PANGOLIN MONITORING GUIDELINE FOR NEPAL

Government of Nepal
Ministry of Forests and Environment
Department of National Parks and Wildlife Conservation
Babarmahal, Kathmandu
2019

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Cover Photo: Chinese Pangolin (Photo credit: Tulshi Laxmi Suwal/SMCRF)

Acknowledgements

Pangolins are one of the most critically threatened wildlife species. Their population in the wild is drastically reduced due to indiscriminate poaching and illegal trade of the live animals and their body parts; as well as habitat loss and degradation. These creatures are extremely elusive and can easily be captured or trapped. As they live both in the core areas and outside national forests, Pangolins have received high conservation priority in Nepal and across its range. Inadequate information on population size, distribution and ecology has made its conservation a challenging task. Nepal very first time has prepared a comprehensive Pangolin Conservation Action Plan for Nepal (2018-2022) and has already started its implementation. This monitoring guideline will greatly help to study and regular monitor this species that ultimately will help generate adequate information and protect this species from potential threats including poaching and illegal trade. This guideline would not have been possible without the support of concerned government agencies, conservation partners, local communities and experts.

First, I would like to thank Dr. Krishna Prasad Acharya, Joint Secretary, Dr. Maheshwar Dhakal, Joint Secretary, Mr. Pashupati Nath Koirala, Under Secretary from MoFE; Mr. Gopal Prakash Bhattarai, Deputy Director General, Dr. Ram Chandra Kandel, Deputy Director General from DNPWC; and Ms. Madhuri Karki (Thapa), Under Secretary, DoFSC for their support and suggestions and comments.

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Man Bahadur Khadka

Director General,

Department of National Parks and Wildlife Conservation

Executive Summary

Pangolins are small mammal native to Asia and Africa. Of the eight-species found throughout the world, two species, namely the Chinese Pangolin (*Manis pentadactyla*), and the Indian Pangolin (*M. crassicaudata*) are found in Nepal.

Pangolins have been recorded from 43 districts in Nepal, with the Indian Pangolin confirmed from 7 districts and the Chinese Pangolin from 27 districts. In addition, both species are found to be co-existed in 4 districts, while the individual species could not be identified from 14 districts where their presence were recorded. Information gaps exists, especially from central and western region due to unavailability of their detections.

Pangolins are now considered one of the most intensively traded animals globally. Due to geo-political situation, Nepal not only acts as the source site but also represents transit for pangolin trade. Thus, there is an urgent need to gather comprehensive information on the distribution and status of pangolins in Nepal and develop a national-level conservation, protection, and monitoring strategy. Pangolin Conservation Action Plan for Nepal (2018-2022) explicitly identifies the need for standardized guideline for monitoring pangolin and their habitat. This standardized monitoring guideline was developed to collect such uniform data throughout Nepal in a robust and scientifically rigorous way to establish a national baseline and track population trends to take timely conservation actions to address threats to both species of pangolins found in Nepal.

The survey and monitoring guideline is thus designed to:

- conduct rapid presence-absence surveys through PRA (Participatory Rural Appraisal) and FGD (Focus Group Discussion) in areas (districts) with data deficient and create a complete national range distribution map;
- develop a standardized methodology such as occupancy modeling to track the status of pangolin populations and their distribution for mapping all potential habitats within their distribution range;
- conduct applied research to understand the ecology and behavior of species which will aid in developing conservation strategies; and
- establish a guideline for threats assessment for both the species of pangolin.

The standardized occupancy surveys follow systematic survey (a grid-based) methodology. Implementing such surveys, analyzing the output data, and interpreting the results is recommended to trained technical staffs from protected areas, forest sector and partner NGOs. A spatial database should be established and managed by the Department of National Parks and Wildlife Conservation.

Acronyms and Abbreviations

BCN	Bird Conservation Nepal
BS	Bikram Sambat
CARE	Cooperative for Assistance and Relief Everywhere
CEO	Chief Executive Officer
CIB	Central Investigation Bureau
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DBH	Diameter at Breast Height
DFO	Division Forest Office
DNPWC	Department of National Parks and Wildlife Conservation
DOFSC	Department of Forests and Soil Conservation
FECOFUN	Federation of Community Forestry Users, Nepal
FGD	Focus Group Discussion
GIS	Geographical Information System
GPS	Global Positioning System
HSI	Habitat Suitability Index
IUCN	International Union for Conservation of Nature
IVI	Important Value Index
MaxEnt	Maximum Entropy
MoFE	Ministry of Forests and Environment
NTNC	National Trust for Nature Conservation
PRA	Participatory Rural Appraisal
RPN	Red Panda Network
SMCRF	Small Mammals Conservation and Research Foundation
USAID	United States Agency for International Development
TU	Tribhuvan University
WWF	World Wildlife Fund Inc.
ZSL	Zoological Society of London

Table of Contents

List of Tables

List of Figures

List of Boxes

Chapter One | Introduction

1.1 Background

Pangolins are small mammal native to Asia and Africa. The word "Pangolin" is derived from Malayan phrase "Pen gulling" that denotes the ability of the animal to curl up into a ball. The pangolins are commonly known as the scaly ant eaters due to their scaly structure and food habits.

Eight species of pangolins are found in the World - four species each in Africa and Asia (Corbett & Hill 1992, Gaubert & Antunes 2005). Among the four species of pangolin in Asia two species are found in Nepal: Chinese pangolin (Kalo Salak) *Manis pentadactyla* and Indian pangolin (Tame Salak) *Manis crassicaudata*. The Chinese pangolin is smaller (length: 70-100 cm) in size and weight (2-8 kg) and are covered with large rounded scales of dark brown color. It has 18 rows of overlapping scales accompanied by hair, a rare combination in mammals. It occurs in the Himalayan foothills in Nepal, Bhutan, India, Bangladesh, Myanmar, Vietnam, Thailand, China and Taiwan (Fig. 1a). The Indian pangolin is bigger than the Chinese pangolin in size (length: 100-120 cm) and weight (8-9 kg[1]) with yellowish brown scales on the body. It has usually 11-13 rows of overlapping scales. It occurs in Pakistan, India, China, Bangladesh, and Nepal (Fig. 1b). Pangolins are popularly known as Salak in Nepal, although different communities of Nepal have local names like Keynneyan in Newari and Ghose in Tamang languages.

