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CAT SPECIALIST GROUP

CATnews is the newsletter of the IUCN SSC Cat Specialist Group, a component of the Species Survival Commission SSC of the International Union for Conservation of Nature (IUCN). It is published three times a year, in spring, summer, and late fall. It features original articles and short communications relevant to the conservation of the free living wild cats, including news on the IUCN Red List and Green Status of Species assessments, important ex situ conservation breeding programmes, and form Species Working Groups affiliated with the Cat SG.

الهيئة الملكية لمحافظة العلا
Royal Commission for AlUla

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For joining the Friends of the Cat Group you can also contact Christine Breitenmoser at ch.breitenmoser@kora.ch

Original contributions and short notes about wild cats are welcome
Send contributions and observations to ch.breitenmoser@kora.ch.

Guidelines for authors are available at www.catsg.org/catnews

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Editors: Christine & Urs Breitenmoser
Co-chairs IUCN/SSC
Cat Specialist Group
KORA, Talgut-Centrum 5, 3063 Ittigen
Switzerland
Mobile ++41(79) 789 84 65 (C)
Mobile ++41(79) 410 14 39 (U)
<u.breitenmoser@kora.ch>
<ch.breitenmoser@kora.ch>

Associate Editors: Juan Reppucci
Sugoto Roy
Giridhar Malla
Maximilian Allen
Roland Bürki

Technical editor: Eline Brouwer

Cover Photo: Arabian leopard at RCU Conservation Breeding Centre in Taif, the Kingdom of Saudi Arabia
Photo: D. Chancellor

The new Cat News

This is the first issue of the new Cat News. Not much has changed with regard to the appearance and the layout, but there are two major changes, indeed improvements, as we hope.

First, we will now have three issues per year, with a spring, summer and late fall publication. The number of manuscripts submitted has consistently increased over the past years, and we have increasingly been fighting a backlog of printing the accepted contributions. Cat News is meant to publish short articles on new findings relevant to cat conservation, and especially colleagues less experienced to publish scientific articles in English are invited to submit papers. Nevertheless, all original contributions are peer reviewed. This implies, however, that some of the manuscripts need to go back and forth several times. To better support the preparation of manuscripts, we have therefore also updated the Guidelines to Authors for Cat News.

Second, Cat News comes with a number of new rubrics, also meant to reinforce the news character of the journal:

- *News from the Red List of Threatened Species* will highlight topical uploads and changes or new assessments, including the new Green Status of Species assessments of cats.
- *News from the working groups* presents short summaries of the activities of the Species Working Groups affiliated with the Cat Specialist Group (see also Editorial to Cat News 78, autumn 2023).
- *Ex situ news* is covering conservation breeding programmes relevant to in situ conservation of cats. Over the past years, the Cat Specialist Group has strengthened its ties with the zoo world – e.g. through cooperation with the EAZA Felid TAG – to help aligning breeding programmes such as the European Endangered Species Programmes EEP better with the conservation needs of the free-living cats.
- *Through the lens* will celebrate the beauty of wild cats, but also provide news from wildlife photography, including the use of automatic cameras. "Camera trapping" has, over the past years, become the most important tool to study elusive cats, and deserves more attention also from our side. We are grateful to have Malini Pittet as a competent editor of this section.
- Last but not least, *Cats in the news* features media releases on wild cats. This used to be an important part of Cat News in the times of Peter Jackson, and we want to take this up again. Roland Bürki, who handles this rubric, is happy to get hints to news from all parts of the globe.

Submitted articles, both Original Contributions and Short Communications, will not change – with the exception that we will insist more to observe the Guidelines when preparing the manuscript and hope to accelerate the process and publication of the papers.

It is no coincidence that the frontispiece of this first issue of the refreshed Cat News shows an Arabian leopard and that the first articles of the rubrics *News from the Red List of Threatened Species* and *Ex situ news* feature the updated assessment and, respectively, the conservation breeding programme of *Panthera pardus nimr*. On the one hand, this Critically Endangered leopard subspecies (Fig. 1) deserves all of our attention, and on the other hand, we are most grateful to have the Royal Commission for AlUla as a new sponsor of Cat News. To produce, print and mail a third issue of Cat News per year would not be possible without this additional funding provided by the RCU!

We also hope that the new form of Cat News will be appealing to more readers. So, we invite all members of the Cat Specialist Group and all *Friends of the Cat Group* to advertise the new Cat News and to help us gaining additional subscribers.

Urs Breitenmoser

Fig. 1. Arabian leopard cub, seen at RCU Conservation Breeding Centre in Taif, the Kingdom of Saudi Arabia (Photo D. Chancellor).

FLAVIA P. TIRELLI[1,2,3*], PAULA E. HORN[1,2], MARINA FAVARINI[1,2,3], FELIPE PETERS[1,2,3] AND MAURO LUCHERINI[2,4,5]

Collaborative conservation efforts for Geoffroy's cat and sympatric small wild cats

Geoffroy's cat *Leopardus geoffroyi* can be used as an umbrella species among small wild cats, as its wide distribution overlaps with seven other small wild cat species. The Geoffroy's Cat Working Group GCWG was established to ensure the survival of Geoffroy's cats and other small wild cat populations, as well as their habitats in South America. Our mission involves raising awareness and implementing mitigation strategies to protect these species and promote coexistence with humans. Until now, our efforts focused on developing educational materials, implementing road signs and reducing conflicts in rural communities.

Geoffroy's cat is a small wild cat distributed from Bolivia to southern Chile and Argentina. Although the species is categorised as Least Concern in IUCN Red List of Threatened Species™ (Pereira et al. 2015), many of its populations are negatively affected by different threats and in some countries, it is listed as a threatened species. Due to its large geographic distribution, it can be used as an umbrella species in strategies addressing the conservation of small wild cats in South America. This is justified by the fact that seven other species coexist with Geoffroy's cat populations in different regions: jaguarundi *Herpailurus yagouaroundi*, ocelot *Leopardus pardalis*, margay *L. wiedii*, southern tiger cat *L. guttulus*, Andean cat *L. jacobita*, guigna *L. guigna*, and Pampas cat *L. colocola* (*sensu* Kitchener et al. 2017). However, this number could be greater if we accept the recent proposal that *L. colocola* should be split into several species (Nascimento et al. 2021).

All of these small wild cats are facing local threats such as, habitat loss, collision with vehicles, retaliatory killing, predation by dogs, and diseases transmitted by domestic dogs and cats. Therefore, conservation efforts are crucial to protect these species and ensure their survival.

Geoffroy's Cat Working Group GCWG

GCWG was founded in December 2020, following some previous successful experiences fostered by Jim Sanderson (Small Wild Cat Conservation Foundation). We are a group formed by people from Bolivia, Paraguay, Brazil, Argentina, Uruguay, Chile, and the USA, and we aim to reduce threats and promote conservation of the Geoffroy's cat populations and sympatric small wild cat species across its entire distribution range. Overall, the GCWG goal is to promote harmonious coexistence with humans and enhance understanding of the species' ecological and conservation needs.

With funds from MbZSCF, we designed educational materials about the Geoffroy's cat and other Neotropical small wild cats to assist Latin American conservationists and local school teachers in awareness campaigns (Fig. 1). We created small wild cat crossing signs and vehicle stickers and are deploying them in 11 distinct projects in six countries to mitigate collision with vehicles. Additionally, we designed a brochure on building and repairing chicken coops and are helping small local farmers to build or improve them, in order to reduce predation on their poultry and thus, mitigate conflicts.

Educational and awareness activities

We created colouring sheets of 13 small wild cat species, using different common names to embrace distinct regions and languages, totalling 25 colouring pages. We also developed a set of masks and games about wild cats in three languages (Portuguese, Spanish and English), which can be easily edited and adapted to different regions and their local contexts. These materials are already being used by different conservationists from Argentina (from north to south in different projects), Bolivia, Brazil, Chile, Mexico, and USA, primarily with children from rural schools (Fig. 2). These activities aim to change the perception of wild cats in rural communities and increase the pride of living together with these animals.

We developed an engaging brochure for all audiences that provides information on

Fig. 1. Educational material designed about the Geoffroy's cat and other Neotropical small wild cats (Photo F. Tirelli).

Fig. 2. Educational materials being used by different conservationists in Latin America with children from rural schools. A) Argentina (Photo M. Lucherini); B) Bolivia (Photo P. Nogales); C) Brazil (Photo F. Tirelli).

Geoffroy's cat, its biology, the threats it faces and the GCWG. Additionally, we designed banners and education signs for workshops and community events (you can download these materials for free at http://geoffroys-catwg.org/ingles/action-2-actions). GCWG is also very active on Instagram. We have already posted more than 455 publications and we currently have 2,693 followers.

Conservation actions

We prioritised addressing traffic accidents and retaliatory killing. To mitigate the threat posed by roads and vehicles, we implemented measures such as distributing stickers for vehicles and installing road signs in roadkill hotspots (Fig. 3). Since the installation of the road signs, we did not record any roadkill in these sites. To support farmers in rural communities, the GCWG created a brochure on non-lethal anti-depredation strategies, while also producing a video guide for coexistence between chicken farmers and small wild cats. Finally, a portion of the grant received from MbZSCF was donated to a local rescue center to improve small wild cats' enclosures by increasing the area and providing environmental enrichment to enhance their quality of life (Fig. 4).

Fig. 3. Road sign installed on municipal road (Photo F. Peters).

Fig. 4. Conservation actions: Improved small wild cats' enclosure. A) Before (Photo M. Favarini), B) After the improvement (Photo A. Boyink).

Small Grant Report

Global network of conservation education for Geoffroy's cat and its habitats

Funding:	Mohamed bin Zayed Species Conservative Fund (Project Nr. #210526877)
Total grant:	$5,000
Duration:	12 months
Website:	http://geoffroyscatwg.org/ingles/
Contact:	flavia.tirelli@gmail.com

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[1] Programa de Pós-Graduação em Biologia Animal, Universidade Federal do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brasil
[2] Geoffroy's Cat Working Group GCWG
[3] Instituto Pró-Carnívoros, Atibaia, São Paulo, Brasil
*<flavia.tirelli@gmail.com>
[4] INBIOSUR, Depto. de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur and CONICET
[5] Andean Cat Alliance AGA

MADELYN PETERSON[1*] AND LOUISE ILOTT-BAUDON[2]

First record of a tailless puma within Cloudbridge Nature Reserve, Costa Rica

Throughout Costa Rican jungles, the puma *Puma concolor* is widely dispersed. At Cloudbridge Nature Reserve, located in a cloud forest of Pérez Zeledón, Costa Rica, pumas are frequently seen on the camera traps within the property. Until 2023, there were no records of a tailless puma in the database. Now, there have been two separate events captured on the cameras within the reserve. This is an acutely unusual event with limited literature about how this is caused. Globally, it is rare to have documentation of any tailless wild felid. Such little information requires further studies to understand the impact this may have on the individual and how this came to be. Cloudbridge will continue to monitor these cameras with anticipation of seeing the tailless puma again.

The puma is the second largest feline in the Americas, after the jaguar *Panthera onca* (Nielsen et al. 2015), with a vast geographical range from tropical rain forests to deserts (Redford & Eisenberg 1992, Nowell 1996). While the global population trend is decreasing, in 2014 the IUCN Red List of Threatened Species listed the puma as "Least Concern" (Nielsen et al. 2015). The main threats towards this feline include anthropogenic actions like habitat loss/degradation and poaching (Wang et al. 2017). Throughout the Americas, several studies have been done to better understand the impact that habitat loss has had on puma populations, and to increase human tolerance to their populations (Ávila-Nájera et al. 2018, Zorondo-Rodríguez et al. 2019). In Costa Rica, conservation efforts have included establishing publicly and privately owned reserves and national parks (SINAC n.d.). For example, Cloudbridge Nature Reserve (hereafter Cloudbridge) is a private reserve located in the Talamanca mountains of Costa Rica (9°28' 20.352"N / - 83°34'39.4572"W), bordering the over 505.9 km² Chirripó National Park (Powell et al. 2022), which ultimately connects to the 1,938.5 km² La Amistad International Park (SINAC n.d.). Since 2002, Cloudbridge has purchased and reforested over 2.8 km² of land, implementing conservation practices by planting native cloud forest tree and shrub species (Cloudbridge n.d.). Now this reserve consists of mature, naturally regenerated, and planted forests (Powell et al. 2022). The reforestation success at Cloudbridge has contributed to the larger national and international biological corridor into Panamá (SINAC n.d.), supporting mammalian conservation efforts like for the puma (Wang et al. 2017).

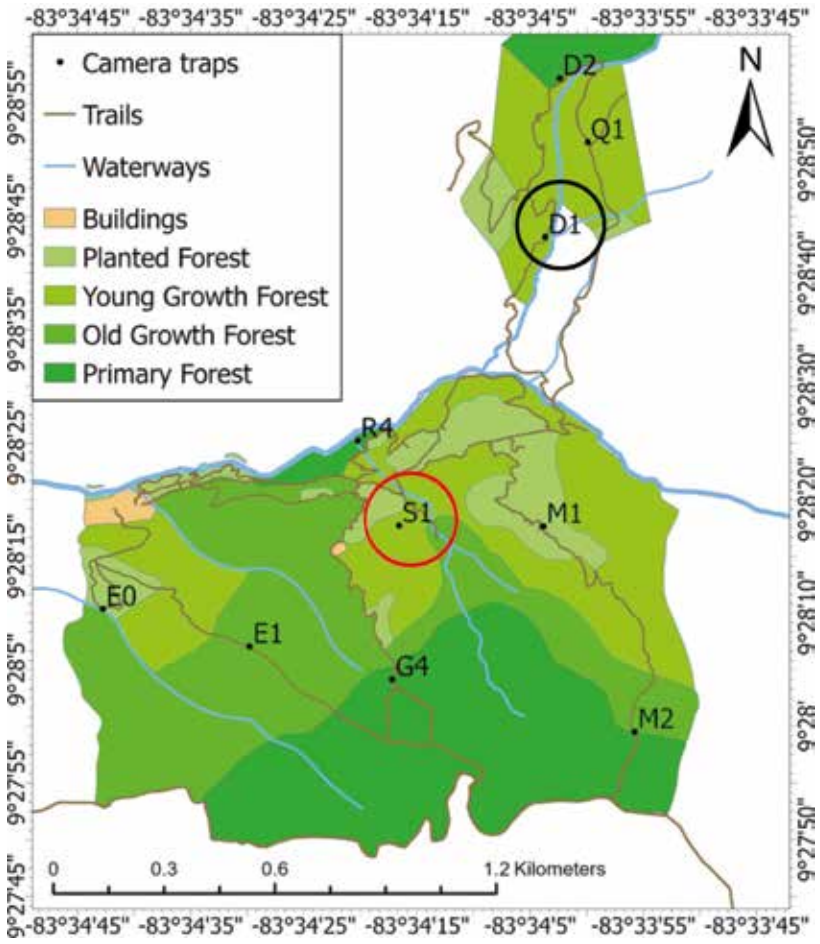

Fig. 1. Map of Cloudbridge Nature Reserve, Costa Rica; symbols denote each camera trap placement from January to April 2023. The Sentinel camera trap placement (red; 9° 28' 17.7348"N, -83° 34' 16.5756"W) and Don Victor camera trap placement (black; 9° 28' 43.1796"N, -83° 34' 3.684"W) are circled (Map L. Ilott-Baudon).

A characteristic trait of pumas is having long tails, which can range from 61 cm to 74 cm in length (Reid & Zamora 2022). For felines in general, the main uses for their tail are balance, thermoregulation, and communication (Walker et al. 1998). Feline tails have reflexes like a limb, which respond quickly to stimuli, protecting it from damage (Walker et al. 1998). Additionally, tail use has been observed as crucial during locomotion, like jumping and shifting their weight; essential motions for hunting (Walker et al. 1998). As tails play an important role in maintaining equilibrium, the loss of a tail could potentially compromise these skills (Young et al. 2021).

Tailless puma in Cloudbridge Nature Reserve

Cloudbridge has been conducting ongoing camera trap research since 2015 to monitor general species abundance and diversity. The protocol includes a total of 10 remotely triggered Bushnell (Trophy Cam E3 Essential, Overland Park, USA) infrared camera traps programmed to record 10 second videos. From October 2022 to April 2023, the methodology of data collection used was the placement of a random grid (1.2 km by 1.2 km, 300 m² per quadrant) for 92 days, then a non-random placement of the cameras for 92 more days to target high activity areas (i.e. obvious game trails; areas with high animal scat; natural bottlenecks). Biweekly, the batteries and

Fig. 2. Camera trap images showing the two tailless puma events. Left: captured on 3 March 2023 on the Sentinel trail. Right: captured on 27 March 2023 on the Don Victor trail. (Photos Cloudbridge).

memory cards were replaced and the videos were revised.

Since 2022, 45 independent puma camera trap events have been recorded in the Cloudbridge database (Cloudbridge n.d.). In March 2023, evidence was captured for the first time of a tailless puma in the reserve in two separate events during the non-random camera placement. The first event was on 3 March 2023, at 6:57 h; the second event was 24 days later on 27 March 2023, at 17:35 h. The first recording was on the Sentinel trail (9°28'17.7348" N / - 83°34'16.5756" W) while the second recording was located on the Don Victortrail(9°28'43.1796"N/-83°34'3.684"W), 1.1 km away from each other, as shown in Fig. 1. Displayed in Fig. 2 are images extracted from the camera trap videos of both tailless puma events. It was clear from the videos that the gender of this puma was a female due to the lack of male testes. The rarity of this event and consistency of tail length in both videos suggests that this is the same individual. Although unknown, a possible cause for being tailless could be from a genetic mutation, resulting in being born without it (Buckingham et al. 2013). Human interference (e.g. poaching, captivity) is unlikely due to the connection with large protected areas (SINAC n.d.). Interspecific species conflict is possible, but uncertain (Attenborough 2017).

Tailless pumas around the world

Very limited literature could be found on other tailless pumas globally. One finding was recorded in Torres del Paine (Chile) in 2015, when a tailless puma cub was photographed (Stone 2015). Due to the young age and lack of injury marks, it is likely that this individual was born without a tail (Stone 2015); however, this is not known with certainty. Another viewing of a tailless puma was in Vancouver (Canada), where a YouTube video displays a mother puma eating an elk with her two cubs, and the mother had no tail (Chantelle 2017). This Canadian puma has about 15 cms (6 inches) left of the tail, although the cause of the tail loss is unknown.

