using a mix of Illumina short-read and Pacbio long-read technology. One of the male individuals from the BFN site has been sequenced using Pacbio long-read technology for high coverage with the aim of establishing a reference genome. The next stages for the genome assembly include scaffolding to add to contiguity before final quality checks and release. Establishing a high-quality reference genome will assist planned analyses for this current project while providing aid to future studies focusing on BFC evolution and general biological questions. In addition to this Pacbio individual, 34 additional samples have been sequenced using Illumina Hiseq and Novaseq technology. These samples will be used to determine the population structure of the sample set and establish heterozygosity levels within these potential population groups. These future analyses provide an opportunity to learn more about the species at a genomic level and reveal any potential concerns such as signs of inbreeding, and other information about gene flow between populations. Additionally, this data will be used to develop a genomic tool for non-invasive population monitoring in conjunction with the scat detection dog project. This novel genomic research is led by Stanford Ph.D. candidate Victoria Grant.

Outreach and social media coverage of BFCs and the BFCWG: Throughout 2021 several members of the BFCWG have spread information on the species, through interviews and presentations about our joint research. Scientific tourists and interested laypersons were provided the opportunity on a few occasions to join in tracking sessions of the radio-collared BFCs. We continue to have our almost annual field capture trip followed on social media by ISEC Canada (International Society for Endangered Cats) as part of their long-term crowdsourcing project for the smaller wild cats.

Also, since November 2018, Beryl Wilson and Alex Sliwa regularly update the Facebook Page "Black-footed Cat Working Group" https://www.facebook.com/groups/black.footed.cat/ with publicly visible posts. These are shared from the public Instagram page "blackfootedcat.life" https://www.instagram.com/blackfootedcat.life/ administered by Alex Sliwa with posts about every 4-7 days using pictures of black-footed cats and other parts of the species biology and the research endeavours taken over the past decades with a few sentences of informative text.

Martina Küsters started the Facebook page "Black-footed Cat Research Project Namibia" https://www.facebook.com/blackfootedcatsnam/ and developed a new logo for it, which was used on the vehicle, in reports, and also on the certificates presented to supporters of the projects, including farmers and financial sponsors. The "Custodian of black-footed cats" [Bewaarder van miershooptiere] program aims to recognise landowners/ farmers throughout Namibia who voluntarily strive and commit to conserving the BFC and its habitat; support active research and practice selective species-specific methods of predator control measures. This may promote overall biodiversity conservation and raise awareness within the farming community and the public. Interested farmers can contact the project coordinator Martina Küsters at bfootedcat@gmail.com.

The field technicians provided regular updates on the monitored cats and wrote several (*n*=4) field reports for sponsors, leading to excellent support even in these difficult Covid-19 times in 2021.

Non-Profit Company (NPC): The Working Group continues to be solvent and funding for fieldwork is still possible for the next financial year. There are no outstanding debts or stipends owed. However, there are pledged funding outstanding from sponsors, which we hope to receive in 2022.

Publications, conference papers, and presentations by BFCWG group members on *Felis nigripes* in 2021:

Küsters, M. & Ndele, S. (2021) *Thank you for sponsorship, update to Auas Motors.* Nictus Holding Head Office, Windhoek. Unpublished PowerPoint Presentation, 27 slides.

Küsters, M. (2021) Black-footed cat research Project Namibia. Unpublished progress report. Namibian Commission on Research, Science and Technology, Windhoek. Permit renewal application August 2021.

Küsters, M., Hauptfleisch, M., Sliwa, A. & Ndele, S. 2021a. Black-footed cat research Project Namibia. Project update April 2021. Unpublished report, 6 pp.

Küsters, M., Hauptfleisch, M., Sliwa, A. & Ndele, S. 2021b. Black-footed cat research Project Namibia. Project update August 2021. Unpublished report, 10 pp.

Schroeder, M. 2021a: Update from the field: Black-footed Cat Working Group – February 2021. Unpublished report, 7 pp.

Schroeder, M. 2021b: Update from the field: Black-footed Cat Working Group – July 2021. Unpublished report, 9 pp.

Schroeder, M. Herrick, J., Küsters, M., Lamberski, N., Sliwa, A., Wilson, B. – July 2021. *Black-footed cats (Felis nigripes): 28 years of in-situ research and monitoring by the Black-footed Cat Working Group.* Cleveland Metroparks Zoo. Unpublished PowerPoint Presentation, 30 slides.

Sliwa, A., Wilson, B., Küsters, M., Herrick, J Lamberski, N, Hartmann, A. Anver, J., Schroeder, M., Shipala, P. & Hauptfleisch, M. 2021. Black-footed Cat Working Group - Report on surveying, catching and monitoring Black-footed cats (*Felis nigripes*) on Benfontein Nature Reserve, South Africa and on Grünau Farms, Namibia in 2020. April 2021. DOI: 10.13140/RG.2.2.17733.78569.

