

1st International Conference

on

**Pangolin conservation, trade
and rehabilitation**



Mabula Game Reserve

South Africa

12 – 15 October 2015

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Welcome Note

Pangolin species globally are now faced with a very real probability of extinction, primarily as a result of unprecedented levels of poaching on natural wild populations. The four Asian species are reaching critically low population levels and the four African species are now experiencing extensive poaching and illicit trade volumes to compensative for the low availability of pangolins in the Asian market. Local harvest and trade has also been found to be completely unsustainable in these mammals with naturally low population recruitment. However, this group of rare mammals has received very little attention from the scientific community and many aspects of their ecology, biology and physiology remain unknown.

This conference is the first attempt to bring together scientists, animal welfare and animal rights organisations, conservationists and government officials from across global pangolin range states to share their knowledge and expertise gained from their experience and research with regards pangolin ecology, biology, conservation, rehabilitation and trade.

We hope that this interactive experience in this beautiful savanna African setting will forge friendships, collaborative projects and help us to better understand, manage and conserve these illusive, rare and fascinating mammals. We further hope that your stay at Mabula will be a most enjoyable and memorable one.



Prof Ray Jansen
Chairperson of the conference organising committee

Conference proceedings

The keynote address will focus on the global plight of pangolins and their current conservation status which we all know has now reached alarming levels primarily due to the unprecedented illicit trade. Dan Challender can arguably be regarded as the authority on pangolin trade worldwide and we are very fortunate that he could join us to deliver this address. Abstracts of all oral and poster presentations are available in this Booklet.

Presentation information

A notebook computer, data projector and overhead screen will be available throughout the Symposium. The presenters are requested to bring their PowerPoint presentations on a USB in order to load it on time before each session.

Catering

Throughout the duration of the conference, tea/coffee will be available at the conference venue and a buffet lunch will be served in the main dining hall of the lodge. Breakfast is daily from 8:00 to 9:00 am and dinner from 19:00.

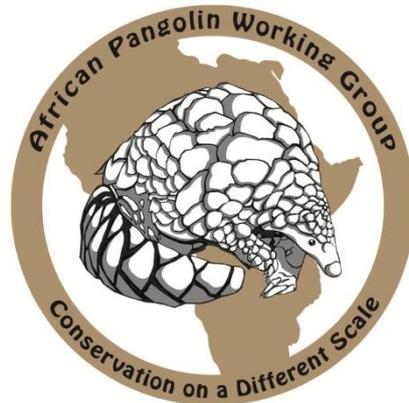
Game drives

A daily game drive will depart in front of the main lodge reception at 16:30 on Monday, Tuesday and Wednesday afternoons for those delegates that have requested this as part of their conference package.

Conference Organizing Committee

Prof Ray Jansen, Prof Antoinette Kotze and Ms Lizzy Sibiya

This conference is hosted by the African Pangolin Working Group; a South African Government approved non-profit organisation dedicated to the conservation of pangolins.



<https://www.pangolin.org.za>

<https://www.facebook.com/pages/African-Pangolin-Working-Group/513407302073363>

We thank the National Research Foundation Knowledge Interchange and Collaboration funding programme for travel support for the keynote speaker.

Mabula Game Lodge is located at the foothills of the Waterberg Mountains in the Limpopo Province of South Africa. This privately owned reserve is close on 12 000 hectares large and is home to sixty mammals, three hundred birds, and numerous reptiles and insects.

Wildlife includes the big five: lion, leopard, buffalo, African elephant and rhinoceros, but also the small five: ant lion, leopard tortoise, buffalo weaver, elephant shrew and rhino beetle.

Apart from these, the following mammals can be seen here: hedgehog, lesser bushbaby, vervet monkey, chacma baboon, pangolin, scrub hare, tree squirrel, spring hare, greater cane rat, porcupine, bat-eared fox, black-backed jackal, striped polecat, honey badger, Cape clawless otter, African civet, large spotted genet, small spotted genet, yellow mongoose, marsh mongoose, slender mongoose, white-tailed mongoose, banded mongoose, aardwolf, spotted hyena, brown hyena, cheetah, caracal, serval, African wildcat, black-footed cat, armadillo, rock hyrax, Burchell's zebra, bushpig, common warthog, hippo, giraffe, klipspringer, common duiker, steenbok, blesbok, reedbuck, mountain reedbuck, impala, springbok, blue wildebeest, black wildebeest, tsessebe, red hartebeest, gemsbok, waterbuck, bushbuck, nyala, kudu and eland.



Conference programme

DAY 1, 12 OCTOBER 2015 PANGOLIN TRADE & TRADITIONAL USE Chair: Prof Ray Jansen	
09:00 – 09:15	Opening and welcome: Ray Jansen (Chair of the organising committee & Co-Chairman of the APWG)
09:15 – 10:15	<p>Keynote Address Pangolins and their Conservation: Past, present and future</p> <p>Dan Challender: Co-Chair: IUCN Species Survival Commission Pangolin Specialist Group; Programme Officer: Sustainable Use and Trade, IUCN Global Species Programme</p>
10:15 – 11:00	Tea
11:00 – 11:30	<u>M Boakye</u> , D Pietersen, A Kotzé, DL Dalton and R Jansen. Pangolin bushmeat trade in Ghana: a threat to their survival
11:30 – 12:00	<u>C Barylak</u> and <u>A Peyman</u> . Recent trends in legal and illicit trade in pangolins, and opportunities for new protections
12:00 – 12:30	<u>H Quine</u> , TV Nguyen, PT Quang, HL Tat, and LV Wicker. An overview of the pangolin trade and rehabilitation in Vietnam
12:30 – 14:00	Lunch
14:00 – 14:30	<u>JL Chong</u> , MS Hafiz, H Marina and W Afzan. Our seven year love affair with the Sunda Pangolin (<i>Manis javanica</i>): Important findings and conclusions
14:30 – 15:00	D Challender. Global pangolin trade dynamics and key conservation challenges
15:00 – 15:30	AO Baiyewu, <u>R Jansen</u> , DW Pietersen, A Kotze and DL Dalton. Customary beliefs and traditional use of Temminck's Ground Pangolin (<i>Smutsia temminckii</i>) within South African tribal communities
15:30 – 16:00	Tea & end of day one

