

Sunda Pangolin

(Manis javanica)

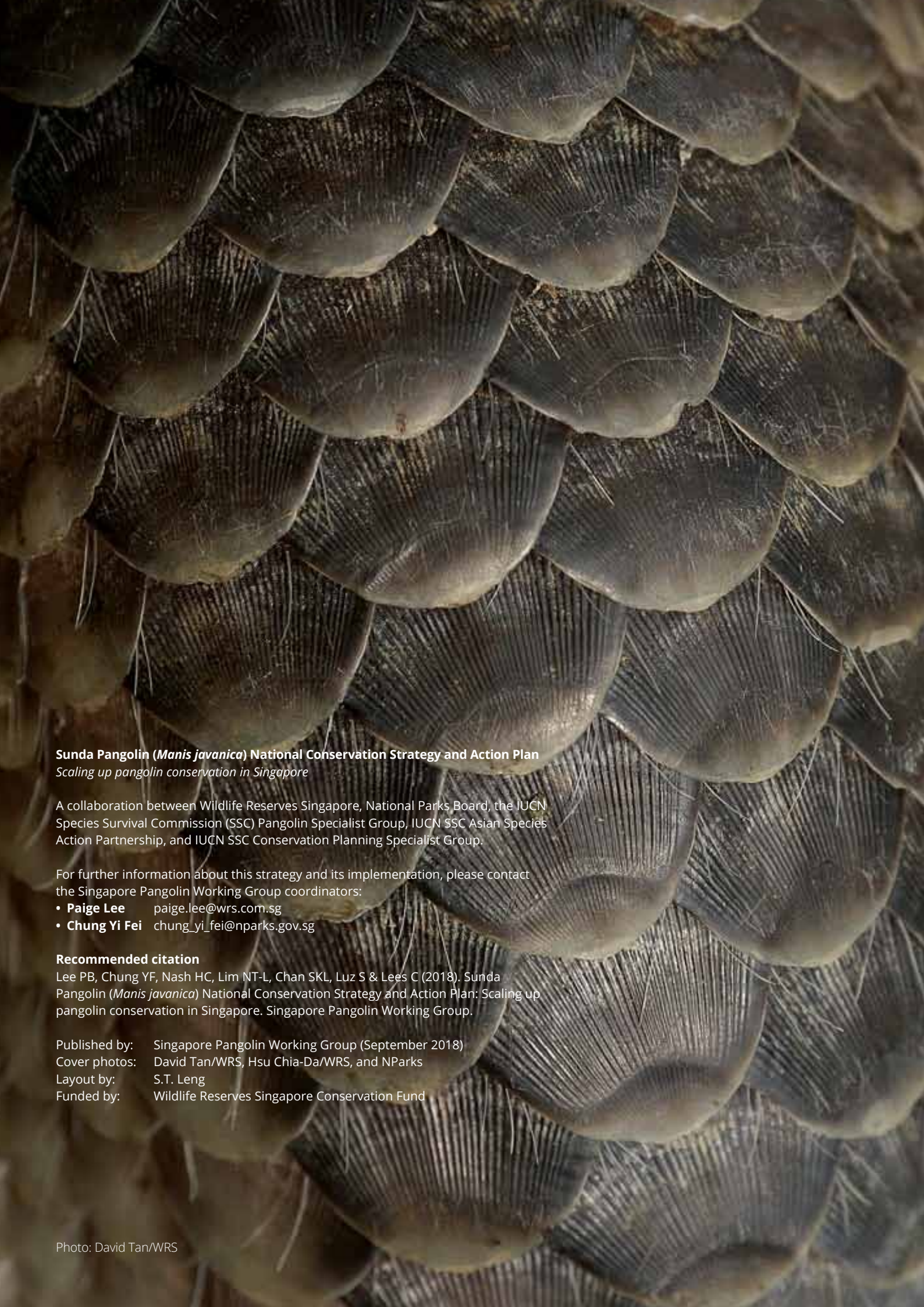
National Conservation Strategy and Action Plan 2018

Scaling up pangolin conservation in Singapore



Wildlife Reserves Singapore
National Parks Board
IUCN SSC Pangolin Specialist Group
IUCN SSC Asian Species Action Partnership
IUCN SSC Conservation Planning Specialist Group





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Scaling up pangolin conservation in Singapore

A collaboration between Wildlife Reserves Singapore, National Parks Board, the IUCN Species Survival Commission (SSC) Pangolin Specialist Group, IUCN SSC Asian Species Action Partnership, and IUCN SSC Conservation Planning Specialist Group.

For further information about this strategy and its implementation, please contact the Singapore Pangolin Working Group coordinators:

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Wildlife Reserves Singapore Group



Wildlife Reserves Singapore
Conservation Fund



Pangolins are the world's most trafficked mammals and are also globally threatened with extinction. Internationally, we see that steps are being taken to protect this species from the threat of illegal poaching, and in 2017, a total ban on international commercial trade was placed for all eight pangolin species.

One of the species – the Sunda pangolin, is native to Singapore, and is found in our forests. Even though there is still much to be learnt about the species, we are in a good position to protect the Sunda pangolin. We have balanced urban development with conservation of our natural heritage, and there has been progress in our efforts. Over the years, we have focused on expanding habitats and linking fragmented nature zones. For example, NParks has introduced buffer parks and culverts to enhance ecosystems for our wildlife, including pangolins. These efforts are a considerable help in a densely developed city like Singapore, and infrastructure coordination is important for biodiversity to thrive in the midst of our city. But we can do more together.

In this regard, the Sunda Pangolin National Conservation Strategy and Action Plan is a step in the right direction. I am happy that the Working Group has adopted a whole-of-community approach in putting this together. It has brought together Government agencies, interest groups, nature stakeholders, and members of the public to develop a science-based and holistic conservation plan for this species. Looking ahead, there is a need for sustained support from the public to successfully implement the plan. Thus, I encourage the Working Group to continue to build awareness, and encourage more citizens to get involved in conservation efforts. In this manner, we can truly be considered a biophilic City in a Garden.

The Action Plan will reinforce our joint commitment towards ensuring that the Sunda pangolin continues to thrive in Singapore in the long term. This document will guide, sustain and implement conservation efforts for the species in Singapore. I look forward to seeing more results from the good work done by the Singapore Pangolin Working Group. I hope that more individuals and organisations will come forward to partner the Working Group and NParks in conserving our Sunda pangolins.



Desmond Lee

Minister for Social and Family Development

Second Minister for National Development



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The workshop that led to the development of the Sunda Pangolin (*Manis javanica*) National Conservation Strategy and Action Plan, would not have been made possible without the generous contributions of various stakeholders.

Special thanks to Mr Desmond Lee, Minister for Social and Family Development and Second Minister for National Development, who provided support to the efforts in local biodiversity and nature conservation.

Leading this effort, were co-organisers Wildlife Reserves Singapore (WRS) and National Parks Board (NParks). Both parties were instrumental in ensuring the success of the workshop and development of the document.

We gratefully acknowledge the support of Wildlife Reserves Singapore Conservation Fund, which provided funding to the organisation of the workshop, the engagement of professional facilitator and the publication of this document.

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We acknowledge IUCN SSC Asian Species Action Partnership (ASAP) and IUCN SSC Pangolin Specialist Group for their input on regional pangolin conservation efforts.

We also thank workshop participants from fellow government agencies, including but not limited to Agri-Food and Veterinary Authority (AVA), Housing & Development Board (HDB), Public Utilities Board (PUB), and Urban Redevelopment Authority (URA), which provided insights on conservation policy strategies and the feasibility of action plans. Major support on rescue practices and public education strategies came from local non-governmental organisations (NGO), such as Animal Concerns Research and Education Society (ACRES), Nature Society (Singapore) (NSS) and The Pangolin Story. Their roles in education and public awareness were critical in the comprehensive development of strategies and action plans. It is with great appreciation as well that we recognise the valuable academic input and research efforts from tertiary institutions such as National University of Singapore (NUS) and Nanyang Technological University (NTU), that guide and advise conservation action.

We would like to thank Paige and Yi Fei for their time and patience in putting this document together. We would also like to acknowledge the efforts and dedication of various other staff members of NParks and WRS who have helped in the preparation and organisation of the workshop and subsequent events.

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Scaling up Pangolin Conservation in Singapore

Southeast Asia is home to a significant number of the world's threatened and unique fauna, making it a biodiversity hotspot. Habitat loss, hunting and the illegal wildlife trade are driving its threatened species towards extinction. One such species is the Sunda pangolin (*Manis javanica*).

It is widely distributed geographically, occurring from southern China across mainland and island Southeast Asia. Prized for its meat and scales, which are used in traditional medicine, the pangolin is the world's most trafficked mammal.

Remarkably, despite being highly urbanised, Singapore remains home to this species. Since 2014, the Sunda pangolin has been classified "Critically Endangered" in the IUCN Red List of Threatened Species. Locally, the species is also considered Critically Endangered. It is protected throughout the country under the Wild Animals and Birds Act (Cap. 351) and in nature reserves and parks under the Parks and Trees Act (Cap. 216). The Sunda pangolin also receives protection in Singapore under the Endangered Species (Import and Export) Act (Cap. 92A).

The species is reported to be breeding in the wild on mainland Singapore, whilst also occurring on adjacent islands, including Pulau Tekong and Pulau Ubin. However, population estimates and trends remain to be determined. Natural greenery such as those in nature reserves or regenerating abandoned plantations and waste ground sites are crucial habitats for the species. Although in Singapore, Sunda pangolins have also adapted to the urban landscape, using roads, drains and other man-made structures.

Conservation projects on the Sunda pangolin started in the 1990s, involving NParks, WRS and nature enthusiasts. Current *in situ* research, comprises gathering data from radio telemetry, camera traps, rescues and roadkill, while *ex situ* research projects include captive breeding and genetic analysis as well as gut microbiomes profiling to guide captive diet.

A degree of cohesion between stakeholders working on Sunda pangolins has been achieved through the establishment of the Singapore Pangolin Working Group (SPWG) in August 2014. Since its inception, the SPWG has facilitated both *in situ* and *ex situ* research,

as well as community outreach, education, media engagement, and pangolin rescue and release.

In July 2017, 50 local and international conservationists gathered at Singapore Zoo to consider the plight of the Sunda pangolin in Singapore and to create a Singapore-wide plan of conservation action for the species. The initiative was co-organised by Wildlife Reserves Singapore and National Parks Board, in collaboration with the IUCN SSC Asian Species Action Partnership and the IUCN SSC Pangolin and Conservation Planning Specialist Groups.

Looking ahead for the next 50 years, the gathering led to a vision and an aspirational document that is the National Conservation Strategy and Action Plan for Sunda pangolins in Singapore, to be coordinated and implemented by the SPWG.