Discussion and Conclusions:

Valuable data on censusing and monitoring of black-footed cats was collected again by the BFCWG in 2021. We saw more than one BFC per night on GR (129% chance of sighting a BFC/night) and caught

four (100% capture success of four attempts) of them in seven nights, while we didn't attempt any new cat captures on BFN in 2021.

The BFC sighting frequency on GR was thus higher than during the previous year, but in the range of the two South African study areas over the years (Sliwa et al. 2019; 2020). The capture success was similar and comparable to that of preceding capture periods in previous years. On BFN we managed to exchange all four still functional radio collars of cats monitored since March 2020, some of them already since November 2018. We had no restrictions for the first six nights of searching on GR but had to stop early on the 7th night due to tyre and electrical problems with the research vehicle. We saw no jackals and caracals during any of the seven nights of spotting on GR. For the days preceding the capture operation and afterward, several uncollared BFCs were spotted by M. Küsters and N. Shipala, including males attending our radio-collared females. Despite a continuously high jackal density on BFN (pers. Comm. M. Schroeder) sighting frequencies of un-collared cats confirm that there is still a good population of BFCs of both sexes, probably both resident and transient, on BFN.

2021 has been a year of kittens in GR. We recorded 11 litters born from May-December 2021, totaling 20 kittens from the six females. Some females had more kittens than others, but the high reproduction rates are phenomenal, maybe due to improved productivity and higher prey densities through good rainfall in 2021 (Küsters et al. 2022). The two juvenile females we caught on GR and didn't collar, due to their insufficient body weight, were likely born in February 2021 and may have been clandestinely born and raised by females *Kara* and *Lace*, or even yet by not detected and caught adult females in the adjacent areas of the monitored females' home ranges (Map 1). It is unusual for females to give birth in the colder months of the year (June, July, August), with litters usually born from October to March, but some births have been recorded until May (Sliwa et al. 2010). In contrast reproduction on BFN was not good in 2021. *Kazi* had two reproductive events with none of the kitten(s) apparently surviving. This seems unusual, perhaps above average rainfall (800mm – 2020, 700mm – 2021), plus the grass boom post-fire has resulted in reduced fitness (disease, higher parasite load, difficult hunting conditions in thick/tall grass). *Durga* only had litters in early October and mid-December 2021, none apparently survived to dispersal as of February 2022.

On BFN, we had remarkably all four radio-collared cats survive throughout the year 2021. This zero mortality rate, although looking at only a small sample size is unusual, given that we had 38% in 2020 and 50% in 2019 due to predation. Likewise, we had zero mortality on GR, including the two new females, thus for six monitored cats there. In general, the year 2021 has been an exceptional one in terms of no BFC mortality for 10 individuals, which may also have to do with the fact that all but one cat (*Zola*) seems to have been established residents, with no added dangers encountered during dispersal.

Home range sizes of cats on BFN were mostly lower than previously recorded (Table 1, Map. 2), lower than average published for the respective sex from the 1990ies (Sliwa 2004). All but one (*Putter*) of the four cats had smaller home ranges than in the previous year (Sliwa et al. 2021), however, *Putter* and *Durga* were only monitored for 10 months of 2020, after their capture in early March. This smaller than average size of home ranges could have been due to higher prey density, due to good rainfalls throughout the year, but also that the home ranges of these four cats were generally located in productive BFC habitats when looking at it over the past decades. Remarkably the overlap between three of the cats was also surprisingly high in the southwestern part of BFN (Map. 2).

Home ranges of the six females from GR in Namibia with a much drier habitat than BFN, were at least double their size (Map. 1, Tab. 1). Home range shifts, like that of *Auas* obviously greatly increased home range size. This second year of monitoring for females in GR is highly interesting with the range between 9.4 to 82.8 km² (MCP100), an average of 26.0 ± 28.0 (SD) km² (n=6) but a mere median of 15.6 km². This is a substantial change when looking at the ranges of the four females from 40.8 – 213.0 km² (mean=

108.1 ± 79.2 (SD) km²; median= 89.3 km²) in 2020. Also, GR received better rainfall in 2021 than in the previous year. The four females monitored since 2020 may also have settled more securely into their ranges due to their high reproductive activity in 2021, caring for multiple litters of kittens, which resulted in their much more restricted ranging, as reported for one female on BFN (Molteno et al. 1998) in the late 1990ies. Even with median home ranges of 15.6 km² in 2021 GR females have much larger HRs than the two females on BFN (5.8 and 6.6 km²) in 2021, likely due to a significantly lower prey density in the two study sites.