DAY 2, 13 OCTOBER 2015 PANGOLIN CONSERVATION & REHABILITATION Chair: Prof Antoinette Kotze	
09:00 – 09:15	Opening and announcements: Ray Jansen
09:15 – 09:45	AP Khatiwada. Lessons learned and the way forward: a case study of community-based Chinese Pangolin conservation in the eastern Himalayas of Nepal
09:45 – 10:15	<u>F Tarla</u> , C Waterman, C Ransom, P de Ornellas and N Gelman. Introducing the MENTOR-POP (Progress on Pangolins) Programme in Central Africa
10:15 – 11:00	Tea Poster session
11:00 – 11:30	<u>E Connelly</u> and L Hywood. Ground Pangolin rescue, rehabilitation, release and legal protection in Zimbabwe
11:30 – 12:00	<u>S Wu</u> , H Lo, C Lien and S Chin. The development of a hand-reared Formosan Pangolin cub at Taipei Zoo, Taiwan
12:00 – 12:30	<u>S Wu</u> , F Zhang, G Ma, S Li, R Sun. Reassessment of the threatened status of the Chinese Pangolin, <i>Manis pentadactyla</i>
12:30 – 14:00	Lunch
14:00 – 14:30	<u>HC Nash</u> , MHG Wong and ST Turvey. Determining status and threats of the Critically Endangered Chinese Pangolin (<i>Manis pentadactyla</i>) in Hainan, China, using local ecological knowledge
14:30 – 15:00	A Kurniawan. Husbandry of the Sunda Pangolin (<i>Manis javanica</i>) in Night Safari, Singapore
15:00 – 15:30	Alexis Kriel. Rehabilitation of an orphaned long tailed Pangolin and tree Pangolin in the Central African Republic
15:30 – 16:00	Tea & end of day two

DAY 3, 14 OCTOBER 2015	
PANGOLIN BIOLOGY & ECOLOGY	
Chair: Darren Pietersen	
09:00 – 09:15	Opening and announcements: Ray Jansen
09:15 – 09:45	<u>R Khatri-Chhetri</u> , H Wu and KJC Pei. Health assessment of free-ranging Formosan Pangolins (<i>Manis pentadactyla pentadactyla</i>)
09:45 – 10:15	<u>T Mahmood</u> , N Irshad, R Hussain, F Akrim, H Fatima, I Hussain, M Anwar, M Rais and MS Nadeem. Ecology of the Indian Pangolin (<i>Manis crassicaudata</i>) in the Potohar Plateau, Pakistan
10:15 – 11:00	Tea
11:00 – 11:30	<u>CM Sun</u> , J-S. Lin, C-Y. Lai and KJC Pei. Home range, density, habitat preference and modelling of Taiwanese Pangolins (<i>Manis pentadactyla pentadactyla</i>) in south-eastern Taiwan
11:30 – 12:00	<u>Z du Toit</u> , P Grobler, A Kotze, R Jansen, DW Pietersen and DL Dalton. Molecular phylogeography of Temminck's Ground Pangolin populations in southern Africa
12:00 – 12:30	<u>JCK Pei</u> , JS Lin, CM Sun, KH Hung and SP Chang. Reproductive biology and body weight variation of the Taiwanese Pangolin (<i>Manis pentadactyla pentadactyla</i>)
12:30 – 14:00	Lunch
14:00 – 14:30	<u>T Radebe</u> , A Kotze, R Jansen and E Suleman. African pangolins and ectoparasite associations
14:30 – 15:00	<u>DW Pietersen</u> , R Jansen and AE McKechnie. Ecology and physiology of Temminck's Ground Pangolin (<i>Smutsia temminckii</i>) in an arid region of South Africa
15:00 – 15:30	<u>C Steyn</u> and MR Crole. The radiological anatomy and scale pattern of the thoracic limb of <i>Smutsia temminckii</i>
15:30 – 16:00	Tea & end of day three

Oral Presentations

Pangolin bushmeat trade in Ghana: a threat to their survival

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Bushmeat remain a key source of animal protein and income during lean agricultural periods in Ghana and mammals are regarded as the prime source of bushmeat. A mammal that is frequently hunted as a source of bushmeat in Ghana are the endangered pangolins (Pholidota: Manidae). Currently, pangolins can be regarded as the most traded group of mammals on Earth, however, very little is known with regards to the level of trade of pangolins in Ghana. The aim of this study was to determine the level of trade among additional stakeholders outside of major bushmeat market surveys in the bushmeat commodity chain for pangolins in Ghana. Data were gathered through semi-structured interviews and direct observation from 153 stakeholders comprising 84 chopbar operators, 48 farmer hunters and 21 wholesalers between September 2013 and January 2014. A total of 341 pangolins were recorded to have been traded in this study period and, of this number, 98 pangolins were personally observed. 82% of pangolins traded were white-bellied pangolins (*Phataginus tricuspis*) and 18% were black-bellied pangolins (*Phataginus tetradactyla*), but no trade was observed for the giant ground pangolin (*Smutsia gigantea*). The number of pangolins traded was negatively correlated to the distance between stakeholder's settlements and protected forest regions where the animals are mostly sourced. Snares were the most commonly used hunting technique. The current levels of pangolin harvest in Ghana can be considered as unsustainable due to the very high offtake levels and the low reproductive rates of these mammals. In addition, the Wildlife Conservation Act of 1971 (LI 685) classifies pangolins under Schedule 1, prohibiting any person from hunting or being in possession of pangolins, an indication that legislation pertaining to pangolin conservation is not being implemented in Ghana.