The vision is that, "The iconic Sunda pangolin is a widely-cherished part of Singapore's natural heritage. Thriving populations live across well-connected natural habitats and urban landscapes, where their needs are sensitively incorporated into Singapore's development. Coordinated conservation efforts by all stakeholders are successful in eliminating threats, including roadkill, poaching, and trafficking."

To achieve this, five goals have been developed to operationalise conservation action and ensure that the Sunda pangolin will both survive and thrive in Singapore. First, information on the species' status, ecology, biology and behaviour needs to be gathered and shared through ongoing studies and initiatives. Second, habitat protection, restoration and connectivity must be prioritised to ensure we





Photo: Jeanne Tan/NParks

Five Goals

To Operationalise Conservation Action

GOAL

1

To gather and share information on the Sunda pangolin's status, ecology, biology and behaviour through ongoing studies and new initiatives.

GOAL

2

To ensure viable populations through habitat protection, restoration, and connectivity.

GOAL

3

To establish wildlife-conscious urban planning policies and measures that protect Sunda pangolins.

GOAL

4

To develop successful rescue, rehabilitation and release strategies for the Sunda pangolin and secure the resources to implement them.

GOAL

5

To generate collaborations, clear communication, and awareness across all relevant agencies and solidify a commitment to the conservation of Sunda pangolins.

have viable populations on the island. Third, urban planning policies should endeavour to balance development and the protection of threatened wildlife, in this instance, the Sunda pangolin. Fourth, resources must be secured to develop successful rescue, rehabilitation and release strategies for the species. And finally, conservation action at a national scale cannot be achieved without ongoing collaboration, communication and awareness between all agencies, stakeholders, academics and nature groups. Based on the timelines indicated in the action plan, immediate priorities have

been identified as the gathering and sharing of information, reducing roadkill, protecting habitats, and strengthening rescue, rehabilitation, and release procedures.

With the launch of this National Conservation Strategy and Action Plan, it is hoped that the vision to protect the critically endangered Sunda pangolin will be realized, making Singapore a leading example and a model of biodiversity conservation in densely populated cities.



Introduction

1.1 Background

Southeast Asia comprises four of Earth's 36 biodiversity hotspots (Myer et al., 2000; CEPF, 2018). Unfortunately, the region has lost most of its natural habitat, especially forests and wetlands, while the rate of habitat loss remains the highest in the world (Pereira et al., 2012; Hughes, 2017). In addition, hunting and illegal wildlife trade remained as significant drivers of biodiversity threat.

In the heart of this extinction crisis sits Singapore, a metropolitan city with a population of 5.6 million people on a land space of less than 750 km². Despite this Singapore is one of the most biologically diverse cities in the world which provide refuge for several threatened South-east Asian species (Blaustein, 2013). Among them is the Sunda pangolin (*Manis javanica*), one of the four species of pangolins found in Asia, which was recognised as one of the most threatened species on this planet (Challender et al., 2014).

While poaching and illegal trafficking is not known to be a threat to wildlife in Singapore, reduction and fragmentation of wild habitats challenges the survival of such charismatic animals. Singapore is fortunate to

have a large nature conservation community which for many years, has been working together to find solutions to better conserve and manage wildlife on this island.

With that, national strategies and action plans — Singapore freshwater crab (*Johora singaporensis*) (Ng et al., 2015) and the Raffles banded langur (*Presbytis femoralis femoralis*) (Ang et al., 2016) — were in place for species of high conservation value. Given the increasing regional conservation threats and IUCN Red List Status (Challender et al., 2014), it was timely for a coherent conservation strategy to address specific action needed for the long term survival of Sunda pangolins in Singapore.

On 1 and 2 of July 2017, 50 local and international stakeholders met at Singapore Zoo for the Sunda Pangolin National Conservation Planning Workshop — *Scaling up pangolin conservation in Singapore*. The workshop was held in conjunction with the regional conservation planning workshop, which was held between 28 June and 30 June 2017. The workshop enabled the development of a National Conservation Strategy and Action Plan for Sunda Pangolins, which aims to serve as a guide for the practical and scientific approaches to the long-term survival of pangolins in Singapore.



Juvenile pangolin on tree trunk Photo: David Tan/WRS

1.2 The National Conservation Strategy and Action Plan

A central process to the development of the Sunda Pangolin (*Manis javanica*) National Conservation Strategy and Action Plan, the Sunda Pangolin National Conservation Planning Workshop took place at Singapore Zoo from July 1-2, 2017 and was attended by 50 essential stakeholder persons and institutions (see Appendix 1 for the list of participants). The initiative was co-organised by Wildlife Reserves Singapore and National Parks Board, in collaboration with the IUCN SSC Asian Species Action Partnership (ASAP) and the IUCN SSC Pangolin and Conservation Planning Specialist Groups (PSG and CPSG respectively).

The purpose of this plan is to support efforts to combine and coordinate pangolin conservation resources behind commonly agreed priorities. These priorities are aimed at ensuring the ongoing protection and conservation of the species in Singapore.

The workshop opened with a welcome from Wildlife Reserves Singapore and summary of Sunda Pangolin Regional Conservation Planning Workshop outcomes (see Regional Sunda Pangolin (*Manis javanica*) Conservation Strategy 2018-2028). A series of brief presentations by local experts followed, summarising the status and challenges to pangolin conservation in Singapore, which set the scene for planning discussions (see Appendix 2 for the full programme).

Alongside the development of actions, a series of goals was developed defining the broad directions in which conservation should proceed for pangolins in Singapore over the longer-term. These goals re-define the vision in operational terms and connect it to the shorter-term, issue-based objectives. The resulting conservation strategy and action plan includes:

- **A STATUS REVIEW:** summarising the current state of knowledge of the species
- **A VISION STATEMENT:** a desirable future state for the species in Singapore
- **GOALS:** long-term directions for conservation work
- **OBJECTIVES:** shorter-term results that we want to achieve
- **ACTIONS:** specific activities aimed at achieving the objectives

Planning process

The planning process through which the recommendations were generated, followed a science-based, participatory and stakeholder-inclusive model, introduced by CPSG. Planning work began with a visioning exercise in which all delegates participated. In contemplating the future of Sunda pangolins in Singapore over the next 50 years, the following common themes emerged:

1. Singapore will be the regional leader in pangolin conservation;
2. Healthy pangolin populations will exist in Singapore;
3. Residents of Singapore will have an appreciation of and compassion for pangolins;
4. There will be integration and connection between forested and urban areas of Singapore;
5. No trafficking, poaching, hunting, or trapping of pangolins will occur in Singapore.

Drawing from these recurrent ideas, a small visioning group built a vision statement describing a desirable but also realistic future for pangolins in Singapore, that was unanimously adopted by the participants.

Participants next worked to describe the threats and obstacles to achieving this vision, with consideration given both to existing and potential threats. Participants were encouraged to specify those threats impacting directly on pangolins, their root causes, and the relationships between them. The full set of threats considered is illustrated on Page 18.

Four working groups were formed around the main themes that emerged from this exercise:

- Communication and Inter-Agency Collaboration;
- Rescue, Rehabilitation & Release;
- Sustainable Habitats and Connectivity; and
- Urban Design and Policy.

Groups were assigned a series of tasks and timelines but otherwise managed their own work, supported by designated facilitators. Groups began by discussing, describing and prioritising the issues within their designated theme. For each issue, groups attempted to determine what is known, what is assumed, and what needs to be known, for effective conservation to be carried out. Objectives were agreed to address each of the issues defined and were prioritised across groups, by all participants, using a simple prioritisation scheme. To progress each objective, smaller action steps were defined, each accompanied by a lead agency, potential collaborators, a timeline and an indicator for measure of successful completion.



The Sunda Pangolin National Conservation Planning Workshop participants with Guest of Honour Mr Desmond Lee, Minister for Social and Family Development, and Second Minister for National Development on 2 June 2017

Photo: David Tan/WRS

1.3 Implementation and Audience

The Singapore Pangolin Working Group (SPWG) will be responsible for driving and coordinating the implementation of this conservation plan. A funding strategy will be developed to assist in the management of the plan by members of the SPWG. The structure of the working group and future meeting agendas will be aligned with this document.

Pangolins are disappearing from other parts of the world due to wildlife trade and trafficking. The viability of Sunda pangolins in Singapore is therefore important not just within Singapore, but to global pangolin conservation efforts. This plan is written for multiple audiences, including:

- Participants of the 2017 planning workshop
- All relevant government and non-government wildlife conservation agencies in Singapore
- Universities and other research institutions
- Those working with rescued pangolins, both within Singapore and elsewhere

- Education and outreach organisations
- Donors interested in supporting pangolin conservation
- The pangolin conservation community *sensu lato*

The Singapore Pangolin Working Group (SPWG) was formed on 16 August 2014, after the 1st IUCN SSC Pangolin Specialist Group Conservation Conference in Singapore Zoo. Since then, pangolin conservation and research projects across Singapore have been coordinated through the SPWG, stakeholders of which comprise of government agencies, private entities, and local and international NGOs (see Appendix 4 for list of members). The working group also facilitates both *in situ* and *ex situ* research, as well as community outreach and education.

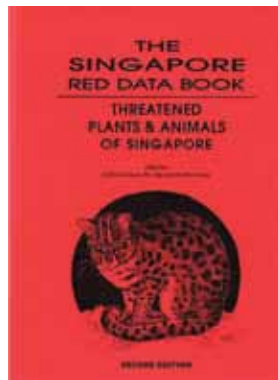


General Overview and Status Review

2.1 Conservation Status

The species is widely distributed geographically, occurring across mainland and island Southeast Asia, from southern China and Myanmar through lowland Lao PDR, much of Thailand, central and southern Vietnam, Cambodia, to Peninsular Malaysia, to Sumatra, Java and adjacent islands (Indonesia) and to Borneo (Malaysia, Indonesia, Brunei) though the northern and western limits of its range are poorly known (Schlitter 2005, Wu et al. 2005, Muhammad et al., 2016). It has been recorded from sea level up to 1,700 m asl.

As of 2014, the species has been classified Critically Endangered on the IUCN Red List of Threatened Species (Challender et al. 2014), and locally, the species is also considered Critically Endangered (Singapore Red Data Book 2008).



2.2 Population and Distribution

The species occurs in the wild in mainland Singapore and offshore islands, including Pulau Tekong and Pulau Ubin (CITES, 2000; Lim & Ng, 2008; National Parks Board, 2014). The species is present and breeding in Singapore (Chan, 2017), but absolute abundance estimates and population trends remain to be determined.

Natural greenery such as those in nature reserves or regenerating abandoned plantations and waste ground sites are the preferred habitat of the Sunda pangolin, similar to many local rare and endangered wildlife. The loss of these vegetated patches can critically impact local biodiversity conservation; for instance, the Sunda pangolin is known to utilise mature trees during their reproductive phase (Lim, 2007). Nevertheless, Sunda pangolins in Singapore appear able to adapt to urban landscape, such as roads, drains and other man-made structures (BIOME, 2018).