Tailless felids around the world

There is also limited literature about other tailless species in the Felidae family, with only a handful of sightings in the last 20 years. In South Africa in 2005, it was found that a lioness *P. leo* had her tail severely injured by hyenas *Hyaenidae* spp., and chewed off the remains of her tail to "prevent an infection" (Attenborough 2017). Similarly, there was a jaguar captured via camera traps in Guatemala and Belize that was tailless (Broad 2020). The jaguar was seen with its tail in 2009, yet in 2011 the tail was gone, suggesting an injury occurred to the tail within those two years (Broad 2020). In an extremely rare occurrence, a snow leopard *P. uncia* was photographed without a tail. In every other regard, the snow leopard looked healthy and seemed to have adapted to its life without a tail (Snow Leopard Trust 2022). It is unknown how the tail was lost.

Tailless felids have also been seen when living in captivity. In the United States, a captive tiger *P. tigris* had her tail bitten off by a racoon as a juvenile, and tended to the wound on her own (Piniat 2011). Another tailless tiger was discovered living in captivity in Vietnam, likely as part of the illegal wildlife market (Ives 2021); however, it is unknown how that tiger came to be without its tail.

With such little information about what types of injuries could cause a feline to be tailless, it is difficult to know with confidence what the recovery and adaptation process looks like. There are currently no statistics that show the likelihood of life or death after losing a tail.

Conclusion

Considering the importance tails play in the lifestyle of a felid (Walker et al. 1998), surviving without a tail shows the great resilience of this family. Due to the rarity of these observations, when one is discovered, it is important to monitor and report them. Many populations of wild cats are decreasing (Nielsen et al. 2015, Bauer et al. 2016, Quigley et al. 2017), so better understanding these adaptations is crucial for improving their conservation success. Cloudbridge will continue this ongoing camera trap research of mammalian fauna, with hopes that the individual tailless puma will be seen again in the future.

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[1] Scientific Officer at Cloudbridge Nature Reserve, Costa Rica
[*] <madelyn.peterson@cloudbridge.org>
[2] Research Intern at Cloudbridge Nature Reserve, Costa Rica, University of the West of England

EDUARDO CARRILLO[1] AND TODD K. FULLER[2*]

Jaguar predation on lemon sharks in Costa Rica

On two separate occasions, individual jaguars *Panthera onca* were observed catching (and subsequently consuming) lemon sharks *Negaprion brevirostris* in shallow surf water on Sirena Beach, Corcovado National Park, Costa Rica. The continued discovery of such previously unnoted species interactions can generate new and more widespread investigation of transboundary food web interactions in the tropics, leading to unusual and insightful ecological discovery.

Jaguars are known for a broad diet of at least 111 wild species prey items (Emmons 1987, Hayward et al. 2016). In addition to terrestrial species, ranging in size from <0.5 kg marsupials to 220 kg tapirs *Tapirus* spp., jaguars also prey on both freshwater and marine species. Some of these are rarely eaten, such as dolphins, otters, and turtles (Brito et al. 2018, Castañeda et al. 2013, Defler 1994, dos Santos Ramalheira et al. 2015, Schaller & Vasconcelos 1978, Thomson et al. 2022), some are seasonally or consistently important in their diet, such as nesting sea turtles (Carrillo et al. 1994, 2009, Montalvo et al. 2020), and some are essential primary prey, such as caiman, fish, and capybaras *Hydrochaeris hydrochaeris* (de Azevedo & Murray 2007, Eriksson et al. 2022, Schaller & Vasconcelos 1978).

A recent essay on fishing by jaguars (Burton 2022) inspired us to revisit past observations by one of us (Eduardo Carrillo [EC]) of jaguars capturing freshwater fish, and then to a recollection of observing jaguars catching sharks in the shallow surf of the Pacific Ocean. Here we describe these two unique observations of jaguars on Sirena Beach, Corcovado National Park, Costa Rica preying on and consuming lemon sharks, and comment on the potential ramifications of such observations.

The observations were made from the beach (Playa Sirena) between the Sirena River and the Corcovado River on the Pacific coast of the 500 km^2 Corcovado National Park CNP in southern Costa Rica (8°28'45" to 8°31'38"N and 83°35'54" to 83°39'08" W; Fig. 1). The portion of the park adjacent to the beach included some farms when the park was established in 1975 but is now a mosaic of second growth habitats (Gilbert et al. 2016). Several small rivers flow through the area from the pluvial low-mountain forest at higher elevations (50–700 m above sea level) down through the humid tropical forest at low elevations. The climate is hot and humid, with an annual average temperature of 25°C. Annual average precipitation is about 5,000 mm, with pronounced dry (December–April) and wet periods (May–November). Jaguars, nesting sea turtles, and white-lipped peccaries *Tayassu pecari* have been studied there since the 1990s (Altricher et al. 2001, Carrillo et al. 2002, 2009, Chinchilla 1997, Olson et al. 2019), and jaguar density

was estimated at ~7 individuals per 100 km^2 in 2003 (Salom-Pérez et al. 2007).

The first observation was made on 4 December 1994, a clear and sunny afternoon (~29 °C) when one of us (EC) was walking along the beach and then sat at the top of the beach where the vegetation began (Fig. 2). At 17:05 h (about 10 min after sitting down), an adult male jaguar was observed walking along the beach near the tide line in a north-south direction. The waves were moderate (<1 m), and broke ~25 m from the shore such that the surf was 20–50 cm deep. When the jaguar was perhaps 75 m away from the observer, it bounded approximately 5 m into the surf where, while standing, it caught a lemon shark about 90 cm in length by grabbing it behind the head. Once the shark was captured (but still struggling), the jaguar dragged it by the head up the beach several metres where the jaguar sat down and began to consume it. The jaguar fed on the now inactive/dead shark by first tearing at the body flesh and then gnawing on the head. After about 15 minutes, the jaguar got up and carried the remains ~50 m into the 1-m tall grassy vegetation beyond the edge of the beach.

EC observed the same behaviour on at 15:22 h on 2 May 1995, a clear and sunny day with calm seas. Again, while sitting at the palm tree line, he observed a young female jaguar walking on the beach which appeared to notice the movement of two or three sharks in a shallow area (20–50 cm) of the surf. The jaguar immediately ran and jumped in the surf and, while standing, captured a ~75 cm lemon shark by the back of the head and body. The jaguar carried the shark into the beach vegetation where, as determined from the ensuing sounds, she began to consume it. The next day, the location of feeding was checked and only a few small bones and the fins of the shark were found.

In the hundreds of hours that EC has walked the beach at Sirena over the past 30 years, he has observed jaguars 20 times, and lemon sharks in the surf 5 times, but these are the only instances of predation on sharks that he has witnessed.

Just as terrestrial apex predators kill other predatory species (e.g. Miquelle et al. 1996, Simcharoen et al. 2018), both cetaceans (Fertl et al. 1996) and pinnipeds (Allen & Huveneers 2005, Fallows et al. 2015) prey on sharks. Lemon sharks reach a length of >3 m and have relatively small litters (4–17) of ~60 cm pups (Carlson et al. 2021). Newborn and small juvenile lemon sharks typically reside in shallow habitats in their natal nursery area, utilising habitats close to shore to avoid larger predatory sub-adult lemon sharks and exploit abundant prey communities (Guttridge et al. 2012, Morrissey & Gruber 1993). Thus, where jaguars regularly use beaches also used by juvenile lemon sharks, threats of jaguar predation are present. Still, though these natural interactions (i.e. additive juvenile mortality) likely may be considered more often in conservation planning for chondrichthyan fishes in the region (Espinoza et al. 2018), the dominant threats to the species remain target and bycatch of artisanal and commercial longline and gillnet fisheries, and degrading of mangrove habitats by shrimp aquaculture (Carlson et al. 2021).

The ecological importance of jaguar predation on lemon sharks is currently unknown, but just because it has not been reported previously does not mean it should be ignored. Until fairly recently (e.g. Autar 1994, Carrillo et al. 1994), for example, the degree to which jaguars preyed on nesting sea turtles were not widely known or reported, but currently they are recognised as potentially important predators of a number of nesting populations (Arroyo-Arce & Salom-Pérez 2015, Fonseca et al. 2020, Veríssimo et al. 2012). Some of these provide a seasonal resource pulse for jaguars (Montalvo et al. 2020), while others provide a supplementary year-round resource (Carrillo et al. 2009), in both cases driving jaguar behaviour. Importantly, this interaction also has been shown to have larger ecosystem effects, mainly as provider of sea turtle carcasses to many other terrestrial scavengers (Escobar-Lasso et al. 2016). Whether jaguar predation on nesting sea turtles has or will have larger ecosystem consequences, including changes in patterns of population abundance, nutrient distribution, and trophic structure and niche dimensions of consumers from donor ecosystems (Hilderbrand et al. 1999, Levi et al. 2020, Recalde et al. 2016, Rose & Polis 1998), remains to be discovered.

Finally, the ongoing discovery of unnoted species interactions continues to generate new and more widespread investigation, often leading to unusual and insightful ecological interactions, particularly regarding transboundary food web interactions (e.g. Roffler et al. 2023). More and wider ranging naturalist and ecologists, in conjunction with new investigative tools (e.g. Monterroso et al. 2019), will likely continue to discover and reveal natural history occurrences that astound us and motivate a better understanding of life's web of intrigue.

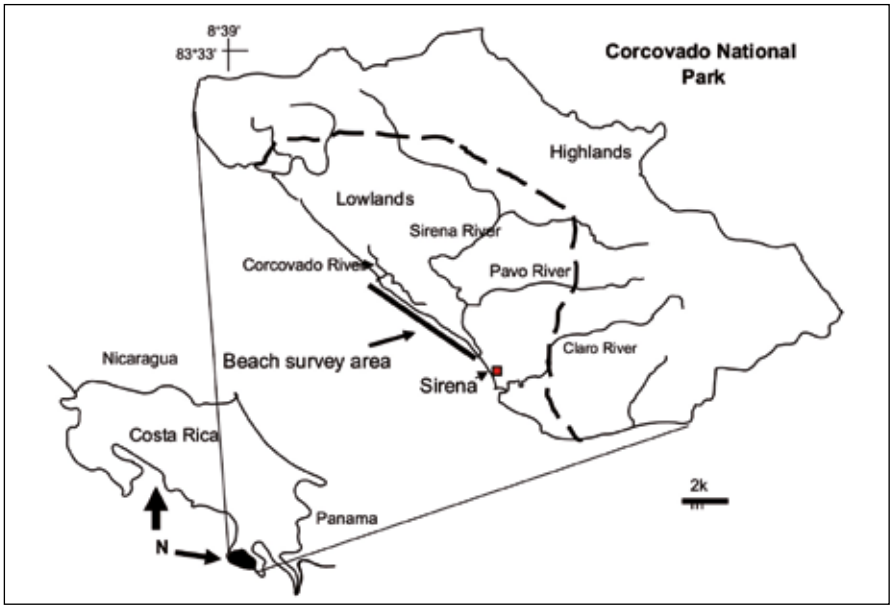

Fig. 1. Location of Playa Sirena/Sirena Beach on the Pacific edge of Corcovado National Park, Costa Rica. Dashed line indicates the 50-m contour interval.

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Fig. 2. Playa Sirena/Sirena Beach habitat of Corcovado National Park, Costa Rica similar to where two instances of jaguars preying on lemon sharks were observed (Photo E. Carillo).

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[1] Instituto Internacional en Conservación y Manejo de Vida Silvestre, Universidad Nacional, Apdo. 1350-3000, Heredia, Costa Rica

[2] Department of Environmental Conservation, University of Massachusetts, Amherst, Massachusetts 01003, USA

* <tkfuller@eco.umass.edu>

ABDULLAH A. H. ABOALFOTOOH[1], OMER BAESHEN[2] AND RIADH SAIF[3]

Arabian leopard in Yemen – an update

The Arabian leopard *Panthera pardus nimr* is assessed as Critically Endangered in the IUCN Red List of Threatened Species. Only limited and disjointed information is available from Yemen. However, in the last few years, several reports turned up on social media. They were mostly cases of illegal killing, but often from areas where scholars believed the leopard to be extinct, especially from the Al Dhabiyaniyah region. There was even one report of reproduction. Whilst active in situ projects remain highly unlikely due to the armed conflict, citizen science reports and social media should continually be surveyed to gather all possible information on these largely unknown populations.

Editor's note: This article is the amalgamation of several reports that have been shared with the IUCN SSC Cat Specialist Group in the past years. We are especially grateful to David Mallon for helping with this compilation and keeping the contact with Yemeni colleagues over many years. Yemen hosts the largest remaining population of the Critically Endangered Arabian leopard and is therefore of outstanding importance for the survival of this smallest of all leopard subspecies. However, information is scarce and difficult to check. An important source of information are social media posts, albeit sometimes overlapping and impossible to confirm due to the political fragmentation of the country. Nevertheless, killing and capturing of leopards in Yemen seems to be widespread and frequent, and this article demonstrates the magnitude of such losses. And it indicates that Arabian leopards in Yemen may still be rather wide-spread and how important and urgent protection and conservation measures would be. On the positive side, there is news about increasing awareness and efforts from authorities in various regions of Yemen to save the Arabian leopard, e.g. through the establishment of new protected areas. It will be of utmost importance in the years to come that the international conservation community supports any effort to protect these few remaining nuclei of the Critically Endangered Arabian leopard.

The smallest subspecies of the leopard *P. pardus* is the Arabian leopard, which is endemic to the Arabian Peninsula and was assessed as Critically Endangered in the IUCN Red List of Threatened Species (Mallon et al. 2008). Back in 2006, Cat News Special Issue 1 presented the known information about the status of this subspecies. At that time, recent confirmed records were only reported from western and south-western Saudi Arabia, western Yemen, and southern Oman (Spalton & Al Hikmani 2006). In Yemen, there were recent records of leopards captured in the central part of the western highlands, notably around Wada'a, and verbal reports of presence or possible presence in other parts of the western mountains, southwest Yemen, central-southern Yemen, and Al Mahra in eastern Yemen (Al Jumaily et al. 2006). Accordingly, the newest Red List assessment (Al Hikmani et al. 2023) shows only two small patches as "Extant", but three more as "Possibly Extant", underlying the continuous shortage of confirmed information.

At the time, some field visits tried to gather more information on the occurrence of Arabian leopards in specific areas in Yemen (e.g. Mallon 2009). In 2009, the Foundation for the Protection of the Arabian Leopard in Yemen FPALY was founded as a local NGO. FPALY undertook several field surveys within historic leopard range, conducted education and awareness programmes, and liaised on leopard conservation with national and regional governments. From December 2010 to January 2011, FPALY installed 12 trail cameras in Hawf Protected Area in south-east Yemen, close to the border with Oman (Pittet 2011a). On 18 January 2011, two photos of a leopard were taken, and a further photo on 24 February 2011 (FPALY 2011a, b). No photos have been obtained since then. It is not known if a breeding population occurred in Hawf, or whether the leopards photographed were from the known population in Dhofar (Oman), just across the border. At that time, a partial (4 km long) border fence was in place. This fence has since been extended and strengthened and now forms a formidable barrier to wildlife, severing connectivity between Hawf and contiguous habitat to the east. Pittet (2011a, b) reported that only older herders were aware of leopard depredation in this region and that people had generally a low and rather mystical understanding of the species. It is unclear, whether leopards occasionally discovered in the Hawf reserve are resident animals or transitory individuals from the Oman population.

In late 2011, a video was posted on YouTube of a leopard captured in Lawdar. FPALY representatives met with the Director-General of Lawdar District to discuss leopard conservation in the area (FPALY 2011c). In 2012, a photograph of an injured leopard captured in

Shabwa governorate apparently in a steel-jawed trap, was posted on social media. This area was considered as "probable" leopard range in 2006 (Al Jumaily et al. 2006).

Since late 2014, Yemen has been in the grip of an ongoing civil war. Armed conflicts mostly negatively impact fauna and flora in the affected areas (Gaynor et al. 2016). It must be assumed that the situation of the Arabian leopard has become even more dire since 2014; but field surveys, missions by the Environment Protection Agency (EPA), and conservation activities of any kind have become extremely difficult. Soon after the beginning of the civil war, it was reported that Arabian leopards held in captivity in Yemen, which would be crucial to be integrated into the conservation breeding programme, were suffering up to starvation (Bürki & Breitenmoser 2016).

Photos of leopards killed or captured have continued to be posted on social media. Since 2016, one of the authors (AAF) has collated online posts. Many of the online reports originate from the Al Dhabiyaniyah region of southern Yemen, and more recently from Al Dhale' Governorate, with some from other locations in southern Yemen (Table 1). At least 10 leopards were estimated to have been killed or caught in Al Dhabiyaniyah from 2015 to 2021 and the EPA has investigated at least 18 cases of capture or killing in this region. In September 2021, OB received reports of "several cases of killing" of leopards including a recent case in Al Dhabiyaniyah.

In March 2022, a report by the Sanid Organisation for Relief and Development SORD mentions 22 illegally hunted leopards since the beginning of the armed conflict (SORD 2022). The Sanid Organization for Nature Conservation SONC sent a report to the IUCN SSC Cat Specialist Group in May 2022 listing 21 cases of leopards (including 4 cubs) illegally killed since 2014 (SOM 1). These included many of the reports referred to above from Al Dhabiyaniyah, with others from Lawdar and Hawf (Fig. 1).

Al Dhabiyaniyah is a remote mountain region situated where the borders of the three governorates of Al Dalie', Al Bayda and Lahej meet. AAF has visited Al Dhabiyaniyah to raise awareness of the persecution and the importance of this leopard population, and met with local leaders and negotiated agreements between them on behalf of the Environmental Protection Agency EPA to stop the persecution.

The number of posts and photos of leopards captured or killed in this region since 2014, plus the verbal reports of presence and depredation given to AAF during his visits strongly suggests that the region harbours a leopard population of unknown size – but one that is clearly in great peril from the ongoing persecution. A short video sequence of a leopard was obtained recently in Al Dhabiyaniyah. It is unclear whether these reports represent a single population, several nuclei, and/or animals moving between them. The approximate location of the recent leopard incidents and main locations in Al Dhabiyaniyah are shown in Fig. 2. There are very old records of leopards from Al Bayda, and some more recent unconfirmed reports of presence in this general area, but the occurrence of a breeding population here has been overlooked until very recently, including the latest review (Jumaily et al. 2006). In late 2023, the office of the Prime Minister in Sana'a issued a draft decree declaring an Arabian Leopard Reserve in Al Dhabiyaniyah covering approximately 6,765 km^2 (two core area totalling 1,067 km^2; buffer zone 1,857 km^2; utilisation zone 2,940 km^2). Moreover, the Ministry of Water and Environment in Aden is also preparing the gazetting of further reserves and improving public awareness.

The precise location of most of the other incidences of killing and capture listed in Table 1 is not known, and the map (Fig. 1) is therefore not very accurate.