Recent trends in legal and illicit trade in pangolins, and opportunities for new protections

C Barylak¹ and A Peyman²

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An in-depth study of legal and illicit trade in pangolins and their products was conducted by analyzing the latest available trade and seizure data in hopes of determining trends and major routes in the trade to determine what role both legal and illicit trade plays in the decline of these endangered mammals . Data from the UNEP-WCMC CITES trade database and from publically available seizure reports from the last ten years were sourced and analyzed, and major trade routes and trends in both legal and illicit trade in pangolins over this period was determined. The results indicate possible illicit trade taking place through legal venues as evidenced by suspicious reports of pangolin trade reflected in the CITES trade data, as well as illicit trade taking place on a massive scale; both of which pose a dire threat to the continuing survival of the eight species. The data also indicate continuing trade in Asian pangolin species, which are either critically endangered or endangered and protected under CITES zero-export quotas. Evidence shows that traders are turning to African species of pangolin to satisfy continuing Asian demand for pangolins and their products. All of the results point to the dire necessity of heightened protection for pangolins through domestic and international regulations such as stronger national and international laws. Two efforts to institute such protections – a recent petition to list all pangolin species as Endangered under the US Endangered Species Act, and nascent efforts to list all eight species under Appendix I of CITES – are currently being considered, with varying degrees of potential effectiveness in curbing current pangolin trade if they are successful

An overview of the pangolin trade and rehabilitation in Vietnam

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Despite being protected under Vietnamese domestic law, and CITES placing a zero export quote for trade in the species, market investigations indicate the critically endangered Sunda pangolin (*Manis javanica*) and the critically endangered Chinese pangolin (*Manis pentadactyla*) are being confiscated with increasing frequency within Vietnam. Vietnam is a source, destination, and transit country; social surveys suggest significant pangolin products cross the northern border into China. Trade is primarily driven by demand for their scales, which are used in traditional medicine, and meat, which is considered a delicacy. Pangolin scales, which until 2015 were listed under the Vietnamese pharmaceuticals benefits scheme, are prescribed to treat cancer, reduce toxins and heat, and activate circulation amongst other ailments. With declining populations of Asia pangolin species, growing numbers of African pangolins are being trafficked to the continent to meet demand.

The Carnivore and Pangolin Conservation Program (CPCP) was the first organisation working to save pangolins in Vietnam, and has been successfully rehabilitating pangolin since 2006. Now operating under the banner of Save Vietnam's Wildlife (est. July, 2014), the CPCP is one of only two organisations within Vietnam with the capacity to successfully rehabilitate and release pangolins confiscated from the wildlife trade. The successful rehabilitation- and eventual release - of pangolin demands exacting husbandry, provision of specialised diets, well-designed enclosures - and with a propensity to stress - careful monitoring of individuals' adaptations to the challenges of captivity.

Recent directives from Vietnam's Ministry of Justice enshrine the pangolin's status as a 'Priority Species' and subsequently any trafficking of pangolins or their parts is considered a criminal offence. This means release requests may be denied until criminal cases are finalised – sometimes taking months - compounding the challenges faced by SVW in conserving this species.

Our seven year love affair with the Sunda Pangolin (*Manis javanica*): Important findings and conclusions

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The Malayan Pangolin or the Sunda Pangolin (*Manis javanica* Desmarest) is one of the eight extant pangolin species worldwide. Although is threatened by illegal hunting and habitat loss, this unique species received minimum scientific attention in Malaysia. Conservation efforts are difficult due to lack of information in various aspects. Our seven year study employs several methods namely questionnaires and interview-based survey techniques, fieldwork and molecular techniques to obtain information on the ecology, biology and genetics of this elusive animal. Results of the questionnaire, interview survey and fieldwork in three different Malaysian landscapes revealed that the Sunda Pangolin is largely influenced by its habitat in its choice of den, with hollows in living trees being its preferred den in primary forest, and adapting to boulder cavities in a harsh landscape devoid of matured trees. As for parasitism studies, *Amblyomma javanese* was the only tick species found, with 68.8% of the pangolins sampled infected. Preliminary results of the Sunda pangolin genetics revealed some variations in the 500 bp cytochrome b sequences obtained from wild and confiscated samples, which may be used to enable rapid identification of the origin of confiscated samples in forensics and law enforcement. *Ex-situ* conservation efforts with the aim for local community awareness and diversifying sources of income in rural areas is essential to conserve the Sunda Pangolin in the long-term.

Global pangolin trade dynamics and key conservation challenges

Dan Challender

Programme Officer, Sustainable Use and Trade, IUCN Global Species Programme; Co-Chair, IUCN
SSC Pangolin Specialist Group

Focusing mainly on the Asian species, this talk examines the dynamics of international trade in pangolins and their derivatives since the inception of CITES, both legal and illegal, concentrating on derivatives in trade, trade volumes and routes, and the drivers and motivations of trade along value chains. It does so in relation to conservation action taken for pangolins within CITES in order to evaluate the efficacy of these measures. Looking in greater detail at trade dynamics post-2000, the talk incorporates evident and emerging trends in pangolin trade, including inter-continental trade in African pangolin derivatives to Asian markets, and other market dynamics. Finally, it considers future options for conserving pangolins both within CITES and beyond, and highlights some key challenges to controlling international trade in pangolins and in order to deliver pangolin conservation.

