

# Nest existences and population of Pangolin (*Manis javanica* Desmarest, 1822) at the designated area of Cisokan Hydropower, West Java, Indonesia

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**Abstract.** Withaningsih S, Noorahya F, Megantara EN, Parikesit, Husodo T. 2018. Nest existences and population of Pangolin (*Manis javanica* Desmarest, 1822) at the designated area of Cisokan Hydropower, West Java, Indonesia. *Biodiversitas* 19: 153-162. Pangolin (*Manis javanica*) is one of the unique mammals found in Indonesia, which is categorized as protected species. However, the scientific information regarding with the population and distribution of this species is still low. Therefore, the study aimed to estimate the total population, distribution, and potential threat to Pangolin in the designated area of Cisokan Hydropower, West Java. Study was conducted using three methods; direct observation (survey) of animal signs (nest, footprint, tail print, claw marks, and feed left over), camera traps placement, and semi-structure interviews. The result shows that the active and abandoned (inactive) nests were found within the study site, and could be classified as tree nest, rock nest, and ground nest. The total population of Pangolin in Cisokan hydropower project site was estimated around 6-20 individuals. This population was distributed in five different areas; first areas were Pasir Gagak, Cigintung, Batu Nunggul, and Batu Sahulu; second area was Batu Wulung; third areas were Curug Japarana and Curug Walet; fourth areas were Hutan Gowek and Cadas Gantung; fifth area was Pongpok. The potential threats experienced by Pangolin were from illegal hunting activity and habitat fragmentation caused by infrastructure development and field clearing for crops plantation.

**Keywords:** Distribution, nest, Pangolin, population

## INTRODUCTION

Pangolin (*Manis javanica*) is known as one of the unique mammals inhabiting in the fragmented and remote habitat in some parts of Indonesia. The unique characteristic of the Pangolin is its body covered by a hardened-scaled made of keratin in most of its body except for the belly section (Farida 2010). Pangolin also has a specific behavior to roll in its body as a ball on a threatening condition, so that it has been named as Pangolin, which in Malay means to roll or roll in as a ball (Astuti 2012). In Indonesia, Pangolin is classified as a protected species referring to the Indonesian Government Policy No. 7, 1999 and also included into Convention on International in Trade Endangered Species (CITES) Appendix II watch list, indicating that Pangolin could only be sold internationally through quota system from origin countries (IUCN 2017). Despite all of the issued regulations, the declining population of Pangolin apparently still happens. Therefore, during the 17<sup>th</sup> Conference of the Parties (COP) 2016 all of the Pangolin species are included into Appendix I CITES list. The high demand and price of Pangolin at international market is one of the main factors causing the decreased population of Pangolin. In addition, the illegal hunting practices caused the wild population of Pangolin decreased more than 50% during last 15 years (Adiseno 2008).

In Indo-China area, Pangolin has become one of the main ingredients for Traditional Chinese Medicine (TCM) for a hundred years as a part of heritage in the Chinese culture (Challender et al. 2014). The population of *Manis pentadactyla*, one of the local Pangolin species in Indo-China, plummeted significantly leading to the increased status of this species becomes an extinct species. Therefore, the Pangolin hunting spread to other countries such as Indonesia, Malaysia, India, and even in Africa (Wirdateti et al. 2013). Indonesia is the main target market of Pangolin suppliers to collect Pangolin species by illegal sale practices, which was known very high in the world (Sutter 2014).

One of the Pangolin's remnant habitats in Java Island is around Cisokan Hydropower Project area in the Regency of West Bandung, West Java, Indonesia. Many types of ecosystems presented in this area, including secondary forest, production forest, agroforestry or *talun*, shrubs, areas of burned and damaged fields, paddy field, fishpond, local settlement, and yards. The development of electrical hydro-power (PLTA) in Cisokan and the human activity in the designated area of Cisokan, might disturb Pangolin activities and habitats leading to the declined number of its population. This study aimed to determine the population number of Pangolin and its distribution in the designated area of PLTA Cisokan, which could be recommended in the further management of adaptive conservation of *Manis javanica*.