Table 1. Records of illegally killed leopard in Yemen in recent years. ID: locations with coordinates are designated by numbers, locations where only a place name is given are designated by letters (see Fig. 1). Ind.: number and (where known) sex of killed individuals.

ID	Date	Location	Ind.	Source
a	2011	Hawf Protected Area, Al Maharah	1M-2	FPALY 2011a, b
b	2011	Lawdar (Video on Youtube)	1	FPALY 2011c
c	2012	Shabwa	1	(D. Mallon, pers. comm.)
d	2015–20	Al Dhabiyaniya	10	AAF
	thereof	Al-Shuaib	2*	AAF
		Al-Jouben district	1	AAF
		Khabah village, Al-Qwaim subdistrict	1	AAF
e	Jul 2019	Kur Al Awalik mountains, Shabwa	1**	AAF
f	recently	Al Dhale'	1	OB
g	2015-22	Various	22	SORD
h	6 Jul 2014	Al Shuaib, Al Dhale'	3	SONC
i	22 Oct 2014	Hudub area, Hawf Protected Area, Al-Mahra	2	SONC
1	5 Dec 2014	Lab'ous Hateeb, Yafa' district, Lahej	1	SONC
2	5 Nov 2016	Juban area, Al-Dhale'	1	SONC
j	22 Feb 2017	Hallak mountains, Mudiyah district, Abyan	1	SONC
3	22 Dec 2017	Juban area, Al Dhale'	1	SONC
4	21 May 2018	Al Shuaib area, Al Dhale'	2	SONC
5	9 Jan 2020	Hadd area, Yafa' district, Lahej	1	SONC
6	5 Apr 2021	Wadi Shi'b Al-Dhabi, Al-Hawzn area, Lawdar district, Abyan	1F***	SONC
7	2 Jul 2021	Shi'b Al-Dhabi, near Jabal Thara, Abyan	2	SONC
k	Apr 2022	Aqtan area, Wadi Bana, Halaymin district, Lahej	1	SONC
l	Apr 2022	Al-Dhabiyaniyah, Abyan	1F + 4juv	SONC

* Animals believed to have left the breeding area on search for food
** Does not refer to an illegal killing, but to leopard vocalisation and attack on livestock.
*** Unclear whether the animal caught in a trap for hyenas was killed or survived.

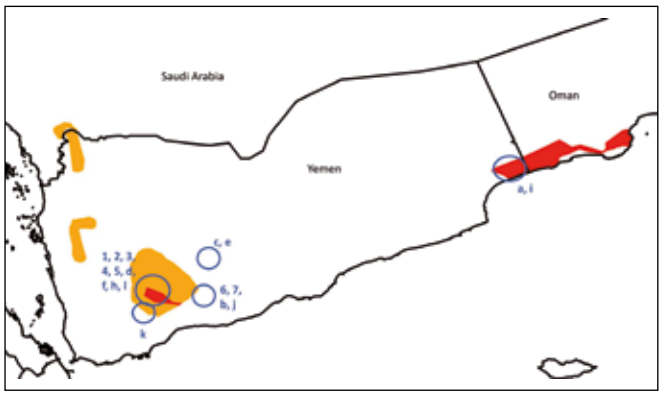

Fig. 1. Map of the approximate locations of the Arabian leopard records from Yemen according to Table 1 (dark blue circles, numbers and letters). The polygons indicate where the Arabian leopard is believed to be Extant (red) and Possibly Extant (orange; Al Hikmani et al. 2023).

Fig. 2. Location of recent Arabian leopard reports in the Al Dhabiyaniyah region (map prepared by Eng. Abdullah A. H. Aboalfotooh, EPA).

An additional Facebook post sent to AAF came from a local biologist in Shabwa governorate, farther to the east, who said local Bedu reported hearing leopard vocalisations and recorded depredated livestock in the Kur al Awaliq mountains.

It is believed that leopards once occurred all along the mountains of western Yemen (Al Jumaily et al. 2006). The latest confirmed evidence is leopards captured in the Wada'a area of Amran governorate in the late 1990s/early 2000s. No social media posts referring to western Yemen have been reported so far. Whether leopards survive in any part of western Yemen is not known, though there have been local reports of presence at several sites in the last 10 years.

It is impossible to establish the exact number of different events from the various sources, but indeed, only two pictures were presented by both, AAF and SONC. We assume that there is some overlap between the different sources, but each report also contained events not listed in the other one. At least 20 leopards – mostly killed animals – have been recorded from areas with few or no former records. The fact that Arabian leopards in Yemen are readily killed is worrying, but the extent of the cases seems to indicate that the distribution of the leopard in Yemen may still be larger than previously assumed. Sex and age of the animals killed was mostly not reported or not visible from many of the photos; we cannot assess how many of the dead leopards might have been dispersing males outside the permanently occupied areas. One case of the killed female in Al-Dhabiyaniyah area, Abyan governorate, with its four "less-than-a-month" old juveniles (see SOM 1, Picture 11), proves reproduction in this area.

Al Hikmani et al. (2023) estimate the Arabian leopard population in Yemen to be fewer than 50 individuals, but this is highly speculative. They assume that the leopard may still exist in five sites, namely the northern part of the western highlands (between Sa'dah and the Saudi border), the central-western highlands (Jebel Bura'a), southwest Yemen (between Taizz and Ad Dale), southeast Yemen (Lawdar area in Abyan governorate) and Hawf in Al Mahra, as already suggested by Al Jumaily et al. (2006). It is unrealistic to expect reliable density estimations in Yemen in the near future, but consistent collection of citizen science data may shed some light on the extant distribution. Social media seems to be a promising source of leopard records from Yemen. We encourage all who have access to social media and any other sources to collect as much information on leopards in Yemen as possible and to share it with the conservation community.

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[1] Director General, Biodiversity and Nature Reserves, Environmental Protection Agency, Yemen

* <alfotooh.abdullah@gmail.com>

[2] CITES Focal Point, Environmental Protection Agency, Yemen

[3] Programme SONC/SANID

HADI AL HIKMANI[1,2], TALAL AL SHAHARI[1], KHALID M. ALI AL HIKMANI[1], SAID ZABANOOT[1], ALI AKAAK[1] AND KHALID M. DAAN AL HIKMANI[1]

Observations on the predatory behaviour of caracal in the Dhofar Mountains, Oman

The caracal *Caracal caracal schmitzi* is a widely distributed felid species in the Arabian Peninsula; however little is known about its predatory behaviour. This paper presents new observations from the Dhofar Mountains of Oman of caracals killing several mammal species including rodents, rock hyrax *Procavia capensis* and mongoose. These observations further our understanding of the predatory habits of this little-studied felid species in the Arabian Peninsula.

The caracal is a widely distributed felid species in Arabia, occurring from Jordan in the northwest to Oman in the southeast (Mallon & Budd 2011, Al Hikmani et al. 2017, Gubiani et al. 2020), but is considered extinct in Kuwait (Cowan 2003). Despite this relatively wide distribution, little is known about the predatory behaviour of caracals in the Arabian Peninsula. Two previous studies in the region include Van Heezik & Seddon (1998) of a single radio-tracked adult male in northern Saudi Arabia, and Stuart & Stuart (2007) of caracal diet in the UAE and Musandam Peninsula. A greater number of studies address caracal diet in Africa and Asia where results show that caracals are generalist feeders, with a preference for small- to medium-sized mammals, and rodents play an important role in their diet (e.g. Mukherjee et al. 2004, Farhadinia et al. 2008, Ghoddousi et al. 2009, Braczkowski et al. 2012, Moqanaki et al. 2016, Drouilly et al. 2018, Momeni et al. 2019, Leighton et al. 2020, Müller et al. 2022).

Although the caracal is globally listed as Least Concern by the IUCN (Avgan et al. 2016), it is considered threatened or declining in regional assessments for North Africa, and West and Central Asia (Avgan et al. 2016). For example, the caracal is regarded as being rare in Jordan, Saudi Arabia, and UAE (Mallon & Budd 2011), while it is considered locally endangered in Turkey and India (Avgan et al. 2016). Threats to the caracal also vary throughout its global range. Habitat change due to agriculture and desertification is the major threat in Central, West, and Northeast Africa (Avgan et al. 2016), whilst habitat loss due to road and settlement expansion is the main threat in the Arabian Peninsula (Mallon & Budd 2011).

Caracals, like all predators, are reliant on a healthy prey base to survive, and thus changes in the abundance or composition of the prey base can directly impact their life-history strategies, population dynamics, and how they adapt in a rapidly changing world (Havmøller et al. 2021). Observations of predatory behaviour, such as those reported here for the caracal in the Dhofar Mountains of Oman, improve our knowledge of the inter-specific relationships in a landscape where very little is known about the mammal community.

Observations of caracal predatory behaviour in Dhofar

On 6 November 2012, a camera trap (Bushnell Trophy Cam Model 119435) was set up in Jabal Qamar, in the west of Dhofar (16°46'7.12"N/53°33'2.45"E), by wildlife rangers from the Office for Conservation of the Environment. On 12 November, it recorded an adult caracal feeding on an African grass rat *Arvicanthis niloticus* (Fig.1). A different camera trap (Bushnell Trophy Cam Model 119456) deployed on 17 January 2013 in Jabal Samhan (17°13'41.63"N/55°0'44.94"E), in the east of Dhofar, recorded caracals killing rock hyrax on three different occasions on 13 February 2013, 14 March 2013 and 7 April 2013 (Fig. 2). Another camera trap (Bushnell Trophy Cam Model 119456) was set up in Jabal Samhan (17°11'26.77"N/54°55'21.95"E) on 7 January 2017 and photographed a caracal carrying a white-tailed mongoose *Ichneumia albicauda* on 12 February 2017 (Fig. 3).

To our knowledge, this is the first observation of a caracal killing a mongoose in the Arabian Peninsula, though some mongoose species have been reported in the diet of caracals in Asia (e.g. Moqanaki et al. 2016) and Africa (e.g. Drouilly et al. 2020). Both rock hyrax and white-tailed mongoose occur throughout the Dhofar Mountains and have a scattered distribution in Saudi Arabia and Yemen (Mallon & Budd 2011). However, in Arabia, the African grass rat seems restricted to Yemen and the monsoon-influenced grasslands and

Fig. 1. Photo (taken on 12 November 2012) of caracal feeding on an African grass rat, Jabal Samhan, Oman (Photo H. Al Hikmani).

Fig. 2. Photo (taken on 7 April 2013) of caracal carrying a Rock hyrax, Jabal Samhan, Oman (Photo H. Al Hikmani).

woodlands of the Dhofar Mountains (Spalton et al. in press).

There have been two previous studies of caracal feeding behaviour in the region. Van Heezik & Seddon (1998) found that caracal diet in Saudi Arabia mostly consisted of rodents, notably the Libyan jird *Meriones libycus*. They also observed caracal feeding on carcasses of a juvenile camel *Camelus dromedarius*, a steppe eagle *Aquila nipalenis* and recently-dead gazelles *Gazella subgutturosa*. Stuart & Stuart (2007) found caracal diet in the UAE consisted mostly of livestock, including goats, and sheep. They also found evidence of Egyptian spiny mouse *Acomys cahirinus*, unidentified bird species, and invertebrates in the diet; the latter identified as the malleoli blades of Solifugae.

The observations reported here provide new and important information about caracal predation in the Dhofar Mountains of Oman. Where caracal and these prey species co-occur elsewhere in Arabia, similar interspecific interactions may well occur. Several of these prey species, most notably the rock hyrax, are also important prey species for the Critically Endangered Arabian leopard *Panthera pardus nimr*. Whether and how competition for prey between these two felid species might impact their population dynamics in the Dhofar remains unknown.

Fig. 3. Photo (taken on 12 February 2017) of caracal carrying a white-tailed mongoose, Jabal Samhan, Oman (Photo H. Al Hikmani).

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[1] Office for Conservation of the Environment, Oman.

[2] The Royal Commission for AlUla, Saudi Arabia.

*<hadidofar@gmail.com>

JACQUELINE SUNDERLAND-GROVES[1,2*], DEDE AULIA RAHMAN[3], DENNY KURNIAWAN[2], EKO PRASETYO[2,3], JAMARTIN SIHITE[2], CATHERINE SUN[1], COLE BURTON[1]

The first photographic record of a Borneo bay cat pair of both colouration forms

The Endangered Borneo bay cat *Catopuma badia* (hereafter bay cat) is one of the rarest and least known of all the small cats; however, recent studies using camera traps are increasingly contributing to our knowledge of bay cat distribution. During a three-year camera trap study in the Bukit Batikap Protection Forest (Batikap) located in Central Kalimantan, Indonesia, images of this highly elusive species were captured on five separate occasions, the second of which captured images of a bay cat pair that appeared to consist of both known colouration phases, the reddish-bay form and the light or dark grey, of which the latter is thought to be rarer. To our knowledge, this is the first photographic record of a bay cat pair of both colouration morphs in the wild and the first photographic record of bay cat in Batikap.

Bukit Batikap Protection Forest (Hutan Lindung Bukit Batikap) is a primarily undisturbed tropical forest located in the Murung Raya district of Central Kalimantan, Indonesia, within the Muller-Schwaner Mountain range (0°2'23.172''N/113°30'0.072''E; WGS 84; Fig. 1). Topography ranges between 100–1,580 m with lowland areas dominated by dipterocarp species. Since 2012, the area has been the focus of an orangutan reintroduction programme by the BOS Foundation (Nayasilana et al. 2017).

New photographic records of the Borneo bay cat

In March 2020, 30 camera trap stations were deployed in undisturbed forest across a grid system at a spacing of ca.1 km with a primary goal to gather long-term data on the reintroduced Bornean orangutan *Pongo pygmaeus wurmbii* population. Twenty-one Reconyx Hyperfire, 5 Browning Dark Ops and 4 Browning Strike Force remote cameras were set at heights of between ca. 50–120 cm across the 30 stations with cameras programmed to record three images per trigger. Between March 2020 and April 2022, 26 operational cameras gathered data over 13,215 camera trap days, with four independent detections of bay cat recorded at 4 of the camera trap stations (Supporting Online Material SOM Table T1, Fig. 1). During the third year of the study, a further detection was recorded in July 2022. In December 2020, images were captured of a bay cat pair of possibly both colour phases, reddish and grey (Fig. 2 & SOM Figure F1a,b). The light or dark grey form is thought to be rarer (Kitchener et al. 2004, Mohd-Azlan & Sanderson 2007). The four other photograph detections recorded were of a single individual of the reddish form reflected in Fig. 3.

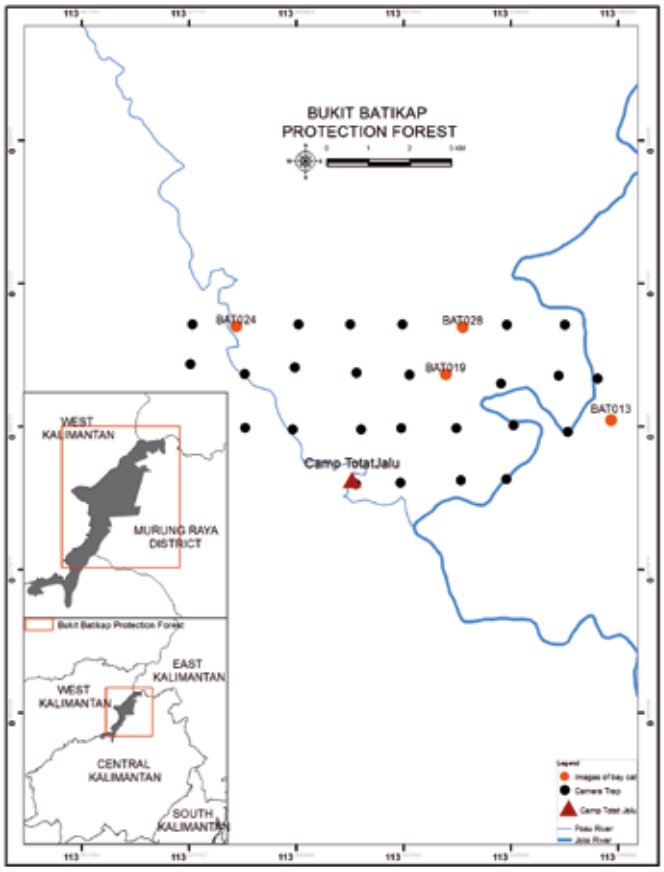

Fig. 1. Location of bay cat image records

Confirmed distribution

Whilst slowly growing, records of bay cat are still rare and its distribution has been largely determined by habitat suitability (Hearn et al. 2016b, 2018). In Indonesia, presence has been recorded in East (Yasuda et al. 2007, Sastramidjaja et al. 2015), West (Hearn 2003, Meijaard et al. 2005), and Central (Bricknell 2003) Kalimantan. While in South Kalimantan, there have been no reported sightings. It is unclear if this is due to a lack of sampling effort or their genuine absence. Bukit Batikap Protection Forest lies in the heart of their estimated range and it is encouraging to confirm that this location continues to serve as important habitat for their ongoing conservation in the region. Limited information is available on bay cat ecology, including the relevance of the different pelage morphs, and expanded surveys and population monitoring are required to further understand their overall ecology, and emerging threats.

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Fig. 2. Bay cat pair of both colour phases pictured in December 2020 (Photo BOSF/UBC/IPB).

Fig. 3. Individual bay cat of red colour phase pictured in March 2022 (Photo BOSF/UBC/IPB).

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Supporting online Material Table T1 and Figure F1 are available at www.catsg.org.

[1] University of British Columbia
[2] Borneo Orangutan Survival Foundation
* <jacqui.sunderland-groves@ubc.ca>
[3] IPB University

DEVAVRAT PAWAR[1*], ANANYA SARATHE[1], SIDDHANT UMARIYA[1], NITISH MANI TRIPATHI[2], ARPAN KUMAR GUPTA[1], ANKUR PATRA[1], ANIL KUMAR SINGH[1] AND I. P. BOPANNA[1]

Discovery of rusty-spotted cat from Dehradun Forest Division, Uttarakhand, India

The rusty-spotted cat *Prionailurus rubiginosus* is the smallest member of the Felidae family and is historically only found in the Indian subcontinent. While evidence of its distribution in Uttarakhand is limited, a recent observation was made in the northwest region of Dehradun Valley during an ecological census for large mammals. A camera trap deployed in Arcadia Beat of Asharodi Range in Dehradun Forest Division, at an abandoned tea plantation captured an image of the rusty-spotted cat. This is the first photographic evidence of the cat's presence in the Dehradun Forest Division.