This year's so far unique event was the fire that burned about 50% of BFN study area, including the same proportions of the four study cats' home ranges. Remarkably there wasn't a strong discernible effect on their ranging behaviour, the cats only minimally moving, staying in their dens when the fire burned the dry grass above them. One female even reused a den whose surroundings had burned to raise her kittens shortly after, whilst the ground was still charred black. Fire seems to have a rejuvenating effect, probably making parts of BFCs' home ranges even more suitable for hunting when fresh new grass is sprouting and rodents feeding on these shoots immigrate, like the gerbil mouse (also called a large-eared mouse, *Malacothrix typica*), prey for the BFCs.

With two active field sites, BFN with four radio-collared cats and GR with all of the four radio-collared cats surviving for a whole year, plus two new females radio-collared, the BFCWG was happy to enlist the work of two field technicians in 2021, collecting 1 221 waypoints on BFN and 1 177 waypoints on GR (Maps 1 & 2; Table 1). This was possible despite the difficulties in schedules, some vehicle issues on both BFN and lockdown in GR. Both field technicians, one for each site, have their own future research plans.

The BFCWG will return to the study sites for capturing and sampling of wild black-footed cats earliest in late 2022, because the batteries of the currently fitted radio collars should be operational for a minimum of 18 months, thus at least until early 2023.

Acknowledgments: We thank De Beers Consolidated Mines and the Diamond Route for permission to work on Benfontein NR, South Africa. Landowners and farm managers that border Benfontein, are thanked for their continued support and permission to enter the properties to check on cats. Heidi Fölscher and the McGregor Museum for assisting in the field during a period when the project had no field vehicle. Funds for fieldwork came from Cologne (Kölner) Zoo; Zoo-Verein Wuppertal e. V. (friends of Wuppertal Zoo); Ch. Ritzen, K. Stellmacher, A. Brüggemann & Koch Gang; - all Germany; Zoological Association of America (ZAA), Punta Gorda FL, USA; Omaha's Henry Doorly Zoo & Aquarium, Omaha, NE, USA; San Diego Zoo Global, CA, USA; The Living Desert, Palm Desert CA, USA; Denver Zoological Foundation, CO, USA; The International Society of Endangered Cats (ISEC), Canada, provided funds and again reported directly to their sponsors when we were in the field and through all the field technicians' quarter-yearly reports. We sincerely thank our respective employers for supporting us and granting us leave from our busy work schedules to carry out this fieldwork.

Scat dog detection work was made possible through genetic work led by Vimbai Sizwiba, Ph.D. candidate at the University of Kwazulu-Natal. Scat detection dog *Dougal* was temporarily loaned by his owner Carolyn Geary, Purposefully Lost, Hoedspruit, SA. This project received additional support from Panthera's Small Cat Action Fund, USA.

In Namibia, we sincerely thank the van der Merwe family, in particular Kobus and Margaret for their continued support and permission to conduct the research on their farm near Grünau. All the farmers in the Grünau area are thanked for supporting, helping and allowing access to their properties in order to monitor the radio-collared BFCs: Johandre & Anri van der Merwe; Marisa & Phillipus Fourie; Alwyn Smith; Dolf & Kinna de Wet; Rean Steenkamp & Barend Matheus Swartz.

The Black-footed Cat Research Project Namibia wishes to acknowledge our generous international funders: Naples Zoo and Tim Tetzlaff for funding fieldwork, Dr Alex Sliwa through Cologne Zoo and the Black-footed Cat Working Group for equipment and technical support. The Cat Life Foundation is sincerely thanked for substantial funding to purchase a dedicated field vehicle for the project and fieldwork. April Campbell made funds available to cover costs of vehicle insurance, vehicle registration and other vehicle-related expenses. ISEC is thanked for its financial support to the Black-footed Cat Research Project, enabling fieldwork to continue, thank you. We are grateful to Secacam for donating camera traps.

To our local Namibian funders: Thank you to Philippus and Gerard Tromp of Nictus Holdings Ltd. and Gerhard Vermeulen, CEO of Auas Motors for the significant loan and maintenance of an Isuzu D-Max 4x4 bakkie to enable fieldwork. The Namibian Chamber of Environment (NCE), B2Gold and Total are acknowledged for substantial funding awarded for 2021-2023. NCE is also acknowledged for the loaning of vehicles for field work and for crucial administrative work for the project. A big thank you to the Pupkewitz Foundation, Agrimark and Pupkewitz Megabuild for sponsoring accessories and equipment for the new field vehicle and 540 litres of diesel fuel. Alex Maritz, AM Designs is thanked for assistance with the logo design for the project.