## MATERIALS AND METHODS

This study was conducted using three methods; direct observation (survey) of signs, camera trap placement, and semi-structure interviews. Direct observation for signs was done to find footprints, tail prints, nests, claw marks, and feeding sites. The camera traps were placed at 20 locations to estimate the total number of individuals (population) and Pangolin distribution (Figure 1). The semi-structure interviews were conducted to gather initial information for *M. javanica*'s characteristics, presence, distribution and also the potential threats that may occur.

The estimated number of individual was undertaken on the assumption that the individual observed and trapped by recorded camera located in the same designated area of Pangolin was assumed as the same individual (Jansen et al. 2014). The determination of individual based on the camera trap recording also considered another Pangolin characteristics including the body size of the recorded Pangolin, time, and its direction of movement. The total number of individuals could be acquired from the number of active nests with the assumption that each nest was inhabited by one up to four Pangolins, because Pangolins are a solitary animal, however, during mating and breeding season, those nests could be inhabited by more than one individuals. The determination of the individual number of Pangolin was done by measuring footprints, on the assumption that the first and second footprints having the

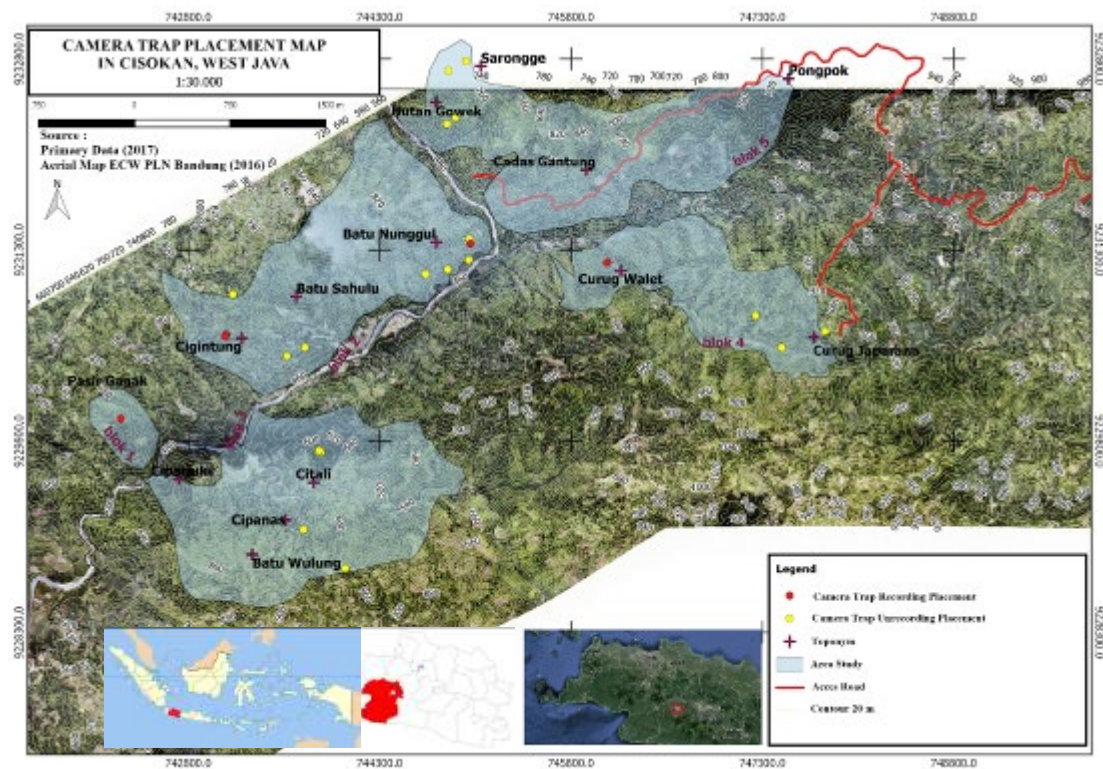
same size was found less than 7 km area, it came from the same individual. □