Customary beliefs and traditional use of Temminck's Ground Pangolin (*Smutsia temminckii*) within South African tribal communities

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Pangolins are highly evolutionarily distinct in that they are the only representatives of an entire mammalian order, the Pholidota. Temminck's Ground Pangolin (*Smutsia temminckii*) is one of the four African pangolin species, considered to be very rare in South Africa and believed to be declining in most parts of its range. This species was recently up listed to *Vulnerable* by the International Union for the Conservation of Nature (IUCN). One of the contributing threats to the species is believed to be its exploitation for traditional medicine purposes and other cultural beliefs. These solitary animals are revered in most South African tribal communities because of their alleged mystical powers and economic values. Community members were interviewed from the seven tribes across the species distributional range in South Africa. Cultural belief in the species prevailed in the elderly while few younger people were familiar with the animal. The beliefs and uses of the animal and its body parts within the tribal communities are similar and diverse where the animal's scales followed by its blood and fat are the most culturally important body parts used in traditional medicinal practice. The most prevalent ailments for which pangolin body parts are prescribed are nosebleeds, headaches and for protection against harm and evil. The species is believed to be at risk due to the high levels of illegal harvest from the wild populations for cultural and economic purposes.

Lessons learned and the way forward: a case study of community-based Chinese pangolin conservation in the eastern Himalayas of Nepal

Ambika Prasad Khatiwada

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The eastern Himalayas of Nepal is a biodiversity hotspot and a crises eco-region. Agriculture is the traditional occupation and main source of livelihood of local people. This paper presents a case study of community initiatives for the Chinese pangolin (*Manis pentadactyla*) conservation in Taplejung district, eastern Himalayas of Nepal. The Chinese pangolin, the burrowing small mammal commonly known as the scaly ant eater, is a critically endangered species. More than a million pangolins were illegally traded in the past ten years. We piloted this project in human dominated landscape covering 40 sq.km areas in two remote villages of eastern Nepal in 2012 where eighteen sub-committees and two pangolin conservation committees were established directly engaging 263 people and informed >1182 individuals with regards pangolin conservation. Pangolin conservation outreach programs were implemented organizing community meetings, school teaching, essay competition etc. The effectiveness of outreach program was assessed interviewing local communities which indicated a significant impact of the program as > 85% of respondents were aware about wildlife law and understood the importance of pangolin conservation. This is the first ever conservation effort made at these villages. We believe communication and outreach programs about the threatened status of local animals influence attitudes and win support for conservation. Pangolin conservation committees now started to raise awareness among villagers in preventing poaching and if any one captured a pangolin, the committee members would help to release the animal back into its natural habitat. This approach supported the conservation of Chinese pangolins and contributes to controlling illegal pangolin trade locally. Communities now believe that Chinese pangolins are worth more alive than dead.

Introducing the MENTOR-POP (Progress on Pangolins) Programme in Central Africa

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The Congo Basin is home to three species of pangolin (*Phataginus tricuspis*, *Phataginus tetradactyla* and *Smutsia gigantea*), all of which were recently upgraded to Vulnerable on the IUCN Red List on the basis of inferred current and projected population declines due primarily to overexploitation (IUCN 2014). Pangolins in the region are hunted for bushmeat and used in traditional medicine and, increasingly, to supply Asian markets via illegal wildlife trafficking.

Several Central African countries have recently pledged to address wildlife trafficking. However, there remain numerous barriers to effective conservation of pangolins in the region; notably, a lack of knowledge about the population biology, ecology, status, trends, or relative magnitude of the specific threats facing pangolin populations, and a lack of capacity within range states to address pangolin trafficking.

Initiated in July 2015, the 18 month MENTOR-POP (Progress on Pangolins) programme aims to overcome these barriers by developing a trans-disciplinary team of early-career Central African and Asian conservation practitioners to conserve pangolins in the Congo Basin. Building on experiences from the USFWS MENTOR Signature Initiative (*Mentoring for Environmental Training in Outreach and Resource Conservation*; est. 2008) and ZSL's EDGE of Existence programme (est. 2007), MENTOR-POP will provide a team of nine Fellows with academic and field-based training and internships, mentoring from experienced conservation professionals, and experiential learning in best conservation practices. As part of the programme, the MENTOR-POP Fellows will work with experts to develop and implement three 9-month projects to address the gaps in knowledge about pangolins in Central Africa and the threats to their survival. Specifically, the projects will focus on field assessments, legal systems and demand reduction. Upon successful completion of the Fellowship programme, Fellows will be equipped with the skills, knowledge and networks essential for making a significant contribution to the survival of pangolins in Central Africa.

Ground Pangolin rescue, rehabilitation, release and legal protection in Zimbabwe

Ellen Connelly and Lisa Hywood

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The Tikki Hywood Trust has been working with Ground Pangolins rescued from illegal wildlife trade since its establishment in 1994. Through this experience we have handled, treated, hand-reared and released a number of pangolins of different ages and physical conditions. In this presentation we will be illustrating our work with the husbandry and captive management of Ground Pangolins. In addition, our exposure to this species has increased particularly in the last three years being 2013 to date. In addition, we will also be presenting the work we have undertaken with regard improving the legislation and protection for the species in Zimbabwe and the results we have achieved through these actions.