The rusty-spotted cat is the smallest species of cat, typically measuring between 35 cm and 48 cm in length with a tail length of 15 cm to 30 cm. On average, the mammal weighs between 1.1 kg and 1.6 kg (Philips 1935). It is characterised by a short, rust-coloured coat with reddish-brown markings and four black lines on its forehead, two of which extend to the back of its body. The cat's belly and inner limbs are whitish with small brown spots, while its tail and paws are consistently reddish-grey in colour (Menon 2014). The rusty-spotted cat has been observed in diverse habitats, including grasslands, scrub forests, tropical dry evergreen forests, moist deciduous forests, and even near populated areas and agricultural fields, (Nowell & Jackson 1996, Athreya 2010, Pawar et al. 2021). This demonstrates the species' impressive adaptability to various environments. The cat is a skilled hunter, feeding primarily on small animals such as rodents and birds and small reptiles, amphibians, and insects. It is elusive and rarely seen, making it challenging for researchers to gather information on its ecology and population size, (Mukherjee et al. 2016).

Recent studies have shown that the species is distributed across India, Sri Lanka and the Western Terai of Nepal (Yadav et al. 2021). In the Shivalik Bhabar region of India, where little is known about their ecology, distribution, or behaviour, few studies have been conducted on the rusty-spotted cat. However, with the advancement of wildlife research and technology, researchers were able to locate breeding grounds through photographic evidence of these cats in Uttarakhand (Pawar et al. 2021), Uttar Pradesh, (Pawar et al. 2021) and Haryana, (Ghaskadbi et al. 2016).

Study Area

Dehradun Forest Division DFD (Fig. 1) is situated in the southwest region of Uttarakhand and spans over an area of 454.95 km^2. It shares its boundary in the east with Rajaji Tiger Reserve, on the west with Soil Conservation Kalsi, in the south with Shivalik Forest Division, Uttar Pradesh and in the north with Mussoorie Forest Division and Narendranagar Forest Division. The northern boundary consists of the lower ranges of the Himalayas, while the valleys consist of the floodplains and the southern boundary is formed by the Shivalik Hills. The altitude of the Division ranges from 400 m to 1,900 m approximately. DFD comprises of eight ranges viz. a viz. Asharodi, Malhan, Lacchiwala, Malsi, Jhajra, Thano, Barkot, and Rishikesh. In one of these ranges, the Arcadia Beat of the Asharodi range, our camera trap detected the rusty-spotted cat (Fig. 2 & 3).

Capture event

In order to better understand the diversity and distribution of mammalian fauna in the DFD, a rigorous and continuous camera trap survey was conducted between September 2021 and May 2022. Approximately 600 camera traps were deployed throughout the division, with pairs of cameras placed in each 2 km^2 grid cell to maximise coverage. Other relevant parameters, such as terrain type, vegetation cover, and human disturbance, were also recorded to provide context for the results. The camera traps were placed at a height of 2–2.5 feet above the ground, and the camera trap pairs were spaced apart by 16–26 feet. The cameras were set at 30-second intervals, and placed for 25 consecutive nights, providing comprehensive coverage of the study area. During the survey, a photo of a rusty-spotted cat was captured on a camera trap deployed in Arcadia Beat of Asharodi Range of the DFD (30°18'47.09"N/ 77°55'22.11"E; Fig. 3) at an elevation of 594 m on 26 December 2022, at 22:37 h at night. Throughout the study only once one image of the rusty-spotted cat was captured. This is the first photographic evidence of the species from DFD. The rusty-spotted cat's photo-capture location was in a 30-m vegetation plot within the Arcadia beat, where the camera trap was deployed. The Arcadia beat area is surrounded by human habitation on all sides, and the particular location where the rusty-spotted cat was photographed is highly fragmented, with frequent human activity throughout the day (Fig. 2). This vegetation plot consisted of 6 sal trees *Shorea robusta*, 10 bamboo *Dendrocalamus strictus*, and 8 teak trees *Tectona grandis*. The understory comprised 10% curry leaf plants *Murraya koenigii*, 30% rohini *Mallotus philippensis*, 10% Kadu *Clerodendrum*, 10% karonda *Carissa carandas*, and 40% lantana bushes *Lantana camara*. The surrounding area adjacent to the Arcadia beat encompassed a tea plantation. Over the study duration, images captured by the same camera trap that captured the rusty-spotted cat included evidence of human and livestock movement, featuring 105 human images, 10 cow images, and 23 buffalo images. Other wildlife photo-captured at this location were Indian hare *Lepus nigricollis* (image count-01), barking deer *Muntiacus muntjak* (image count-09), wild pig *Sus scrofa* (image count-10), and Indian crested porcupine *Hystrix indica* (image count-06).

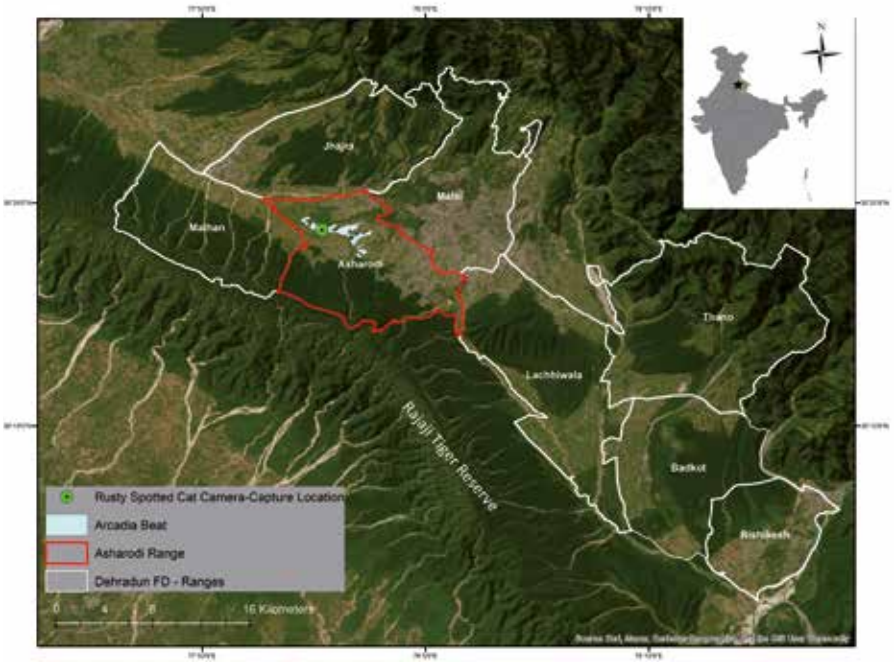

Fig. 1. Map of Dehradun Forest Division showing the location where the rusty-spotted cat was photo captured (Photo D. Pawar).

Discussion

Arcadia beat is separated from the main Asharodi Range of DFD by roads, human settlements, and agricultural fields. Despite these factors, the region lying adjacent to Rajaji Tiger Reserve renders it ecologically significant, potentially enabling future wildlife migration via the adjoining riparian habitat. As with other species that suffer from loss of habitat and connectivity, rusty-spotted cats are also at risk due to a declining population, however, the extent of this threat cannot be verified due to the limited studies conducted on the species (Singh & Kariyappa 2020). The rusty-spotted cat's elusive nocturnal behaviour and activity pattern may be a contributing factor to the paucity of data available on its ecology. In-depth studies in regions with species' presence should be undertaken to gather comprehensive knowledge on its ecology, behaviour, interaction and habitat use. This knowledge would serve as a crucial basis for designing species-specific interventions aimed at promoting its sustained survival. Given that a substantial proportion of these diminutive felines are likely to persist beyond protected zones, conducting studies in such inhabited areas, on understanding how the rusty-spotted cat uses the components from its environment, would be

Fig. 2. Habitat of Arcadia beat, Asharodi Range of DFD. Clockwise - Sal Forest, Crop fields visible from the Camera trap location, and abandoned tea plantations (Photos A. K. Gupta).

an interesting exploratory research subject, and the gathered knowledge would additionally support the formulation of conservation strategies tailored specifically to the species, extending beyond the boundaries of these protected areas.

Prior to our discovery, the existence of rusty-spotted cats in the DFD was unknown. The information presented in this paper would be helpful in assisting the Forest Department and other conservation organisations in preparing species' specific management decisions and conservation plans, particularly within the Division.

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[1] WWF-India, Terai Arc Landscape Head Office, Dehradun, Uttarakhand, India 248001.
*<dpawar@wwfindia.net>

[2] DFO, Dehradun Forest Division, Dehradun, Uttarakhand, India, 248001

Fig. 3. Rusty-spotted cat photographed on 26 December 2022 in Arcadia Beat of Asharodi Range, Dehradun Forest Division (Photo WWF-India).

It had been a hot day, with temperatures soaring as high as 47°C in the shade. The drought had been severe this year and the Ingwe Pan waterhole was the only permanent water body for miles around.

As dusk set in, the shyer animals that were seeking shelter in the shade began emerging to quench their thirst. A large male leopard slinked to the water's edge and lapped up as much water as he could before making a hasty retreat into the growing darkness. Another leopard, a female appeared on the opposite side of the waterhole and seemed more at ease, taking her time to drink as she kept a watchful eye on the other animals that were also drinking. As we approached her with photography on our minds, we noticed a third leopard perched in a tree. It looked like a female; we watched her for a while as she made herself comfortable in the branches and took a few images of her while she waited for the other leopard to move away from the water. Finally, she made up her mind and climbed down from the tree but rather than drink from where the first female had quenched her thirst, she moved towards where the male leopard had been. All in all, Ingwe Pan lived up to its name after all "Ingwe" is the Setswana word for "leopard".

Advised camera settings: your night photography settings will depend greatly on the type of light being used to view the animal. Generally, it is advised to use a high ISO (over 2500), a low f-stop (as low as f/4), underexpose (by at least 1 stop) and use the spot-metering mode. Note that it is not advised to photograph diurnal species at night as it puts them in a particularly vulnerable position as a result of dilated pupils making them less adapted to low/no light conditions.

Digital photography has significantly helped advancing cat research and conservation in recent years. "Through the lens" is a new rubric in Cat News dedicated to spectacular and intriguing photographs of felids, but also technical innovations regarding both hard- and software as well as photography tips for the field. The rubric is edited by Malini Pittet, who is grateful to receive further suggestions, input, and comments. Please write to Malini at malini.pittet@gmail.com.

SUNIT KR. DAS[1*], JYOTISHMAN DEKA[2], DEBA KR. DUTTA[3], SUSHANTA K. BORTHAKUR[4], UDDIPTA KALITA[5], TRIDIP SHARMA[6], PRANAV CHANCHANI[7], ANUPAM SARMAH[8], JASIMUDDIN AHMED[9] AND DIBAKAR DAS[10]

First confirmed tiger dispersal record in Bornadi Wildlife Sanctuary, Bhutan and India

Bornadi Wildlife Sanctuary is the critical tiger habitat of Manas Tiger Reserve, and for the first time, a tiger *Panthera tigris* was photo-captured in the sanctuary. Previously in 2018, the same individual was recorded on a camera trap in Manas National Park, more than 50 km to the west. This dispersal event is of significance for three reasons: first, it establishes functional connectivity in the Manas and Bornadi; second, it highlights the significance of areas like the Bornadi wildlife sanctuary for tiger conservation and emphasises the need to strengthen protection and management in such 'satellite' habitats. Lastly, it testifies to the recovery of tigers in Manas National Park, which may serve as a source site for surrounding areas. The finding also emphasises the need for joint collaborative monitoring and conservation practices to secure the transboundary habitats that are crucial for the recovery and persistence of tigers within the larger Manas complex.

Dispersal is a compulsion in tigers to establish new territories and to ensure their survival from intra-specific competition. It also plays an important role in population dynamics (Singh et al. 2013). On the other side, habitat loss is the greatest threat to large carnivores around the world (Thatte et al. 2018) and habitat connectivity is critical for maintaining healthy populations. Transboundary Manas Conservation Area TraMCA is a key wildlife conservation landscape between India and Bhutan. The landscape is a cluster of National Parks, Wildlife Sanctuaries, Reserve Forests and Proposed Reserve Forests that covers around 6,500 km^2 area, and Manas National Park MNP on the Indian side, and Royal Manas National Park RMNP in Bhutan act as key source population site for tigers in the entire landscape (Ahmed et al. 2016). However, the Indian side of the landscape has experienced major habitat loss during the ethno-political conflicts (1989–2000) that resulted in fragmentation and drastic decline of the tiger population and its prey species (Goswami & Ganesh 2014). In 2003, however, after the Bodo Territorial Council was formed, combined conservation efforts resulted in reversal of the population declining trend (Lahkar et al. 2020) and today MNP has 52 adult tigers and RMNP has 22 adult individuals. Some individuals use transboundary habitats, and this has resulted into the entire area holding a healthy transboundary tiger population (WWF 2019, The Hindu 2022).

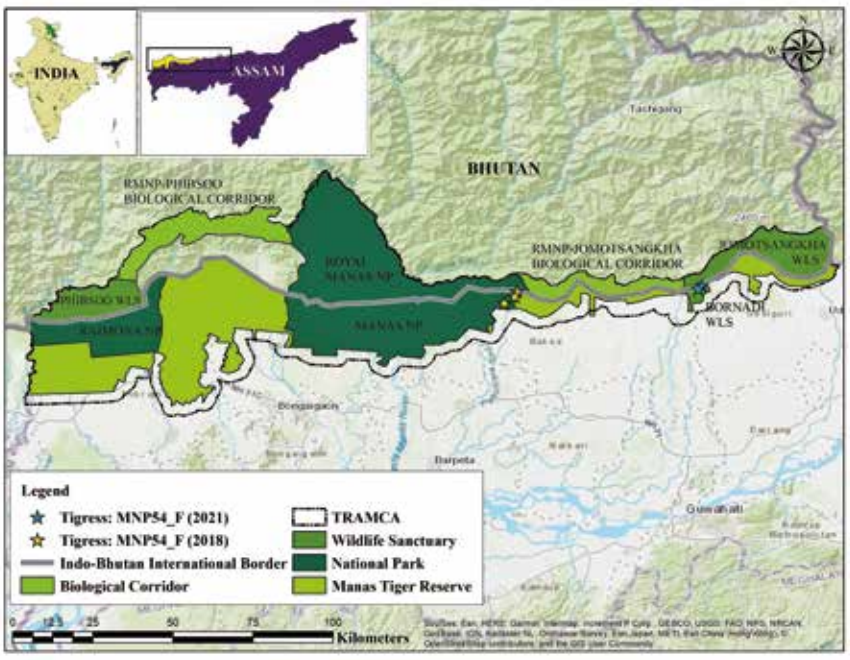

Fig. 1. First photographic and confirmed dispersal record of tiger in Bornadi Wildlife Sanctuary under Transboundary Manas Conservation Area, Bhutan and India. Map is developed using ArcGIS software 10.8 (ESRI 2020).

Located on the eastern part of MTR, Bornadi Wildlife sanctuary (WLS (26.22 km^2) is critical tiger habitat of the reserve (FDMTP 2019), which is connected with MNP with fragmented habitat (Fig. 1). In the north it shares its boundary with the biological corridor that connects RMNP and Jomotsangkha WLS of Bhutan. In 2021 camera traps were deployed in Bornadi WLS, covering 11 locations. A tiger photo, captured during this exercise, was identified as MNP-54 (female), after comparison of the stripes, an adult female previously first recorded from Bhuyanpara Range of MNP in 2018 (Swargowary et al. 2018; Fig. 2 & 3). Thereafter it was not recorded from MNP till 2021. The aerial distance covered by the tigress between MNP and Bornadi WLS was nearly 56 km (Fig.1). The same tiger was photo-captured from two locations the of the sanctuary during the same season. Earlier surveys to document the faunal diversity of the sanctuary (Chakraborty et al. 2015, Ahmed et al. 2019), did not yield evidence of tiger presence, making this the first photographic evidence of the species from this protected area as well as the first evidence of confirmed dispersal from MNP to Bornadi WLS. As such we hypothesise that the tiger may have used the RMNP-Jomotsangkha biological corridor to the north of the sanctuary located in Bhutan, as the remaining habitat between MNP and Bornadi WLS in India is highly fragmented and disturbed.

It is likely that with the recent recovery of tigers in MNP and RMNP, some animals will disperse from their source sites. It also identifies the importance of the entire TraMCA and the need for effective protection of both protected and non-protected habitat areas outside of RMNP and MNP, including systematic monitoring in the corridors. To achieve the larger goal of tiger recovery in the TraMCA complex, proper investment and management interventions in comparatively low-profile new areas like the Bornadi-Jomotsangkha complex are necessary, including close coordination between Bhutan and India.

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Fig. 2. First photo-capture of Tigress MNP54(F) in Manas National Park 2018 (Photo Manas TR & WWF India).

Fig. 3. First photo-capture of tigress MNP54(F) in Bornadi WLS in 2021 (Photo Manas TR & WWF India).

[1] Sunit Kr. Das, Senior Project Officer, c/o WWF India, Brahmaputra Landscape, Parvati Nagar, Tezpur 784001, Assam India
*<sdas@wwfindia.net>

[2] Jyotishman Deka, Research Biologist, Manas Tiger Reserve, Assam Forest Department, India

[3] Deba Kr. Dutta, Landscape Coordinator, Manas Conservation Area, Brahmaputra Landscape WWF India

[4] Sushanta K. Borthakur, Project Officer, Brahmaputra Landscape, WWF India

[5] Uddipta Kalita, Research Biologist, Manas Tiger Reserve, Assam Forest Department, India

[6] Tridip Sharma, Project Officer, Brahmaputra Landscape, WWF India

[7] Pranav Chanchani, National Lead, Tiger Conservation Programme, WWF India

[8] Anupam Sarmah, Team Leader, Brahmaputra Landscape, WWF India

[9] Jasimuddin Ahmed, Assistant Director, AFS, Manas Tiger Reserve, Assam Forest Department, India

[10] Dibakar Das, Deputy Director, AFS, Manas Tiger Reserve, Assam Forest Department, India

TASHI DHENDUP[1*], LETRO[2], TANDIN[3], SAPANA SUNAR[1], KENCHO RIGZIN[1], DORJI DUBA[1], UGYEN WANGCHUK[1], SONAM WANGDI[2]

Tiger, snow leopard, and the common leopard co-occur in the forests of Bhutan

Tigers *Panthera tigris*, snow leopards *P. uncia* and common leopards *P. pardus* are three of the top predators in Asia. Although habitat overlaps between the three species have been previously reported, we provide the first photographic evidence of the three big cat species of the Himalayas in the same area in Bhutan. Camera traps at one of the stations set up as part of the nationwide snow leopard survey in 2022 photographed the three wild cats in Thimphu Forest Division in the western part of the country. We recommend further monitoring to understand the nature of their coexistence and their impacts on the local ecosystem.

