

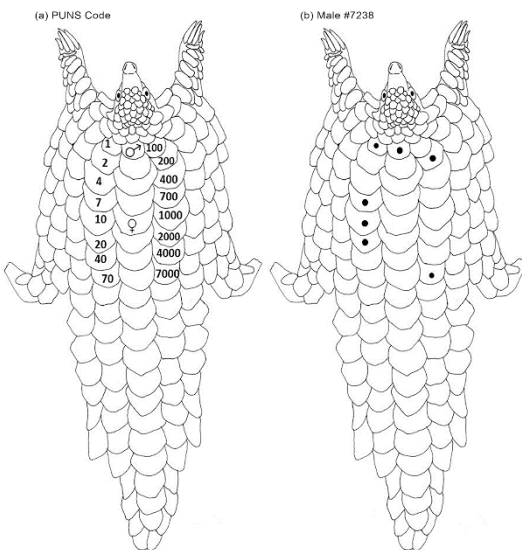
Save Pangolins website text:

Advancing Pangolin Tracking Science: A Review of Current Methods and Future Directions

This guide was developed to summarize best practices and tools for deploying pangolin tracking devices. The findings highlight relevant scientific literature, as well as the results of a new survey of practitioners regarding: transmitters, field logistics, and animal handling and welfare. Finally, this guide provides resources for pangolin conservation practitioners and researchers, including, a comprehensive table of transmitter specifications, three-dimensional ([3D\) printing protocols with model access links](#), [a scale notching protocol](#), uniform passive integrated transponder (PIT)--tagging location, [species-specific line diagrams](#), a practitioner directory, information about emerging nano-tag technology, and [education and marketing materials](#).

Pangolin Universal Notching System (PUNS)

Based on the findings of the survey, the authors of the guide also created a new Pangolin Universal Notching System to unify notching efforts in the pangolin community. The protocol uses a numerical based code to communicate individual identification and/or sex through a series of notches involving scales on or adjacent to the dorsal midline. The full manuscript and Standard Operating Procedures are available [online](#).



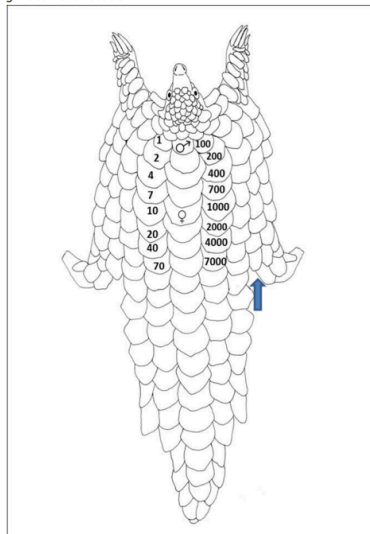
Pangolin Universal Notching System (PUNS) applied to a Temminck's pangolin (*Smutsia temminckii*). (a) Dorsal view: On its stomach with the anterior (head) at the top of the image with the pangolin facing away from the observer. The first scale immediately left of the midline scale row at the pectoral girdle

(shoulder) and the first scale immediately right of the midline scale row at the pectoral girdle are always 1 and 100, respectively. The first midline row scale between the 1 and 100 scales is male, and the fifth midline row scale is female. (b) Male Individual #7238 marked with the Pangolin Universal Notching System (PUNS): To identify number 7238, the 7000, 200, 20, 10, 7, and 1 scales as well as the first scale in the midline, indicating male, are marked.

PIT Tagging Protocol

Based on [survey results](#), the authors recommend adopting a uniform PIT tagging location to facilitate ease and consistency of scanning for tags when a new individual is encountered. For those practicing PIT tagging, utilizing the top of the thigh area of the right hind leg is recommended. This location is consistent with what is required for all pangolins being rehabilitated from trade in South Africa (APWG, 2022)*

Recommended PIT Tag Placement Location

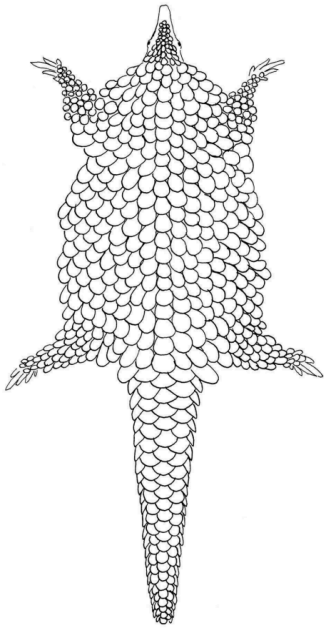


* African Pangolin Working Group (APWG). (2022). *Standard Operating Procedure (SOP) For All Pangolins Retrieved Out Of The Trade In South Africa, As Set Out By Government*.