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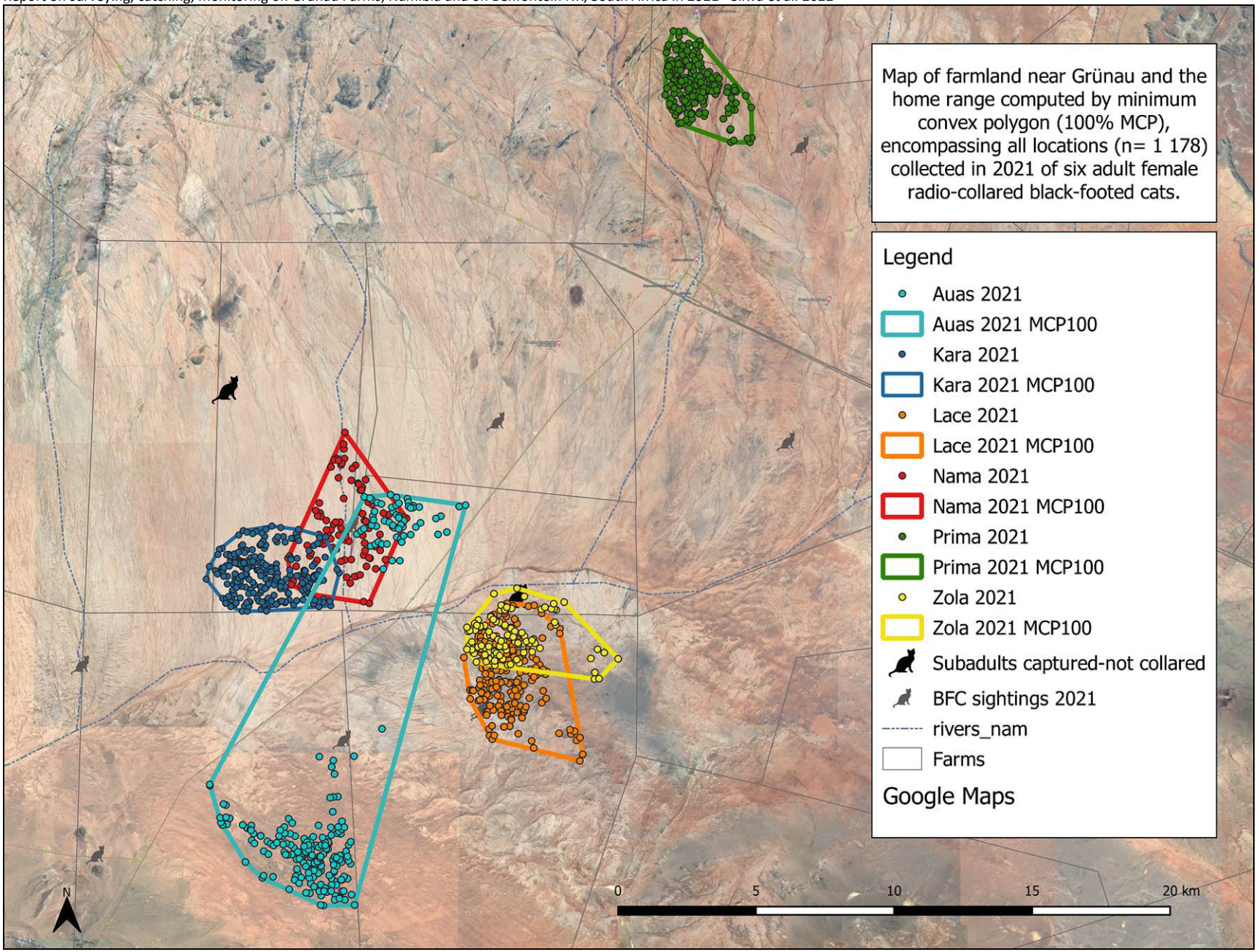