The development of a hand-reared Formosan Pangolin cub at Taipei Zoo, Taiwan

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The female Formosan pangolin cub, Chiung-Wu, was born on September 30, 2014. The hand-rearing program was started on the third day after its birth because of the loss of body weight from 133 g to 115 g and general weakness of the cub. The cat milk replacement and milk substitute were used, and the ratio of two kinds of milk to water was modified according to the digestive condition of the cub. The same keeper fed the cub to help her feel secure and kept the record of vital signs, including times of feed, amount of milk taken, daily weight before morning feed, urination and defecation. Weaning commenced at about 5 months old. Initially, the formula is enriched by adding frozen then thawed egg, larvae and adult of ants (*Crematogaster rogenhoferi*), ants mixture with captive diet, and then captive diet with milk. The cub completely weaned at 6.5 months and the growth of body weight and length is from 115 g to 1,532 g and from 23.8 cm to 61 cm. The captive box and activity area were provided. The condition of captive box was controlled by the utilization of a heating pad, wet cloth and dry towel to regulate the temperature and humidity. The average temperature and humidity of the captive box was $29.3^{\circ}\text{C}\pm 3.4^{\circ}\text{C}$ and $67.8\pm 12.1\%$, respectively. We also furnished the wood chips as substrate, perch, basin with soil, bowl with water, and nest box in the activity area to stimulate and facilitate the development of the natural behaviour such as sleeping, curling-up, walking, climbing, digging, clinging and sniffing, and most of those behaviours were observed at 2 weeks of age. Currently, the cub can survive independently as other adult pangolins at the Taipei Zoo. The accumulation of experiences and data of hand-rearing this cub is helpful for the Formosan pangolin cubs rescued from the wild or through captive breeding.

Reassessment of the threatened status of the Chinese pangolin, *Manis pentadactyla*

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Chinese pangolins (*Manis pentadactyla*) are distributed mostly in the southern region of the Changjiang River, China, including Taiwan and Hainan Islands, and only a few are found in the countries bordering Guangxi and Yunnan Province in China. Some information with regards its threatened status is presented here. Nineteen factors threatening this species survival were used to assess its threatened status, the attributes of these factors were sourced from published information and the findings of this study. Each of these factors was assigned a score on the basis of the potential to cause this species risk in survival, ranging from a maximum of 5 (highest risk) to 0 (no potential risk). The overall threatening index (T_i) is the summed scores of all factors divided by the total possible scores. The results indicate that the Chinese pangolin is a susceptible species due to its food specialization and stenophagy (only feeding on several species of ants and termites), very low reproductive rate (usually one cub per litter, one litter per year), strict habitat requirement and very poor defence (moving slowly, shy, curling up into a ball when threatened). As such, the potential extinction risk for this animal is very high. The high threatening index ($T_i = 0.7474$) suggests that this species is currently in a high risk situation, and has become a critically endangered species. The most key external threatening factors of this species is over hunting, utilization and illegal trade, owing to its rare value in medicine and food. The second is the loss and alteration of its natural habitat. Currently, this species is very rare in China where the estimated population density has decreased by 90%, at least since the end of 1960s last Century. The high hunting pressures are expected to persist, so the threatened status of this species is expected to become more serious and the potential extinction risk rise accordingly.

Determining status and threats of the Critically Endangered Chinese Pangolin (*Manis pentadactyla*) in Hainan, China, using local ecological knowledge

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Mammal species in eastern and southeast Asia face the world's highest levels of extinction risk. The ant and termite eating pangolins (Family Pholidota) are particularly threatened, and are now the most heavily trafficked mammals in illegal wildlife trade at a global scale. Methods to monitor and assess status and threats of pangolins are urgently required across all range states. We demonstrate that large-scale surveys of local ecological knowledge (LEK) can strengthen the evidence-base for informing robust conservation action and management plans for pangolins. 714 community interviews were conducted across seven protected areas in Hainan, China, to investigate status and threats, including hunting, of the Critically Endangered Chinese Pangolin (*Manis pentadactyla*). LEK of pangolins remains high in Hainan (90% of informants recognise pangolin from photographs and can provide supporting information), and varied cultural attitudes exist towards pangolins. Pangolins are still present across protected areas in Hainan, as evidenced by recent sightings dating from 2013-2015 collected from all protected areas. However, all populations are perceived to be of very low abundance (only 34% of informants consider pangolins to still be locally present, and these informants all regard pangolins as rare), and all populations have reportedly declined across their range. Illegal hunting continues across this region (reported by 56% of informants), and pangolin body parts are both used locally and sold to outsiders. Chinese Pangolins are likely to be extirpated across Hainan unless effective conservation management plans can be initiated that also engage local people.

Husbandry of the Sunda Pangolin (*Manis javanica*) in Night Safari, Singapore

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The Sunda pangolin (*Manis javanica*) is one of the eight species of pangolins (Order: Pholidota) which is native to Singapore. Pangolins are rarely housed in zoological institutions due to their strict myrmecophagous diet which is difficult to replicate in captivity. Given the increasing threat to their survival, it is imperative to develop husbandry knowledge for these unique groups of animals. The Night Safari has been housing Sunda pangolins since 2005. Since 2010, there have been 3 successful births, all via parent rearing, with the most recent birth on the 13th July 2014. This presentation will cover various aspects of the Sunda pangolin husbandry such as diet, housing, enrichment and captive breeding.

Rehabilitation of an orphaned long tailed pangolin and tree pangolin in the Central African Republic

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This presentation deals with the maintenance of two orphaned pangolin pups in the Central African Republic, over a 6-week period - a black bellied or long-tailed pangolin (*Phataginus tetradactyla*) and a white bellied or tree pangolin (*Phataginus tricuspis*). There is very little documented information on the rehabilitation, care or husbandry of either of these species. The presentation highlights diet preferences and requirements as well as food intolerance, the value of rehabilitation in close proximity to the rainforests and foraging behaviour. The challenges of the isolated rainforest region include the bush meat trade, logging and local hunting which increase the vulnerability of these pangolin species. The value of rehabilitating an individual pangolin lies in creating an ambassador species with which to engage with the local Ba'aka pygmies and other communities in education programmes. The presentation touches on observations of behaviour and how they use their unique physiology, of accommodating a nocturnal animal, soft release and pangolin safety. Hand rearing pangolins in this region has been successful but there are still challenges that need to be overcome.