27 camera traps were placed at 20 locations; five camera traps placed at four different locations successfully recorded Pangolin's movement. The location of camera traps placement was shown in Figure 1. The distribution data was projected in a map, where coordinate points of the Pangolin's signs and observations were interpreted into satellite imagery or maps. The distribution maps were made using QGIS ver.2.18 Las Palmas software.

## RESULT AND DISCUSSION

### Cues of Pangolin existences

Pangolin is nocturnal, which the main activity is taking place during nighttime while during the daytime is used as sleeping or hibernation mode (Medway 1969). The result of field tracking using sign survey showed that 45 traces consisting of nests, footprints, tail prints, claw marks, and feeding site was found in the designated area (Table 1). Those cues were mostly found in the designated area confirmed by local people during the interview section, although not all of them were traced in all of designated area. There were also some traces found in another location, which has not been informed previously.



**Figure 1.** Camera trap placement map for observing Pangolin existence located at 27 different places in Cisokan, West Java, Indonesia

**Table 1.** The traces of Pangolin found in the study site of Cisokan, West Java, Indonesia

Trace	Number
Nest	36
Footprints	2
Tail prints	4
Claw marks	1
Feeding site	2
Total	45

Results from the field observation and sign survey showed that the trace of Pangolin's nest was mostly found in the study area compared to other traces. This might happen because Pangolin is a nomadic animal, which tended to change its nest location on a daily basis resulting in many leaving nest sites in different places. In addition, nest is also the easiest trace to be found because it is more preservable compared to other traces such as footprint, tail prints, and claw marks, which could be easily erased or cleansed by rainfall.

In this study, the trace of Pangolin's footprint was only found twice (Figure 2). Pangolin's footprints are hard to be found because it could only be seen if the ground is wet enough, but the footprint will disappear in the open space because rain might wipe it off. Of the two footprints found, the only visible part of the footprint was three claws from Pangolin's rear legs. Pangolin usually lifts both of its front legs and rests on the rear legs when it is sniffing around (Masy'ud 2011). Furthermore, the posture of the front and rear legs differ because the front legs are mostly used for digging up the ground or dismantling tree bark when it is searching for food. Front legs claws have a long length bend inside while walking, therefore only its back part that touches the ground (van Strien 1983). Figure 2.A shows the footprint of Pangolin, which could only be observed in distance of 10 m before it disappeared. However, not all footprints were formed in a perfect shape, they were only seen as a mark on the ground. Figure 2.B shows a single footprint did not form a step mark. The width of both footprints from the top left to right was 2.5 cm. This result

was in line with the sketch of Kanjanavanit (1997) in which the footprint in a perfect formation might spread up to 3.2 cm. □

The tail print of Pangolin marking on the ground came from the movement of Pangolin tail and left a mark on trees, rock, and leaves during the rub activity (Figure 3). There were four tail prints found in this study. Tail prints are hard to be found as sign/trace, similar to footprints because they disappear easily when the rain comes. However according to the informant hunter, tail prints were easy to recognize and many traces could be found compared to footprints or claw marks. Tail prints might be found next to rock where Pangolin was passing through or even on grasses or leaves. This was because when Pangolin was moving, their tail was lifted based on observation in camera recording. Therefore, in most of the time Pangolin's tail was rubbing on to soil surface higher than the ground where they stepped on. □

The length of Pangolin's tail print might vary, depending on the surface, which it was rubbed and the direction of movement. Figure 3.A and 3.B show that the tail length reached up to 16 and 12 cm. But in Figure 3.C, the tail print dispersed on the leaves. The direction of Pangolin's movement could be determined based on its tail print, which is located in the same direction as the tail print trace and goes to lower ground. The key informant mentioned that the tail of Pangolin would rub more frequently when they walked down to lower ground, but they tended to lift their tail when they are walking up to higher ground.