Tiger, snow leopard and common leopard are the only three big cats inhabiting the Himalayas. The tiger is listed as Endangered, and the snow leopard and common leopard are listed as Vulnerable on the IUCN Red List of Threatened Species. There are estimated to be between 3,736–5,578 tigers and 2,710–3,386 snow leopards in the wild (Goodrich et al. 2021, McCarthy et al. 2017). A robust estimate of the global leopard population is currently lacking (Stein et al. 2020). However, all three species are experiencing a decline in population due to poaching, habitat loss and fragmentation, and prey loss (Goodrich et al. 2021, McCarthy et al. 2017, Stein et al. 2020). The snow leopard exhibits a habitat specialisation, primarily inhabiting colder elevations between 500 m to 5,800 m. In the Himalayas, snow leopards occur at higher elevations, typically above 3,500 m. In contrast, tigers and common leopards are more adaptable and occupy a broader elevational range, from as low as 100 m in tropical plains to 4,500 m in mountainous regions. Habitat overlap is reported between tigers and common leopards, often resulting in competition, with tigers exerting dominance (Palomares & Caro 1999). Snow leopards and common leopards also experience habitat overlap, though they differ in their habitat preferences, with snow leopards favouring grasslands and shrublands and common leopards selecting forested environments (Lovari et al. 2013). As for tigers and snow leopards, it was only recently that the species were recorded for the first time in the same area in Jigme Dorji National Park, Bhutan (Dendup & Choki 2023). Overlap among these apex predators is most

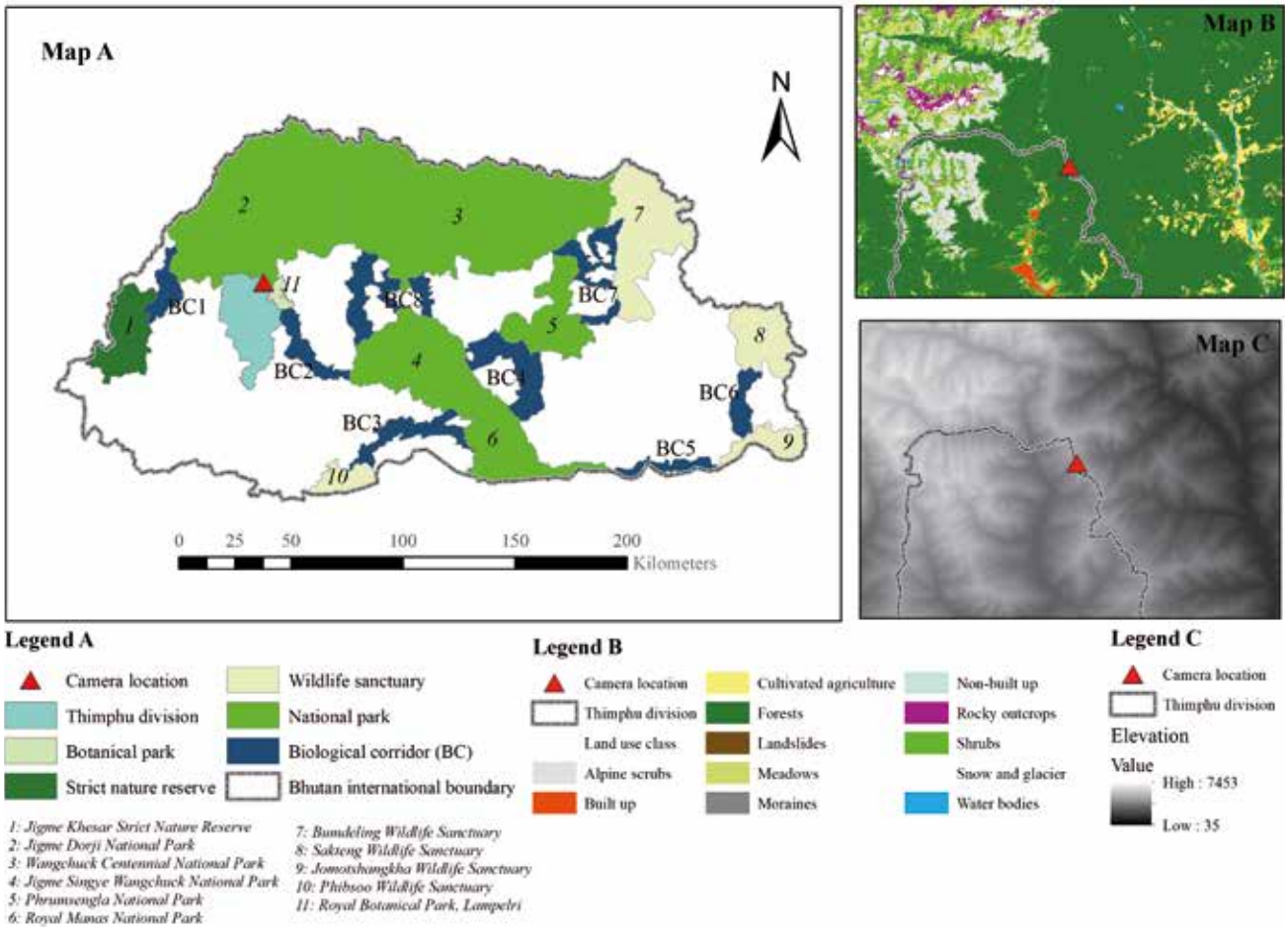

Fig. 1. Map showing the location of the camera station where a tiger, snow leopard and common leopard were photographed. (JKSNR: Jigme Khesar Strict Nature Reserve, JDNP: Jigme Dorji National Park, WCNP: Wangchuck Centennial National Park, BWS: Bumdeling Wildlife Sanctuary, PNP: Phrumsengla National Park, JSWNP: Jigme Singye Wangchuck National Park, RMNP: Royal Manas National Park, PWS: Phibsoo Wildlife Sanctuary, JWS: Jumotshangkha Wildlife Sanctuary, SWS: Sakten Wildlife Sanctuary).

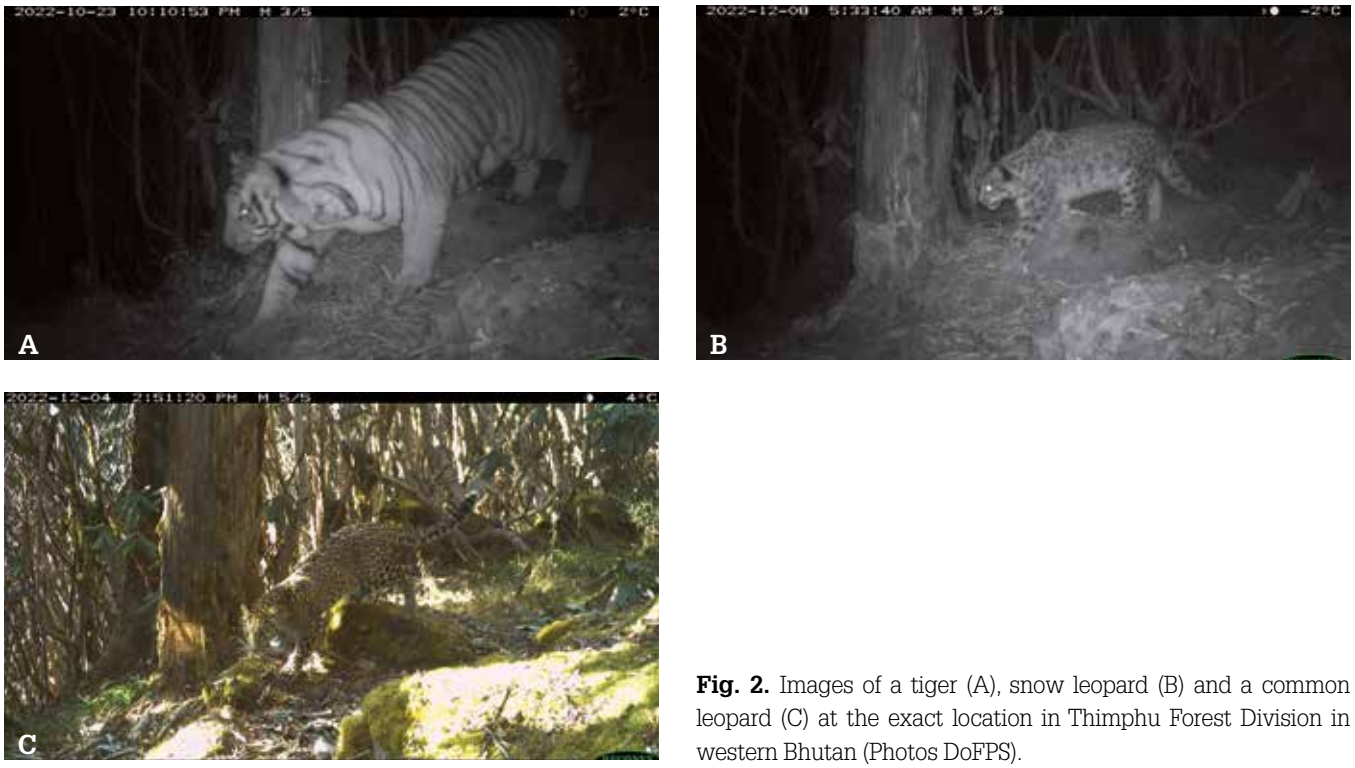

Fig. 2. Images of a tiger (A), snow leopard (B) and a common leopard (C) at the exact location in Thimphu Forest Division in western Bhutan (Photos DoFPS).

pronounced in transitional zones, where the snow leopard and tiger and leopard habitats intersect. While occasional coexistence may occur, it remains infrequent due to their distinct habitat requirements and elevational preferences. Consequently, interactions between these species are sporadic, with implications for shared prey and territorial conflicts. The rarity of such overlap underscores the importance of recognising the unique ecological niches and geographic distributions of these species in conservation strategies. Here, we report the first photographic evidence of a tiger, snow leopard and common leopard co-occurring in the same area and discuss the conservation implications.

From August to December 2023, Bhutan conducted its second nationwide snow leopard survey using camera traps. Potential habitats between 3,400 and 5,200 m were identified to determine the survey area, and the inaccessible regions were excluded. These habitats were then categorised into high and low-density zones using a density map from the 2016 nationwide snow leopard survey. Within accessible potential habitats, a 2 km x 2 km grid was applied in QGIS, using the potential snow leopard habitat as a mask layer for camera station locations in an SECR design simulation. This simulation identified grid cells for camera placement, verified on the ground by field offices. A total of 310 grids were selected for camera trap placement after adjusting for accessibility and suitability (NCD 2022, 2023). Within the grids, camera sites were chosen based on the presence of animal signs. Cameras were placed along trails, ridges, valley bottoms, cliffs, etc., to maximise the capture probability of snow leopards (NCD 2022, 2023).

One camera station in Thimphu Forest Division (Fig. 1), located in the western part of Bhutan, recorded a tiger, snow leopard and common leopard inside a rhododendron forest at an elevation of 3,634 m (Fig. 2). The tiger was recorded on the night of 23 October 2023, the snow leopard in the morning of 8 December 2023, and the common leopard in the afternoon of 4 December 2023 (Fig. 1). Other species recorded at the same sites were the Asiatic black bear *Ursus thibetanus*, Asiatic golden cat *Catopuma temminckii*, barking deer *Muntiacus muntjac*, sambar *Rusa cervicolor*, red fox *Vulpes vulpes*, red panda *Ailurus fulgens*, Asiatic wild dog *Cuon alpinus*, wild pig *Sus scrofa*, yellow-throated marten *Martes flavigula* and several species of birds.

The finding marks the first recorded instance of a tiger, snow leopard, and common leopard using the same area. Although several studies have examined the niche relationships between tigers and common leopards and their dependence on both wild and domestic prey (Carter et al. 2015, Kumar et al. 2019, Kumar et al. 2020, Thapa et al. 2020), there have been no prior studies examining the dynamics of coexistence between snow leopards and either of the other two species. It is well-documented that snow leopards exhibit a narrower niche breadth, while tigers and common leopards display more generalised habitat preferences (Gubbi et al. 2020, Lovari et al. 2013, Nowell & Jackson 1996). While tigers are known to traverse landscapes above 4,000 m in Bhutan, there have also been documented snow leopards in fir and mixed conifer forests (Thinley et al. 2016). In a note-worthy occurrence, a solitary snow leopard was observed in Jigme Singye Wangchuck National Park, located in central Bhutan, at a distance of at least 40 km from the nearest known snow leopard habitat in Wangchuck Centennial National Park (Letro et al. 2021).

In the present location, the area's narrow spectrum of available wild prey species suggests that the three carnivores may compete for food resources, with tigers likely exerting dominance over snow leopards and common leopards. Previous research has also reported interference competition by tigers against common leopards, leading to leopards being pushed to the outskirts (Kafley et al. 2019). Dendup & Choki (2023) reported snow leopard and tiger capture at the same camera trap sites on different dates in Jigme Dorji National Park, with both species displaying nocturnal behaviours; however, snow

leopards were predominantly active before dawn. Our records align with these observations, and the recording of common leopards in the afternoon hints at temporal partitioning as a possible mechanism for the coexistence of the three species.

In Bhutan, all three species are known to be involved in livestock depredation, although snow leopards to a lesser extent than tigers and common leopards (Sangay & Vernes 2008), likely due to lower livestock and human densities at higher altitudes. Prior to this survey, the presence of tigers, snow leopards, and common leopards in the region had yet to be documented. However, when these three apex predator species coexist within the same geographical area, it raises the potential for an increased incidence of livestock predation. This phenomenon can be attributed to the competition for prey resources among these large carnivores, consequently amplifying the impact on local livestock populations. Furthermore, the presence of Himalayan black bears and Asiatic wild dogs in the area, both species known to be prominent contributors to human-wildlife conflicts in Bhutan, should also be considered.

While such occurrences are intriguing, they remain infrequent. The increasing documentation of these species in previously uncharted areas suggests potential range shifts, possibly induced by climate change. Evaluating the extent to which climate change and anthropogenic disturbances impact the species and their habitats is paramount. Notably, Thimphu, as the capital of Bhutan, experiences relatively higher anthropogenic pressures on its natural environment compared to other regions in the country. However, it is also plausible that these individuals are transients searching for territories. Given the historical lack of extensive and consistent surveys in these habitats, tigers, snow leopards, and leopards within the same landscape may have occurred but remained undetected. Therefore, it is imperative to conduct thorough, long-term monitoring of these sites to understand the nature of these occurrences and the potential interactions among the three species and other carnivores. Bhutan's fragile mountain ecosystem faces unprecedented challenges from climate change and rapid anthropogenic pressures if not effectively managed. Studies focusing on these species and their ecosystems can provide valuable insights into the impacts and mitigation strategies that must be implemented.

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[1] Bhutan Tiger Center, Nature Conservation Division, Motab Gor, Panbang, Zhemgang, Bhutan.
* <tashidhend@gmail.com>

[2] Nature Conservation Division, Taba, Thimphu, Bhutan

[3] WWF Bhutan, Kawajangsa, Thimphu, Bhutan

KARMA WANGDI[1*], TSHERING DHENDUP[1], PENJOR[1], YESHI DORJI[1], AND NGAWANG TASHI[1]

Evidence of habitat overlap between tigers and snow leopards in WCNP, Bhutan

Bhutan is one of the few countries in which both tigers *Panthera tigris* and snow leopards *P. uncia* are found. Both these animals are totally protected in the country. Previously, habitat overlap between tigers and snow leopards in Bhutan was claimed based on evidence such as pugmarks, livestock kills and camera trap images. Until recently, there were no photographic evidence on the habitat overlap between these two species. The first photographic evidences on their co-occurrence was reported from Jigme Dorji National Park JDNP of Bhutan, based on camera trap data of the nationwide tiger survey 2021. In 2022, Wangchuck Centennial National Park WCNP carried out the camera trap survey for the snow leopard as a part of nationwide survey. For that, eighty-seven pairs of camera traps were deployed across 87 stations (2 km x 2 km grid) between altitude range of 3,714 to 5,287 m in the park. A total of 18 different identifiable mammals were photo-captured in the camera traps. The snow leopards were photo-captured in 31 different camera stations. Remarkably, in a pair of camera traps both the tiger and the snow leopard were photo-captured at the same point. In this report, we present evidence to claim the co-occurrence of tigers and snow leopards in WCNP.

The tiger is listed as Endangered on IUCN Red List assessment with global population estimate between 3,726 and 5,578 individuals (Goodrich et al. 2022). Whereas, the snow leopard is listed as Vulnerable with global population estimate between 7,446 to 7,996 (McCarthy et al. 2017). In Bhutan, both these animals are listed under Schedule I of Forest and Nature Conservation Act 2023 (FNCA 2023), thus, giving them the highest legal protection status in the country. As per the latest reports, Bhutan has an estimate of 134 snow leopards (NCD 2023) and 131 tigers (DoFPS 2023). Despite being the world's most iconic species, these apex predators are also the most threatened ones (Ripple et al. 2014). In fact, both these animals are the flagship species for the conservation (Harihar et al. 2011). And tigers in particular are one of those charismatic animals that has universal instant recognition, a great public appeal and empathy (Seidensticker 2010). Moreover, these large carnivores could exert ecological effects and regulate ecosystems through trophic cascades (Gompper et al. 2015, Harihar et al. 2011, Ripple et al. 2014). So, their importance in the ecosystems is undeniable.

Based on the anecdotes and evidence like pugmarks, livestock kills and camera trap images of tigers occurring at above 4,000 m often suggested the habitat overlap between tigers and snow leopards in Bhutan (Dendup & Lham 2023). However, there were no photographic evidence of these two species occupying the same area despite several camera trap surveys in the past. But during the nationwide tiger survey 2021, JDNP reported photo-capturing of both tigers and snow leopards in camera traps at same locations, which further cemented the claim on co-occurrence of tigers and snow leopards in Bhutan (Dendup & Lham 2023). Here, we also report the similar evidence to claim the spatial overlap between the tiger and snow leopard in WCNP.

Study area and data collection

Gazetted in 2008, WCNP is the largest protected area in Bhutan and it covers an expansive range from low lying sub-tropical valleys to high snowcapped mountains. The park is spread across an area of 4,914.65 km^2 with altitude ranging from 1,370 m to over 7,500 m. The park has a diverse habitat, encompassing cool broadleaf forest, blue pine forest, mixed conifer forest, fir forest, juniper forest and alpine meadow, all hosting a rich array of wild flora and fauna. Around 44 different mammal species are present in the park and the latest national survey reports indicated the presence of 17 snow leopards (NCD 2023) and 7 tigers (DoFPS 2023) in the park.