Health assessment of free-ranging Formosan Pangolins (*Manis pentadactyla pentadactyla*)

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The Formosan Pangolin (*Manis pentadactyla pentadactyla*), a sub-species of Chinese pangolin, is an endangered insectivorous mammal found only in Taiwan. The objective of the present study was to evaluate the health of a free-ranging population of Formosan Pangolins by investigating through clinical and pathological examinations, and analyzing their blood and faecal samples. Reference intervals for hematologic, serum biochemistry analyses and basic clinical findings (body weight, heart rate, body temperature, blood oxygen saturation) were calculated by parametric and non-parametric percentile methods from 100 apparently healthy pangolins captured during an ecological survey. Seasonal, age-group and sexual differences were also investigated. Post-mortem examinations were undertaken for pathological and parasitological findings on 15 dead pangolins submitted to our rescue center. Faecal samples were used to study the prevalence of selected gastro-intestinal parasites and pathogens using microscopic and molecular techniques. Significant seasonal differences were observed in heart rate, body temperature, serum alanine aminotransferase, lipase activities, and phosphate concentrations. The variables, which were significantly different between adult and sub-adult pangolins, were heart rate, mean corpuscular hemoglobin, creatinine, total protein, phosphate, glucose, potassium and amylase. The histopathological findings included mild to severe interstitial pneumonia, emphysema, focal hepatic necrosis, bile duct hyperplasia, steatosis and extensive hepatocyte degeneration, mild to chronic interstitial nephritis, and nephrolithiasis. Hookworms and *Strongyloides stercoralis* parasites larva and eggs were recovered from gastrointestinal tract. One unusual case included parasitic infestation of the spleen where multiple cross-sections of nematode parasites were located. The parasites identified by the microscopic examination included hookworms, *Strongyloides spp.*, protozoa, coccidia and ticks (*Hemophysalis spp.*). A high number of faecal samples tested positive for *Necator americanus*, *Strongyloides spp.* and *E. coli* from DNA analysis using PCR. The presented pathological and parasitological findings can aid in our understanding of diseases in pangolins, and contribute towards implementing health monitoring strategies for the conservation of these endangered mammals.

Ecology of the Indian pangolin (*Manis crassicaudata*) in the Potohar Plateau, Pakistan

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The Indian pangolin (*Manis crassicaudata*), is the only scaled mammal in Pakistan and is a vital component of the countries biodiversity since it consumes large volumes of ants and termites but the species has not been the focus of ecological studies in the region. We investigated its distribution, population, diet, and breeding habits in Potohar Plateau from 2010 to 2013. Indian pangolins were recorded in all sampled transects in two districts of the Plateau while in the remaining two districts, it showed a patchy distribution. The species was found limited to a maximum elevation of 879.95 m asl in the sub-tropical scrub and sub-tropical deciduous forests. Average population density of the species was estimated at 1.08 /km² individuals during the year 2010, 0.36/km² individuals in 2011 and 0.23/km² individuals in 2012, showing an overall decline of approximately 79% over a period of three years. Faecal analysis revealed ants (% Frequency=100 %, %Weight=37.9 %) and soil particles (% F=100%, %W=57.95%) recovered in large proportions compared to bugs (% F=2.27 %, %W=0.375 %), termites (% F=2.27 %, %W=0.95 %), wood (% F=13.63 %, %W=2.3 %) and grass (% F=22.7%, %W=0.89%). Prey species of Indian pangolin identified from faecal analysis included two species of black ants (*Camponotus confucii* and *Camponotus compressus*) and one termite species (*Odontotermes obesus*). The species breeds once a year, usually from July to October, having a litter size of 1 – 2 offspring. Eight out of eleven field sightings reported one mother pangolin with two baby pangolins. A highly male-biased sex ratio of 16:5 (M:F) was recorded in the Plateau. Indian pangolin population is declining rapidly and the most lethal factor for this decline being illegal hunting for its scales. Nomads and native hunters sell them in local and international markets. Massive decline in the species population demands urgent conservation measures to restore this rapidly dwindling species, and strict wildlife laws need to be enforced, in addition to creating awareness among the native people.

Home range, density, habitat preference and modelling of Taiwanese pangolins (*Manis pentadactyla pentadactyla*) in south-eastern Taiwan

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The ecology of Taiwanese pangolins (a subspecies of Chinese pangolin) was investigated during June 2009 to December 2014 by camera-trapping, radio-tracking and field observations. The average *minimum convex polygon* (MCP) 95% home range size was found to be 106.9 ± 32.8 ha for 6 adult males and 25.1 ± 8.2 ha for 8 adult females, MCP 50% core area sizes were 35.1 ± 13.8 ha and 6.0 ± 2.9 ha, respectively. In dryer seasons, home ranges decreased significantly than that of the wet season. Male home ranges did not overlap much, but each contained several extensively overlapped female home ranges. Long-term monitoring revealed that pangolins were extremely bound to their home ranges once settled. Population density was estimated to be 12.8 pangolins/100 ha. Pangolins used low- (secondary and bamboo forests, tall grass- and shrub-lands) to medium-disturbed environments (orchards, short grasslands, managed forests) without preference. Pangolins also created many burrows when searching for termites; mainly during the dryer season when ants were not readily available. The burrow density was estimated to be 110.8 burrows/ha, comprised predominantly of food searching burrows in all environments. However, 81% of the resting burrows were found in low-disturbed environments. Individual pangolins used a limited number of permanent burrows for resting (ca. 30-90 burrows). Also, individuals that co-inhabit shared resting burrows rarely used the same burrow simultaneously. Pangolin presence signs were recorded in 193 1-ha grids. Analysis showed that pangolins prefer habitat with $10-40^\circ$ in slope, 200-1,000m in elevation, high Whole Light Sky Space (> 125), high range of NDVI, and slopes with western and north-western aspects. We calculated 4 distribution models (MAXENT、DK-GARP、OM-GARP and Two-class SVM) by using the present data. While MAXENT was the best model, the AUC value of the 4 models was all above 0.7, which indicated these predictions were useful in conservation decision making.