Exact statistics for Sunda pangolin abundance, population trend, distribution and carrying capacity of each habitat have yet to be established.



Photo: Jeanne Tan/NParks

DATA EVALUATED	DATA DEFICIENT	LEAST CONCERN	NEAR THREATENED	VULNERABLE	ENDANGERED	CRITICALLY ENDANGERED	EXTINCT IN THE WILD	EXTINCT
NE	DD	LC	NT	VU	EN	CR	EW	EX

2.3 Legislations and Penalties

2.3.1 Legislations

The Wild Animals and Birds Act (Cap. 351) is, in practice, the main legislation in Singapore that protects wildlife outside of designated protected areas, namely the nature reserves and parks (Vinayagan, 2011). This Act prohibits the unlicensed killing, taking, and keeping of any wild animal in Singapore by any means (e.g. nets, traps, snares, spring guns, etc.). The appointed authority for the implementation and enforcement of the Wild Animals and Birds Act is the Agri-Food & Veterinary Authority (AVA)¹.

The Parks and Trees Act (Cap. 216) provides for the planting, maintenance and conservation of vegetation within parks, nature reserves and other specified areas. Activities leading to the capture, displacement, injury, or death of wildlife within these areas are illegal unless prior approval from relevant authorities has been granted. Under this Act, the unauthorised release of animals at parks and into nature reserves is also forbidden. The National Parks Board ('NParks') is responsible for the administration of the Parks and Trees Act.

The Endangered Species (Import and Export) Act (Cap. 92A) in Singapore gives effect to the Convention on International Trade in Endangered Species of Wild Fauna and Flora ('CITES'), which is an international agreement between 183 countries to ensure that international trade in wildlife species, including its parts and derivatives, does not threaten their survival (CITES, 2018). Having been uplisted to CITES Appendix I (previously Appendix II) at the 17th Meeting of the CITES Conference of the Parties (CoP) in 2016 (CITES, 2016a), commercial trade in the Sunda pangolin and its parts and products is strictly prohibited (CITES, 2016b).

Singapore has been a party to CITES since 1987; obligations under which are implemented and enforced by the designated authority, AVA. This includes national legislations to ensure trade in protected species is legal and sustainable.

¹ With effect from 1 April 2019, AVA will be dissolved. All non-food plant and animal functions of AVA will be transferred to NParks, who will be the lead agency for animal and wildlife management (MND, 2018).

2.3.2 Penalties

• Wild Animals and Birds Act

Anyone found to be killing, taking or keeping wild animals, including pangolins, in Singapore without a licence may be fined up to S\$1,000 upon a conviction in court. Anyone found setting, placing, or preparing a trap for pangolins may be fined up to S\$1,000 or imprisoned for a term up to 6 months, or both upon a conviction in court.

• Parks and Trees Act

The poaching of wild animals, including pangolins, within a nature reserve or national park in Singapore will incur a fine of up to S\$50,000 or a jail term of up to 6 months, or both. Continuing with the offending activity after conviction will incur a further fine of up to S\$500 per day during which the offence continues. If the poaching activity occurs within a public park, the corresponding penalty will be a fine of up to S\$5,000.

• Endangered Species (Import and Export) Act

The importing of or exporting/re-exporting of wildlife, including pangolins or any pangolin parts or products, into or out of Singapore without valid CITES permits will incur a fine of up to S\$500,000 and/or imprisonment for a term up to 2 years. Possessing, selling, advertising or displaying of pangolins or parts of pangolins that have been imported without valid CITES permits and other relevant documents will incur the same penalties. The transit of a pangolin (including its parts and products) through Singapore without valid CITES permits will incur a fine of up to S\$500,000 or imprisonment for a term up to 2 years, or both.

Legislations

Refer to Singapore Statutes website <https://sso.agc.gov.sg>, for the most updated version of the legislations.

- (i) Endangered Species (Import and Export) Act (Cap. 92A)
- (ii) Parks and Trees Act (Cap. 216) and Parks and Regulations (Cap. 216, R1)
- (iii) Wild Animals and Birds Act (Cap. 351)



2.4 Conservation Education and Public Awareness

Past and current pangolin conservation outreach, education and awareness raising sessions have been conducted opportunistically by various stakeholders with a public facing arm. Common activities include school and public lectures, craft events, dance productions, festival booths, documentaries, media, brochures, as well as educational signs in exhibitions and nature reserves. As yet, qualitative and quantitative evaluations of the effectiveness of such conservation outreach activities have not been carried out. Surveys of people’s perceptions are important to best design and plan conservation outreach and education projects for maximum impact. Future pangolin projects in Singapore should be aligned through this conservation strategy and action plan.



Mr Desmond Lee (second from left), Minister for Social and Family Development and Second Minister for National Development, and Mr Desmond Choo (third from left) Member of Parliament for Tampines GRC visiting the Singapore Pangolin Working Group and The Pangolin Story booths at the Festival of Biodiversity 2018

Photo: Paige Lee/WRS



Talk on the Singapore Pangolin Working Group at the Festival of Biodiversity 2017 by Paige Lee (left) and Helen Nash (right) Photo: Xu Wei Ting/NUS

2.5 Conservation and Research Projects Past, Present, and Future

Current conservation projects build on past activities in Singapore, which pioneered in the 1990s by NParks, Singapore Zoo and local nature enthusiasts with the objective to rescue and rehabilitate pangolins found in urban estates. The rehabilitated pangolins were released into suitable habitats around the island. This rescue, rehabilitate and release initiative has continued for more than 20 years to date. In total, more than 90 pangolins have been rescued and released.

In situ research projects presently include camera traps, tracking methods, sightings and roadkill reports. *Ex situ* research projects focus on profiling and monitoring of rescued pangolins, and genetics. Lim’s (2007) study, on the autecology of Sunda pangolins in Singapore with a focus on radio telemetry on Pulau Tekong, has been widely referenced to by pangolin conservation scientists.



Group discussion at the Sunda Pangolin National Conservation Planning Workshop in 2017

Photo: David Tan/WRS

In situ Research

■ Camera Traps

A large scale intensive camera trapping survey was commenced in late 2010 by NParks, as part of the Eco-Link@BKE project, to investigate the distribution and estimated relative abundance of target species, which included the Sunda pangolin. One hundred camera traps were deployed in 50 m square grids at each survey site for 30 days, before they were retrieved and transferred to another site. In total, four surveys were conducted at each location, with the fifth survey currently ongoing. Preliminary results showed that pangolins were found across all sites, namely Bukit Timah Nature Reserve, Central Catchment Nature Reserve and the nature parks adjacent to them. An important limitations to population size estimation from camera traps is the lack of knowledge of home range sizes and population structures. To add a crucial spatial layer to population models of camera trap data, Sunda pangolin home ranges need to be better understood, which can hopefully be addressed through various tracking methods.

Additional groups with an interest in camera traps surveys include Mandai Park Holdings, NSS Vertebrate Study Group, and the Asian School of Environment at NTU. Everyone needs to use a standardised protocol to obtain effective results, to be agreed upon under the framework of a national strategy and action plan.

■ Tracking

The first *in situ* radio telemetry tracking project was conducted between September 2005 and November 2006 on Pulau Tekong by Lim (2007), which included an investigation of habitat preference, prey preference, natural behaviour and baseline natural history. Field methods used incorporated capturing pangolins by hand, tracking via radio telemetry, and infra-red triggered camera traps. Although the tag drop-off rate was 80% within two weeks, four adult males were successfully tracked for seven days, and their average daily activity period per night was 165 (± 13) mins, between the hours of 21:00 and 07:30. The average minimum-convex polygon home-range was 43.3 ha. Territorial behaviour was demonstrated including a stand-off between two males. Results suggested that a broad variety of habitats were utilised by male pangolins, most to least frequent:



The Eco-Link@BKE in 2015, a bridge constructed in 2013 for wildlife to cross from the Bukit Timah Nature Reserve to the Central Catchment Nature Reserve

Photo: NParks



Image of Sunda pangolin caught on a camera trap in Singapore

Photo: NParks

secondary forest, plantation, urban. Pangolins were observed to feed on both ants and termites (67% and 33% of the foraging time respectively). Eleven genera of ants were recorded, and preferred ant genera were *Anoplolepis*, *Polyrachis* and *Oecophylla*. One female pangolin, mean daily activity period 127 (± 13) mins, was also observed raising a single juvenile (Lim and Ng 2008). The female pangolin's minimum convex polygon (MCP) home-range was only 6.97 ha, much smaller than the males. She used three natal dens, including tree hollows and burrows leading towards large trees, all over 50cm DBH, and the maternal care period was three to four months.

Further radio telemetry work is currently being conducted across Central Catchment Nature Reserve to further understand pangolin

ecology and behaviour. This comprises post-release monitoring of rescued and translocated pangolins and began in March 2016 (Nash et al., 2018a). Preliminary results indicate significant differences between juvenile and adult behaviour, with juveniles potentially dispersing over large distances per night (up to 3 km), and frequent use of urban sites by both adult and juvenile pangolins, including drains, culverts and roadside verges.

Another *in situ* tracking method currently employed across Singapore is the use of microchips. Each rescued pangolin seen by the veterinary physicians at Singapore Zoo is tagged with a subcutaneous Trovan microchip. Any pangolin re-found can be identified via a Trovan tag reader.

As technology advances, GPS tagging options are also becoming more feasible for pangolins. In collaboration with other regional pangolin researchers, GPS options will be trialled throughout 2019-2020 to determine which tag is most appropriate for use in Singapore. Due to the nocturnal ecology of pangolins, radio-tracking is often difficult and at times impossible due to the low transmission range of the radio tags (sometimes less than 50m in dense or underground habitats), particularly where permit regulations forbid researcher access. Therefore, GPS tags would significantly improve our understanding of pangolin ecology and behaviour, and potentially improve post-release monitoring.



Release of a rescued Sunda pangolin in a protected area in Singapore after being rehabilitated and tagged at WRS
Photo: David Tan/WRS



Helen Nash tracking a released pangolin via radio telemetry Photo: David Tan/WRS



VHF tag attached on a pangolin scale for tracking via radio telemetry Photo: Paige Lee/WRS

■ Sightings and Roadkill

Pangolin occurrence data is also collected through sightings and roadkill reports across a variety of databases, for example ACRES rescue logs, LKCNHM roadkill database, NUS mammal sightings, NSS Vertebrate Study Group sightings, NParks BIOME & SG BioAtlas, and NEA roadkill clearance records. Ong (2017) has compiled maps of roadkill locations and roadkill hotspots (See page 17). However, sightings records have yet to be assimilated. Ideally all sources of data should be combined to better understand pangolin distribution and threats.