The sign of a claw mark was only found once during this study. This is because the trace of claw mark is hard to be found and it was easily erased when rain comes as same as tail print and footprint. Moreover, claw marks left by Pangolin are somewhat alike with other animal's claw mark like porcupine, and it might be difficult to differentiate from one another. If claw marks are found in single form, it is highly possible that the claw marks belong to Pangolin because this animal is a solitary animal, while porcupine's claw marks were commonly found in many traces because this mammal is social animal.

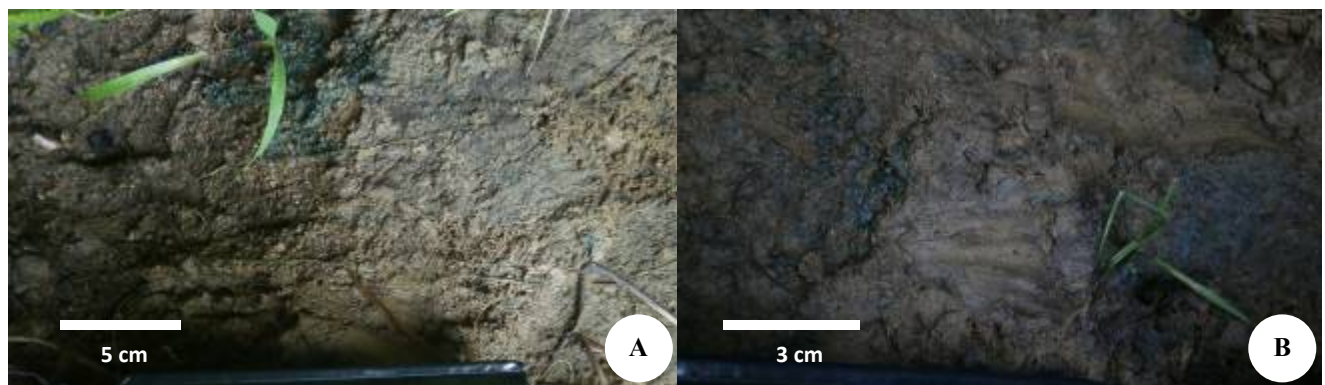


**Figure 2.** A. and B. Footprint of Pangolin found at two different locations in Cisokan, West Java, Indonesia; C. Footprint sketch (Kanjanavanit 1997)





**Figure 3.** Tail print of Pangolin found in Cisokan, West Java, Indonesia. A. Tail print on a branch; B. Tail print on a rock; C. Tail print on leaves



**Figure 4.** The claw mark of Pangolin found in Cadas Gantung, Cisokan, West Java, Indonesia



**Figure 5.** Types of Pangolin's nest found in the study area of Cisokan, West Java, Indonesia: A. Rock nest; B. Ground nest; C. Tree nest

**Table 2.** Type and number of nests found in the study area of Cisokan, West Java, Indonesia

Nest type	Number		Total
	Active	Inactive	
Tree	0	4	4 (11%)
Rock	7	11	18 (50%)
Ground	1	13	14 (39%)
Total	8 (22%)	28 (78%)	36

In the study area, claw mark was found at the entrance of rock nest on the river bank (Figure 4). Based on the claw mark, the movement of Pangolin could be trailed. Based on this claw mark, it showed that Pangolin had a tendency to go to higher grounds, while tail mark was found when the Pangolin went to lower grounds. In the area where claw marks were found, it seemed that marks have different length and connected each other, which showing its direction. The claw mark found had average length of 5-15.5 cm.

### Nest characteristics of Pangolin

There were three types of nest found in the study area, i.e. rock nest, ground nest, and tree nest. Nests sites were usually found in different environmental conditions. Figure 5 illustrates the surrounding condition in nesting sites, while types and numbers of active and inactive nests are summarized in Table 2.