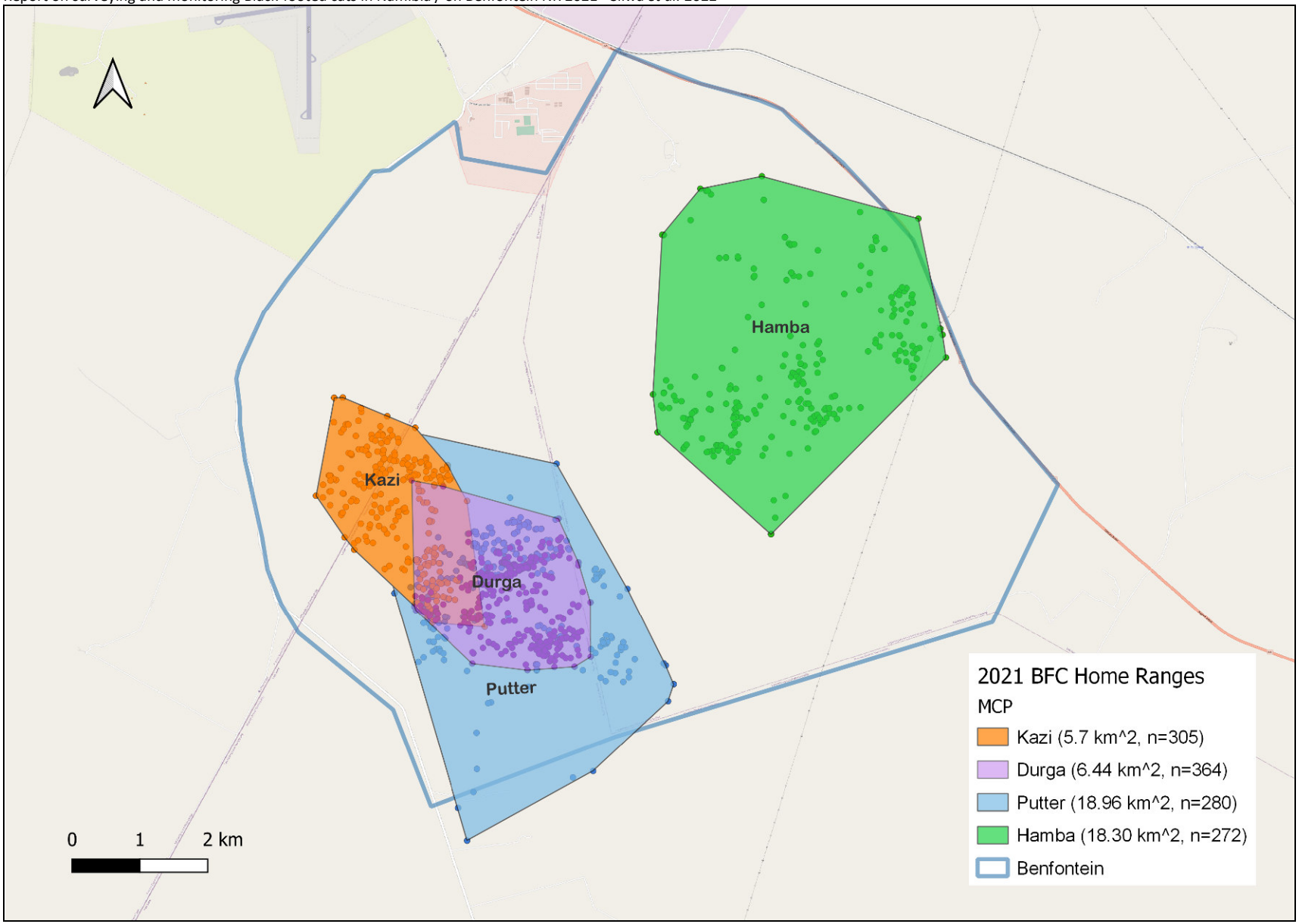
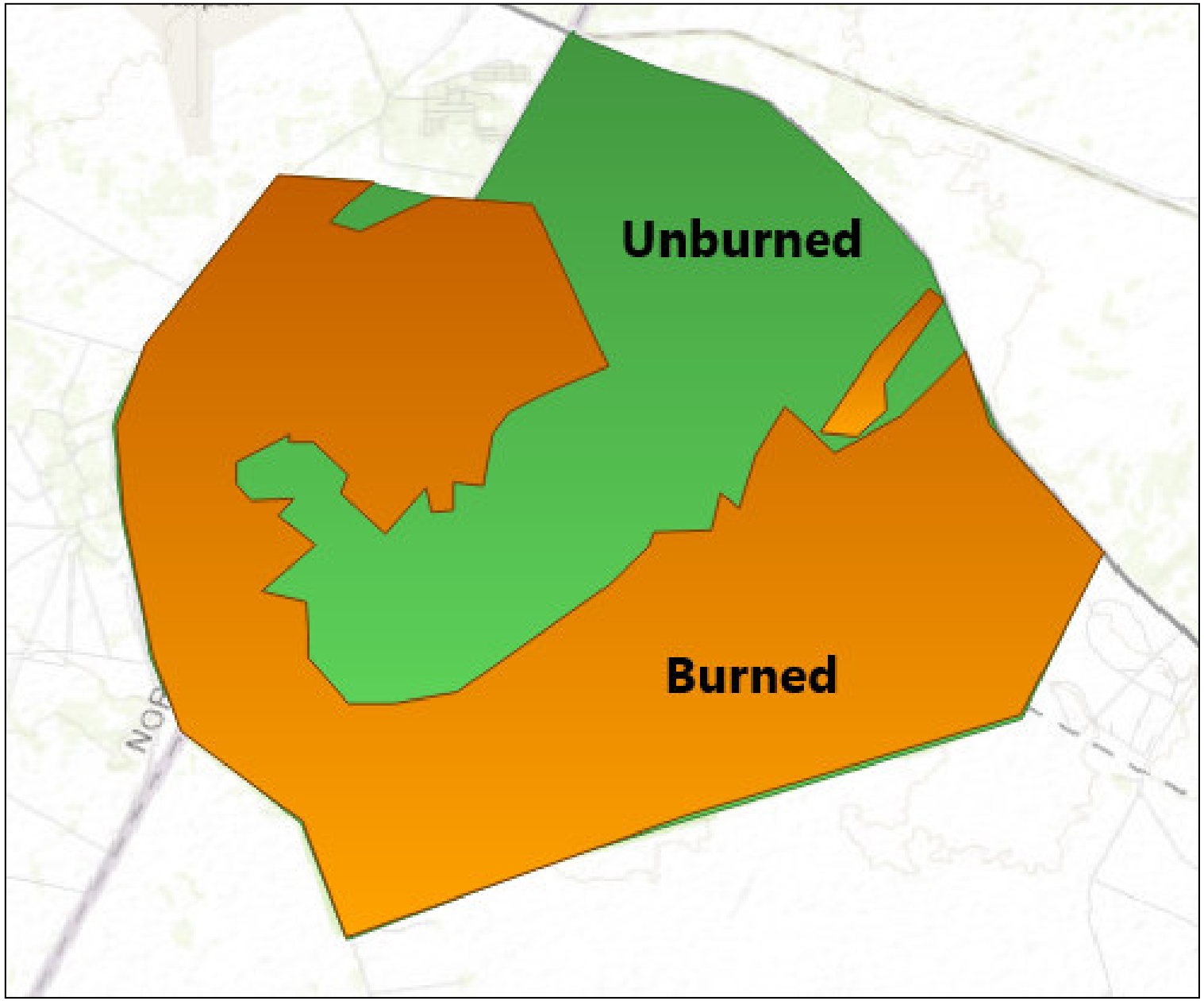