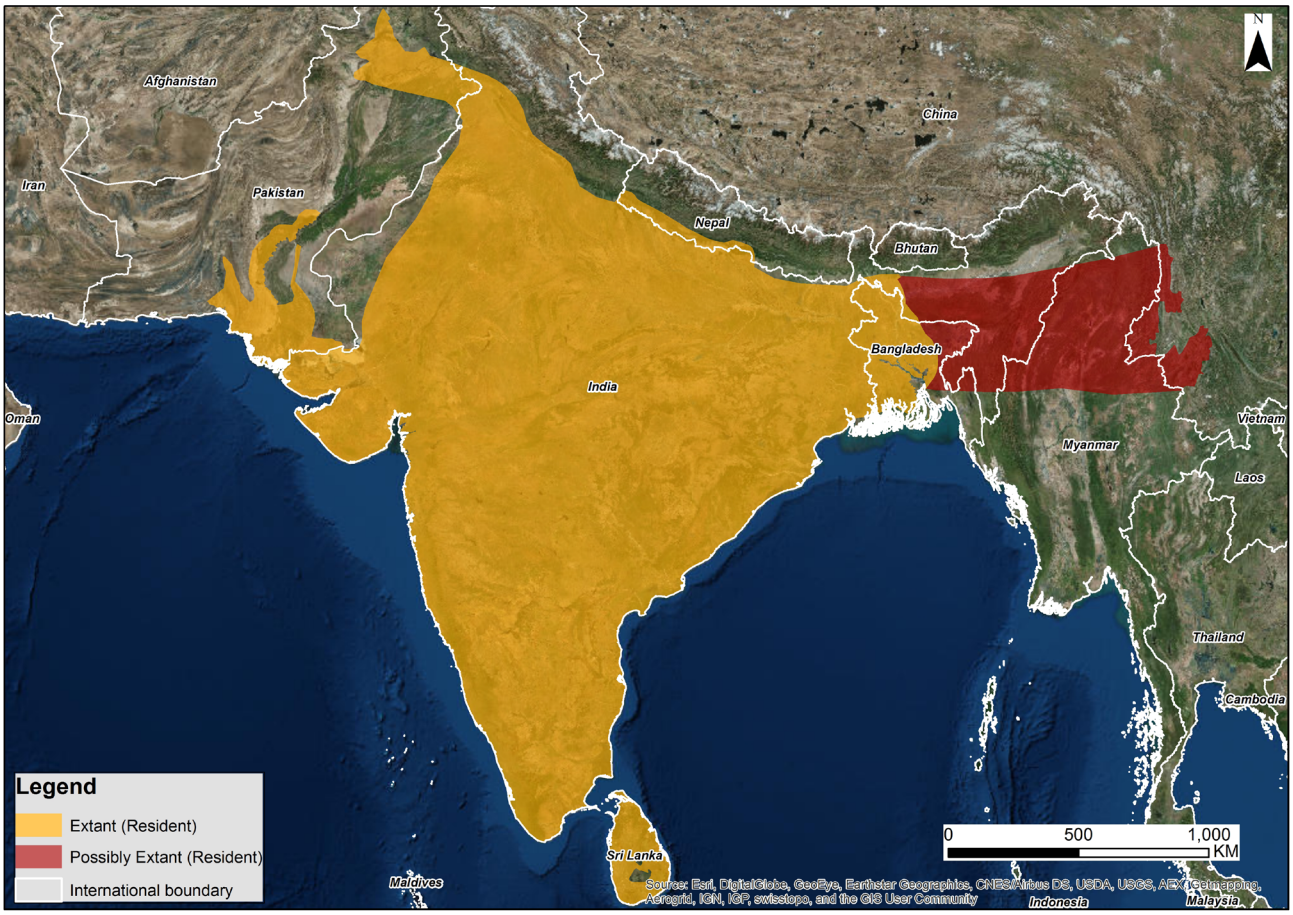


Figure 1a . Distributions range of Indian pangolin (*Manis crassicaudata;* map above), while Indian pangolin is extinct in the far eastern range, in Bangladesh (indicated by the purple polygon). Source: IUCN Red List (2014)

1 21 kg Indian Pangolin recorded in Buffer Zone community forest of Bardia National Park in 2017 (Personal Communication: Mr. Ambika Prasad Khatiwada)

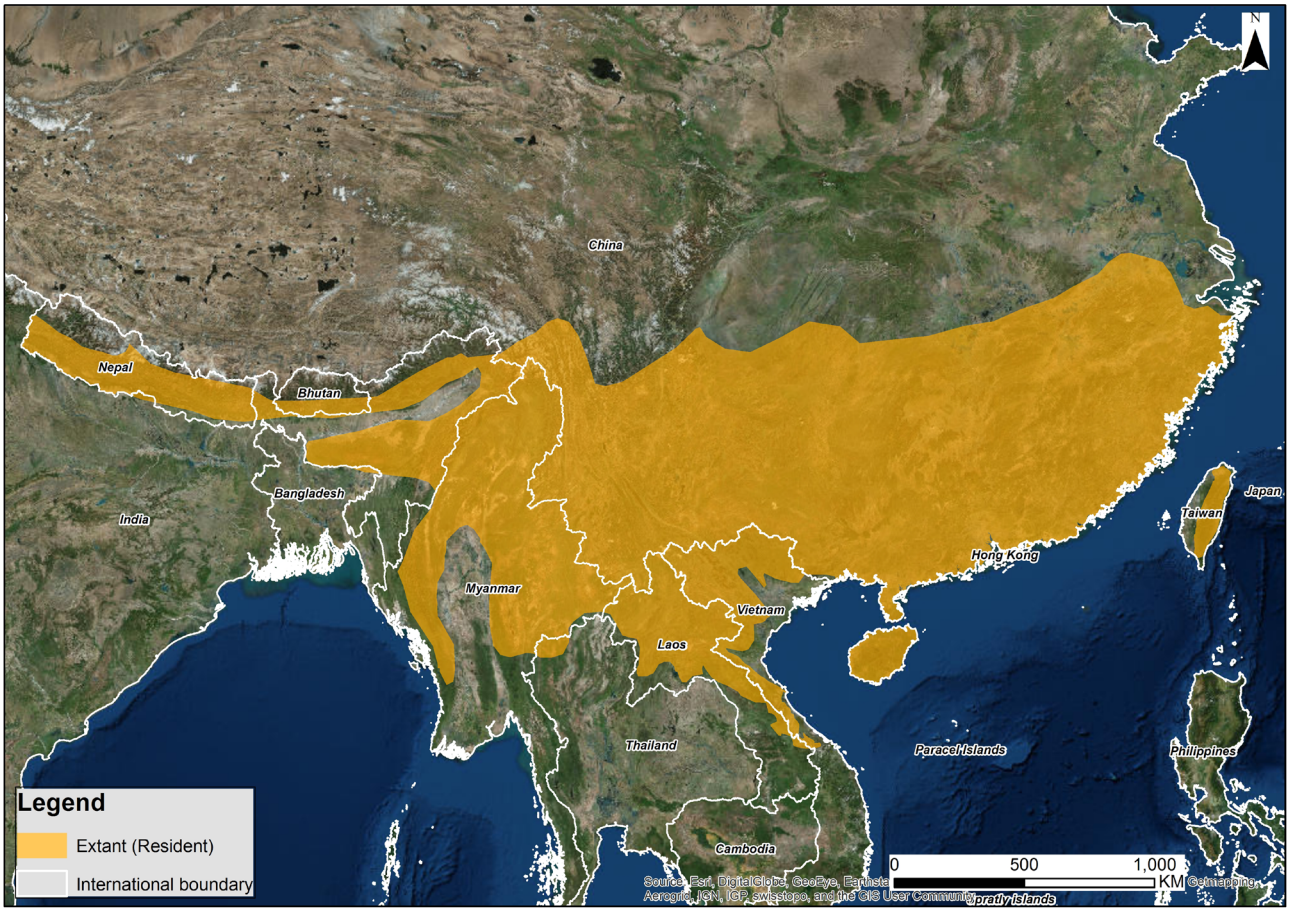


Figure 1b. Distribution of Chinese pangolins (*Manis crassicaudata*; map above) (Source: IUCN Redlist 2014)

Besides, they are also called as Hilemachha (fish of the mud) and Salmachha (fish of the Sal forest) in different parts of Nepal.

Pangolins are solitary, nocturnal animals. They sleep during the day in burrows and can walk on their hind legs but most move along on all fours. When a pangolin is threatened or attacked it rolls up into a ball with its head sandwiched against its stomach and its muscular tail wrapped around its body and emits an unpleasant smell like a skunk (Roberts, 1997).

Pangolins are recorded from 43 districts of Nepal (Fig. 2). Among these, Chitwan and Parsa districts have record of both Indian and Chinese pangolins. Seven districts are confirmed to have occurrence of the Indian pangolin. They are Bara, Parsa, Chitwan, Banke, Bardia, Surkhet and Kanchanpur. Similarly, Chinese pangolins are recorded from 27 districts- Kanchanpur, Bardia, Palpa, Baglung, Gorkha, Lamjung, Dhading, Dolakha, Chitwan, Makwanpur, Kathmandu, Lalitpur, Bhaktapur, Parsa, Kavre, Sindhupalchowk, Sindhuli, Solukhumbu, Dhankuta, Ilam, Jhapa, Khotang, Panchthar, Sankhuwasabha, Taplejung, Terathum, and Ramechhap. Out of 43 districts with the presence, remaining 15 districts have presence record with unidentified species of pangolins. They are Bhojpur, Dadeldhura, Dhanusa, Kaski, Morang, Myagdi, Nuwakot, Okhaldunga, Rasuwa, Salyan, Saptari, Siraha, Surkhet, Tanahu and Udaypur (Basnet et al. 2016).

The Chinese Pangolin is listed as Critically Endangered (CR) and the Indian Pangolin Endangered (EN) in the IUCN's Red Data Book (Challender et al. 2014; Baillie et al 2014). Both species of pangolins are included in the Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES) Appendix I (CoP 17, CITES 2016) and protected in Nepal by the National Parks and Wildlife Conservation Act, 1973 (2029 BS) that restricts killing or hunting pangolins. However, they have received little conservation attention and Pangolins outside protected areas are highly threatened due to poaching & trade of their body parts. Pangolins are considered the most traded mammal species, with the trade being especially heavy in south east and south Asia, including Nepal (Newton et al. 2008). Pangolins are traded for their meat and scales, used in traditional Chinese medicines (Chin and Pantel 2009, Hiep 2009, Yongping 2009, Challender et al. 2012; 2015a). Besides poaching, mining, grazing, deforestation, forest fire, excessive use of chemical fertilizers in farmland and development activities like construction of roads, urbanization are the major threats to the pangolins in Nepal.