Ex situ Research

■ Profiling and monitoring of rescued pangolins

A comprehensive system of profiling and monitoring each rescued pangolin which is taken to Singapore Zoo has been in place for several years. Each pangolin is microchipped and profiled, including weight, size, gender, ultrasound, and other anatomical features. A variety of samples are taken, including blood hormones, DNA, sperm and stools. This provides a comprehensive base for wide-ranging conservation research topics, including captive breeding, rehabilitation, survival, and disease screening.

■ Genetics

Genetic analysis of local pangolins is currently conducted at NUS and NTU. Nanyang Technological University has sequenced several whole pangolin genomes, both nuclear and mitochondrial, which could potentially form a starting basis for further study of local population genetics. Meanwhile NUS has used metagenomic techniques to compare the microbiomes of wild and captive pangolins and characterise the diet of wild pangolins. A lack of prey reference markers in public databases has limited this dietary analysis, and the pangolin's own DNA can also mask prey DNA. Yet some understanding of pangolin prey has been gained from these methods.



Vets at WRS conducting a physical health assessment on a rescued pangolin



Tail length of a rescued pangolin being measured



Rescued pangolin being microchipped

All photos: David Tan/WRS



Blood being drawn from a rescued pangolin



Mitochondrial and RADseq markers have additionally been used at NUS to compare Singaporean pangolins with other regional pangolin lineages to better understand genetic differentiation and population structure (Nash et al., 2018b). Preliminary results suggest that Singaporean pangolins are likely to be genetically similar to Northern Sumatran Sunda pangolins.

A comprehensive study of local population genetics within Singapore to understand health and viability of local populations has not been conducted. Such research is important because of the likely small population size of pangolins in Singapore. There might be a need to genetically manage populations in Singapore for effective conservation, but to determine this requires significant amounts of further field sampling and genetic analysis.



Stomach contents of a Sunda pangolin being analysed

Photo: Amrita Srivathsan/NUS

■ Diet

Upon receiving a batch of confiscated pangolins in the early 2000s, WRS started to explore husbandry best practices for their captive management, which included the development of a suitable diet for a species that is known to subsist mainly on ants and termites. Whilst Sunda pangolins have been able to survive and breed under human care at WRS, research is ongoing to better meet their nutritional requirements.

Pangolins have been observed to feed on both ants and termites on Pulau Tekong, 67% and 33% of foraging time respectively (Lim, 2007). Furthermore, eleven genera of ants were recorded as prey, and the preferred ant genera were *Anoplolepis*, *Polyrachis* and *Oecophylla*. More widespread biological field sampling is still required across Singapore to better understand dietary preferences of pangolins, perhaps also the potential role of pangolins in helping to control ant and termite pests.



Sunda pangolin foraging at a log Photo: David Tan/WRS



2.6 Threats

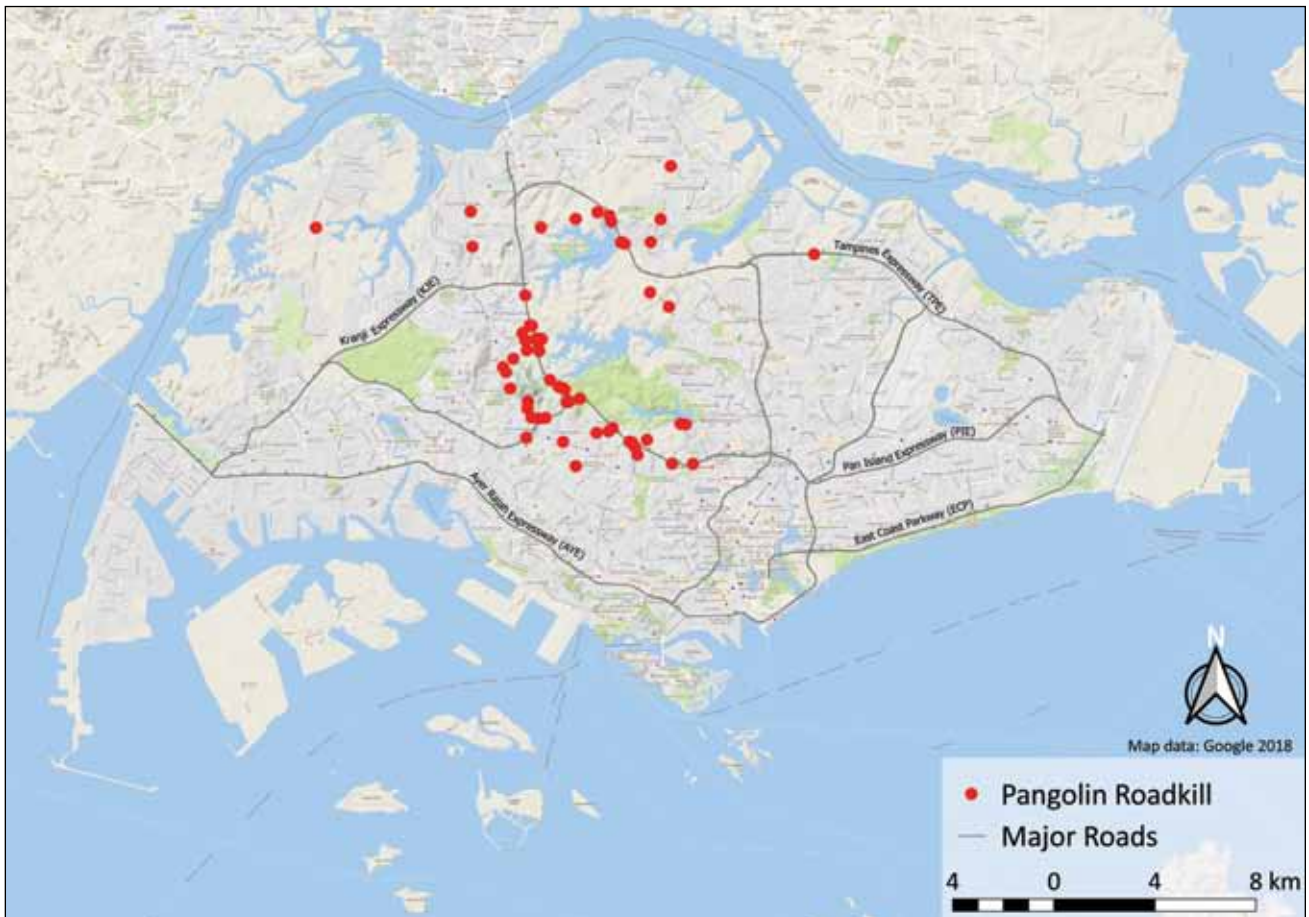
During the workshop, a threat mapping exercise had participants analysing the threats impacting directly on pangolins (both existing and potential), their root causes, and the relationships between them. An illustration of the full set of threats considered may be found on the next page.

2.4.1 Habitat loss, fragmentation, and roadkill

Like many endangered species of wildlife, Sunda pangolins are also threatened by rapid habitat loss and fragmentation. In Singapore, forest patches are separated by man-made barriers such as expressways. In the long term, the lack of gene flow between segregated populations of pangolins may cause genetic isolation to occur, leading to a loss of genetic diversity and inbreeding depression. Ecological corridors, for instance Eco-Link@BKE, may mitigate the severity whilst enhancing



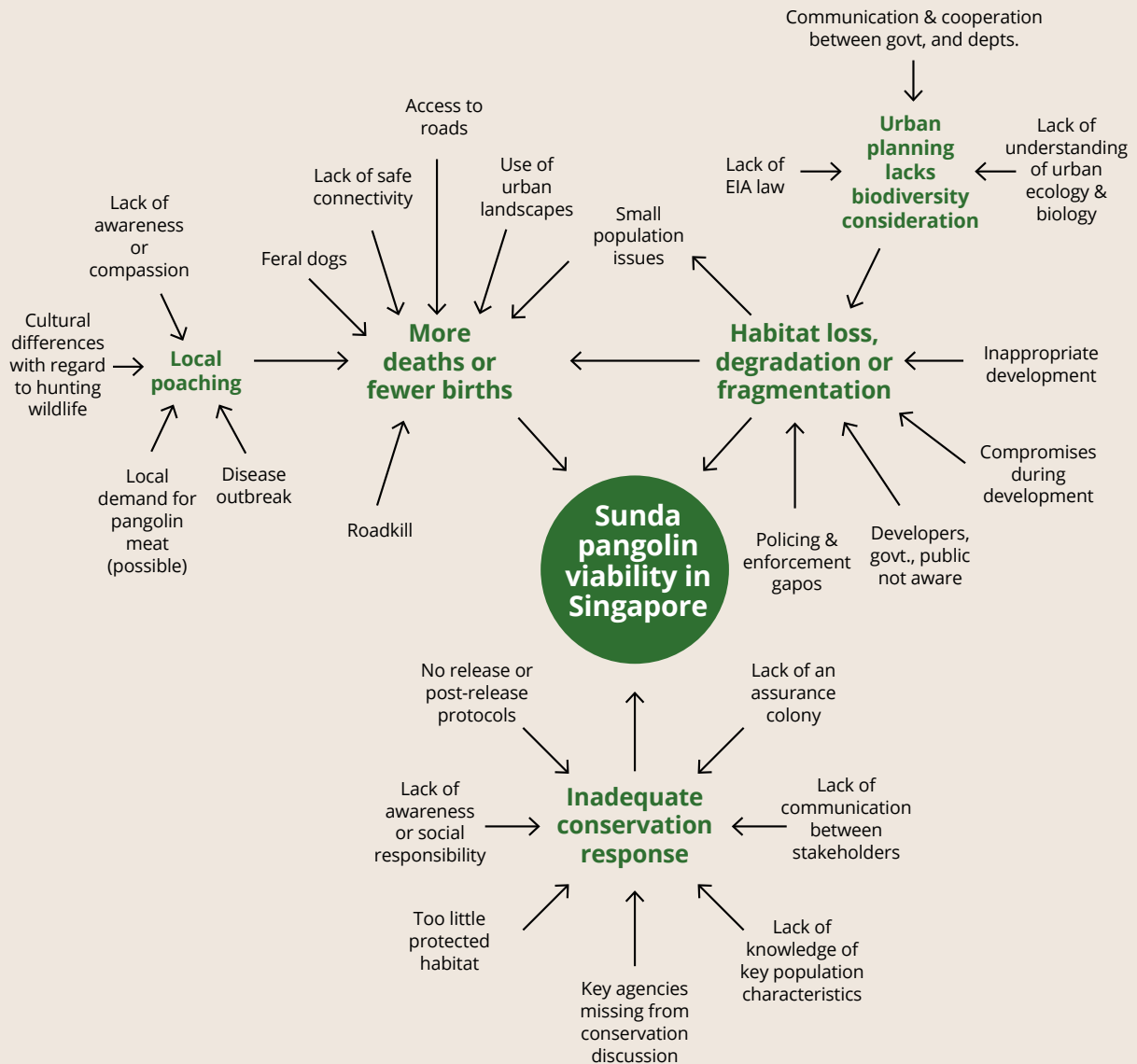
Sunda pangolin roadkill on Eng Neo Road, 7 March 2017
Photo: Benjamin Li



Locations of pangolin roadkill from 2004 to 2017 on the mainland of Singapore (Ong, 2017; NParks, 2018).