Map 1: Map of Grünau (GR) with minimum convex polygons (100% MCP) home ranges encompassing the locations (*n* = 1177) of 6 radio-collared black-footed cats monitored in 2021.



Map 2: Map of Benfontein (BFN; boundary = blue polygon) with ranges of BFCs in 2021, minimum convex polygons (100% MCP) encompassing the locations (*n* = 1221) of four radio-collared black-footed cats monitored between January – December 2021. All four BFCs were monitored throughout 2021 and there were no losses (deaths)



Map 3: Map of Benfontein with the extent of fire damage, the fire coming through on the night of 27 September 2021 from the west. The home ranges of the four cats mostly matched the largely unburnt parts of Benfontein with a stronger than usual overlap of individuals with each other over the year.

June 2021: Grünau (GR), Namibia - Fieldwork

Fig. 1: Team with *Lace* (A. Sliwa – self release).

Fig. 2: Martina and Shipala covering *Auas* in the net (A. Sliwa).

Fig. 3: Beryl drawing blood from *Auas* (A. Sliwa).

Fig. 4: Axel crating *Kara* after procedures for full recovery (A. Sliwa).

Fig. 5: Alex collaring *Nama* (B. Wilson).

Fig. 6: Tracking with Auas Motors vehicle (A. Sliwa)

Fig. 7: Tracking on foot (A. Sliwa).

Fig. 8: Black-footed cat Custodians certificate handing to the Van der Merwe family (A. Sliwa- self release).

June 2021 – Namibian cats

Fig. 9. *Kara* pausing at a burrow (A. Sliwa)

Fig. 10: *Auas* followed by kitten (A. Sliwa)

Fig. 11 *Prima* stalking (A. Sliwa)

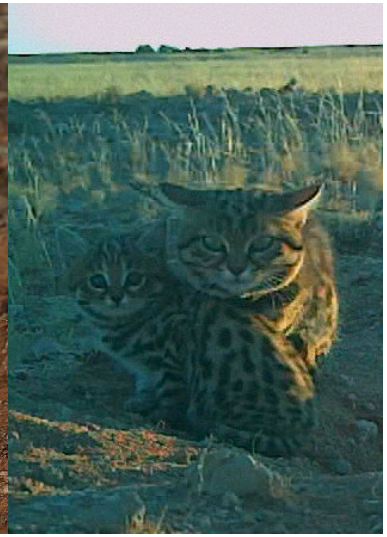


Fig. 12 *Lace with kitten 14.10.21*
(Camera Trap set by S. Ndele – BFC-RPN)

Fig. 13: *Prima*'s front paw (A. Sliwa).

Fig. 14: *Nama*, a new captured female in good condition (A. Sliwa)

Fig. 15: *Auas* feeling safe in long grass, June 2021 (A. Sliwa).