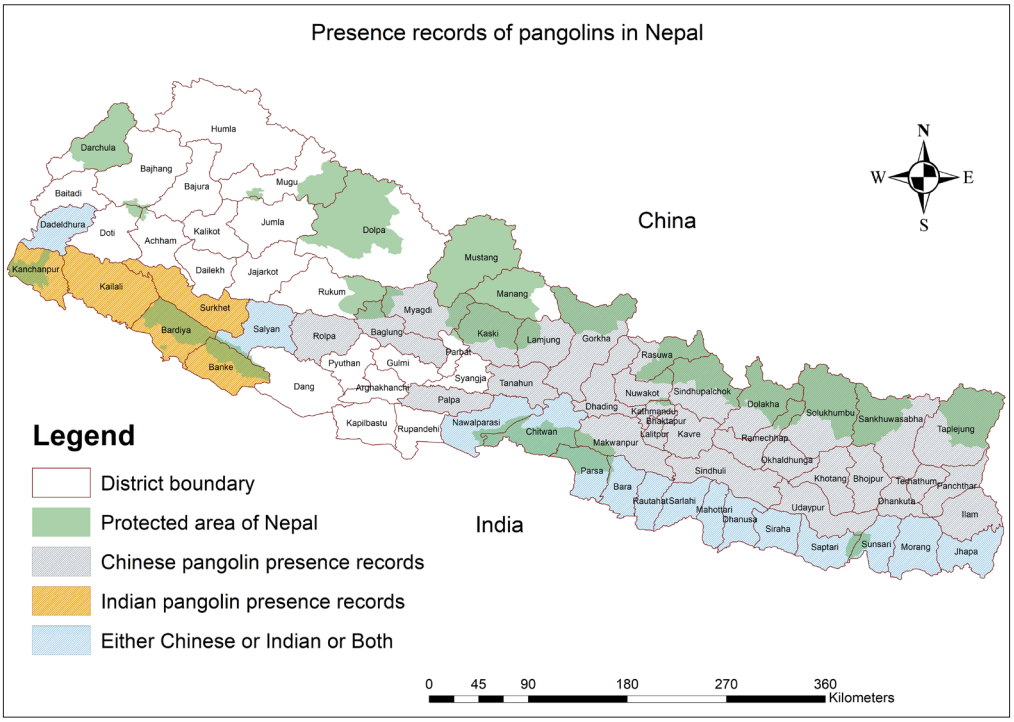


Figure 2. Distribution of Chinese and Indian pangolins in Nepal

1.2 Difference between Chinese and Indian Pangolin

Chinese and Indian Pangolin are two different species and have notable differences in their morphology upon careful observation (Table 1). The morphological differences between Chinese Pangolin and Indian Pangolin are as follows:

The footprint of adult Chinese Pangolin recorded at Balthali,

Table 1. Differences between Chinese and Indian Pangolin

S.N.	Chinese Pangolin (Fig. 3)	Indian Pangolin (Fig. 4)
1.	The adult Chinese Pangolin are smaller (70-100 cm) in size and weight (2-8 kg).	Adult Indian pangolin are bigger than Chinese pangolin in size (100-120 cm) and weight (8-21 kg).
2.	External ears are well developed .	External ears are not well developed or reduced than Chinese Pangolin .
3.	The row of scales are 15-18 in middle part of the body .	The row of scale are 11-13 in middle part of the body.
4.	The scales are hard, sharp and dark brown in colour.	The scales are hard and sharp but yellowish brown in colour.

(Source: Chakraborty et al. 2000, Baral and Shah 2008, Suwal 2011)

Figure 3. Chinese Pangolin (Photo credit: Tulshi Laxmi Suwal/SMCRF)

Figure 4. Indian Pangolin (Photo credit: Bardia National Park and Suklaphanta National Park)

Kavrepalanchok district in 2009 measured 9 cm in length and 7 cm in breath (Suwal 2011) (Fig. 5).

The color, texture and shape of pangolin's pellets depend upon the type of food. Normally, the color of pellets is dark in solid form and yellowish in semi-solid but do not have any notable smell. Ants and termites remaining can be observed in the pangolin scat sample (Fig. 6 and 7).

Figure 5. Footprint of Chinese Pangolin (Photo credit: Tulshi Laxmi Suwal/SMCRF)

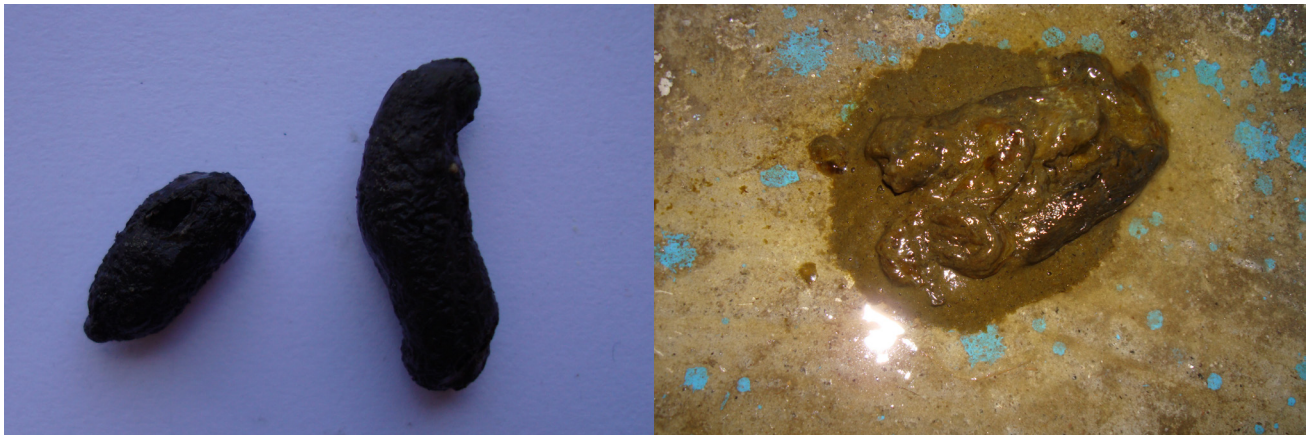


Figure 6. Chinese Pangolin scat collected in captivity (Photo credit: Tulshi Laxmi Suwal/SMCRF)

Figure 7. Indian Pangolin scat collected in natural habitat; Rani Community Forest, Makwanpur and Private Forest of Taplejung.
(Photo credit: Ambika Prasad Khatiwada/NTNC and Tulshi Laxmi Suwal/SMCRF)

1.3 Differences between the Burrows of Pangolin and Porcupine

Burrows of pangolins are semi-circular and sausage type. They have single entrance and heap of soil are found that are thrown out during burrowing. In case of porcupine, burrows are nearly circular in shape with different inlets and outlets which are interconnected with each other. But soil piles are not found at the entrance as in case of pangolin's burrows. Shapes of the burrows are illustrated in the Fig. 8 & 9.

Figure 8. Burrows of Pangolin (Photo credit: Ambika Prasad Khatiwada/NTNC (Left) and Tulshi Laxmi Suwal/SMCRF (Right))

Figure 9. Burrows of Porcupine (Photo credit: Tulshi Laxmi Suwal/SMCRF)

1.4 Threats and Challenges

Major threats and challenges to pangolin include poaching and illegal trade for skins, scales, and meat; loss and degradation of their habitats, fire, drought, low conservation priority and poor knowledge on the species. Pangolin Conservation Action Plan (2018- 2022) is prepared to ensure long-term survival of this species by addressing these threats and challenges. The primary goal of Pangolin Conservation Action Plan (2018-2022) has been to secure pangolin populations from emerging threats so that the species can be recovered in the wild. Preparation of Monitoring Guideline is one of the priority actions mentioned in the conservation plan.

1.5 Need of the Monitoring Guideline

Detail information on the status and distribution of both species of pangolins in the country is lacking. And its population is under threats mainly due to illegal trade, habitat destruction, food deficiency, low awareness among local communities on its ecological significance, etc. The current population of the Chinese Pangolin has been estimated at roughly 5,000 individuals in Nepal, but the population of the Indian Pangolin is not known (Jnawali et al. 2011). Therefore, there is an urgent need of gathering data on status, distribution and potential habitat of both species of pangolin over the period.