Threat map

Threats map on issues considered relevant to the viability of Sunda pangolins in Singapore and their underlying causes. Generated by participants during the 2017 Sunda Pangolin National Conservation Planning Workshop.

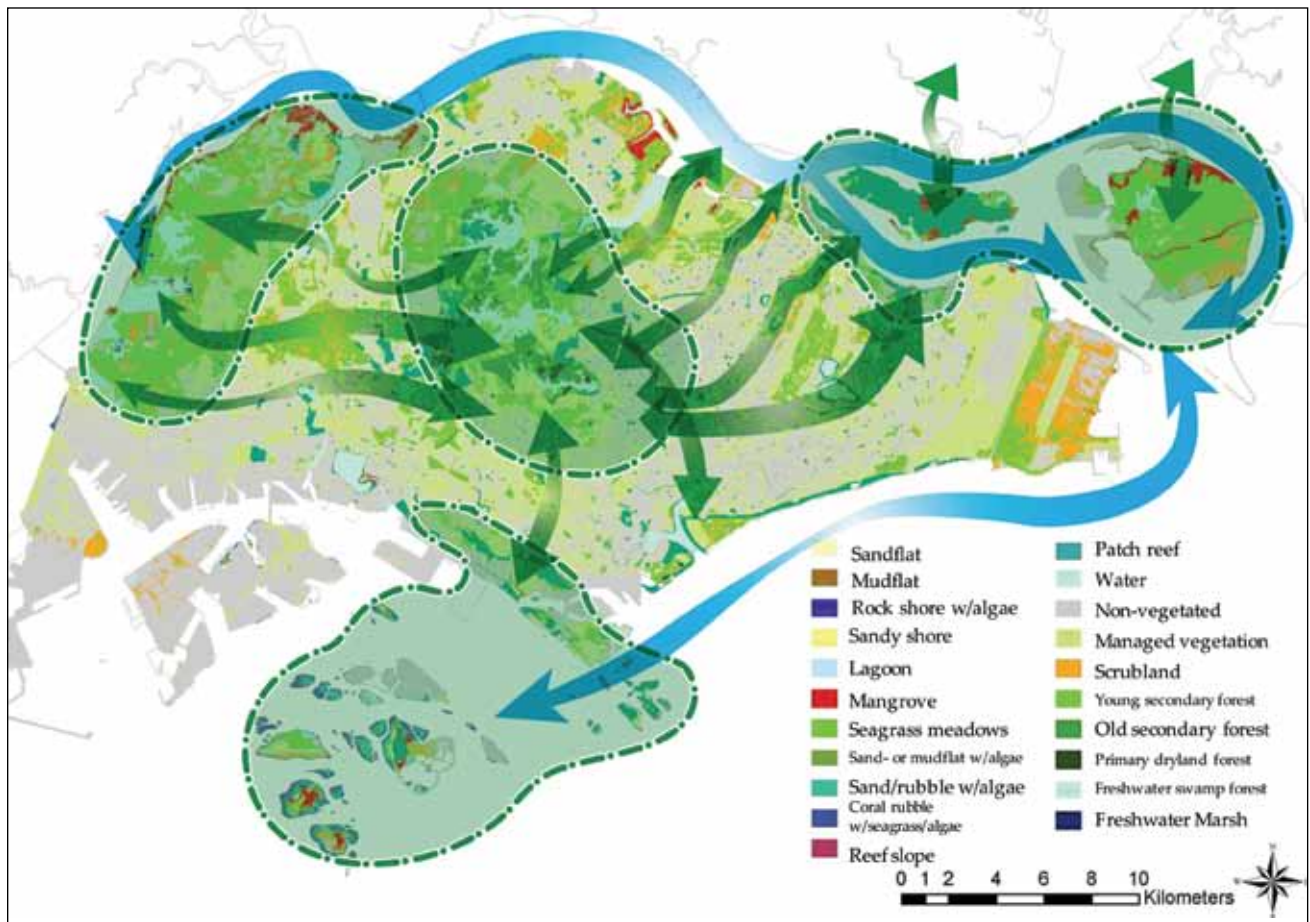


connectivity. However, measures to ensure island-wide connectivity should be in place to facilitate interactions between pangolin populations.

As pangolins in Singapore adapt to urbanisation and development, frequent sightings of pangolins at manmade structures mentioned previously have been recorded, especially where there is natural vegetation in close vicinity. They often cross roads that are adjacent to forested areas and green spaces, which often results in accidents with vehicles and roadkill, especially along high-speed carriageways. Lim (2007) and Chua et. al (2017) suggested that roadkill is most likely the major threat to this species in Singapore. The

sheer number and distribution of roadkill (See page 17) could potentially lead to significant repercussions.

The mitigation of this threat is unfortunately hindered by a lack of understanding about pangolin biology, behaviour and ecology. Despite being a small and densely populated island with limited natural resources, Singapore has emerged a leader in multiple economic sectors, including transportation and commerce (The World Bank in Singapore 2018). In our progression as a country, further development is unavoidable and even essential; hence to be effective in our pursuit of conservation goals in a highly urbanised country, the costs of conservation on



The Nature Conservation Master Plan developed by NParks in 2015 propose the use green corridors to improve connectivity between widely spaced areas of high conservation value (highlighted in green with dotted line borders). This will allow for the movement of organisms between each of the biodiversity-rich core areas. These areas are also surrounded by a matrix of significant biodiversity. Source: NParks

development ultimately need to be low and benefits to national development need to be demonstrated (Reid 2015). This starts with conducting accurate cost-benefit analyses, and to do so, we need to understand the trade-offs between conservation and development (e.g. how do we ensure ecologically-sensitive development; and how do the costs of deforestation compare to the benefits of building new roads?). This in turn requires an understanding of the impacts of development on nature, and to understand the impacts on pangolins, we need to understand the species.

2.4.2 Poaching and trafficking

Though poaching of wildlife has been known to occur in Singapore, Sunda pangolins are not believed to be the target species. Nevertheless, the pangolins may be trapped as bycatch or suffer collateral damage during capture. Illegal poaching cases are reportedly increasing locally (Feng 2015; Tan 2017) and the potential impacts on the Sunda pangolin are uncertain.

Despite being neither the source nor the destination, Singapore's role as a major global trading hub, can



Sunda pangolin roadkill in Singapore

Photo: Marcus Chua/LKCNHM

inadvertently facilitate the trafficking of wildlife. For example, the most recent seizure of 324 kg of pangolin scales along with 255 species of raw elephant tusks on 12 December 2015 was a shipment originated from Lagos, Nigeria and en route to Vientiane, Laos, via Singapore (AVA & Singapore Customs, 2015). In instances where seizures are made, the data will be analysed by international organisations such as The International Criminal Police Organisation (INTERPOL) to track trends and understand the modus operandi of traffickers. Such insights are used for enforcement purposes and these cases are publicised in an effort to deter trafficking (AVA, personal communication, August 13, 2017).

3.2 Objectives and Actions

GOAL 1

To gather and share information on the Sunda pangolin's status, ecology, biology and behaviour through ongoing studies and new initiatives.

Objectives

- 1.1. Increase knowledge of pangolin biology and behaviour
- 1.2. Establish population status, trends and viability of pangolins in Singapore
- 1.3. Improve knowledge of natural and urban ecology of Sunda pangolins
- 1.4. Develop an understanding of road ecology in relation to roadkill dynamics
- 1.5. Fill gaps in knowledge and prioritise research for effective rehabilitation and release efforts
- 1.6. Share findings on all of the above with relevant agencies

Actions for Goal 1 are set out in the following tables.

Objective 1.1 Increase knowledge of pangolin biology and behaviour

No.	Action	Indicator	Timeline	Stakeholders
1.1.1	Establish a tracking protocol for pangolins using GPS tags, VHF and other techniques	Optimal tracking protocol for pangolins	Mid 2020	NUS, NTU, NParks, WRS
1.1.2	Undertake research to identify home range habitat requirements and microhabitat investigations in urban areas	Home range maps of pangolins	End 2020	NUS, NTU, NParks, WRS
1.1.3	Undertake diet preference studies of pangolins via stomach content analysis, field tracking and field sampling of prey	Reports on diet preference studies	End 2020	NUS, NTU, NParks, LKCNHM



Objective 1.2

Establish population status, trends and viability of pangolins in Singapore

No.	Action	Indicator	Timeline	Stakeholders
1.2.1	Consolidate and analyse camera trapping data to understand population distribution and estimates (nature & military areas)	Population distribution maps, reports with trends	Jun 2019	NParks , NTU
1.2.2	Consolidate and analyse sightings and roadkill databases to understand distribution patterns	Distribution maps of pangolins roadkills and sightings	Jun 2019	NUS, ACRES, NParks
1.2.3	Population viability analysis across Singapore using genetic tools	Population viability analysis reports	End 2024	Potential PhD student, TBC
1.2.4	Analyse existing information and gather further information of cause of injury and reason of rescue for pangolins	Reports on causes of injuries and reasons for rescue	End 2019	NUS, ACRES, WRS
1.2.5	Undertake camera trapping in core areas to collect data to establish population trends (nature & military areas)	Population distribution maps, reports with trends	3 years after baseline research, then every 5 years	NParks, NTU, NSS



Objective 1.3**Improve knowledge of natural and urban ecology of Sunda pangolins**

No.	Action	Indicator	Timeline	Stakeholders
1.3.1	Quantify impact of habitat loss, fragmentation and roads on pangolin population and movement	Findings from <i>in situ</i> research projects, eg tracking & cameras	End 2021	NParks, NUS, ACRES, NTU, WRS
1.3.2	Formulate an ecological connectivity map across Singapore to identify potential key habitats and connectors	Ecological connectivity map	Mid 2019	NParks, NUS, NTU
1.3.3	Undertake research to understand impact of linear infrastructure on pangolin population	Reports on impact of linear infrastructure on pangolins	End 2021	NParks, NTU, LTA, URA
1.3.4	Investigate pangolin use of urban habitat, including food resources, den sites and features (targeted areas)	Findings from study and information on urban ecology of pangolins	End 2019	SPWG, WRS, NPARKS, ACRES

Objective 1.4**Develop an understanding of road ecology in relation to roadkill dynamics**

No.	Action	Indicator	Timeline	Stakeholders
1.4.1	Conduct a systematic unbiased study of pangolin roadkill hotspots	Findings from the study, including a map showing roadkill hotspots	Aug 2019	NUS, NTU, NParks, LTA, WRS, ACRES, LKCNHM, NEA, AVA, HDB
1.4.2	Investigate successful pangolin crossing based on rescue and sighting records	Recommendations for safe crossings (location, road designs/features)	End 2019	NUS, NTU, NParks, LTA, WRS, ACRES, LKCNHM, NEA, AVA, HDB
1.4.3	Study the effectiveness of traffic calming measures on roadkill / vehicle speed (targeted areas)	Recommendations on most effective traffic calming measures	As soon as possible	NParks, NUS, MPH (MPD & WRS), SDC, LTA



Objective 1.5

Fill gaps in knowledge and prioritise research for effective rehabilitation and release efforts

No.	Action	Indicator	Timeline	Stakeholders
1.5.1	Complete a regional literature review with specific areas of concern identified as research priorities, including diets and digestion, reproductive biology, disease surveillance, genetics, and husbandry	Regional literature review with specific areas of concern identified as research priorities	Jun 2019	WRS
1.5.2	Based on results from Action 1.5.1, develop specific research projects	Specific research projects developed	Jul 2019	WRS

Objective 1.6

Share findings on all of the above with relevant agencies

No.	Action	Indicator	Timeline	Stakeholders
1.6.1	Share updates and findings at SPWG meetings and provide recommendations to agencies	Meetings and eventual formulation of conservation management plan	Every 6 months	SPWG, LTA, MOE, URA



GOAL

2

To ensure viable populations through habitat protection, restoration, and connectivity.