Fig. 16: *Auas*, with her three kittens, 14.10.21
(Camera Trap set by S. Ndele – BFC-RPN).

Fieldwork on Benfontein (BFN), South Africa, September 2021

Fig. 17: The BFN capture team (self-release).

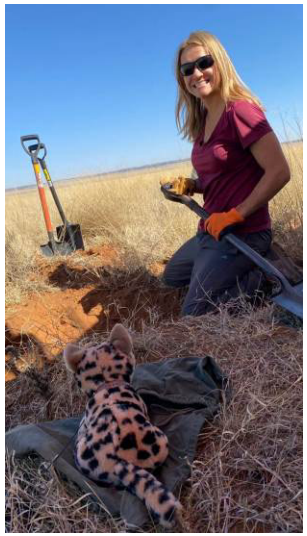


Fig. 18: Michelle being watch by mascot *Gru* (B. Wilson).

Fig. 19: After the fire, the narrow gravel roads acting as fire breaks (M. Schroeder).

Fig. 20: Charred veld (M. Schroeder).

Fig. 21: 6 weeks post-fire. Greening (M. Schroeder).

Fig.22: *Lyka* eager to search for BFC scats (M. Schroeder).

Fig.23: Michelle collecting a scat found by *Lyka* (B. Wilson).

Black-footed Cats on Benfontein (BFN) in 2021

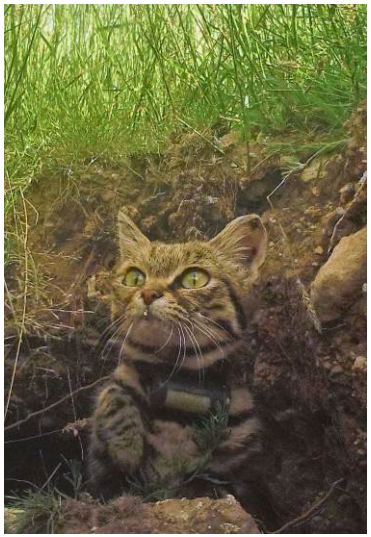


Fig. 24: *Durga* leaving a degraded den in long grass (CT set by M. Schroeder).

Fig. 25: *Durga* leaving her den the day after the fire went over (CT set by M. Schroeder).

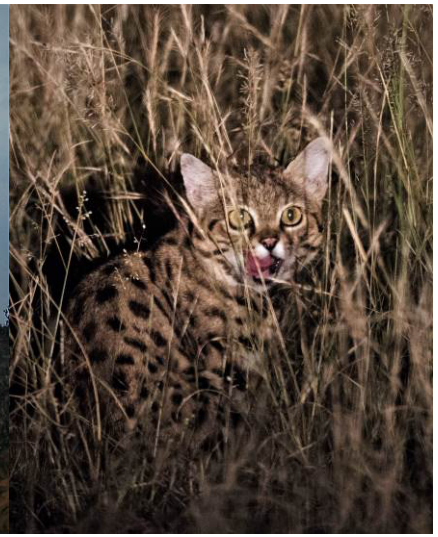


Fig. 26: *Putter* licking after meal (C. Ne).

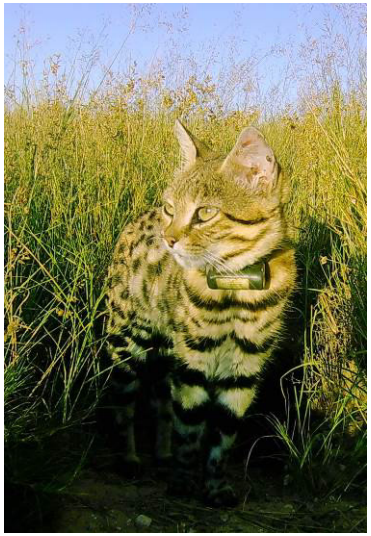


Fig. 27: *Hamba* (CT set by M. Schroeder).

Fig. 28: *Kazi's* kittens, 2 March 2021, 3 weeks old (M. Schroeder).

Fig.29: *Kazi's* feeding on a lesser red musk shrew (*Crocidura hirta*), a new prey species recorded for black-footed cats (C. Ne).

Table 1: Body measurements (cm), range size (km²) and remarks on 12 black-footed cats captured in 2021 on Grünau Farms (GR), Namibia and Benfontein Nature Reserve (BFN), South Africa.