Pangolin populations are declining across its range. The decline in the population of the species is assumed based on the increasing offtake, indicated by the number of seizures and global demand for pangolin's body parts. Surveys conducted to date have also differed in their approaches and guidelines, making information incomparable.

This guideline has clearly defined sets of procedure that will be followed when doing a scientific study. Thus, this document is designed to collect the monitoring data on the pangolin distribution, population status and habitat based on agreed sets of survey method and techniques. Thus, a standardized comprehensive monitoring guideline helps to establish a national baseline and track population trends to take timely conservation actions to address the threats to both species. The database compiled from uniformly collected data is essential for the government and conservation agencies as it will aid in devising appropriate conservation strategies and action plans for conservation of pangolins. In addition, it

will be useful to evaluate the effectiveness of conservation interventions targeting these species. This is also one of the prioritized action point identified in Pangolin Conservation Action Plan for Nepal (2018-2022).

In Nepal, a few basic research projects on pangolins have been taken up to date but the uniformity or consistency is not maintained in the survey and monitoring procedures. Therefore, this guideline can be useful document for monitoring pangolins in the field especially by the forest staff, protected area staff, university students and faculties as well as Community Forest User Groups (CFUG) who are working on research, monitoring and conservation of pangolins.

1.6 Objectives of the Monitoring Guideline

The main objective of the monitoring guideline is to standardize method for monitoring pangolins in their natural habitat. Standardized data collections shall maintain consistency and allows comparison among data collected at various scale spatially and temporally. The monitoring guideline serves as a guiding document to update on species information in a regular and systematic manner.

Chapter Two | Standard Guideline for Monitoring Pangolin and their Habitat

2.1 Presence/Absence Survey

Monitoring of pangolin and its habitats can be initiated by conducting few initial researches in their potential habitats. This includes presence/absence (detection/non-detection) survey for identifying preliminary data/information on occurrence and distribution. This can be done through an extensive literature review, and by conducting recce for collecting spatial data on the physiographic and topographic parameters. Other standard methods to ascertain the presence/absence of species in a given area includes:

- Literature review
- Consultations and field records
- Participatory Rural Appraisal
- Focus Group Discussion
- Key Informant Survey
- Questionnaire Survey
- Tracking records of seizure case (body parts) and confiscated records.
- Direct field survey through observation and photographic evidence of burrows, scales, digs, feces, footprints and tracks including opportunistic live records and presence of pangolins through belt transect methods in the grids.

2.2 Selection of Appropriate Site for Survey

Selection of potential site identified through presence absence survey and/or through background information (as per above sections) indicates that habitats (sites) for pangolin can be characterized by following variables as per their preference:

- Soil texture: Brown and red soil with medium texture
- Landscape variables: Elevation (altitudinal gradients) between 500 and 2500m; Slopes between 5-45 degrees; shapes and aspects of the land surface with crevices, defaults, rocks with ample amount of water sources, prey species, safety, etc.
- Habitat: ground cover (25- 50%), canopy cover (0-25%)
- Foraging grounds: presence of ants and termite mounds
- Vegetation types: Sub-tropical forests (Dominant: Sal forest, Schima forest), Broad leaved coniferous forests (Dominant: pine forest)

The above variables can be used in a Geographical Information System (GIS) and species distribution models to model potential habitats at the landscape scales (see Box 1). The resulting spatial outputs can be used to prioritize surveys, hotspot identification and monitoring areas.

2.3 Design for Occupancy-based Survey

Basic occupancy framework can be used to identify proportion of habitat occupied by species when detection imperfect is less than 1. The basic objective of the occupancy survey is to determine proportion of the potential habitats occupied by the species during the survey period. Occupancy survey involves survey (camera trapping and/or sign survey) across the potential habitat of pangolin looking for signs of pangolin. The potential habitat is overlaid with the grid of appropriate size. Size of the grid depends upon the home range of species. Home range of Chinese Pangolin is 0.35 km^2 estimated at 35.1 ha (Sun et al. 2015). Based on this information, we suggest minimum grid size of 600m x 600m as a sampling unit and adequate representative and replicated samples should be taken (Fig. 10). For measuring the covariate influencing the occupancy, in each

Box 1. Step to prepare a MaxEnt model

- Collect pangolin presence locations (not pseudo-absence) through extensive literature reviewed. Prepare the MS Excel sheet of the geo-referenced presence points.
- Convert the .xlsx file into .csv file
- Collect environmental covariates or variables (as much as possible) that are likely to affect the distribution of species and modify these environmental layers in the same extent (geographic or landscape grids, bounds and cell size) using ArcGIS.
  a. Load layers into Arc Map and opening the extract by Mask Tool
  b. Set up Extract by Mask Tool and the extent and cell size in spatial analyst
  c. Convert Environmental Rasters to ASCII Format
- Run the MaxEnt Model

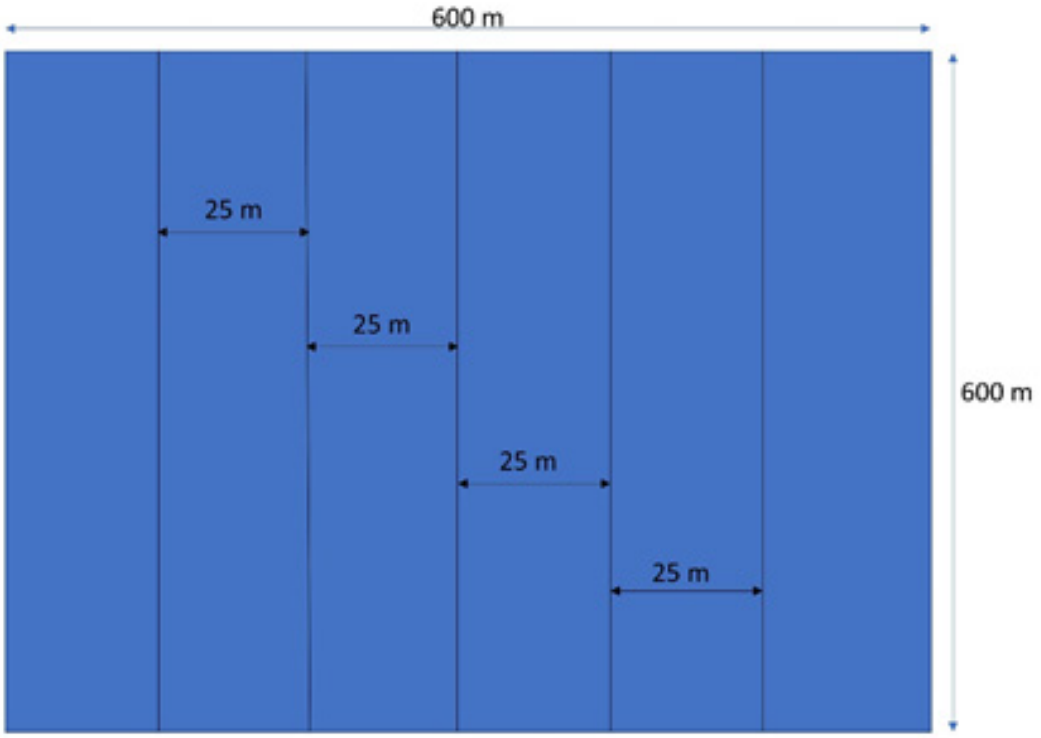


Figure 10. Grid design for the study of pangolin

grid minimum three belt transects of 600m x 50m (25m in either side) should be laid for the survey which covers 25 percentage of the grid. The grids for pangolin field survey should be selected randomly by using Geospatial Modeling Environment built in ArcGIS and marked by reflecting tape/ ribbon/ paint on the tree or GPS. Grid should be arranged in a straight line unless topographically difficult terrain appears. In such case contour lines and stream banks can be followed according to the ground feasibility. At least four people are required to conduct a survey in each grid.