Among the three nest types, rock nest was the most commonly used, not only by Pangolins, but also by Porcupine. According to the informants, some rock nests found in the study site were initially used as porcupine's nests, which was then occupied by Pangolin. This is in accordance with Wirdateti et al. (2013) who pointed out that Pangolin often occupies other animal nest like porcupine's or skunk's nests. The number of rock nest found in the study site suggested that another animal species such as porcupine, was also living in rock nests besides of Pangolin. Rock nests have the average length of 16-170 cm, 8-98 cm wide, and 77 cm up to 3 m in depth. In the present study, Pangolin made hole and path for rock nest by excavating the ground beneath rock, which could be seen from only two holes made from the rock cracks.

Ground nests were also found in a quite large number because Pangolin made a hole, not only for resting hole but also for food source. The main foods of Pangolin are ants and termites, and these kinds of foods required another hole excavation. However, Pangolin has to crack the dead tree bark in order to find termites. The ground nest is easier to be build because it has a soft texture, so that the energy requires to build the ground nest is more efficient by only using half strength of Pangolin than that to build another nest type (Mustikasari 2017). The ground nest has an average of 8-100 cm long, 15-73 cm wide, and 50 cm up to 3 m deep. In a location where ground nest was found, another close holes was also commonly found, which may have a function as food holes.

Tree nests had the average length of 21 cm up to 1 m, 12-15 cm wide and 1-3 m in depth. Some holes on the tree had a large diameter on the entrance and they shrink on the inside, which were ended into a small path. Tree nest were usually found, both in life and dead trees, such as fallen tree trunks. This was in line with Lim and Ng (2008) who reported that Pangolin used three nests in one period; two of them were nest on a dead tree trunk and one was on living tree. □

Based on the utilization time, nest could be separated into active and inactive nests. Active nest is a fresh or newly used nest by Pangolin, while inactive nest is occasionally used and abandoned nest. However, inactive nest might be re-used in the future. Active nests located in the ground could be identified based on the sign and traces found near the nest, like footprint, tail prints, claw marks, feeding site, or fresh excavating material. Nest is considered as inactive if none of those traces or signs were found near the nest. Inactive nest might be identified by the presence of spider web covering the nest or leaves covering the entrance area of the nest. The example of active ground nest found during the data collection was shown in Figure 6 where a fresh excavating material was found.



**Figure 6.** Active ground nest of Pangolin in Cisokan, West Java, Indonesia

The number of inactive nests was larger than active nests because Pangolin is a nomadic animal that tends to change its nest frequently. The nomadic behavior could also be found in Pangolin's habitat at Perkebunan Teh Cigombong, South Cianjur, and at Suaka Alam Gunung Honje Timur, Pandeglang Banten, where activity traces of Pangolin could be seen in specific moving/exploring pattern with the pathway route was not in a straight line but winding from one place to another, and Pangolin never return to the same route again. But after approximately two months or so, Pangolin might use the same path route although it never return to the old-nest (Heryatin 1983). This was supported by Mustikasari (2017) who studied the Pangolin activity at the Cagar Alam Bojonglarang Jayanti in 2016, which indicated that 81% of Pangolin nests was inactive nests (Mustikasari 2017). □

As shown in Table 2, active nests in the study area were mostly rock nest. But ground nest was found in large number, although not all were resting holes; some were feeding hole. As the main foods for Pangolin are ants and termites, this animal has to dig a hole in the ground in search of foods. Pangolin finds ants and termites by sensing the smell from the ground before digging. After finding the estimated area, Pangolin digs the ground using its front leg's claws until ants or termites come out of their nest (Mustikasari 2017). This process left a lot of ground hole that makes a lot of inactive nest of Pangolin. According to Suratmo (1979), the feeding behavior of Pangolin is related to food availability, habitat or environment, season, threats, biological condition and feeding manner. Warsono (2002) also mentioned that feeding behavior is affected by genetic factors, surrounding temperature, available food, and habitat. □