Objectives

- 2.1. Reduce habitat loss and fragmentation
- 2.2. Improve connectivity between habitats impacted by linear infrastructure intrusions
- 2.3. Ensure that habitats suitable for pangolins exist within urban areas
- 2.4. Obtain a better understanding of pangolin poaching and its drivers in Singapore
- 2.5. Eliminate poaching of pangolins in Singapore

Actions for Goal 2 are set out in the following tables.

Objective 2.1
Reduce habitat loss and fragmentation

No.	Action	Indicator	Timeline	Stakeholders
2.1.1	Ongoing monitoring and mitigation	Map of habitat loss for pangolins	Ongoing	NParks, URA, LTA, SPWG

Objective 2.2
Increase connectivity between habitats impacted by linear infrastructure intrusions

No.	Action	Indicator	Timeline	Stakeholders
2.2.1	Develop and implement plans to increase connectivity in linear infrastructures with wildlife corridors and culverts, informed by research findings from Objective 1.3	Plans with wildlife corridors	End 2023	NParks, LTA, URA



Photo: Helen Nash/IUCN SSC Pangolin Specialist Group



Objective 2.3**Ensure that habitats suitable for pangolins exist within urban areas**

No.	Action	Indicator	Timeline	Stakeholders
2.3.1	Engage relevant stakeholders to retain, enhance and install structures in urban areas such as parks, gardens and schools	Relevant stakeholders identified and meetings held, number of pangolin-friendly structures in selected urban areas	End 2023	SPWG, NParks, NSS, schools, garden owners
2.3.2	Encourage pangolin-friendly habitats in urban areas such as landscape refuges in schools, gardens and parks	Proposal for pangolin friendly structures in an urban environment	End 2021	NParks, SPWG

Objective 2.4**Obtain a better understanding of pangolin poaching and its drivers in Singapore**

No.	Action	Indicator	Timeline	Stakeholders
2.4.1	Compile data on poaching and it's drivers e.g. reports of traps and snares and legal data, and undocumented evidence of poaching e.g. personal communications	Consolidate the evidence base on pangolin poaching in Singapore to inform development of a management strategy	Mar 2019	NParks, AVA, ACRES, WRS

Objective 2.5**Eliminate poaching of pangolins in Singapore**

No.	Action	Indicator	Timeline	Stakeholders
2.5.1	Develop a poaching specific management plan based on results from Objective 2.5 which addresses enforcement and legislative issues including WABA	Creation of a poaching management plan to be enforced	Commence Jun 2019	ACRES, AVA, NPARKS



GOAL
3

To establish wildlife-conscious urban planning policies and measures that protect Sunda pangolins.

Objectives

- 3.1. Ensure that the conservation needs of pangolins are incorporated into urban planning policies
- 3.2. Strengthen processes surrounding development work with regard to environmental studies and assessments
- 3.3. Establish and enforce wildlife impact mitigation measures and infrastructure guidelines

Actions for Goal 3 are set out in the following tables.

Objective 3.1

Ensure that the conservation needs of pangolins are incorporated into urban planning policies

No.	Action	Indicator	Timeline	Stakeholders
3.1.1	Advocate government to include urban ecology information from Objective 1.3 into future urban design in targeted areas (e.g. roadkill hotspots) through workshops	At least one workshop conducted for agencies by 2020, and one or more site incorporating pangolin urban ecology within 5yrs	Workshop - End 2020 Designs - End 2025	SPWG, NParks, LTA, URA, HDB, JTC
3.1.2	Conduct pangolin awareness workshops for developers and relevant consultants (e.g. architects, engineers, landscape architects, IES, SIA, SILA)	At least one workshop conducted	After 3.1.1, then within 5yrs	SPWG, NParks, SIA, SILA, IES, SLA



Objective 3.2**Strengthen processes surrounding development work with regard to environmental studies and assessments**

No.	Action	Indicator	Timeline	Stakeholders
3.2.1	Engage relevant stakeholders on developing guidelines and/or protocols for sensitive development (e.g. baseline methodology)	Relevant stakeholders identified and meetings held	End 2019	NParks, relevant government agencies, nature community, environmental industry
3.2.2	Conduct workshops with development stakeholders on environmentally sensitive development	At least one workshop conducted by 2019	End 2019	NParks, relevant government agencies, nature community, environmental industry
3.2.3	Advocate for a more coordinated approach towards regulating developments	Relevant stakeholders identified and meetings held	End 2019	NParks, relevant government agencies, nature community, environmental industry

Objective 3.3**Establish and enforce wildlife impact mitigation measures and infrastructure guidelines**

No.	Action	Indicator	Timeline	Stakeholders
3.3.1	Recommend road and drain design features including traffic-calming measures in hotspots	Publication of a building code for wildlife-friendly features	End 2023	NParks, LTA, URA, BCA
3.3.2	Advocate government to enhance existing road and drain designs in target areas to facilitate safe movement of pangolins, potentially through workshops and based on findings from above studies	At least one workshop conducted by 2018 and one or more road or drain design change within the next 5 years	End 2023	NParks, NUS, LTA, NSS, ACRES, URA, HDB



GOAL
4

To develop successful rescue, rehabilitation and release strategies for the Sunda pangolin and secure the resources to implement them.

Objectives

- 4.1. Build capacity for first responders
- 4.2. Ensure food intake by all rescued pangolins under captive care
- 4.3. Develop adequate infrastructure for successful care and rehabilitation of pangolins prior to release
- 4.4. Ensure rescue, rehabilitation and release of pangolins are carried out in accordance with established protocols
- 4.5. Effectively monitor pangolins post-release
- 4.6. Explore requirements and assess feasibility for establishing an assurance colony in captivity

Actions for Goal 4 are set out in the following tables.

Objective 4.1 Build capacity for first responders

No.	Action	Indicator	Timeline	Stakeholders
4.1.1	Conduct first aid and handling training for first responders such as ACRES (nationwide/WRS)	First aid and handling training for first responders	May 2020	WRS, SPWG
4.1.2	Make a pangolin checklist and verbal test for keepers (WRS)	Pangolin checklist and verbal test	Jul 2019	WRS
4.1.3	Develop a hand rearing module for rescued animals (WRS)	Hand rearing module for rescued animals	Jun 2020	WRS

Objective 4.2 Ensure food intake by all rescued pangolins under captive care

No.	Action	Indicator	Timeline	Stakeholders
4.2.1	Conduct digestibility experiments on current diets (WRS)	Written report on digestibility experiment on current diets	Sep 2019	WRS
4.2.2	Conduct palatability experiments on captive foods (WRS)	Written report on palatability experiment conducted on captive foods	Dec 2019	WRS
4.2.3	Create a palatable, adequate and available diet for newly rescued pangolins	A diet that is readily ingested by all pangolins	Dec 2020	WRS



Objective 4.3**Develop adequate infrastructure for successful care and rehabilitation of pangolins prior to release**

No.	Action	Indicator	Timeline	Stakeholders
4.3.1	Explore feasibility of ant breeding (WRS)	Report to SPWG on feasibility of ant breeding	Dec 2019	WRS
4.3.2	Determine the minimum necessary space and infrastructure for rescue, rehabilitation, and release (MPH)	Report to SPWG the minimum necessary space and infrastructure for rescue, rehabilitation, and release	Dec 2019	MPH
4.3.3	Develop a triage process for rescue, rehabilitation, and release (WRS)	Triage process for rescue, rehabilitation, and release developed	Dec 2020	WRS

Objective 4.4**Ensure rescue, rehabilitation and release of pangolins are carried out in accordance with established protocols**

No.	Action	Indicator	Timeline	Stakeholders
4.4.1	Develop standardised protocols for rescue, rehabilitation, and release	Publication of protocol and workshop for stakeholders	Protocol - May 2020 Workshop - Aug 2020	WRS, NParks, ACRES
4.4.2	Write a guidebook to be used by all rescue, rehabilitation, and release stakeholders, to include: first responder guidelines, post mortem and biomaterial collection protocols, treatment protocols, protocols for large confiscations, types of information to be recorded, release protocols and criteria for absorption into collection (nationwide/ WRS)	Rescue, rehabilitation, and release guidebook for stakeholders	Jun 2020	SPWG
4.4.3	Develop rehabilitation guidelines (WRS)	Rehabilitation guidelines	Pending research results	WRS, SPWG



Objective 4.5

Effectively monitor pangolins post-release

No.	Action	Indicator	Timeline	Stakeholders
4.5.1	Identify suitable release sites based on results of current and future research which takes into account the level of site-based enforcement and protection	List of suitable release sites	Ongoing	SPWG, NParks, NUS, NTU, WRS
4.5.2	Develop post-release monitoring protocols and ensure that they are implemented	Post-release monitoring protocol	Jun 2019	SPWG, Participants from regional pangolin workshop
4.5.3	Develop and present an executive summary on rescue, rehabilitation, and release to NParks	Executive summary and meeting with NParks	Jun 2019	SPWG, NParks

Objective 4.6

Explore the requirements and feasibility of establishing an assurance colony in Singapore

No.	Action	Indicator	Timeline	Stakeholders
4.6.1	Identify the genetic and demographic characteristics, and viability, of the existing group of captive Sunda pangolins in Singapore, and identify how many additional founders, space, manpower and costs would be needed, to establish an assurance colony (WRS)	Written report on the requirements for an assurance colony for Sunda pangolins in Singapore.	Apr 2021	WRS



GOAL
5

To generate collaborations, clear communication, and awareness across all relevant agencies and solidify a commitment to the conservation of Sunda pangolins.