2.4 Sign Survey

Pangolins are elusive animals, which are rarely observed in the wild. During the occupancy survey, one can observe indirect evidences of pangolin such as their burrows (New/ Active and old burrows), digs, footprints, tracks and fecal pellets (Box 2; Fig 11) while walking on the transect within the grid. When a pangolin burrow (either fresh or old) (Box 2) is identified, additional measurement (covariate) will be taken such as the circumference of the burrow entrance. Old and new burrows of pangolin can be categorized as following:

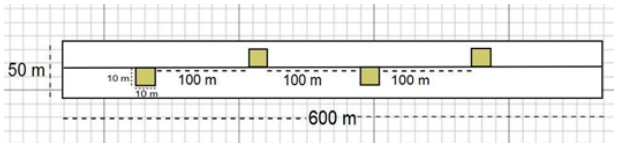
- Old burrow: Compact and dry soil with dry fodders and spider web along with seedlings of vegetation,
- Fresh/Active/New burrow: Fresh and loose soil with fresh scratches and pugmarks; without dry fodders in the burrow and any seedling of vegetation

Box 2. Average size of Burrows

- Diameter: 18 cm
- Circumference: 57 cm
- Depth: 90cm to 115 cm

2.5 Vegetation Survey

Upon the encounter of a burrow, assess the surrounding habitat (as an additional covariate). The quadrate sampling can be applied to measure habitat related parameters. During the transect survey the size of 10m X 10m, minimum 3 quadrates should be laid out in each belt transect of size 600m X 50m in every 100m to record plants of different species (herbs, shrubs and trees). The quadrates can be place either in straight line or alternative.



The standard size of the quadrate is used for measuring vegetation related parameters. Calculate the standard metric (based on objectives) such as density, relative density, frequency, relative frequency, dominance and relative dominance and Important Value Index (IVI) to assess the habitat preference.

Old burrow (presence of dead leaves) (Photo credit: Sanjan Thapa/SMCRF)

New burrow (freshly dug soil) (Photo credit: Sanjan Thapa/SMCRF)

Digging marks. (Photo credit: Tulshi Laxmi Suwal/SMCRF)

Tracks of Chinese Pangolin (Photo credit: Tulshi Laxmi Suwal/SMCRF)

Figure 11. Indirect signs of Pangolin

2.6 Mapping the Distribution of Pangolin

Distribution of pangolins can be mapped based upon various data (for e.g. confirmed survey records, literature based records, Protected Areas (PAs) and Division Forest Offices (DFO) based records, or other information) as well as collation of rescue/confiscation records can also be used to map the species possible distribution (National Pangolin Survey MoFSC, 2016) by deploying one of the following methods:

- MaxEnt modeling (see Box 1)
- Results from occupancy modeling can be used to prepare prediction map showing the distribution of pangolins in their potential habitat in Program PRESENCE.
- Results from MaxEnt and Occupancy Modelling can be used in GIS mapping: Geographical coordinates recorded from the GPS and results from the occupancy data can be used in a GIS domain (ArcGIS or Q-GIS) to map the distribution of the pangolins (Table 2).

Table 2. Tools for Species distribution modeling

Model	Software	Data Types	Data Source
Maximum Entropy (MaxEnt)	SDM Package in R	Presence only	Burrow count, visual observations, camera traps and detection from sniffer dogs
Distribution Map	ArcGIS/ QGIS	Shapefiles, GPS coordinates	GPS (field coordinates)
Occupancy	PRESENCE	Detection/Non-detection data	Burrow count, visual observations, camera traps and detection from sniffer dogs

2.7 Camera Trapping

Camera trapping (captured on camera traps in Taplejung, Makwanpur, Chitwan, Kathmandu and Gorkha districts) has been successful in surveying pangolins in Nepal. Pangolins are even tracked while revisiting old burrows and burrows nearby water sources. Therefore, camera traps should be focused towards burrows that are close to water sources since pangolins frequently visit water sources. The detail method to deploy camera traps during pangolin surveys are as follows:

- Place camera traps focusing on burrows (both old and new).
- Basic orientation shall be in 450 azimuths so that the camera is focused on body portion.
- Each camera trap should be fixed at one-foot height from the ground focusing on burrows.
- At least 6 stations can be deployed within a grid-0.36 km^2 for maximizing the detectability.
- At each station a pair of camera traps opposite to each other should be installed by using an appropriate support.
- Duration of camera trapping in each station should be at least 15 days and at most 30 days in total for a rapid assessment (ensuring closure for density estimates).
- Use of bait for maximizing the trapping success rate: small pieces of boiled chicken eggs and honey could be used as bait (Marler 2016).

2.8 Live Trapping

Live trapping can be used for genetic study assessing objectives which includes population estimate, presence/absence, occupancy and physical movement (activity) of the pangolins in their habitat. Genetic sample can also be collected using standard protocol during live trapping. The basic technique for live trapping includes; identifying burrows by the presence of feces (Richer et al. 1997), or by following fresh tracks during the day light and then capturing any detected pangolin, or by luring outside burrows until the animal appeared in the late afternoon (D. Pietersen pers. comm.). Similarly, species caught by hand, through chance encounters either during field survey or by Park/Forest staff (Heath and Coulson 1997, Richer et al. 1997).

- Pilot survey with live traps (Havahart's trap) kept either randomly or 6 traps in 600m transect,
- The captured individual should be marked with metal/rubber chips drilling the scale/s,
- The number of re-capture of the same individual should be recorded,
- The site of capture of the same individual should be noted which will give an insight of movement/ranging pattern of the species, and

2.9 Use of Sniffer Dogs in Pangolin Survey

Detection dogs have been used for a range of wild mammals and birds from killer whales to spotted owls and bears in equally wide range of habitats with great success (Wasser et al. 2004; Ayres et al. 2012; Wasser et al. 2012). In addition, hunters throughout Southeast Asia have confirmed their successful use of dogs to track pangolins providing evidence that dogs can also be used for pangolin conservation (Newton et al. 2008). There are undocumented evidences of pangolin being poached using local dogs from eastern Nepal as well. Nepal has first piloted sniffer dogs (two dogs with handlers) to track pangolin droppings during February and April 2017 (Fig 12). Fecal sample can be used for species identification (Chinese/Indian pangolins) and individual identification using non invasive genetic approach.

2.10 Scat Collection

Requirements

1. Ziploc bags, Paper bags, filter paper and large vials,
2. Silica desiccant gel,
3. Permanent marker pens,
4. Disposable hand gloves, and
5. Someway to pick up the feces – spoon, plastic spatula, hand gloves, etc.

Procedure

1. Put on new gloves to handle scat sample (if no gloves: use leaves, pebbles or twigs). Do not touch or handle scat sample with bare hands.
2. Place the selected parts of scat pile containing mucus and/or a dry in the paper bag and then place paper bag inside a Ziploc bag containing silica desiccant. Ensure minimal damage of scat structure and transfer of other elements such as grass, sand, etc. To prevent cross contamination, place only one uniquely identified scat sample (5-10 gms) in each paper bag. If multiple scat piles exist, handle and collect (5- 10 gms) samples separately.
3. Label the collection bags using permanent ink with details of scat sample – e.g. species name, GPS location, ID, date of collection etc.
4. If the scat sample is very fresh and moist, add silica desiccant to the Ziploc bag containing the paper bag in an approximate ratio of 4 silica : 1 scat. Reduce silica accordingly – no need to add silica if scat sample appears very dry and old. Ensure minimal exposure of scat sample to moisture and sunlight after collection. Alternatively, large vials can be used to store scat samples. First dry the sample in paper bag and then place it in a large vial containing silica beads in the bottom and a layer of filter paper in between the beads and the scat.
5. Store the samples in a cool and dry place and transport to the laboratory for long term storage. While in storage

Figure 12. Use of sniffer dog to detect droppings and burrows of pangolin (Photo credit: Ambika Prasad Khatiwada/NTNC)

it should be frozen.

6. The DNA will be extracted from epithelial cells on the outer layer of the scat thus this layer should not be disturbed in transport or storage.

2.11 Spatial Ecology of Pangolin using Radio Tracking Devices

Radio-tracking is one of the successful methods to explore and measure the the species home range size, their activity patterns, refuge (e.g. burrow) selection, and habitat selection (Pietersen et al. 2014), as well as its wild diet and prey selectivity (Pei, 2010, Pietersen et al. 2016). It has been applied in Chinese Pangolin and Temminck's Pangolin at Taiwan and South Africa since long time. Required equipments include:

- VHF transmitter or Tiny GPS unit (one for an individual),
- Sling and rubber for strong setting,
- 2mm - 3mm screws and washers,
- Screw driver and drill machine, and
- Hand sanitizer or disposable hand gloves.

Procedure:

- Use the hand sanitizer or put on new gloves to handle a pangolin,
- Drill holes on the single large dorsal scale near the base of the tail,
- Fix the VHF transmitter with sling and rubber then tight by screws,
- Remote sensing images, and
- Sensors (3 axis accelerometers for the behavior pattern).