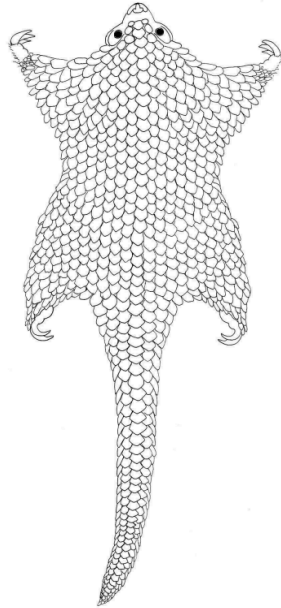
<https://africanpangolin.org/wp-content/uploads/2022/07/Standard-Operating-Procedures-web.pdf>

Species-Specific Line Diagrams: Open source line diagrams are available for use for Sunda, White-Bellied, Black-bellied, and Temmick's pangolins. Artist credit to Sarah Crumb is appreciated.

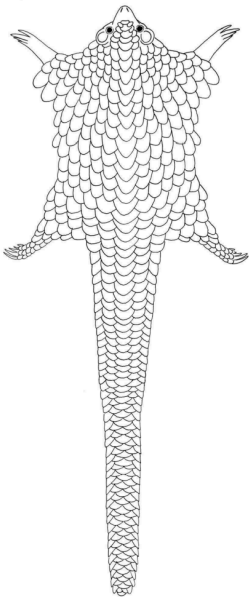
Sunda Pangolin (Manis javanica)



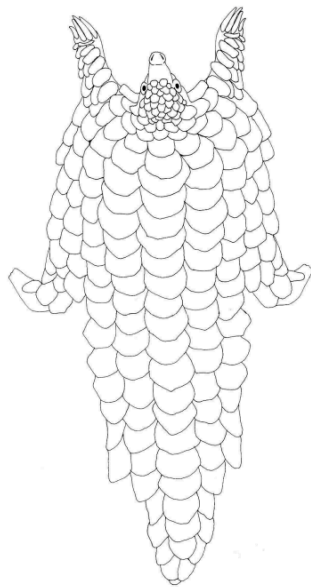
Tree or African White-bellied Pangolin (Phataginus tricuspis)



[*Long-tailed or Black-bellied Pangolin \(Phataginus tetradactyla\)*](#)



Cape or Temminck's Ground Pangolin (Smutsia temminckii)



3D Printing SOP and Links

Lastly, the authors developed 3D models of pangolins and pangolin scales, which were modified from a 3D scan of a pangolin generously provided by the National Geographic Society. An accompanying 3D printing SOP provides guidance on how to physically print the models. The increasing accessibility of 3D printing technology presents a low-cost opportunity to create pangolin models that may be used to address these unique challenges of (1) training specialized handling techniques prior to working with live subjects in a high-stakes setting, (2) designing customized tracking devices, and (3) allowing individuals to interact with a pangolin, all without the need for a live subject. Therefore, these 3D printed models can help reduce the risk of unintended harm during human-pangolin interactions and increase overall pangolin welfare during any necessary handling (e.g., during transportation, deploying tracking devices, biological sampling, veterinary care).

Open source [3D Printing SOP](#) and models for multiple species accessible at the links below:

Model	Species	Access link
Single scale	Temminck's pangolin (<i>Smutsia temminckii</i>)	<i>release forthcoming</i>
Single scale	Giant pangolin (<i>Smutsia gigantea</i>)	<i>release forthcoming</i>
Single scale	Black-bellied pangolin (<i>Phataginus tetradactyla</i>)	https://www.thingiverse.com/thing:6327616
Single scale	White-bellied pangolin (<i>Phataginus tricuspis</i>)	https://www.thingiverse.com/thing:6327616
Single scale	Sunda pangolin (<i>Manis javanica</i>)	<i>release forthcoming</i>
Single scale	Chinese pangolin (<i>Manis pentadactyla</i>)	https://www.thingiverse.com/thing:6327616
Single scale	Indian pangolin (<i>Manis crassicaudata</i>)	https://www.thingiverse.com/thing:6327616
Single scale	Philippine pangolin (<i>Manis culionensis</i>)	<i>release forthcoming</i>
Body cross- section (long)	General pangolin model that can be rescaled as needed	https://www.thingiverse.com/thing:6327767
Body cross- section (short)	General pangolin model that can be rescaled as needed	https://www.thingiverse.com/thing:6327767
Full body (life size)	General pangolin model that can be rescaled as needed	<i>release forthcoming</i>