### The activity and performance of Pangolin

The camera traps were able to capture some of Pangolin activities in several locations. The locations and time of camera trap's recordings are shown in Table 3. Based on the sign and camera trap recording, it was identified that Pangolins were distributed within five areas. The first areas were Pasir Gagak located in Block 1 and; Cigintung, Batu Sahulu and Batu Nunggul located in Block 2. The second

area was Batu Wulung, located in Block 3. The third area was Curug Japarana and Curug Walet located in Block 5. The fourth area was Hutan Gowe and Cadas Gantung located in Block 5. And the fifth area was Pongpok, located in Block 5. The grouping of these areas was based on the capability of Pangolin to roam, which is around  $\pm 4.5$ -7 km in a single night with total roaming area of 6.97-43.3 ha (Heryatin 1982; Lim and Ng 2008). Some areas were separated by a big river, i.e. the first and the second area. While, the third and fourth areas were separated by Cisokan River and; Cilengkok River separated the fourth area with the second and third areas. The strong current of these two rivers might wash away Pangolin when they were trying to cross over. Therefore, areas separated by a strong river current were assumed as a different roaming area of Pangolin.

In general, there were seven type and structure of plants communities found in the study area. These seven types were natural forest, riparian ecosystem, shrubs vegetation, production forest, agroforest called *talun*, *huma*, and rice field. Among these seven types, the trace existence of Pangolin were found in natural forest ecosystem, production forest, shrubs, and *talun*. Pangolin lives in more than one habitat such primary forest, secondary forest, even in plantation area of rubber, palm oil, or even in open spaces near human settlements area (Lekagul and McNeely 1977; Davies and Payne 1982; Nowak 1999). In other areas in Indonesia like in Tanggamus and Lampung Barat Regencies, Pangolin was found in the production forest and secondary forest (Wirdatetiet al. 2013).

In natural forest where signs were found at Hutan Gowe and near Curug Walet, some of the nearby plants

found were *Huru*, *Ki Hiang*, *Areuy*, *Kiara Bunut*, *Kiara Caringin*, *Kipancar*, *Kimokla*, *Ramo Giling*, *Bangsi*. In the production forest at Cigintung, which was dominantly grown by Teak and Mahogany trees, the traces of Pangolin were found. The shrub vegetation usually appeared from abandoned *huma* or other upland agricultural land. There were many plant species found near the Pangolin's signs at Pasir Gagak, Batu Sahulu, Batu Wulung, Pongpok, and Cadas Gantung such as *Kaliandra*, *Katepos*, *Kirinyuh*, *Bayondah*, *Kaso*, *Saliara*, *Cau Kole*, *Mara*, *Gadung*, *Seuseureuhan*, *Beunying*, *Cangkoreh*, *Taleus*, *Kibanen*, *Calik Angin*, *Paku Rane*. Some plant species used for nest materials were *Kiara*, *Bungur*, and *Ki Acret*.

There were 12 Pangolin recordings acquired from five different camera traps placed in four different locations (Table 4). There was one location which two camera traps were placed in different facing angle. The total recordings acquired were 63 photos and 6 videos. Results showed that the activity of Pangolin based on observation in camera traps happened mostly between 20.33 and 03.18 local time. This is in accordance with the behavior of Pangolin as nocturnal animal. Most of collected recordings showed that the activity of a single individual, i.e. Pangolin's walking and digging activities. To differentiate individual Pangolins, camera traps recording could be used because Pangolins do not have any specific characteristic from one another. The differences could be observed from Pangolin's body size, recording time, and the direction of movement when it was recorded. Figure 7 shows one example of a footage captured from camera trap in two different locations.