Molecular phylogeography of Temminck's Ground Pangolin populations in southern Africa

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Phylogeography has become a powerful approach for determining geographical patterns of evolutionary units within species. This study details the phylogeographic pattern and phylogeny of the Temminck's Ground Pangolin, an elusive species in the order Pholidota. We sequenced the whole mtDNA of Temminck's Ground Pangolin using the primer walking method. We also constructed a molecular phylogeny using three mitochondrial gene regions, CO1, Cytb and D-loop. Representative samples were collected from six geographic locations in southern Africa and compared using the three gene regions. The locations included samples from Zimbabwe, Mozambique, northern Namibia and three provinces from South Africa (namely Northern Cape, Mpumalanga and Limpopo Province). Phylogenetic results indicated that the order Pholidota formed a sister grouping with the order Carnivora and not with the order Xenarthra as expected. Data suggests a Laurasian origin around 87 mya and possible migration into Africa during the Paleocene era around 55 mya. Furthermore, analysis of three mtDNA gene regions indicated high levels of genetic variation between individuals within each geographic location. We found low genetic differentiation between the different localities in southern Africa which suggests high gene flow between each locality. In conclusion, this study demonstrates a complex phylogeographic history for Temminck's Ground Pangolin. The high level of genetic diversity between individuals characterizing Temminck's Ground Pangolin populations from the different localities of southern Africa also highlights the importance of such regions as a source of intraspecific genetic biodiversity.

Reproductive biology and body weight variation of the Taiwanese Pangolin (*Manis pentadactyla pentadactyla*)

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Reproduction and body weight changes of the pangolin (*Manis pentadactyla pentadactyla*) were studied in rural habitats in south-eastern Taiwan between 2009 and 2014. A total of 17 births were recorded in the wild, all were recorded between September and March, with 65% of them between December-January. Body weight at birth was 88.3 ± 11.4 g (n=10 including literature records). The asymptotic adult body weight was $5,040 \pm 660$ g (n=63 duplicated measurements) for male and $4,150 \pm 700$ (n=56 measurements) for female. Post-partum body weight growth pattern was modelled using Logistic, Gompertz and Von Bertalanffy models. Body weight data used in fitting these growth curves were collected from three sources: (1) three hand-reared females from <1 month old to approximately 12 month old; (2) 19 females captured/recaptured with a total of 42 (range: 1-13) times from infant stage; and (3) 16 males captured/recaptured 40 (range: 1-15) times from infant stage. All three models revealed that pangolin asymptotic body weight was attained at around three years old for both sexes. However, female showed discontinued body weight increasing between 1.5 to 2.5 year of age. The earliest age at which females give birth was at three years old. Adult body weight showed significant seasonal changes for both sexes, they were heavier in summer and 20-25% lighter in winter, which was consistent with the seasonal availability of ants in the environment. Molecular analysis indicated this population is geographically isolated and likely inbred, and although they are principally polygynous in mating system, females mated with different males in different years.

African pangolins and ectoparasite associations

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Parasites, such as ticks commonly infect species that include pangolins and may play a significant role in inhibiting a population's survival rate. Although certain parasites (primarily endoparasites such as nematodes) have been identified and associated with pangolins, global studies on pangolin parasite burdens have been limited to isolated and opportunistic sampling in both Asia and Africa. In addition, ectoparasitic burdens and the implications these may have on disease and mortality rates of pangolins have not previously been investigated. This study aims to morphologically and genetically identify ectoparasites associated with three African pangolin species, namely the White-bellied, Black-bellied and Temminck's Ground Pangolin. Two non-destructive DNA extraction protocols (Tris-EDTA buffer and Chelex) were applied on model animal's ectoparasites to determine which would be most suitable. In particular, we investigated maintaining the structure for morphological classification and for extracting good quality DNA for phylogenetic analyses. Digital photographic images of ectoparasites captured before and after DNA extraction revealed that the morphology or ultrastructure were not changed by either the TE buffer or Chelex extraction protocols. However, there were significant differences with regards to DNA quantity, quality, PCR amplification and sequence data of target amplicons using the two protocols. The TE buffer extraction method yielded better DNA quality, successful PCR amplification and sequencing data. The sequences obtained were compared with sequences on GenBank via BLAST analysis and identified as *Ctenocephalides felis*. The partial sequence of cytochrome c oxidase subunit I (COI) amplified in this preliminary study showed potential for use in the molecular identification of some ectoparasites.