Capture Date	21.06.21	21.6.21	22.06.21	23.06.21	23.06.21	24.06.21	24.06.21	24.6.21		22.09.21	23.09.21	24.09.21	26.09.21
Name (also on Map)	***Prima***	***Nama***	***Kara***	***Auas***	***Zola***	***JuvF1***	***Lace***	***JuvF2***		***Putter***	***Kazi***	***Durga***	***Hamba***
No. captured	Cat 1 21	Cat 2 21	Cat 3 21	Cat 4 21	Cat 5 21	Cat 6 21	Cat 7 21	Cat 8 21		Cat 9 21	Cat 10 21	Cat 11 21	Cat 12 21
Sex	F	F	F	F	F	F	F	F		M	F	F	M
Age (judged by teeth)	Adult	Adult	Adult	Adult	Adult	Juvenile	Adult	Juvenile		Adult	Adult	Adult	Adult
Microchip #.	953010004073751	992003000078777	953010004073718	953010004073771	992003000078774	992003000078775	953010004073717	992003000078773		945000001951984	945000001808148	945000001951981	276095610401684
Mass (kg)	1.50	1.27	1.51	1.26	1.24	0.91	1.35	0.85		1.85	1.25	1.25	1.85
Ear (cm)	5.05	5.1	4.8	5.2	5.1	-	5.0	-		4.2	4.3	4.5	4.5
Shoulder (cm)	23	24	24	24	25	-	24	-		22	21	20	22
Total Length (cm)	54	56	54	55	58	-	56	-		59	59	57.5	61
Hind foot (cm)	8.2	8.6	8.1	8.83	8.8	-	8.2	-		9.1	9.4	8.1	9.5
Front foot (cm) (L x W)	1.9 x 1.8	1.8 x 1.7	1.8 x 1.7	1.8 x 1.6	1.8 x 1.6	-	1.9 x 1.7	-		-	-	-	-
Tail (cm)	15	16	15	16	17	-	16	-		14.5	17.5	14.5	17
Neck (cm)	11.5	11	11	10.5	10.5	-	11	-		16.5	12	11.5	13
Canine UR (cm)	0.86	0.89	0.78	0.85	0.75	-	0.82	-		1.03	0.98	1.01	1.00
Canine LR (cm)	0.65	0.77	0.65	0.67	0.66	-	0.62	-		0.88	0.83	0.76	0.95
Canine UL (cm)	0.83	0.90	0.80	0.79	0.79	-	0.80	-		1.02	0.93	0.90	1.17
Canine LL (cm)	0.68	0.71	0.70	0.68	0.65	-	0.63	-		0.87	0.77	0.68	1.04
Testes (cm) / condition of nipples	All used	Used before	pregnant	Used before	Nipples never used		4 nipples in use			Well developed	Used in the past, pregnant	pregnant	
No. fixes collected in 2021	230	101	252	266	112	-	217	-		280	305	364	272
Range (100MCP) 2021 (km²)	9.40	17.60	13.40	82.80	13.50	-	19.30	-		18.96	5.76	6.50	18.30

Total fixes collected in 2021 for 6 Namibian Cats, n = 1177; Fixes for 4 BFN cats = 1221; Total= 2398

Remarks:

1) *Prima* (Cat 1 21): GR – adult female, heavily pregnant with 2 kittens, plucked her nipples. Has used her range 25 km north of GR on the farm Mickberg for the past year.
2) *Nama* (Cat 2 21): GR – adult female in good condition, not pregnant but had kittens before. Caught her in a donga. Her home range is in between those other resident females of GR.
3) *Kara* (Cat 3 21): GR - adult female; good condition but backs of ears almost hairless, highly pregnant (in winter!). Has remained in her range for a whole year. Well-habituated female.
4) *Auas* (Cat 4 21): GR - older adult female; good condition and well-fed. Shifter her home range and thus roamed a large area in 2021.
5) *Zola* (Cat 5 21): GR – young adult, good condition, nipples have never been used.
6) JuvF1 (Cat 6 21): GR – juvenile female, good condition but too light for radio-collaring. microchipped and hair sample taken.
7) Lace (Cat 7 21): GR – adult female, good condition, 4 nipples being suckled on by 1 kitten of ~7 weeks old (2 middle nipples not used), she lost 2 of the 3 recorded kittens by 19.6.21.
8) JuvF2 (Cat 8 21): GR – juvenile female, good condition but too light for radio-collaring. microchipped and hair sample taken.
9) *Putter* (Cat 12 21): BFN - adult male; good condition, just one tick, didn't really gin weight from March 2020.
10) *Kazi* (Cat 10 21): BFN – adult female; pregnant with 1 kitten, estimated ~ due in 4 weeks. Monitored her over 4 years.
11) *Durga* (Cat 11 21): BFN - adult female; captured in Nov 2018, good condition, pregnant with 2 kittens, due in 2 weeks.
12) *Hamba* (Cat 9 21): BFN - adult male; captured in Nov 2018 in reasonable condition, lost weight since last capture, many ticks in ears.