2.12 Potential Habitat Survey for Measuring Suitability and Preference

To find out the suitable and potential habitat for the pangolins flourishing in the area, habitat survey should be conducted. Suitable habitat should be mapped out, including pangolin conservation 'hotspots'. Hotspots are considered priority areas for conservation and protection of these species. Threats to habitats from natural disasters (forest fires, landslides, floods) should be assessed and potentially hazardous areas should be mapped out.

2.12.1 Procedure for the habitat assessment

During the habitat assessment following data/information should be collected from the field surveys as described in section 2.2.

- Record the name of tree, herb and shrub species,
- List (if available) with local name, common name and scientific name, collect and prepare herbarium with photographs of unidentified vegetation,
- Classify the habitat type of pangolin i.e. Forests (with tree species as dominant vegetation), Agriculture land (with cultivated crops), Grassland (with vegetation as dominant grass) and disturbance regime like grazing,
- Count the number of tree species in each quadrate, measure DBH and height and calculate density, relative density, frequency and relative frequency,Estimate the Important Value of Index (IVI) using the formula IVI=RD+RF+RDom, (RD=Relative density, RF= Relative frequency, RDom= Relative dominance), and
- Assess the habitat quality of the species. Run Habitat Suitability Index Model (HSI-Model).

Box 3. Major variables required for modeling

Proximity Variables

- Distance from the nearest settlement,
- Distance from the main road, and
- Distance from the nearest water resources (river, tunnel, streams, pond, lake, etc).

Environmental Variables

- Temperature
- Moisture
- Rainfall
- Humidity

Figure 13. Procedure of transistor setting in Pangolin (Photo credit: Nick Ching -Min Sun, Taiwan)

2.13 Hotspots Identification

Occurrence of high frequency and density of fresh burrows, and variables like large area of suitable habitat (e.g. availability of food and water sources, open land for free movement, suitable canopy cover and regular occurrence of pangolins' direct and indirect signs, etc.) are considered to identify a site as a biological hotspot of pangolins. In addition, pangolin hotspots can also be identified by assessing the sites with high and low anthropogenic activities as well as tracing locations of illegal trade routes and seizure cases.

Hotspots of pangolins can be identified by following methods:

- Published and unpublished literature review,
- Direct and indirect field survey,
- Records in Division Forest Offices, PAs, CFUGs, CIB and Central Zoo,
- Rescue/confiscation records, and
- MaxEnt modeling, etc.

2.14 Threats Identification

Methods to identify the threat to the species and their habitats can help to assess types of threats pertaining to the species in a given area. Following methods can be explored and used for identifying threats to pangolins.

2.14.1 Questionnaire survey

- Prepare semi-structured set of questions following pre-test (see Annex VII),
- Dispatch the questionnaires to the local individuals and the community to fill the questionnaire forms by themselves,
- Scheduled interviews can be conducted where the interviewer can fill the questionnaire form based on the answers provided by the local person being interviewed,
- Manage data from the questionnaires in an excel sheet, and
- Data can be analyzed either using MS-Excel or program R.

2.14.2 Informal with local people

- Informal talks with local residents should be conducted to get fundamental aspects on pangolin, and
- Interview conversations should be either noted down or recorded by a sound recorder.

2.14.3 Observations

- Indirect evidence of threats such as habitat fragmentation, forest fire, anthropogenic disturbances, and
- Skins, scales and stuffed skin of the animal kept in the houses of the villagers should be observed.

2.14.4 Seizure records

Record of the seizure of animal body parts at DFOs/PA offices, CIB, District and High Courts as well as a press release and press news should be considered for the threat assessment. Record (data) should be appropriately maintained at the concerned government offices with a possible link to the central database system.

Chapter Three | Data Management and Analysis

Several types of data (numeric-continuous and/or discrete, categorical and nominal) can be collected using prescribed survey techniques. Proper management of data need to be checked which shall be shared in a standardized format. Data quality need to be checked at least by researcher so that collected data can be used in drawing robust results.

3.1 Data Quality and Management

Field data should be properly coded, entered into the software and maintained in a specified format in a conventional database system. This implies to data keeping, processing and quality checks such as reliability of data. Data entry should be done carefully and quickly after the completion of field work to reduce the potential error.

3.2 Data Analysis

3.2.1 Presence/absence

The assessment where by a researcher or a team confirms the presence of the species either by direct sighting or observation of indirect evidences of pangolins such as burrows, footprint, digs, scales and fecal pellets or both. This type of data helps in modeling distribution using proper modelling approach such as MaxEnt. Spatial locations (GPS data) of presence data can be used in a GIS (ArcGIS or Q-GIS) to map the distribution of pangolins.

From the habitat and social surveys, confirmation of the presence and absence of the pangolins can be done. This type of data can be analyzed using proper regression models such as logistic models or mixed models.

3.2.2 Occupancy estimation

Detection, non-detection data can be analyzed using occupancy framework when detection probability is less than one. Program PRESENCE and/or using package "unmarked" in R platform can be used for measuring probability of occupancy and/or detectability. Site level covariates affecting the pangolin occupancy and detectability can be modelled in the same way.

3.2.3 Density estimation

Capture and recapture data can be managed based on individual researcher's objectives and at least fed to national database system. Spatial and temporal variations in populations, prey predator dynamics, life table data can be assessed, predicted and evaluated using population level studies and monitoring. Mark-recapture methods and distance sampling can be used to estimate the species and burrow density. In addition, if capture rate is very less, camera trapping can also be used to estimate the species populaion density, but it needs large numbers of camera (depends upon the geographical area) must be installed for long term at least 2-3 months. Individual identification is tricky but needs a training data (camera trap pictures) to build the capacity for individuals identification.

3.2.4 Distance sampling

Distance sampling can be applied to estimate the burrow density in a given area. Observation data collected during the transect survey can be used to estimate the density. Observation data includes: burrow observation data, radial distance, and angle between transect and burrow orientation. Transect survey data sheet is provided in Annex III. These data can be collected from the field surveys as described in section 2.2. Pangolin burrow density can be estimated using the program DISTANCE.

3.2.5 Activity pattern/ movement

Activity and movement pattern can be estimated using data collected by direct observations and capture-recapture collected using live traps, camera trapping or using radio-tracking devices. Temporal and spatial pattern in pangolin can be estimated using program PRESENCE (Spatial interaction factor), temporal activity pattern (Ridout & Linkie, 2009), etc. Wide range of analytical tool is available to estimate home range pattern and movement pattern (Laver and Kelly, 2008).

3.2.6 Habitat preference and suitability

Habitat quality is a set of ecological factors that affects the species to establish and maintain their population. Therefore, all habitat variables such as biological (flora and fauna, ants and termites), topographic (slope, aspect, altitudinal

gradients, canopy cover, ground cover), environmental (temperature, rainfall and humidity), proximity (distance from road/settlement/ water resources and ant/ termites mound) and anthropogenic factors (forest fire, grazing, deforestation etc.) affecting pangolins should be collected to analyze the habitat preference and habitat suitability. The IVI of different tree species and the Habitat Suitability Index Model (HSI-Model) should be calculated to analyze the habitat quality of the species.

3.2.7 Threats assessment

Database can be extracted from existing habitat and social surveys that provides an opportunity to gather information with a caveat. A lot of non-response, censored, truncated and zero inflated data are the major challenges to the researchers.

Literature review gives a baseline information to compile list of potential threats documented by previous studies. Focus group discussions assist in gathering perception about threats to the species. To assess the threats at the site of survey, intensity of grazing, fire, natural resource collection, and other threats related variables including proximity to settlements and roads should be recorded from each plot. Other information like poaching, resource exploitation, natural calamities, electricity transmission lines/towers, resorts, roads, trekking trails, pesticide use, etc. should be assessed at the entire community forest level. The logistic regression, occupancy based, and generalized additive model, etc. are available to analytically understand the factors determining habitat conditions and threats to the pangolins.

Focus group discussion among the expert groups can be done to assess the site-specific threat to the pangolin and their habitat. Information gathered from focus group discussion and expert opinions can be cross verified with questionnaire survey, interviews, observation, and seizure records to identify the threats, assess their level, frequency, and severity of threat. Use of available tools including MIRADI (www.miradi.org) are available for threat assessment (Gurung et al., 2018).