Objectives

- 5.1. Develop, implement, and evaluate appropriate strategies to increase public involvement in pangolin conservation
- 5.2. Increase institutional understanding and awareness of their role in the conservation of the Sunda pangolin
- 5.3. Increase priority afforded to pangolins by all agencies such that comprehensive participation in conservation efforts is ensured
- 5.4. Develop a deeper understanding of the role of Singapore in international pangolin trafficking
- 5.5. Establish constant vigilance against pangolin trafficking in Singapore

Actions for Goal 5 are set out in the following tables.

Objective 5.1

Develop, implement, and evaluate appropriate strategies to increase public involvement in pangolin conservation

No.	Action	Indicator	Timeline	Stakeholders
5.1.1	Conduct a large scale survey among Singapore residents (adequate sample size) across multiple levels and segments of society to obtain baseline data on awareness and perception with regard to pangolins	Survey report	Jul 2019	WRS (zoo visitors, secondary schools), ACRES (town councils), The Pangolin Story (poly, ITE, joint tertiary initiatives, universities), NParks (government agencies), other NGOs
5.1.2	Develop general strategies and campaigns	Launch of campaigns/ strategies	Jul 2019	WRS, SPWG, media companies
5.1.3	Conduct targeted strategies and campaigns	No. of targeted strategies/campaigns	2019 onwards	SPWG, social scientists from NUS, NTU, NParks
5.1.4	Evaluate effectiveness of campaigns/strategy and improve strategy accordingly	Survey report and recommendations for improvement	End 2020	SPWG, social scientists from NUS, NTU, NParks
5.1.5	Conduct follow-up surveys among Singapore residents	Follow up survey completed (annually)	Conducted annually	The Pangolin Story



Objective 5.2**Increase institutional understanding and awareness of their role in the conservation of the Sunda pangolin**

No.	Action	Indicator	Timeline	Stakeholders
5.2.1	Create a platform through the minister's support for SPWG to present plan to relevant government agencies	Number of agencies reached out to and platform developed	Jul 2019	WRS, varied
5.2.2	Create a multi-layered, web-based map of Singapore indicating jurisdiction i.e. owner, manager, user, etc.	Map creation	Jun 2019	WRS
5.2.3	Make a list and make contact with relevant non-government entities e.g. independent schools, transport companies	Number of non-government entities reached out to & list compiled	Apr 2019	WRS / The Pangolin Story
5.2.4	Develop standardised communication materials	Material creation	Jun 2019	ACRES / The Pangolin Story
5.2.5	Create SPWG website for information sharing (as part of a Wildlife Working Group website)	Website creation & launch	Ongoing	SPWG, ACRES, others

Objective 5.3**Increase priority afforded to pangolins by all agencies such that comprehensive participation in conservation efforts is ensured**

No.	Action	Indicator	Timeline	Stakeholders
5.3.1	Schedule regular talks at relevant agencies during working hours	Number of meetings & attendance at meetings	Jul 2019	The Pangolin Story, AVA, ACRES, Urban Design and Development groups that are planning workshops with developers, architects, etc.



5.3.2	Plan and implement rapport-building events, e.g. wildlife hero award between and within each participating agency, field trips, and coffee meetings	Number of events and attendance at events	Calendar - Apr 2019	The Pangolin Story
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Objective 5.4
Develop a deeper understanding of the role of Singapore in international pangolin trafficking

No.	Action	Indicator	Timeline	Stakeholders
5.4.1	Implement research at the regional level to understand the scale of trafficking of pangolins through Singapore and the modus operandi of traffickers for enforcement and to deter trafficking	AVA to analyse Singapore seizure data inhouse and with other agencies such as INTERPOL and share a report with SPWG	Jul 2019	AVA, and possibly other law enforcement agencies
5.4.2	SPWG to remain updated on and attend relevant CITES meetings (esp. Standing Committee meetings and CoPs), and partake in inter-sessional activities on pangolins (e.g., working groups) as appropriate	Meeting attendance	Ongoing	SPWG

Objective 5.5
Establish constant vigilance against pangolin trafficking in Singapore

No.	Action	Indicator	Timeline	Stakeholders
5.5.1	Subject to results from Action 5.4.1, make recommendations on appropriate measures to implement CITES requirements with regard to pangolin trafficking	Assessment against CITES provisions including Res. Conf. 17.10 and measures within	Jan 2020 (subject to 5.4.1)	AVA, SPWG, other partners identified from results of 5.4.1

3.3

Immediate Priorities

The Singapore Pangolin Working Group (SPWG) will be responsible for driving and coordinating the implementation of the Sunda Pangolin National Conservation Strategy and Action Plan. Based on the timelines indicated in the action plan, and the importance and urgency ranking of the raw objectives during the workshop (see Appendix 3 for the complete table of ranked objectives), immediate priorities for the action plan are as follows:

3.3.1 Information gathering and sharing

- Increase knowledge of pangolin biology and behaviour (Actions 1.1.1 to 1.1.3)
- Establish population status, trends and viability of pangolins in Singapore (Actions 1.2.1 to 1.2.4)
- Share research findings with and provide recommendations to relevant agencies (Action 1.6.1)

3.3.2 Roadkill reduction

- Develop an understanding of road ecology in relation to roadkill dynamics (Actions 1.4.1 to 1.4.3)
- Establish and publish recommendations for wildlife-friendly road and drain features and designs (Action 3.3.1)

3.3.3 Habitat protection

- Improve knowledge of natural and urban ecology of Sunda pangolins (Actions 1.3.2 to 1.3.4)
- Strengthen processes surrounding development work with regard to environmental studies and assessments (Action 3.2.1 to 3.2.3)

3.3.4 Rescue, rehabilitation, and release

- Build capacity for first responders (Actions 4.1.1 to 4.1.3)
- Establish standardised protocols for rescue, rehabilitation and release of pangolins based on research findings and ensure efforts are carried out accordingly (Actions 4.4.1 to 4.4.3)
- Establish suitable release sites for pangolins and efficient procedure for release, and effectively monitor pangolins post-release (Actions 4.5.1 to 4.5.3)

The Sunda Pangolin National Conservation Strategy and Action Plan was officially launched on Tuesday, 18 September 2018 at the Singapore Zoo by Mr Desmond Lee, Minister for Social and Family Development and Second Minister for National Development. The launch was hosted by the National Parks Board and Wildlife Reserves Singapore.



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Appendices

Appendix 1 Workshop Participants

First Name	Last Name	Affiliation
Abraham	Mathew	Wildlife Reserves Singapore
Ade	Kurniawan	Wildlife Reserves Singapore
Adeline	Seah	The Pangolin Story
Adrian	Loo	National Parks Board
Ali Anwar	Bin Ahmad	Wildlife Reserves Singapore
Amrita	Srivathsan	National University of Singapore
Angelica	Teo	POL-ITE Eco Group / The Pangolin Story
Bee Choo	Tay	Housing & Development Board
Bee Choo	Strange	Nature Society Singapore
Benjamin	Lee	National Parks Board
Brian	Cudge	Free the Bears
Caleb	Chia	Agri-Food and Veterinary Authority of Singapore
Carly	Waterman	IUCN SSC Pangolin Specialist Group
Caroline	Lees	IUCN SSC Conservation Planning Specialist Group
Chia-Da	Hsu	Wildlife Reserves Singapore
Claudia	Tay	Wildlife Reserves Singapore
Dan	Challender	IUCN SSC Pangolin Specialist Group
Delaney	Eng	Mandai Park Development
Francis	Cabana	Wildlife Reserves Singapore
Gurusamy	Permaloo	Wildlife Reserves Singapore
Helen	Nash	National University of Singapore
Kalai	Bala	Animal Concerns Research and Education Society
Kok Hwee	Cheong	National Parks Board
Li Ling	Ho	Wildlife Reserves Singapore ¹
Li Min	Cheah	Urban Redevelopment Authority
Madhu	Rao	Wildlife Conservation Society / IUCN SSC Asian Species Action Partnership
Marcus	Chua	National University of Singapore
Mary-Ruth	Low	Wildlife Reserves Singapore ¹
Michelle	Sim	Public Utilities Board
Natalia	Huang	The Pangolin Story
Nerissa	Chao	IUCN SSC Asian Species Action Partnership
Nick	Baker	Nature Society Singapore
Norman	Lim	Nanyang Technological University
Paige	Lee	Wildlife Reserves Singapore
Razak	Jaffar	Wildlife Reserves Singapore
Roopali	Raghavan	Wildlife Reserves Singapore
Serena	Oh	Wildlife Reserves Singapore ¹
Shane	Chiok	National University of Singapore
Sharon	Chan	National Parks Board
Shuyi	Ong	National University of Singapore
Sivasothi	N.	National University of Singapore
Sonja	Luz	Wildlife Reserves Singapore
Subaraj	Rajathurai	Strix Wildlife Consultancy
Tianjiao	Li	National Parks Board
Tzi Ming	Leong	Independent freelancer
Wei Bin	Ong	Mandai Park Development
Xin Rui	Ong	Agri-Food and Veterinary Authority of Singapore
Yee Wen	Tan	Urban Redevelopment Authority ¹
Yi Fei	Chung	National Parks Board

¹ No longer with organisation at time of publication



Appendix 2 Workshop Agenda

Day 1

June 30, 2017 (Friday)
Forest Lodge, Singapore Zoo

Time	Activity
5:00 pm	Registration at Singapore Zoo entrance
5:30-10:00 pm	Opening and Cocktail Dinner at Forest Lodge <ul style="list-style-type: none"> • Opening speech • Summary of Regional Workshop outcomes • Sunda Pangolins in Singapore and the National Workshop

Day 2

July 1, 2017 (Saturday)
Ulu Court, Night Safari

Time	Activity
8:30 am	Registration at Night Safari entrance
9:00 am	Opening and Welcome
9:15 am	Summary of Regional Workshop outcomes
9:30 am	Introduction to the workshop format and philosophy
9:45 am	Participant introductions
10:00 am	Tea/Coffee break
10:30 am	Introductory Presentations (10-15 minutes each): <ol style="list-style-type: none"> 1. Status, distribution and current <i>in situ</i> work on pangolins in Singapore, with updates on known threats, rescue and rehabilitation 2. Pangolin roadkill in Singapore 3. Research on pangolins in Singapore 4. <i>Ex situ</i> management of pangolins in Singapore 5. Vision and Goals for the future of pangolins in Singapore
12:00 pm	Lunch and Group Photo
1:00 pm	Discussion and diagramming of issues
2:00 pm	Formation and Discussion of working groups around issue themes
3:30 pm	Tea/Coffee break
3:45 pm	Discussion continues around issue themes
5:00-6:00 pm	Working groups - develop issue-based objectives

Day 3

July 2, 2017 (Sunday)
Ulu Court, Night Safari

Time	Activity
8:30 am	Summary of Day 1 and presentation of draft vision and goals
9:00 am	Presentation by working groups and consolidation of outputs
10:00 am	Tea/Coffee break
10:15 am	Plenary session: prioritisation of objectives
11:00 am	Working groups develop conservation strategies & actions, (Timeline, Feasibility, Budget, Lead agencies, Key Collaborators)
12:30 pm	Lunch
1:15 pm	Group discussion continues
3:15 pm	Working group presentations and discussion
4:00 pm	Implementation Framework (coordination and communication of the Action Plan)
4:15 pm	Final presentations and agreement - vision, goals, priority objectives, report editors
4:45-5:30 pm	Closing remarks by Minister Desmond Lee with high tea reception



Appendix 3

Prioritised and ranked objectives for Sunda Pangolin Conservation in Singapore

Workshop participants ranked the objectives by assigning sticky dots providing in two colours, one denoting urgency, the other importance.