WCNP conducted camera trap survey as a part of the nationwide snow leopard survey from 7 August until 9 December 2022. For that, a pair of camera traps were deployed in 87 survey grids (2 km x 2 km) ranging from 3,714 m

Table 1. Record showing the capture date and time of tiger and snow leopard in the camera trap

Station ID	Species	Date	Time
a	Tiger	17 August 2022	20:08
	Snow leopard	27 August 2022	21:25

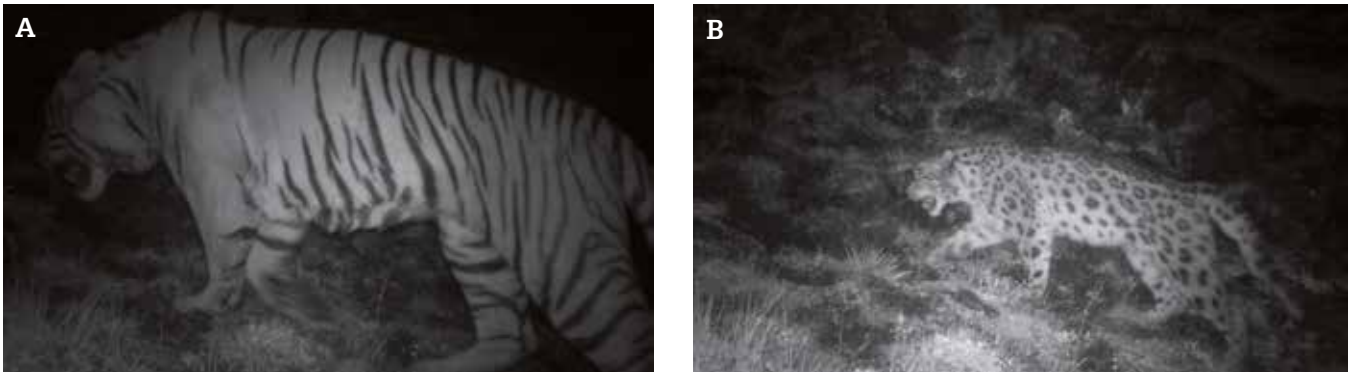

Fig. 1. Image of a tiger (a) and a snow leopard (b) captured on the same camera trap in August 2022 (Photos Wangchuck Centennial National Park).

to 5,287 m in altitudes. Within the grids, the camera traps were strategically positioned along the animal trails, ridgelines, cliffs, and valley bottoms to maximize the chance of the target animal capture. All the camera traps were affixed to poles at the height of 30–50 cm above ground at a minimum distance of 1–2 m from the trail to capture the full body of the animals. No baits were used to maintain the authenticity of wildlife presence in the area.

Results

As per the camera trap data, we had captured 18 different mammal species from the survey. We have captured snow leopards from 31 different stations in our camera traps. But unexpectedly, camera traps had captured a tiger and a snow leopard at a same location in a span of 10 days (Fig. 1, Table 1). There were in total 7 images of a tiger and 16 images of a snow leopard in the camera traps placed along the livestock trail at 4,281 m. Other animals captured at the same location were Asiatic golden cat *Catopuma temminckii*, red fox *Vulpes vulpes*, blue sheep *Pseudois nayaur* and domestic yak *Bos grunniens*. This probably could be the highest elevation record at which both tiger and snow leopards are photo-captured in the world.

Discussion

It is really interesting to see the tigers moving up into the supposedly snow leopard territory. The upward movement of treeline triggered by climate change could have expanded the habitat for the tigers towards mountain as similar was reported for the common leopard (Lovari et al. 2013). Tigers also exhibit remarkable resilience, which enables them to adapt to a wide range of climatic conditions, ecosystems and prey species (Tempa et al. 2019). Moreover, as per the latest survey reports, Bhutan observed a significance increase in both tiger (DoFPS 2023, DoFPS 2016) and snow leopard (NCD 2023) numbers, which further increases their dispersal chances across the treeline due to intraspecific competition. All these factors could have led to the convergence of tiger and snow leopard into a common landscape. Having both tigers and snow leopards is great for the conservation as besides being apex predators, tigers and snow leopards with their charismatic qualities draws wide public recognition, could attract conservation funds, and may have spill-over benefits for the other species that are neglected (Alexander et al. 2016). However, the interspecific competition might arise between these two species at lower distribution range of snow leopards due to their co-occurrence. Consequently, tigers being larger in size and highly adaptable could replace or displace the snow leopard in the long run. In addition, tigers moving up into high mountains could exacerbate the livestock depredation of the yak herding communities in the alpines. In turn, human-carnivore conflicts may lead to the retaliatory killing of both snow leopards and tigers. Thus, further monitoring of these species and their movement becomes a vital for the conservation of these endangered species. Our finding further substantiates and support the previous reports on the co-occurrence of tigers and snow leopards in Bhutan.

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[1] Wangchuck Centennial National Park, Bumthang, Bhutan

*<sangaydendi@gmail.com>

LAM NORBU[1*], KARMA LEKI[1], SONAM TOBGAY[1], SONAM TOBGAY[1], TSHERING DORJI[1], UGYEN DECHEN[1], DAWA TSHERING[1], TSHERING DORJI[1], PASANG DORJI[1], UGYEN LHENDUP[1], UGYEN PHUNTSHO[1], LEKEY DORJI[1] AND BAL KRISHNA KOIRALA[1]

Felid diversity in a montane forest of eastern Bhutan

We report the presence of six wild cat species in Trashigang Forest Division in eastern Bhutan from a camera trap survey conducted in 2015 and 2017–2021. The species reported are: common leopard *Panthera pardus*, clouded leopard *Neofelis nebulosa*, Asiatic golden cat *Catopuma temminckii*, marbled cat *Pardofelis marmorata*, leopard cat *Prionailurus bengalensis* and jungle cat *Felis chaus*. Tiger *P. tigris* was not recorded. The species has however previously been reported in the region. Our findings suggest that landscapes outside protected areas are of equal potential for the long-term conservation of wild felids in Bhutan. Therefore, we recommend further camera trapping exercises in the division with adequate camera trap density and prolonged trapping effort. We also recommend sustainable forest management practices outside protected areas in the country.

Bhutan, a small Himalayan kingdom with a geographical size of ca. 38,394 km² is part of the eastern Himalayan biodiversity hotspot and the global 234 outstanding ecoregions (Olsen & Dinerstein 2002, Mitermeier et al. 2004). The country is located on the southern slope of eastern Himalaya, at the crossroad of two major biogeographic realms, the Indo-Malayan and the Palearctic realms. With extreme topographic variations, the altitudinal gradient ranges from 65 m in the south to over 7,000 m in the northern front enabling different climatic conditions and forest types. Bhutan is home to a rich assemblage of fauna, with close to 200 species of mammals (Wangchuk et al. 2004). In addition, Bhutan is a hotspot of felid diversity with nine species of wild cats which include: tiger, common leopard, snow leopard *Panthera uncia*, clouded leopard, Asiatic golden cat, marbled cat, leopard cat, jungle cat, and Pallas's cat *Otocolobus manul* (NCD 2018, Tenzin et al. 2019). The occurrence of the Eurasian lynx *Lynx lynx isabellinus* and fishing cat *Prionailurus viverrinus* in the country is expected to occur as they are found in neigbouring regions adjoining Bhutan (Wangchuk et al. 2004). However, their presence in Bhutan is officially not confirmed so far.

Over the decades, felids studies in Bhutan have focused mostly on apex predators such as tigers and snow leopards, making these two species the most studied in Bhutan (Thinley et al. 2015, Lham et al. 2021). However, medium and small-sized felids remain understudied, and their published reports are primarily based on by-catch photographs (Tempa et al. 2013, Thinley et al. 2015). In areas where apex predators have experienced declines or are absent, medium-sized and small felids can serve as umbrella species for protecting forests with high biodiversity value; also play-ing crucial ecological and conservation roles, making it essential to intensify conservation study effort on these species (Decoeur et al. 2023).

In Bhutan, wildlife studies have traditionally been focused on protected areas, and available data on wildlife information from regions outside the country's protected areas are primarily derived from nationwide surveys for tigers and snow leopards conducted in 2015 and 2016, respectively. Despite the rich biodiversity potential in areas outside protected areas, there is a lack of specific records for felid studies, highlighting the need for equal attention to these areas (DoFPS 2015, Norbu et al. 2021, Choki et al. 2023). Among non-protected areas, only Gedu Forest Division and Thimphu Forest Division in the west and Sarpang Forest Division in south-central Bhutan have published on felid diversity within their respective areas (Dhendup & Dorji 2018, Tenzin et al. 2019, Dhendup & Tamang 2022). However, the by-catch images of felids from the remaining 11 forest divisions have rarely been published. Bhutan maintains a forest cover exceeding 69.71%, with nearly half of the country (51.44%) designated as part of the protected area network, comprising five national parks, four wildlife sanctuaries, one strict nature reserve (42.83%) and eight biological corridors (8.61%; Lham et al. 2021, Tobgay et al. 2022, FMID 2023). Outside protected areas, the landscape falls under the management of 14 Forest Divisions, covering approximately 48.6% of the country's total area (Dhendup & Dorji

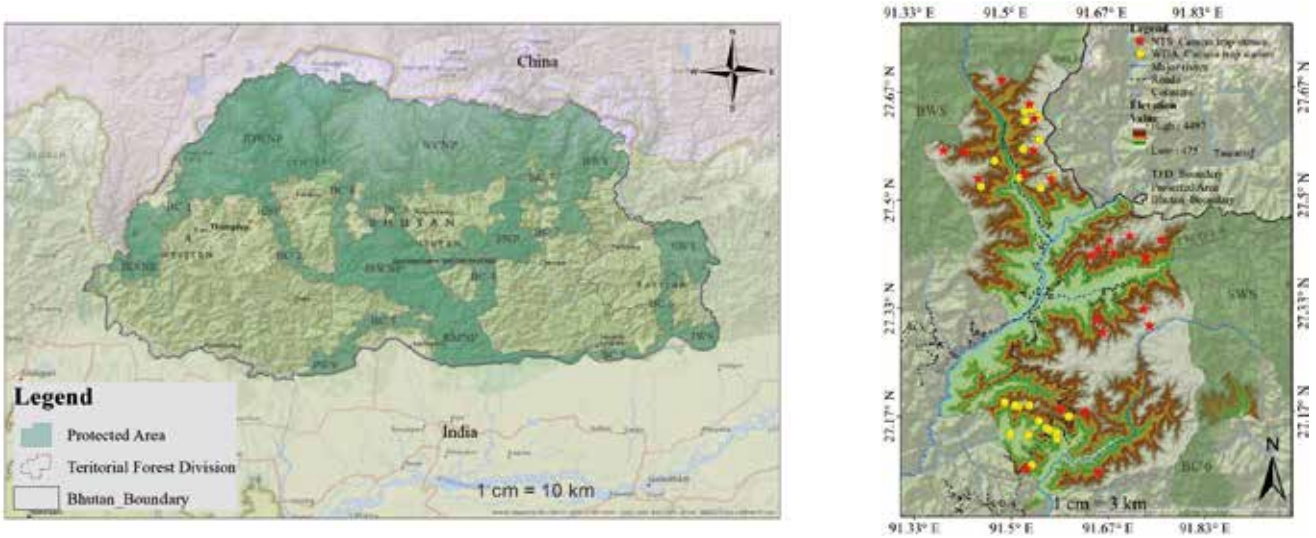

Fig. 1. Conservation map of Bhutan showing location of Trashigang Forest Division in eastern Bhutan (left) and locations of camera traps (right).

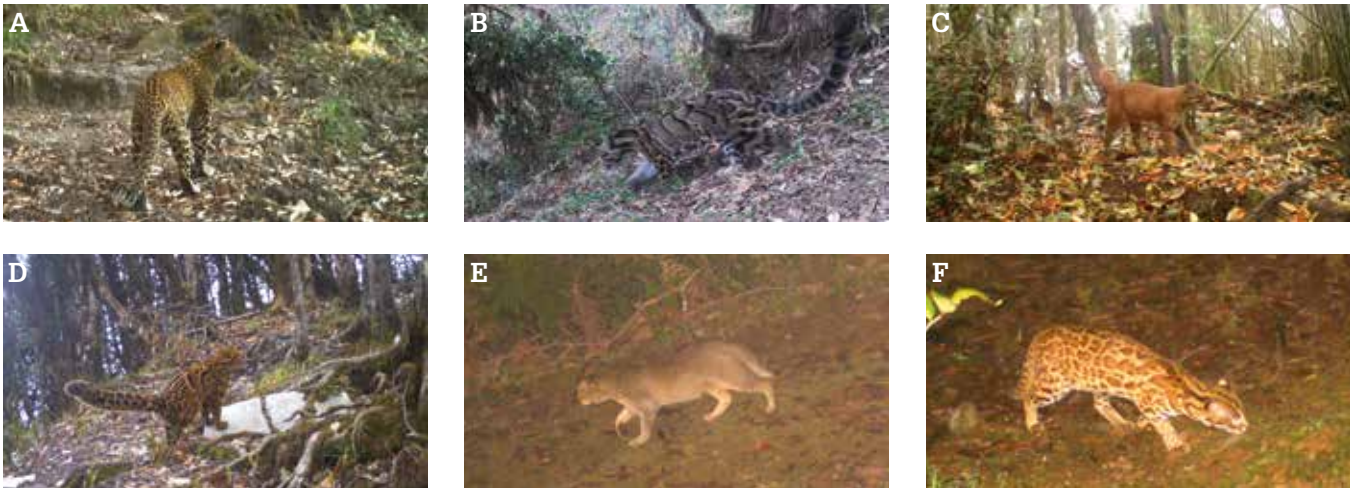

Fig. 2. Wild cat species recorded by camera traps in Trashigang Forest Division: (A) common leopard, (B) clouded leopard, (C) Asiatic golden cat, (D) marbled cat, (E) jungle cat and (F) leopard cat (Photos Trashigang Forest Division).

2018). Their primary mandate is to sustainably provide natural resources to the public while delivering other forestry-related services, and enforcing forest and wildlife regulations. Furthermore, these forest divisions cover a significant portion of a human-dominated landscape, characterised by various forest management regimes, higher resource distribution grades, and forest clearance activities aimed at supporting the country's economic development. Consequently, areas outside protected areas are more vulnerable to habitat destruction and degradation. If sustainably managed, these areas have the enormous potential to support viable populations of some rare wild cat species, enabling population dispersal into larger landscapes in the region (Azlan & Sharma 2006).

To date, there has been no dedicated assessment of wild cats within the Division, thus, there is a deficiency of published information on felids diversity and their spatial distribution. Therefore, to address this knowledge gap we document information on occurrence of a high diversity of felid species in Trashigang Forest Division. These findings serve as baseline information on the presence of felids outside protected areas in eastern Bhutan and contribute to the foundation for future felids studies in the region. Additionally, this study further adds the baseline data on felids diversity in non-protected areas of Bhutan.

Materials and Methods

Study area

Trashigang Forest Division encompasses two eastern districts of Tashigang and Trashiyangtse, spatially extending from 27°22′ to 27°29′ E and 91°22′ to 92°07′ N, covering an area of 2080.92 km² (Fig. 1). Trashigang Forest Division shares borders with several adjacent protected areas and territorial divisions, including Sakteng Wildlife Sanctuary SWS to the east, Jomotshakhag Wildlife Sanctuary JWS through biological corridor six BC6 to the southeast, Samdrup Jongkhar and Pema Gatshel Forest Division in the south, Monggar Forest Division in the west, and Bumdeling Wildlife Sanctuary BWS in the north. It also shares an international border with Arunachal Pradesh, India from the northeastern part spanning over 60.2 km (Tobgay et al. 2022). Irrefutably the landscape is vast swathe of contiguous, integral and remains relatively undisturbed forest habitat.

Altitude in the division ranges from 475 to 4,497 m, and the region features a rich forest cover (84.21%; Tobgay et al. 2022). Dominant forest types include subtropical forest, warm and cool broadleaf forests, mixed conifer forest, pine forest, mixed pine-cool broadleaf forest, chirpine forest, alpine shrubs, meadows and a few plantations. The area experiences unpredictable and variable climatic conditions due to its diverse topographical aspects, slope and forest types, with warm and wet summers followed by relatively cold and dry winters. The mean annual temperature and precipitation average around 20.2°C and 2,000 mm, respectively (Koirala et al. 2021).

Notably, the division contains rich diversity of flora and fauna, including about 810 vascular plants, 273 bird species, 48 hawkmoth species, 68 butterfly species, 34 snake species, 7 fish species, and 25 mammal species (Koirala et al. 2021, Norbu et al. 2022, Tobgay et al. 2022, NCS 2023). The region also serves as the water catchment area for the Kholongchu, Drangmechu, and Nyerama Chu rivers in eastern Bhutan. The landscape supports 11,621 households, with an estimated population of 90,659 people. The main economic activities in the area include agriculture, livestock rearing, off-farm activities, small cottage industries, and the sale of non-wood forest products.

Survey method

A camera trap survey was carried out in the division as a part of the third national tiger survey in 2015. The division area was divided into several survey grids, each measuring 5 km x 5 km (DoFPS 2015). Inclusive sign surveys were conducted within the grid, and trap sites with a higher probability of target species were selected for camera trap installation. A pair of non-baited cameras were set up along trails at each trapping site in the grid. Cameras were placed opposite each other at a distance of 3–5 m, so that one camera did not affect the pictures taken by the other (DoFPS 2015). In total, 27 pairs of camera traps were operated for a period of 90 days across an area of 2,080.92 km².

A second survey, using camera traps was also carried out in the Wamrong and Yangtse Range (2017–2021) within the same division landscape. This survey covered an altitude range of 900 to 4,050 m and encompassed an area of 988.47 km². The primary objective was to document the mammalian diversity, with a focus on tigers. For this survey, 23 numbers of camera traps were placed opportunistically along the trails, and near water holes to increase the likelihood of capturing photographs of tigers and other wildlife. However, due to a limited number of camera traps, some locations were operated individually.

During both surveys, the camera traps were attached to a pole 40–50 cm above the ground and set to function continuously over a 24-hour cycle for 90 days in the field (NCD 2018). GPS coordinates and the altitude of each camera station were recorded. Data processing and analysis were performed using camera trap fill manager (CTFM version 2.1.6), and the photographic capture frequency (No. of independent photograph/ Total No. of independent photograph) of each species was determined using MS excel 2013.

Table 1. Summary of camera trap capture records of the six felids in Trashigang Forest Division. * = number of camera trap stations.