Chapter Four | Best Time to Conduct Survey and Frequency of Monitoring

4.1 Time for Pangoling Survey

Various factors such as locality, seasons, accessibility, availability of food, etc., affecting survey should be considered for achieving good results. Seasonality is one of the main factor (covariates) affecting the detection of pangolin sign thus affecting population and distribution parameters. Pair-wise ranking of the factors based on expert opinion is shown in table 3 suggesting the best time for the survey of pangolins.

Table 3. Expert opinion showing the best time to conduct pangolin survey

S.N.	Season	Factors affecting sign detection					Remarks
		TA	GC	W	ASi	AAT	
1.	Spring (March-May)	3	3	3	2	3	14
2.	Summer (June-August)	1	1	1	1	3	7
3.	Fall (September-November)	3	3	2	2	3	13
4	Winter (December-February)	3	3	3	2	3	14

TA= Travel and accessibility, GC = Ground Cover, W = Weather, ASi = Availability of Signs, AAT = Availability of ants and termites, Spring: March - May, Summer: June - Aug, Fall: Sep - Nov, Winter: Dec - Feb, Ranking as: 1 = Poor, 2 = Acceptable and 3 = Good

These species are nocturnal, thus evening (dusk) time (after 5:00 PM) is the best for monitoring pangolin while daytime can be utilized in searching indirect evidences. Except the summer season (June to August), rest of the seasons are favourable to study pangolins. Due to heavy rain during monsoon period (June to August), fresh and old burrows cannot be easily differentiated, and overgrowth of the ground vegetation often hinders the observations and location of burrows. During the winter season, ants and termites are often found along the top soil as a result pangolins are often found very active and engaged in digging burrows in search of food. Therefore, the detection of indirect signs is higher during this season (Sun et al. 2015).

4.2 Frequency and Schedule of Monitoring

Monitoring can be conducted at the specific time based on monitoring objectives. September to May is better for monitoring due to their mating and breeding season. Pangolins is recorded from 43 districts of Nepal, however based on the habitat modeling using covariates (Box 1), 53 districts are identified as potential habitats for pangolins. Furthermore, 14 districts are identified as `hotspots' areas of pangolin (Basnet et al. 2016), which should be monitored every year and nationwide monitoring should be conducted in every 5 years.

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Annexes

Annex I: Presence/Absence Data Sheet for Pangolin Survey

Date: District/Location: Time of Survey: Recorded by:

Weather: Ambient Temperature: Habitat/Forest Types:

S.N.	Name of Municipality	Community Forest	Chinese Pangolin	Indian Pangolin	Unknown sp.	GPS coordinate/ Elev.	Evidences (Literature/ burrow/ direct sighting/ killing)	Remarks (Local Names, Seizure of pangolin part, Threats)
1								
2								
3								
4								
5								
6								
7								
8								

District:..... Date:.....

Annex II: Data Sheet for Occupancy Survey

Quadrat No	GPS coordinates (Deg. Decinal)		Elev. (m)	Slope	Aspect	Sign of presence (√)	Canopy cover (%) (√)	Ground cover (%) (√)	Litter condition(low/ medium/ high)	Soil type (√)		Habitat Type (√)	Major Vegetation	Threats (G/F/T/L/ LC/D)**	Remarks
										Color	Texture				
1						Burrow (old/ new)	0-25	0-25		Red	Fine	Forest		Settlement	
						Pellets	25-50	25-50		Brown	Medium	Shrub		Road	
						Footprints	50-75	50-75		Dark	Coarse	Grassland		Water Source	
						Scratches/digging	75-100	75-100		Others		Farmland		Ant/termite mount	
						Scales									
2						Burrow (old/ new)	0-25	0-25		Red	Fine	Forest		Settlement	
						Pellets	25-50	25-50		Brown	Medium	Scrubland		Road	
						Footprints	50-75	50-75		Dark	Coarse	Grassland		Water Source	
						Scratches/digging	75-100	75-100		Others		Farmland		Ant/termite mount	
						Scales									
3						Burrow (old/ new)	0-25	0-25		Red	Fine	Forest		Settlement	
						Pellets	25-50	25-50		Brown	Medium	Scrubland		Road	
						Footprints	50-75	50-75		Dark	Coarse	Grassland		Water Source	
						Scratches/digging	75-100	75-100		Others		Farmland		Ant/termite mount	
						Scales									

** G- Grazing, F-Fire, T- Trampling, L-Logging/Lopping, LC-Litter collection, D-Direct Threats

Annex III: Data Sheet for Distance Sampling

Date:

Transect code: District: Team members:

Quadrat No.	Active (New) Burrows					Inactive(Old) Burrows				
	GPS coordinates (N and E)	Distance from the transect	Elevation (m)	Circumference of the entrance (cm)	Remarks	GPS coordinates (N and E)	Distance from thetransect	Elevation (m)	Circumferenc of the entrance (cm)	Remarks

Annex IV: Threat Identification

Date:

Municipality/ Community Forest: ..... Team members:

Threats/Disturbances Factors	Low	Medium	High	Remarks
Logging/tree cutting				
Cattle and/or cattle grazing				
Resources exploitation				
Pangolin related poaching				
Cultivation and settlement				
Forest fire				
Natural calamities				
Road/ electric tower/ resorts etc. construction				
Use of pesticides				
Rural road/ trekking trail				

Impact Scales: Low =10-20%, Medium =21-50%, High=More than 50%

Extra note:

Annex V: Seizure Data Sheet

Date:

DFO/PA: .....

Team members:

SN	Date of seizure	Location of seizure	Parts/ Weight/ Amount	Arrestee details					Transportation			Remarks
				Name	Age	Sex	Address	Occupation	Mode	Origin	Destination	
1.												
2.												
3.												
4.												
5.												
7.												
8.												
9.												
10.												

Annex VI: Field Equipment/Gears

S.N.	Equipments/ gears	Purposes
1	GPS	Tracking transects, recording GPS coordinates, elevation etc.
2	Compass	Recording aspect and direction
3	Clinometer	Measurement of tree height & Slope
4	Camera	Photograph of direct sighting/signs, other wildlife, threats and related anthropogenic activities
5	Measuring Tape (100 m)	Measure the burrow diameter and Quadrate establishment
6	Small scale	To measure litter depth of ground cover and others
7	Masking Tape/Flags/Ribbons	Demarcating the boundary of quadrates
8	DBH Tape	Measurement of DBH of tree
9	Topographic and other maps	Tracking transects and potential habitat identification
10	Pangolins related photographs/ sketches, feild guide/book	Display to the local people during consultation
11	Field note book	Recording information
12	Pen/Pencil/Eraser	Recording information
13	Comfortable Outfits	For proper field stay
14	Rain Suits	To keep safe from rain
15	Trekking Boots	Protection of feet from mud, prickly bushes and other nuisances like leech/ snake etc.
16	Food/snacks and cooking set	Snacks needed while working in forest; Food and cooking set necessary if staying away from settlement
17	Back up materials	e.g. batteries, waterproof paper, lead pens
18	First Aid Kit	For first aid treatment including common diseases

Annex VII: Questionnaire Survey Format

District: Municipality:

Date:.....

Name of respondent: Age: Sex:

Ward no: Education: Occupation:

Team members:

1. (Displaying color photograph of pangolins) Do you know what animal is this?

a. Yes b. No

If yes,

i) What animal do you think the photographs of?.....

ii) What do you call this animal in your local dialect?.....

iii) What do pangolins eat?.....

iv) Where do they live?.....

v) Do you know its ecological, socio-cultural and religious importance of pangolin?.....

2. Have you seen/ heard about pangolins?
a. Yes b. No

If yes, a. dead b. alive

a) When, i) Year ii) Day/Night iii) Number

b) Where.....

3. Have you seen indirect evidence of pangolins? a. Yes b. No

If yes, i) Burrows ii) Scratches/Digging iii) Scales iv) Footprints v) Fecal pellets/matters

4. Where are they seen more frequently?

a) Forest b) Scrubland c) Grazing/ grasslands

d) Agricultural land e) Near water bodies f) Settlement area

5. What do you think about the status of their population during last five years in your area?

a) Increasing b) Decreasing c) Stable d) Not known

Reasons: .....

6. What are the natural predators of pangolins?

a) Man b) Leopard c) Dog d) Others.....

7. What arc current threats to the pangolins in your area?

a) Habitat degradation b) Habitat fragmentation c) Illegal hunting

d) Exploitation of natural resources e) Natural disaster f) Forest fire

g) Others: .....