Objectives	Urgent	Important	Combined
Increase our understanding of pangolin biology, ecology and status by conducting research AND share research findings with government agencies to formulate evidence-based conservation management plans	14 (4)	14 (2)	28 (1)
Reduce pangolin roadkill	24 (1)	3 (10)	27 (2)
Understand the impacts of habitat loss, fragmentation, and roads on pangolin populations and movement to reduce pangolin habitat loss and fragmentation AND increase connectivity through wildlife corridors and culverts	18 (2)	8 (6)	26 (3)
Ensure that the EIA Framework protects wildlife during and after the development process	5 (6)	18 (1)	23 (4)
Improve the understanding of urban ecology of pangolin AND amend/Revise existing policy to incorporate the understanding of urban ecology of pangolin to conserve pangolin in the urban landscape. (Understand the role of big trees as well as other needs and threats to pangolins in urban areas)	4 (8)	14 (2)	18 (5)
Develop protocols to better inform, guide and expedite RRR processes	17 (3)	1 (12)	18 (5)
Ensure an understanding of the level of awareness of Sunda pangolins across all levels and segments of society AND develop and implement appropriate strategies to address problems and gaps identified from data analyses	3 (9)	13 (4)	16 (7)
Identify research priorities to increase knowledge on biology, diseases of pangolins related to <i>ex-situ</i> management	0 (12)	11 (5)	11 (8)
Ensure comprehensive participation by all relevant entities AND ensure buy-in by all entities (to ensure effective and genuine participation)	6 (5)	4 (8)	10 (9)
Gather information and identify suitable release sites and improve post-release monitoring	1 (11)	6 (7)	7 (10)
Propose development of sufficient infrastructure and resources to manage Pangolins prior to release or as assurance colonies	5 (6)	1 (12)	6 (11)
Encourage pangolin-friendly habitats in urban areas such as wildlife refuges in schools, houses and private gardens	0 (12)	4 (8)	4 (12)
Ensure a better understanding of pangolin poaching in Singapore and underlying drivers AND ensure an appropriate management strategy to eliminate poaching is implemented (awareness, deterrence, detection, enforcement)	2 (10)	1 (12)	3 (13)
Ensure a better understanding of pangolin trafficking in Singapore AND ensure Singapore is fully compliant with, and comprehensively engages in CITES, as well as other international policy tools.	0 (12)	3 (10)	3 (13)
Increase stakeholder support, coordination and involvement, as well as insufficient public awareness to carry out RRR efficiently	0 (12)	0 (15)	0 (15)
Ensure alignment with regional strategies	0 (12)	0 (15)	0 (15)
Develop training opportunities/modules/materials to build capacity	0 (12)	0 (15)	0 (15)



Appendix 4 Members of the Singapore Pangolin Working Group

Core members

Anbarasi Boopal	Animal Concerns Research and Education Society
Kalaivanan S/O Balakrishnan	Animal Concerns Research and Education Society
Annette Olsson	Conservation International
Helen Nash	IUCN SSC Pangolin Specialist Group
Norman Lim	Nanyang Technological University
Benjamin Lee	National Parks Board
Chung Yi Fei	National Parks Board
Sharon Chan	National Parks Board
Amrita Srivathsan	National University of Singapore
Bee Choo Strange	Nature Society (Singapore)
Nick Baker	Nature Society (Singapore)
Adeline Seah	The Pangolin Story
Angelica Teo	The Pangolin Story
Madhu Rao	Wildlife Conservation Society & Asian Species Action Partnership
Ade Kurniawan	Wildlife Reserves Singapore
Chia-Da Hsu	Wildlife Reserves Singapore
Claudia Tay	Wildlife Reserves Singapore
Francis Cabana	Wildlife Reserves Singapore
Paige Lee	Wildlife Reserves Singapore
Sonja Luz	Wildlife Reserves Singapore
Nerissa Chao	Wildlife Reserves Singapore & Asian Species Action Partnership

Auxiliary members

Janice Yap	Agri-Food and Veterinary Authority
Lye Fong Keng	Agri-Food and Veterinary Authority
Serena Oh	Independent freelancer
Tzi Ming Leong	Independent freelancer
Marcus Chua	Lee Kong Chian Natural History Museum
Delaney Eng	Mandai Parks Development
Bing Wen Low	National Parks Board
Tianjiao Li	National Parks Board
Natalia Huang	The Pangolin Story
Anwar Ali	Wildlife Reserves Singapore
Jessica Lee	Wildlife Reserves Singapore
Josephine Kawi	Wildlife Reserves Singapore
Mary-Ruth Low	Wildlife Reserves Singapore
Razak Jaffar	Wildlife Reserves Singapore
Roopali Raghavan	Wildlife Reserves Singapore



Acronyms and Abbreviations

ACRES	Animal Concerns Research and Education Society
ASAP	Asian Species Action Partnership (of the IUCN SSC)
AVA	Agri-Food and Veterinary Authority of Singapore
BKE	Bukit Timah Expressway
CPSG	Conservation Planning Specialist Group (of the IUCN SSC)
CI	Conservation International
GPS	Global Positioning System
GRC	Group Representation Constituency
HDB	Housing and Development Board
IUCN	International Union for the Conservation of Nature
LKCNHM	Lee Kong Chian Natural History Museum
LTA	Land Transport Authority
MINDEF	Ministry of Defence
MND	Ministry of National Development
MOE	Ministry of Education
MPD	Mandai Park Development
NEA	National Environment Agency
NGO	Non-Governmental Organisation
NParks	National Parks Board
NSS	Nature Society (Singapore)
NTU	Nanyang Technological University
NUS	National University of Singapore
PUB	Public Utilities Board
RRR	Rescue, Rehabilitation and Release
SLA	Singapore Land Authority
SPWG	Singapore Pangolin Working Group
SSC	Species Survival Commission (of the IUCN)
URA	Urban Redevelopment Authority
VHF	Very High Frequency
WCS	Wildlife Conservation Society
WRS	Wildlife Reserves Singapore
WRSCF	Wildlife Reserves Singapore Conservation Fund

Workshop Organisers

Wildlife Reserves Singapore Group



Wildlife Reserves Singapore
Conservation Fund

About Wildlife Reserves Singapore

Wildlife Reserves Singapore (WRS) is dedicated to the management of world-leading zoological institutions—Jurong Bird Park, Night Safari, River Safari and Singapore Zoo—that aim to inspire people to value and conserve biodiversity by providing meaningful and memorable wildlife experiences.

A self-funded organisation, WRS focuses on protecting biodiversity in Singapore and Southeast Asia through collaborations with like-minded partners, organisations and institutions. Each year, the four attractions welcome 5 million visitors.

Mandai Park Holdings (MPH), the driving force behind the rejuvenation of Mandai into an integrated wildlife and nature heritage space, is the holding company of WRS and oversees its business and strategic development.



About National Parks Board

National Parks Board (NParks) is responsible for providing and enhancing the greenery of our City in a Garden. Beyond building green infrastructure, NParks is actively engaging the community to enhance the quality of our living environment.

NParks manages 350 parks and 300 km of park connectors, 3,347 hectares of nature reserves and the Singapore Botanic Gardens. NParks also manages Pulau Ubin and the Sisters' Islands Marine Park. Adding to this is the extensive streetscape, or roadside greenery, that forms the backbone of our City in a Garden. The island-wide Park Connector Network is also being developed to link major parks, nature areas and residential estates.

As the lead agency on biodiversity conservation, NParks has developed an urban biodiversity conservation model, which aims to conserve representative eco-systems in land-scarce Singapore. NParks also monitors and coordinates measures to enhance the presence of biodiversity in our urban landscape.

NParks is working closely with partners in the landscape and horticulture industry to increase productivity, and provide training for all levels of the workforce. Enhancing competencies of the industry will support Singapore's vision of being a biophilic City in a Garden.



About IUCN

IUCN, International Union for Conservation of Nature, is a membership Union composed of both government and civil society organisations. It harnesses the experience, resources and reach of its more than 1,300 Member organisations and the input of more than 13,000 experts. This year, IUCN celebrates its 70th anniversary. Since its establishment in 1948 in the French town of Fontainebleau, IUCN has become the global authority on the status of the natural world and the measures needed to safeguard it.





About IUCN Species Survival Commission

The Species Survival Commission (SSC) is the largest of IUCN's six volunteer commissions with a global membership of 11,000 experts. SSC advises IUCN and its members on the wide range of technical and scientific aspects of species conservation and is dedicated to securing a future for biodiversity. SSC has significant input into the international agreements dealing with biodiversity conservation.



About IUCN SSC Pangolin Specialist Group

The Pangolin Specialist Group (Pangolin SG) is voluntary network of experts from around the world including field biologists, social scientists, zoologists, veterinarians, ecologists and geneticists, all of whom are actively involved in pangolin research and conservation. The Pangolin SG serves as an advisory body to IUCN, assesses the conservation status of pangolins for The IUCN Red List of Threatened Species™, contributes scientific and technical input to CITES, convenes stakeholders to develop species conservation strategies, and provides technical advice on pangolin research and conservation.



About IUCN SSC Asian Species Action Partnership

The IUCN SSC Asian Species Action Partnership (ASAP) was formed in recognition of the need to mobilise resources to minimise the number of species extinctions and promote species recovery in Southeast Asia. ASAP is an alliance of conservation organisations with the collective aim of focusing urgent conservation attention and catalysing action for the Critically Endangered inland waters and land vertebrate species in Southeast Asia. ASAP is convened by IUCN SSC to bring together organisations to focus attention on a critical region, that without more serious conservation intervention and immediate action, is likely to see the demise of much of its unique biodiversity.



About IUCN SSC Conservation Planning Specialist Group

The IUCN SSC Conservation Planning Specialist Group (CPSG) is a global network of conservation professionals dedicated to saving threatened species by increasing the effectiveness of conservation efforts worldwide. For over 30 years, CPSG has accomplished this using scientifically sound, collaborative planning processes that bring together people with diverse perspectives and knowledge to catalyse positive conservation change. CPSG provides species conservation planning expertise to governments, other SSC Specialist Groups, zoos and aquariums, and other wildlife organisations.



Photo: David Tan/WRS



Photo: David Tan/WRS

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