Species	Red List Status[a]	Notionally independent events		No. camera stations recorded	
		NTS[b] 2015	WDA[c] 2017-2021	(NTS 2015) n*= 27	(WDA 2017-2021) n*= 23
Clouded leopard	VU	7	6	5	6
Common leopard	VU	46	41	10	12
Golden cat	NT	39	25	13	19
Leopard cat	LC	33	21	9	12
Marbled cat	VU	25	9	7	6
Jungle cat	LC	0	3	0	3

[a] NT = Near Threatened; VU = Vulnerable; LC = Least Concern

[b] National Tiger Survey, [c] Wildlife Diversity Assessment

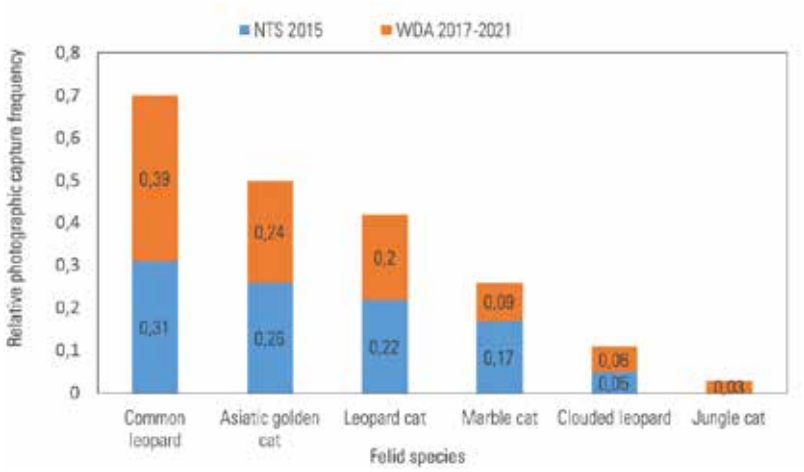

Fig. 3. Showing photographic capture frequency (No. independent photographs/Total No. independent photographs) of felid species in Trashigang Forest Division (NTS-national tiger survey, WDA-wildlife diversity assessment).

Results and Discussion

Six wild felid species belonging to six genera were recorded from Trashigang Forest Division during two surveys (Table 1). These species include the common leopard, clouded leopard, Asiatic golden cat, leopard cat, marbled cat and jungle cat (Fig. 2). Among these species, three are classified as 'Vulnerable', one as 'Near Threatened' and two as 'Least Concern' according to the IUCN Red List (Table 1). In Bhutan, clouded leopards are listed in Schedule I, and other five species are listed in Schedule II of the Forest and Nature Conservation Act FNCA of Bhutan 2023, assigning them the highest protection status. These study recorded additional mammal species, including Himalayan black bear *Ursus thibetanus*, red panda *Ailurus fulgens*, dhole *Cuon alpinus*, spotted linsang *Prionodon pardicolor*, masked palm civet *Paradoxurus hermaphroditus*, large Indian civet *Viverra zibetha*, yellow throated marten *Martes flavigula*, weasel *Mustela* sp., musk deer *Moschus* sp., serow *Capricornis sumatraensis*, sambar deer *Rusa unicolor*, barking deer *Muntiacus muntjak*, wild pig *Sus scrofa*, Himalayan crestless porcupine *Hystrix brachyura*, Assamese macaque *Macaca assamensis*, capped langur *Trachypithecus pileatus*, rodents and shrews.

During the national tiger survey in 2015, a total of 810 trap nights yielded 14,712 photographs. Of these, 150 notionally independent photographs of five wild felid species were obtained from 27 camera trap stations. In the second survey, the wildlife diversity assessment 2017–2021, a total of 10,570 images were collected during 690 trap nights using 23 stations. Of these, 105 independent photographs of six felid species were obtained. The common leopard, clouded leopard, Asiatic golden cat, leopard cat, and marbled cat were captured in both surveys (Table 1). Among these, the common leopards and Asiatic golden cat were recorded at the highest number of camera trap stations and had the highest photographic capture frequency (Fig. 3). The jungle cat was only recorded during the wildlife diversity assessment and had the fewest photographs. The lower photographic rates of the jungle cat may be attributed to a lower detection probability rather than a smaller population number. It is important to note that the camera traps were primarily set to capture tigers, which may have influenced the results for other felids species (Gumal et al. 2014, Dhendup et al. 2016).

Common leopards were captured at 22 camera trap stations, ranging in elevation from 900 to 4,050 m, during two surveys. These findings indicate that common leopards were frequently captured and appeared to be randomly distributed throughout the landscape of Trashigang Forest Division. Furthermore, local communities reported frequent sightings and livestock predations by common leopards, suggesting that the species tends to occupy habitats proximate to human settlements. Common leopards are known for their widespread distribution and adaptability in highly modified and densely populated landscapes (Jacobson et al. 2016). The presence of common leopards in the region was also linked to the relative absence of large, dominant predators like tigers. This finding corroborates with similar observations that in South Asian regions where tigers are abundant; leopards are few, or vice versa (Odden et al. 2010, Thinley et al. 2015). During the wildlife diversity assessment, melanistic leopards (black panthers) were photographed, with five occasions at two camera trap locations in the Warmrong Range of Trashigang district.

The Asiatic golden cat was also recorded at 22 camera trap stations, ranging in elevation from 1,700 to 3,500 m, during two surveys. The Asiatic golden cat was found to be distributed widely within the division, inhabiting subtropical warm broadleaf forests to higher altitude rhododendron scrub. Notably, the Asi-

Fig. 4. Adult male tiger camera trapped from Yangtse in 2019 (Photos from Thinley et al. 2020).

atic golden cat was recorded at an elevation of 4,567 m in Jigme Dorji National Park JDNP, marking the highest recorded elevation for this species in Bhutan (Jamtsho et al. 2021). So far, Bhutan has documented six morphs of the Asiatic golden cat, with five of them reported in Trashigang Division (Norbu et al. 2022). The leopard cat was recorded at 21 camera trap stations, spanning an altitude range of 900 to 3,700 m, from subtropical warm broadleaf forests to fir forests. It had a higher photographic capture rate during the national tiger survey in 2015, with 33 instances from nine camera trap stations. The marbled cat was recorded at 13 camera trap stations during the two surveys, inhabiting cool broadleaf forests to mixed conifer forests within an elevation range of 1,600 to 3,200 m. Remarkably, the species had a higher photographic capture rate of 25 incidences from seven camera trap stations during the national tiger survey in 2015.

Clouded leopards were captured at 11 camera trap stations, ranging in elevation from 2,100 to 3,100 m, during the two surveys. The species was found in cool broadleaf forests to mixed conifer forests. It had a slightly lower photographic rate, with six instances during the wildlife diversity assessment, as opposed to the national tiger survey 2015. In addition, it is the second lowest photographic evidence during the two surveys. Clouded leopards are considered rare in many areas, including national parks and forest divisions like Jigme Dorji National Park and Thimphu Forest Division (Jamtsho et al. 2021, Dhendup & Tamang 2022). The jungle cat was the least recorded felid species, inhabiting temperate warm broadleaf forest to cool broadleaf forests, and mixed broadleaf conifer forests at altitudes ranging from 1,700 to 3,000 m. Although the jungle cat is believed to be common in Bhutan (Wangchuck et al. 2004), no record was collected during the national tiger survey 2015 from Trashigang Division.

Additionally, Trashigang Division is home to tigers (Thinley et al. 2020). In 2017, a tiger killed two adult mithun bulls in the Trashiyangtse district, the northern block of the division. Subsequent camera trapping exercise in 2018 and 2019 captured photographic evidence of an adult male tiger in the livestock predation locality and adjacent environs (Thinley et al. 2020; Fig. 4). Few additional tiger individuals are anticipated in the region, as neighbouring wildlife sanctuaries Sakteng and Jomotshangkha recorded tigers in areas close to the border of the division during the national tiger survey in 2015 (DoFPS 2015). Regrettably, these two surveys failed to detect any tiger individuals in the division, which may be attributed to the lower camera trap density and survey duration, and therefore, necessitate additional camera trap surveys with higher camera trap density and prolonged trapping effort.

The rich diversity of wild felids in Trashigang Forest Division is promising, comparable to the six and five wild cat species recorded in Gedu Forest Division, Sarpang Forest Division, and Thimphu Forest Division, respectively (Dhendup & Dorji 2018, Tenzin et al. 2019, Dhendup & Tamang 2022). The photographic capture rates in Trashiang Forest Division are relatively higher. High wild felid diversity has also been documented in three protected areas of the country. Jigme Dorji National Park is a felid hotspot in Bhutan and reported the presence of nine wildcat species, Jigme Singye Wangchuck National Park JSWNP in central Bhutan has eight species, and Royal Manas National Park RMNP in southern Bhutan has seven (Tempa et al. 2013, Dhendup et al. 2016, Jamtsho et al. 2021). The differences in wild felid richness between protected and non-protected areas may be owed to variations in the intensity of anthropogenic disturbances and habitat contiguity (Dhendup et al. 2016, Letro & Duba 2019). To ensure the viability of felid populations, it is essential to have healthy habitats, abundant prey populations, and effective conservation safeguards (Jamtsho et al. 2021).

Anthropogenic activities within the jurisdiction of forest division are intensive, with fewer restrictions imposed than protected areas (Norbu et al. 2021). With the prevalence of infrastructure development like construction of hydropower, highway widening and also the increasing number of new road and trail construction, increased resource collections and social activities in the division, they are anticipated to pose significant threats to felids and other wildlife living within the landscape of Trashigang Division. Livestock depredation by tigers, common leopards, dhole, Asiatic golden cat and other mid-sized carnivores, has also emerged as one major problem in the region, costing farmers countless hardships and incurring other indirect expenses. A recent survey in Trashiyangtse district, within Trashigang Division, reported 296 livestock depredation cases over the last few years (Thinley et al. 2021). Therefore, the management of the division must implement stringent regulations governing resource allocation, combat illegitimate logging and prevent extensive vegetation clearing in critical wildlife habitats to safeguard the landscape's integrity against habitat conversion. The adoption of a scientifically informed management plan and the defined demarcation of critical wildlife habitats are of utmost importance (NCD 2018).

We strongly recommend the establishment of a biological corridor connecting two wildlife sanctuaries, Sakteng and Bumdeling (Thinley et al. 2020, Tobgay et al. 2022). This initiative not only promotes vital landscape connectivity but also ensure to facilitate the safe passage of felid species and support genetic diversity. The inference of national tiger survey 2015 revealed that divisions are home to more than a tiger population, and showed rich diversity of felids (Dhendup & Dorji 2018, NCD 2018). Therefore, it is utmost important to accord priority to conduct felids research and

conservation efforts within divisions that are most frequently impacted by human activities (Dhendup & Tamang 2022). There is a strong need to strengthen anti-poaching measures, and enhance surveillance programmes by adopting advanced technologies, and strategies like conservation drones, SMART patrolling and zero poaching strategies, in addition to advocacy programmes. Given the urgency of the scenario, we recommend periodic monitoring of felids and other wildlife to plan appropriate conservation actions, and supplement existing biodiversity data from the non-protected areas of the country.

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*<lamnorbu0@gmail.com>

Panthera leo remains globally listed as Vulnerable

Panthera leo

Photo S. Nicholson

RL category & criteria: VU A2abcd

Year assessed: 2023

RL status change: None

Global population size:
20,000–25,000 adults and subadults

Global population trend: Declining

Range: 1,571,296 km²

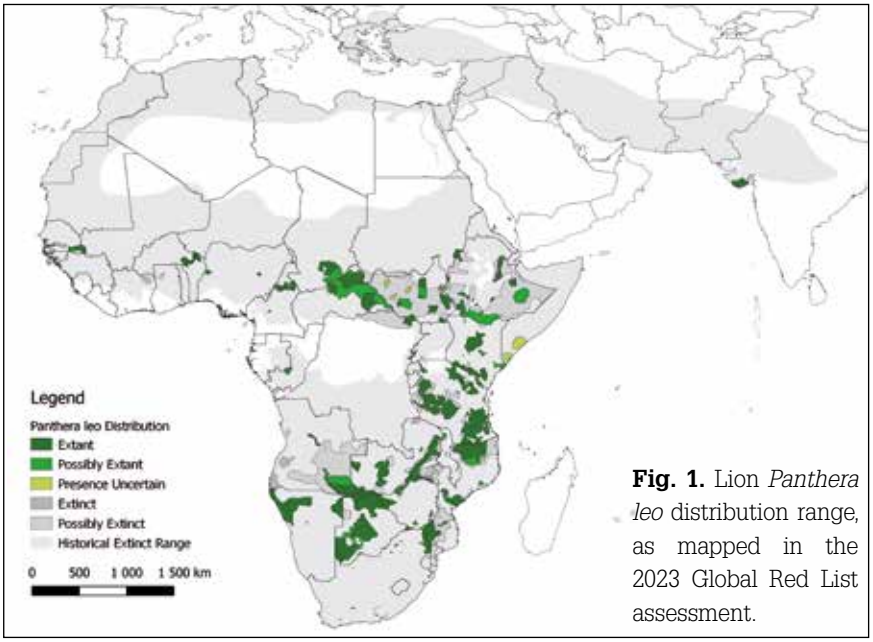

Fig. 1. Lion *Panthera leo* distribution range, as mapped in the 2023 Global Red List assessment.

Reliable population data for lions that are comparable across a temporal scale are lacking, with existing robust and comparable population data being biased towards well-monitored populations. As a result, we were unable to assess lion population change using population numbers, and instead used change in lion range as a proxy for overall population decline.

Different to the last assessment, we included small, fenced reserves, particularly those in Southern Africa. These are under the definitions in the IUCN guidelines considered as 'lightly managed', and can be considered "wild". There was therefore no basis for excluding them, providing that they were within the species historic range, that the reintroduction had taken place at ≥5 years prior, and that offspring had been produced.

Due to significant habitat loss and fragmentation, the global lion population is highly fragmented . Based on the IUCN SSC Cat Specialist Group's African Lion Database, lions occur in ca. 6% of historical range, and range analysis revealed that extant lion range is ca. 1,571,296 km², which is a 36% decline from ca. 24,634,68.83 km² in 2002. As a decline in suitable range or habitat is contiguous with a decline in population, a population decline of 36% is thereby suspected and the lion listed as Vulnerable under A2abcd.

We make a tentative estimate of between 20,000 and 25,000 adult and subadult lions in Africa and ca. 670 adult and subadult lions remain in India. There is a dichotomy in observed population trends across the species' range. Considerable conservation effort has led to stable to increasing lion populations in some areas of the southern subspecies *P. l. melanochaita*, and even species recovery in others. Well-coordinated and planned reintroductions have occurred in many countries, which has contributed to some increasing national population trends. However, over the last 21 years, declines in many populations have also occurred, with some local extinctions taking place, foremost in central and western Africa.

One of the most severe and widespread threats is habitat loss and conversion. Other significant threats include loss of natural prey base, human-lion conflict, bycatch in snares , and the direct and targeted poaching for body parts (within a concerning increase in this trade in Mozambique). Urgent actions are required to halt increasing poaching trends before population declines become evident.

Insufficient funding preventing the effective management of protected areas with lions poses a significant challenge , and the impact of violent extremism and warfare in an area is likely to worsen threats. Particularly the W-Arly-Pendjari complex in Burkina Faso, Niger and Benin, hosting the largest remaining lion population in West Africa, is under severe threat from extremist groups in Niger and Burkina Faso. Lions still occur in the complex, but if the situation remains unchanged, this population will become significantly reduced.

We advise that data is collected using standardised methods when monitoring lion populations. We also identified several data gaps, which include the need for lion population surveys in Chad, Central African Republic, South Sudan, Ethiopia, western Tanzania, and parts of Mozambique, Angola and Botswana. We recommend that regularly robust and standardised surveys be carried out in these areas to gather comparable and reliable data.

Samantha Nicholson, Hans Bauer, Paolo Strampelli, Etotépé Sogbohossou, Dennis Ikanda, Pricelia N. Tumenta, Meena V., Guillaume Chapron & Andrew Loveridge*
*<samanthan@ewt.org.za>
Endangered Wildlife Trust

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Arabian leopard remains Critically Endangered

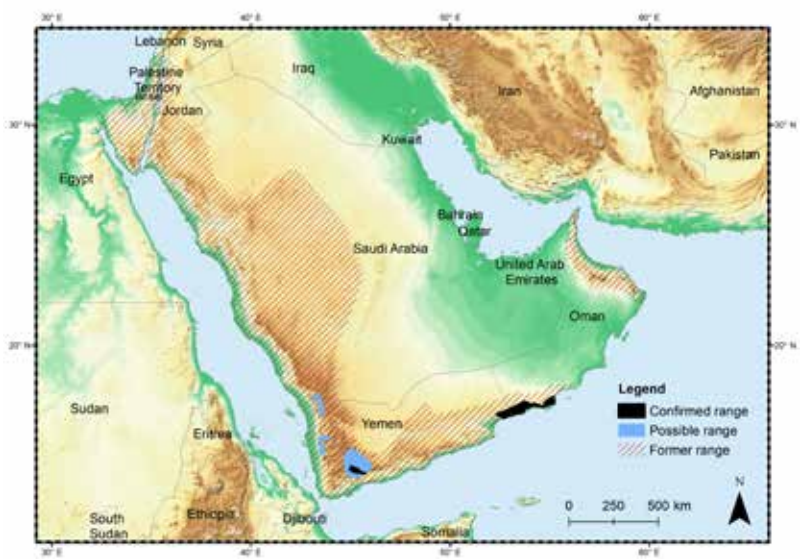

Fig. 1. Arabian leopard distribution range as mapped in 2023 Global Red List assessment.

Panthera pardus nimr

RL category & criteria: CR C2a(i)

RL status change: None

Global population size: 70–84 mature individuals

Global population trend: Declining

Range: 11,000 km²

The Arabian leopard *Panthera pardus nimr* was listed as Critically Endangered in both the 1996 and 2008 IUCN Red List of Threatened Species™. For the new assessment, we had access to more recent information on the Arabian leopard, including studies from Oman and Saudi Arabia, in addition to social media reports from Yemen. The latest assessment shows a continuing decrease of the population compared to the 2008 assessment. The Arabian leopard remains Critically Endangered as the total population size is estimated at 100–120 individuals, with only 70–84 mature leopards. The population is highly fragmented (Fig. 1), and continuously declining, both in the area of occupancy and extent of occurrence, with no subpopulations having more than 50 mature individuals. Thus, the Arabian leopard, now listed under criterion C (small population size and decline C2a(i)), is close to being classified as Critically Endangered under criterion D (very small or restricted population).

The Arabian leopard is believed to still occur in small numbers in Yemen. However, because of the civil war there is no reliable data; only reports of killings and captures posted on social media. We relied on local and regional expert knowledge and estimated the leopard population to be no more than 50 individuals scattered across several regions of the country (Fig. 1). The leopard may also still occur in Yemen's northern mountains between Sa'dah and the Saudi border, and in the central-western highlands between Wada'a and Hajjah. Illegal capture and killing is ongoing with evidence that some animals are illegally traded. This combined with the lack of conservation efforts, may mean that Yemen's wild leopards could soon be lost.