8. What are the main disturbances to pangolins habitats in your area?

a) Deforestation b) Grazing/fodder collection c) Human encroachment d) Forest fire

e) Road/House construction f) Tower construction g) Rock/soil mining

9. How often illegal hunting of pangolins occur in your area?

a) Regular b) Occasional c) Rare d) None

10. Are pangolins harmful or beneficial animal?

a) Harmful b) Beneficial,

Reasons:.....

11. How can you protect and/ or conserve pangolins, in your area?

a) Information about the animal b) Awareness c) Research / study d) Law enforcement e) Others

12. How often do you encounter pangolins in the wild?

a) Frequently b) Occasionally c) Rarely d) Never

13. Are pangolins killed in your area? a) Yes b) No

If yes, why are pangolins killed for? .....

.....

14. When was the last time you saw or heard about killing of pangolins and what was the reason?

.....

15. Who in general kills/hunts pangolins in your area?

a) Local people/herders b) Outside poachers c) Predator (specify).....

d) Others.....

16. How many pangolins have been killed in your area during the last five years? .....

17. What are medicinal/cultural uses of pangolins?

S.N.	Body parts	Uses	How is it used	Remarks
1.	Scales			
2.	Meat			
3.	Blood			
4.	Bone			
5.	Others..			

18. Do you know that hunting of Pangolin is illegal? a) Yes b) No

If yes, how did you know?.....

19. Are there any stories/sayings linked with pangolins? If yes, could you please tell us in brief

.....
.....

20. Do you think pangolins should be protected?

a) Yes b) No c) No idea

If so, why?

.....

.....

.....

21. What should be done to protect pangolins?

a) .....

b) .....

Annex VIII: Reviewer Team

List of National and International Reviewers

	Technical Team
1.	Mr. Gopal Prakash Bhattarai, Deputy Director General, DNPWC
2.	Mr. Laxman Prasad Poudyal, Ecologist, DNPWC
3.	Ms. Madhuri Karki (Thapa), Under Secretary, DoFSC
4.	Mr. Bhupendra Yadav, Assistant Ecologist, DNPWC
5.	Mr. Rishi Ranabhat, Assistant Ecologist, DNPWC
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7.	Mr. Bhagawan Raj Dahal, PhD, Program Manager, ZSL Nepal
8.	Mr. Naresh Subedi, PhD, Manager-Conservation Program, NTNC
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2.	Mr. Maheshwar Dhakal, PhD, Joint Secretary, MoFE
3.	Mr. Pashupati Nath Koirala, Under Secretary, MoFE
4.	Mr. Man Bahadur Khadka, Director General, DNPWC
5.	Mr. Ram Chandra Kandel, PhD, Deputy Director General, DNPWC
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10.	Mr. Narendra M. B. Pradhan, PhD, Program Coordinator, IUCN
11.	Mr. Damber Bista, Red Panda Network
12.	Ms. Seema Karki, ICIMOD
13.	Mr. Tek Raj Bhatta, Senior Program Officer, ZSL Nepal
14.	Mr. Suvas Chandra Devkota, Team Leader, Hariyo Ban Program-II, FECOFUN
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16.	Ms. Tulshi Laxmi Suwal, Co-Founder, SMCRF
17.	Mr. Sagar Dahal, President and Co-Founder, SMCRF
18.	Mr. Sanjan Thapa, Co-Founder, SMCRF
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20.	Mr. Arjun Thapa, PhD, Co-Founder, SMCRF
	International Reviewers
1.	Mr. Dan Challender, PhD, Co- Chair, IUCN/SSC Pangolin Specialist Group
2.	Ms. Carly Waterman, IUCN/SSC Pangolin Specialist Group
3.	Prof. Shibao Wu, PhD, School of Life Science (South China Normal University)
4.	Mr. Nick Ching-Min Sun, PhD, National Pingtung University of Science and Technology, Taiwan
5.	Mr. Raj Amin, PhD, ZSL, UK

Annex IX: Process of Monitoring Guideline Development

1. Formation of a team of experts to develop monitoring guideline including academician, pangolin experts and researchers,
2. Desktop review and preparation of a draft guideline,
3. Meetings and discussion with conservation stakeholders and national experts including academics to develop the draft guideline,
4. Incorporation of feedback from the expert reviewers,
5. Testing the field procedures of the draft guideline,
6. Consultation with relevant government agencies (DoF and DNPWC) conservation organizations WWF, FECOFUN, NTNC, ZSL, RPN and BCN experts and conservationists and feedback collection,
7. Presentation of draft in a sharing workshop for the approval ,
8. Circulation of the post-workshop draft to national and international experts to incorporate their inputs, and
9. Revise and prepare the final draft.

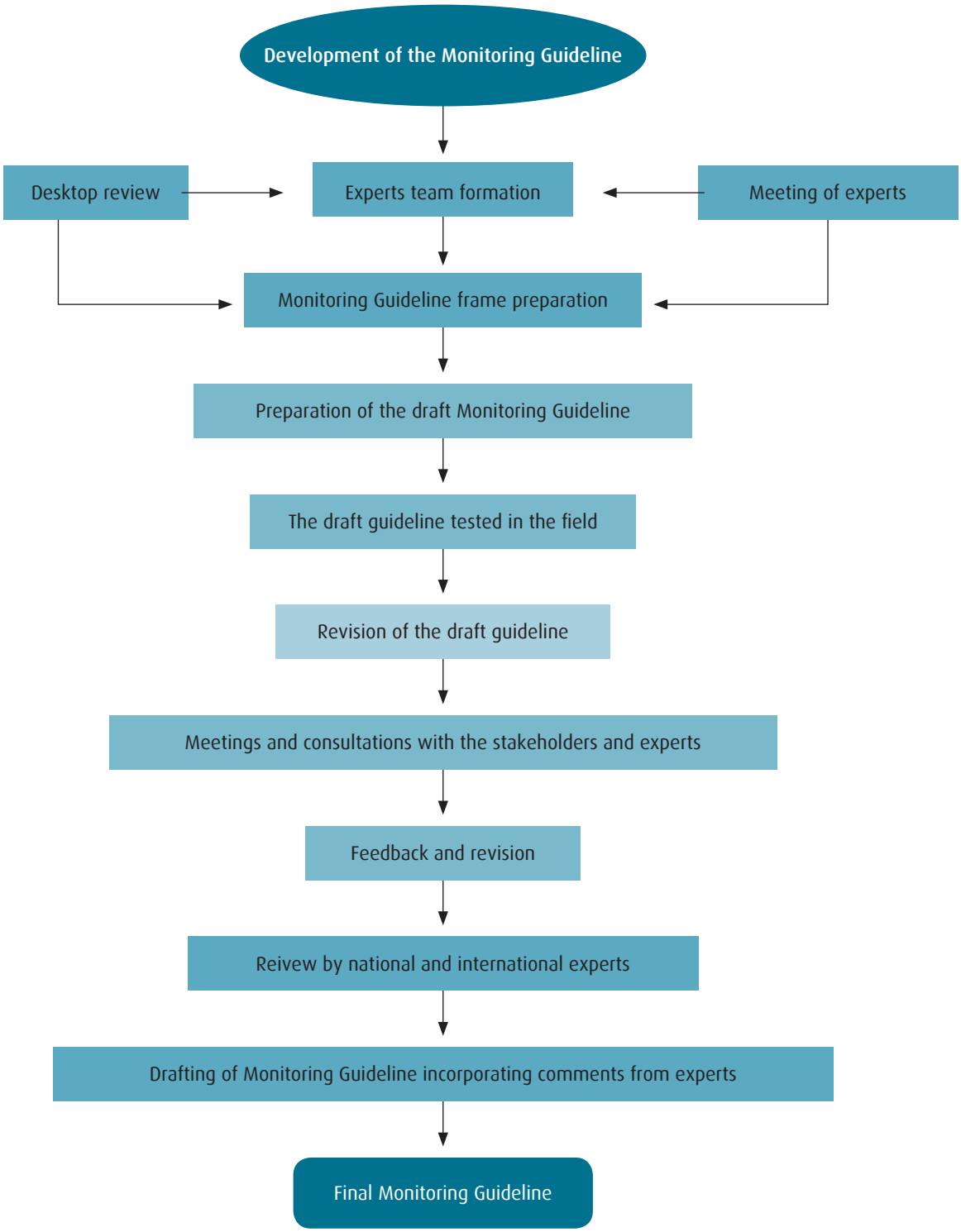

Figure 14. Flow chart for the process of development of Pangolin Monitoring Guideline

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