Ecology and physiology of Temminck's Ground Pangolin (*Smutsia temminckii*) in an arid region of South Africa

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Temminck's Ground Pangolins *Smutsia temminckii* are inconspicuous, mainly nocturnal mammals that occur at low population densities. The handful of previous studies focussing on this species were centred in the mesic eastern regions of its range, with no attention being given to ecological and biological traits in arid environments. To address these data shortfalls, a study was undertaken in the Kalahari Desert in north-western South Africa. Very High Frequency transmitters or Global Positioning System loggers were fitted to 16 individuals and their ecology and physiology studied over a period of three years. A review was also undertaken of the main anthropogenic threats facing this species. Our results suggest that the main threats to *S. temminckii* in southern Africa are accidental electrocution on electrified game fences, the traditional medicine trade, habitat loss, road mortalities and capture in gin traps. Home range sizes are comparable in arid and mesic populations, and *S. temminckii* in arid environments were found to be more active during the day in winter and nearly entirely nocturnal during summer. Study animals were recorded feeding on only four ant and one termite species, representing 7.5 % and 25 % of the total species richness of each of these families, respectively. These results reiterate previous findings that *S. temminckii* are entirely myrmecophagous and highly selective of the species that they eat. This study is the first to investigate the core body temperature (T_b) of a free-ranging pangolin. These data indicate that T_b fluctuated cyclically between 32 – 35 °C and reflected the activity periods of the animal, peaking when the animal was active. When inactive, T_b steadily decreased, suggesting that it used daily heterothermy to cope with the low food availability in this unpredictable environment.

The radiological anatomy and scale pattern of the thoracic limb of *Smutsia temminckii*

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Temminck's ground pangolin (*S. temminckii*) is a mammal covered in hard overlapping scales which rolls up into a defensive ball when threatened. This posture makes identification of underlying anatomical features challenging. Based on the observation that various scale patterns occur in the eight pangolin species, this study aims to determine whether a consistent pattern can be established which may be of clinical relevance in Temminck's ground pangolin, as well as to describe the basic radiological anatomy of the thoracic limbs.

Thoracic limbs from four Temminck's ground pangolins (3.2 – 8.3 kg), which succumbed from electrocution, were radiographed. The scale pattern in this region was described and related to underlying anatomical features by placing radiological markers on selected scales. The bones were robust and displayed open physal lines. The scapula was located in the mid-cervical region. The humerus displayed a massive triangular *Epicondylus medialis* which projected beyond the elbow joint. The ulna and radius were similarly sized, and displayed a large *Tuber olecrani* and broad *Trochlea radii*, respectively. The carpal joint comprised seven individual bones arranged into proximal and distal rows. The manus was composed of five metacarpals with their respective digits. The middle three digits were the best developed with the distal phalangeal bones representing the largest bones in the manus. The *Processus unguicularis* was bifid. An identifiable and regular scale pattern that could be correlated to underlying bones was present and certain landmark scales, such as the olecraneal scale, were named.

This is the first study on the radiological anatomy of the thoracic limb of a pangolin. Numerous features are unique to Temminck's ground pangolin and are indicative of adaptations for pronation, supination and digging. Additionally, the scale pattern may be used to specifically identify the species, as well as for localising injuries to specific parts of the thoracic limb.

Poster presentations

The plight of pangolins: an investigation into the illegal trade in Southeast and East Asia

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Pangolins are the most illegally trafficked mammals in the world, and the demand for pangolins in their range countries is growing exponentially. All eight species of pangolins are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, the poaching for pangolins and their parts continues unabated. The aims of this study were to examine the information available on pangolins; to evaluate the impact of the CITES Appendix II listing with a zero-export quota on the trade in Asian species; and to suggest possible ways forward for the conservation of these severely threatened mammals. Results of this study highlight a number of significant gaps in knowledge concerning the biology and management of Asian pangolins, of which *Manis javanica* Desmarest is the most heavily traded. Even though a zero export quota was established by CITES in 2000 for the four Asian species listed in App. II, illegal trade persists and continues to threaten their survival. If strict control measures are not enforced to stop pangolins from being taken from the wild in Asia and Africa, the entire species will face imminent extinction. In addition, given the demand in China and elsewhere, African species are also in steep decline, and it is very likely that without full protection of all eight pangolin species, the order Pholidota faces a very uncertain future. My results further indicate that listing all species in Appendix I of CITES in the short term, coupled with domestic measures such as a listing under the Endangered Species Act (ESA) in the United States, might prevent further decline in the population, and prevent the extinction of the species.

Piloting tracking technologies in Namibia on Temminck's Ground Pangolin

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Pangolin research at a private reserve, Mundulea, is a pilot project in Namibia, based in the semi-arid dolomite hills of Montane bush-land. The study focusses on the ecology of Temminck's Ground Pangolin (*Smutsia temminckii*). Initiated in 2010, the aim is to increase knowledge of this pangolin's basic survival strategies in dry-land savannahs in a very variable climate, from droughts to flash floods or bush fires. Working closely with the Narrec animal rehabilitation, research and education centre, we have provided a release site for rescued pangolins, monitoring post-release behaviour and survival.

A correlation is attempted between the preferred home ranges of resident pangolins or new arrivals and the varied geology and ecosystems of the Reserve. Essential conservation and monitoring procedures have been learnt, such as the importance of rehydration, the diligence required in tracking releases and avoiding human scent contamination which may attract predators such as honey badgers. We have found, for instance, that pangolins exhibit individual activity patterns, e.g. some have remained in one den for a few days, not emerging every night to forage.

A particular theme is developing better, affordable tracking technology via prototyping and trialling some unique devices. These deliver current location data over cellular GSM, log minute-by-minute GPS movements and are remotely re-programmable. We will advocate the potential of combining GSM+GPS technologies. This is exemplified in our poster by detailed GPS tracking data showing (a) novel results on the clear homing behaviour after releases of an old resident pangolin (seasons earlier the same pangolin had been displaced from its home territory we believe by flooding but had returned), and (b) the initial wide-ranging dispersal following release, in contrast to subsequent home localization of a rescued animal. Finally, our poster presentation will provide a focal point for gathering international input to Namibian perspectives on pangolin conservation.

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