In the Kingdom of Saudi Arabia, illegal hunting and poisoning have pushed the Arabian leopard close to local extinction. Camera-trap surveys throughout the Sarawat mountains from 2020-2022 found no evidence of leopards, concluding that there are no populations in the country, although some individuals might still be present. However, at that time it was not possible to survey the mountains along the Saudi border with Yemen where there are recent, though unconfirmed, reports of leopards. Camera-trap surveys are now underway, though they are unlikely to discover a viable population.

The Dhofar mountains of southern Oman remain the last stronghold for the species in the wild outside the unclear situation in Yemen. More than two decades of conservation efforts have allowed safeguarding a small population of some 51 leopards. There is some evidence of range expansion since the 2008 assessment towards the semi-arid dry wadis of the Nejd region north of the Dhofar mountains. Although the Dhofar population seems to be stable, its small size is a significant risk factor. Conservation needs to include the continuous monitoring, active safeguarding of leopard habitat, and compensation programmes for livestock losses.

Oman's leopard population is not large enough to ensure the long-term survival of the Arabian leopard in the wild. Safeguarding remnant populations is a priority, but across the region, the future of the Arabian leopard will depend on reintroduction and reinforcement programmes with captive bred animals. In Yemen, a return to peace would offer a chance to allow robust surveys and to re-establish active leopard conservation. In Saudi Arabia, conservation of the Arabian leopard is led by the Royal Commission for AlUla. Following country-wide surveys the current focus is on captive breeding and the preparation of sites for reintroduction. All leopard range states, including those with very important captive populations, must continue to work together if the Arabian leopard is to recover across the region.

Hadi Al Hikmani & Andrew Spalton
<h.alhakmani@rcu.gov.sa>
Royal Commission for AlUla, Saudi Arabia

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Beyond the wild: the role of ex situ conservation in the survival of Arabian leopards

Panthera pardus nimr

Conservation breeding programme

Population size 2023: 67 (39/28)

Number of institutions: 5

Last published studbook: 2022

Fig. 1. Female Arabian leopard cub (ID: B23003) born on 23 August 2023 in RCU Taif Conservation Breeding Centre (Photo K. S. Nabelsi).

The Arabian leopard *Panthera pardus nimr*, the smallest subspecies of leopard, is a vital endemic component of the Arabian Peninsula's biodiversity and classified as Critically Endangered on the IUCN Red List (Al Hikmani et al. 2023). Extant populations have been confirmed only in Oman and Yemen, however, they are small and increasingly isolated and fragmented. Range loss is estimated at 98% with a remnant wild population of 100–120 individuals (Al Hikmani et al. 2023), which makes conserving this unique genome ex situ a high priority. Captive breeding is fundamental for threatened subspecies like the Arabian leopard, acting as an extinction buffer by maintaining genetic diversity ex situ and enabling research to aid in situ conservation. Insights from captive studies on reproduction, behaviour, and health are invaluable for the species' survival and reintroduction projects.

Initiated in 1999, the captive breeding programme has progressed from registering wild-caught Arabian leopards from Oman in 1985 to achieving 93 births through regional breeding loan agreements. The establishment of the International Studbook under the umbrella of the World Association of Zoos and Aquariums, WAZA took place in 2009. The Studbook fosters collaboration among participating institutions, guiding population management to maintain genetic diversity, and supporting reintroduction goals. The streamlined approach underscores the Studbook's critical role in unifying efforts toward the programme's objectives (Budd & Leus 2011).

Genetic diversity is pivotal for a species' evolutionary potential and overall fitness. For captive populations to effectively support wild counterparts and reintroduction efforts, maintaining genetic diversity is crucial. Success hinges on two key factors: a sufficient number and diversity of founders, ideally 20 or more, and equitable representation in breeding (Budd & Leus 2011). The Arabian leopard's captive gene pool is based on 14–15 confirmed plus 7 or 6 potential founders in 2010 (Budd and Leus 2011, Budd 2011). However, due to the inaccessibility and subsequent non-participation of the animals from Yemen, the founder representation within the population is only 10 (Budd 2022). The situation reflects an imbalance in descendant distribution, limiting the representation of the wild genetic diversity.

The population according to the 2011 International Studbook consisted of 82 individuals (46 males, 33 females, and 3 unsexed) in 10 participating institutions (Budd 2011). By the end of 2011, approximately 64.5% of the population fell within the prime breeding age of four to twelve years, inclusive of 16 individuals born in the wild. Out of 21 wild-caught animals, only 15 were reproducing and only 10 contributing to the breeding program.

As of 31 December 2022, the Arabian leopard's captive population numbered 59 in five institutions (Table 1) with only 35% of the population within the prime breeding age. The number of holding institutions has declined from 10 to five, with merely two, the Breeding Centre for Endangered Arabian Wildlife BCEAW, in Sharjah, and the Royal Commission for AlUla RCU Arabian Leopard Conservation Breeding Centre RALCBC, in Taif, breeding successfully (Budd 2022). As of December 2023, the population comprises of 67 individuals, in five participating institutions (Table 1).

RCU has undertaken management of the RALCBC as part of a national mandate for the conservation and reintroduction of Arabian leopard in the Kingdom of Saudi Arabia and is now one of the successful Arabian leopard breeding centres in the region. As of January 2024, it holds 27 individuals (16 males and 11 females), with seven Arabian leopard births in 2023 (Fig. 1). This is one of the highest number of births per year in a given collection (RALCBC, unpubl. data).

Several factors hinder the effectiveness of this ex situ programme, notably limited and dwindling holding capacity (Budd & Leus 2011, Budd 2011, Budd 2022) and breeding challenges exacerbated by age structure and sex ratio imbalances (Supporting Online Material SOM Fig. 1; see also Ferreira & Sliwa 2022). The large reduction in population size reflected in the 2022 studbook is due to the exclusion of the non-accessible animals from the database. The programme's genetic diversity is at significant risk due to low founder numbers. Demographic and genetic analysis (PMx; Ballou et al. 2023) predicts a rapid loss if the founder situation is not improved. Additionally, limited collaboration and monitoring further constrain the programme's effectiveness.

To safeguard the Arabian leopards' genetic diversity within the conservation breeding programme, it is crucial that the captive population grows by a minimum of 10% annually to achieve a target size of at least 300 individuals (Budd 2022). Additional holding facilities are urgently needed to fulfil these requirements

Table 1. Holders of Arabian leopards and their present stock according to the Arabian Leopard Studbooks 2011 and 2022 and non-participating institutions. T = Total, M = Males, F = Females, "-" indicates missing information.

Breeding Centre	Country	Population (Dec. 2009)			Population (Sep. 2011)			Population (Dec. 2022)			Population (Dec. 2023)		
		T	M	F	T	M	F	T	M	F	T	M	F
Sharjah Breeding Centre	United Arab Emirates	20	12	8	30	19	11	34	19	15	34	19	15
RCU Taif Conservation Breeding Centre	Kingdom of Saudi Arabia	8	5	3	12	9	3	21	11	10	27	16	11
Oman Mammal Breeding Centre	Oman	6	3	3	4	2	2	2	1	1	3	1	2
Al Ain Wildlife Park and Resort	United Arab Emirates	1	1	0	1	1	0	1	1	0	1	1	0
Al Bustan Zoological Centre	United Arab Emirates	5	3	2	5	3	2	1	1	0	2	2	0
Non-participating holders of Arabian leopard													
Al Areen Wildlife Park	Bahrain	0	0	0	1	1	0	0	0	0	0	0	0
Nakhlee Estate	United Arab Emirates	3[a]	1	1	5[b]	1	1	0	0	0	0	0	0
Sana'a Zoo	Yemen	6	2	4	6	2	4	-	-	-	-	-	-
Ta'iz Zoo	Yemen	18	8	10	18	8	10	-	-	-	-	-	-

[a] Including one leopard of unknown sex, [b] Including three leopards of unknown sex

(Budd & Leus 2011, Budd 2011, Budd 2022). It is also critically important that all founders should be represented in this programme and no founder should be prevented from breeding in this still small population. Ideally, all founders would have large and equal numbers of descendants (Budd & Leus 2011). This will ensure that 86% of the representative gene diversity of this population is maintained within the programme for 100 years. Moreover, it would be beneficial for the programme to periodically integrate new founders from the in situ population without impacting the wild population.

Active monitoring of this WAZA Studbook is crucial for informing the breeding programmes and guiding participating institutions effectively. Annual meetings of Arabian leopard holders for discussion on challenges, solutions, and breeding agreements are essential. Moreover, ongoing genetic research into the Arabian leopard's genetic health and diversity is vital (wild and captive populations). Dedicated genetic research aids in the identification of inbreeding and genetic bottlenecks, thereby shaping effective breeding strategies (Budd 2022; Mochales-Riaño et al. 2023).

Enhancing collaboration and ensuring cooperation among collections is vital and a key to this effort is the development of a robust communication network among institutions. Concurrently, investing in staff training and capacity building is essential, as it directly influences the efficacy of conservation breeding, ensuring the well-being of individuals and the long-term sustainability of the programme. BCEAW has contributed by sharing their knowledge and providing training programs regionally.

RCU is collaborating with global felid experts to share knowledge and improve conservation practices, through bodies like the Arabian Leopard Technical Advisory Group ALTA and partnerships with IUCN and the NGO Panthera. Such collaboration aims to also enhance the breeding programme, raise awareness, and involve communities in conservation, which is crucial for protecting habitats and reducing possible human-wildlife conflicts in future.

Efforts to boost breeding among younger Arabian leopards and incorporate underrepresented founders are essential as many leopards approach reproductive senescence. Additional holding facilities are also urgently required. Updating care, management, and breeding guidelines is vital for creating a uniform, high-standard programme. Considering assisted reproductive techniques for non-breeding specimens is advised if natural mating fails. A thorough understanding of their reproductive physiology and behaviour is paramount for the programmes' success, accentuated using advanced technologies to maintain genetic diversity and population vitality, and building on experience gained with this (de Haas van Dorsser 2006) and other leopard subspecies in captivity (Persian leopard; Ferreira & Sliwa 2017).

Abid Mehmood [1], Jane Budd [2], Abdulaziz M. Alenzy [1] and Jose D. Ferreira [1]
<a.mehmood@rcu.gov.sa>
[1] Royal Commission for AlUla, Saudi Arabia
[2] Breeding Centre for Endangered Arabian Wildlife, Sharjah. United Arab Emirates

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Supporting online Material SOM Figure F1 is available at www.catsg.org.

Persian Leopard WG

Established: 2023

Members: > 40

Mission: To ensure the continued existence of Persian leopards and their prey in coexistence with local communities in their natural habitats

Persian leopard conservation is boosted by a newly established working group

Fig. 1. A Persian leopard in north-eastern Iran (Photo Future4Leopards Foundation).

The Persian leopard *Panthera pardus tulliana* (Fig. 1) is listed as Endangered on the IUCN Red List of Threatened Species™. It is permanently present in Afghanistan, Armenia, Azerbaijan, Iran, Iraq, Pakistan, Russia, Türkiye and Turkmenistan, occasionally present in Georgia and Kazakhstan, possibly present in Uzbekistan, and extinct in Tajikistan, Syria and Lebanon.

According to the 2023 IUCN Red List assessment, the population size of the Persian leopard is estimated as at least 750–1044 individuals (450–626 mature individuals), with the largest populations living in Iran (528–732) and Turkmenistan (60–80). Its main habitats are forests, woodlands and scrublands with an essential presence of rocky outcrops and precipitous slopes. Most of the prey species are wild ungulates such as urial *Ovis vignei*, bezoar goat *Capra aegagrus* and wild boar *Sus scrofa*, but smaller species and domestic animals also can be hunted.

The main range-wide threats are: (1) illegal hunting to mitigate damage to livestock and threats to human safety, or for trophies; (2) prey depletion due to illegal hunting and habitat degradation; and (3) habitat loss and fragmentation that create deadly barriers and make populations too small to survive on their own.

Conservation of the Persian leopard, its prey and habitats requires the mobilisation of global and national efforts. As a vital step, the Range-Wide Strategy for the Conservation of the Persian Leopard was discussed and endorsed at the First Range State Meeting for the Persian Leopard, 20–22 September 2022 in Tbilisi, Georgia, under the auspice of the Convention on the Conservation of Migratory Species of Wild Animals CMS, specifically under the CMS Central Asian Mammals Initiative CAMI. The knowledge base on the Persian leopard was published in 2022 in the Cat News Special Issue No. 15 as an input to the development of the Range-Wide Strategy. The authors and subsequent group members were already involved in the IUCN Red List assessment of the Persian leopard, which was published in December 2023.

The Persian Leopard Working Group PeLeWG was established in March 2023 as a professional group of experts from all the range countries and beyond to help implement the Range-Wide Strategy. It is an affiliated partner of the IUCN SSC Cat Specialist Group and has over 40 members. The group is managed by the Steering Committee of 15 members, including two Co-chairs, all from the range countries. The PeLeWG has a feasible annual working plan. Its current activities are focused on awareness-raising on social media (X/Twitter: @PersLeopWG, Instagram: @pelewg, Facebook: @PeLeWG), professional training (WildTeam), implementation of range-wide monitoring, and fundraising for it.

Range-wide monitoring is one of our pivotal activities, which is based on occupancy analysis of reliable post-2010 leopard records based on a 25 x 25 km grid throughout the range in relation to prey, habitats, human activities and existing threats. We are striving to raise funds for this work, which will be our major step forward in collective monitoring of Persian leopards.

In 2024, we plan to expand our training efforts in collaboration with Snow Leopard Network, Manul Working Group and Society for Conservation Biology Asia, use new channels for awareness-raising and fundraising, spread knowledge by translations from/to national languages, and apply local programmes for capacity building and motivation build-up. The website https://pelewg.net is created and its content has been continuously filled. In 2026, the PeLeWG will produce a triennial report of all its activities and make it available online.

Igor Khorozyan and Mohammad Farhadinia
Co-chairs of the PeLeWG
<info@pelewg.net>

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Cats in the news

Annual Florida Panther report, U.S.A

On 7 December, the Florida Fish and Wildlife Conservation Commission released the Annual Report on the Research and Management of Florida Panthers: 2022–2023. No panthers were captured and collared in this season, but six bobcats were. Telemetry data was collected for a total of 5 panthers and 13 bobcats. A total of 9,074 camera trap days resulted in 151 independent panther detections north of Caloosahatchee River, and 8,666 camera trap days in 479 independent detections south of the river. 16 deaths were recorded, all of which were caused by vehicular trauma.

Source: Florida Fish and Wildlife Conservation Commission, https://t1p.de/w2dn7

Caracals face possible extinction in India

Back in 2001, caracals were reported from 13 Indian states. Nowadays, the only reports stem from two populations in Rajasthan and Gujarat with a combined total of approximately 50 individuals. Habitat loss may have contributed to the decline, but cannot explain it by itself. Some protected areas used to host caracals and still offer a good prey base, but no cats have been found there anymore. There are no reports of poaching either and it is suspected that the species may suffer from an unknown disease. New surveys still hope to find the species outside these two known populations. The caracal would be the second cat species disappearing from India after the cheetah was declared extinct in 1952.

Sources: Mongabay India, https://t1p.de/q875k and https://t1p.de/ozj8b

Colombia releases guidelines for the protection of the jaguar in the country

The Ministry of Environment and Sustainable Development sent a circular to the different authorities in the country. It addresses the responsibilities of the different authorities regarding prevention and control of illegal killing, transportation, possession and illegal trade, as well as guidelines and recommendations for the protection of the species. The guidelines are part of the campaign 'En la Piel del Jaguar' (In the skin of the jaguar) which was launched in June 2023. In the frame of this campaign, there is also a free of charge phone number to report sightings of jaguars.

Source: Minambiente, https://t1p.de/hvgel

New tool to trace source of illegal lion products

The University of Illinois Urbana-Champaign has published the Lion Localizer (www.lionlocalizer.org). By entering the data from a mitochondrial DNA test into this tool, the geographic source of the sample can be determined. A similar tool had already been produced for elephants (www.loxodontalocalizer.org).

Source: University of Illinois Urbana-Champaign, https://t1p.de/cg7ak

Launch of the Arabian Leopard Scholarship Program

The Arabian Leopard Fund, in cooperation with the Royal Commission for AlUla RCU has launched the Arabian Leopard Scholarship Program. It will offer 50 study missions teaching practical skills and knowledge for the conservation of the Arabian leopard.

Source: Asharq Al-Awsat, https://t1p.de/2f8mj

CMS COP14: listing of two cat species and new jaguar initiative

At the 14th Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals 14 species were added to the coverage of the Convention. The Eurasian lynx and the Pallas' cat have now been included into Appendix II. Previously listed were cheetah, jaguar, snow leopard, lion, and leopard. The COP also adopted a new Transboundary Jaguar Initiative.

Source: CMS, https://t1p.de/knzf5

TRAFFIC report on online and international trade in live cheetahs released

The cheetah is listed in Appendix I under CITES prohibiting international commercial trade. However, the report found an alarming signs of a growing illegal trade in live cheetahs online. The top five countries identified by the report are the UAE, Saudi Arabia, Kuwait, South Africa and the U.S.A. Worryingly, many websites offering cheetahs also advertised other potentially illegal exotic pets.

Source: TRAFFIC, https://t1p.de/8qvkc

New Sino-Russian joint research lab on Siberian tiger conservation

Northeast Forestry University in Heilongjiang Province, China, opened a new Sino-Russian joint research lab on Siberian tiger conservation. A total of more than 20 experts from both countries will work together e.g. on wildlife ecology and management, Siberian tiger feeding and breeding and wildlife genetics. The lab will also strengthen data sharing.

Source: China Global Television Network CGTN, https://t1p.de/v78s0

First Eurasian lynx releases in Baden-Württemberg and in Saxony, Germany

In December a female Eurasian lynx was released in Baden-Württemberg, south-western Germany. In March, the first two lynx were released in Saxony's western Ore Mountains, eastern Germany. Whilst some male lynx have dispersed to Baden-Württemberg from Switzerland, there have been no wild lynx in Saxony for 300 years. The releases are part of separate reintroduction projects that aim to create stepping stone populations to connect existing, isolated Eurasian lynx populations.

Source: Linking Lynx, https://t1p.de/eshat

See Supporting Online Material SOM for more news articles at www.catsg.org. Current news articles are also published on the IUCN SSC Cat SG Facebook page (https://t1p.de/evuiq).

Thank you to all the people who have sent in news items: Carlos Augosto Castro-Pastene, Guido Macari, Nobuyuki Yamaguchi and Susie Weller.

If you would like to contribute current news items from your area, please contact: r.buerki@kora.ch.

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