**Table 3.** Location and time of camera traps of Pangolins in Cisokan, West Java, Indonesia

Camera code	Coordinate (48 m)	Place	Elevation(m)	Placement periode	
				Installing	Collecting
PLN 2	743094.84 m E 9230635.66 m S	Cigintung	703	07/02/2017	07/03/2017
PPSDAL 2	743088.25 m E 9230622.41 m S	Cigintung	699	07/02/2017	07/03/2017
PPSDAL 3	742270.22 m E 9229976.83 m S	Pasir Gagak	639	22/02/2017	09/03/2017
PPSDAL 9	745011.59 m E 9231350.18 m S	Batu Nunggul	495	09/03/2017	19/03/2017
PPSDAL 6	746083.2 m E 9231201.34 m S	Curug Walet	524	07/03/2017	10/04/2017

**Table 4.** Time and Pangolin's activity recorded through camera traps

Camera code	Record type	Date	Time (WIB)	Number of individual	Activities
PPSDAL 2	Photograph	16/02/2017	23:03	1	Walk in and out of the hole
PPSDAL 2	Photograph and video	20/02/2017	00:16-00:18	1	Walk in and out of the hole
PPSDAL 2	Photograph and video	27/02/2017	02:31-02:34	1	Walk in and out of the hole
PPSDAL 3	Photograph	02/03/2017	3:18	1	Walk
PPSDAL 3	Photograph	02/03/2017	21:10-21:11	1	Digging/clawing (foraging)
PPSDAL 3	Photograph	02/03/2017	23:16	1	Walk the opposite direction of the Pangolin recorded at 21.10-21.11
PPSDAL 3	Photograph	06/03/2017	23:28	1	Walk
PPSDAL 2	Photograph and video	06/03/2017	1:41	1	Walk in and out of the hole
PLN 2	Photograph	06/03/2017	1:44	1	Walk
PPSDAL 3	Photograph	07/03/2017	1:35	1	Walk
PPSDAL 9	Photograph	13/03/2017	20:33	1	Walk
PPSDAL 6	Photograph	02/04/2017	1.2	1	Walk





**Figure 7.** Java Pangolin recorded in camera trap in Cisokan, West Java, Indonesia

Most of the sign of Pangolin existence were found on sloppy area. Commonly, Pangolins prefer steep slopes, because this area helps them in defensive mechanism. Under threatening situation, Pangolin would tuck in into a ball shape, and sloppy condition will help the animal to roll away from danger (Heryatin 1983). In this study, the signs of Pangolins were found at elevation of 531-757 m above sea level. Different with other studies, Pangolin's signs were found on 10-100 m elevation above sea level (Mustikasari 2017), 25-250 m and 800-1200 m (Heryatin 1983), and on 1450-2000 m (Bhandari and Chalise 2014). These results suggest that Pangolin is an adaptive animal that may live on different elevation, different temperatures, climate, and others natural conditions. In addition, to be able to adapt to different elevation, Pangolin lives on other type of habitat and food availability, which could be seen from results that Pangolin occupied four different plants communities of seven communities present in the study site. This indicates that Pangolin was able to live in different plant community present in the area, except in area where human activities was very intensive. There were three plants communities unoccupied by Pangolin, i.e. riparian ecosystem, *huma* and rice field. Based on feed taken, Pangolin was also considered as adaptive animal as ants and termites could be found easily in any kind of habitat.

The ability of Pangolin as an adaptive animal in different kind of habitats was in line with Lim (2008) who studied the ecology and conservation of Java Pangolin. Pangolins found during his study, were found in secondary forest, agriculture area, and settlement. Lim also pointed out that Pangolin is also adaptive animal based on the type of staple food. Ants and termites could be found in every habitat indicate that food is available in every habitat. A large number of nests found in several locations where food was abundantly available near the nest. However, female Pangolin in her reproductive period showed a low adaptive level compared to another Pangolin. Female Pangolin during the period of rearing her infant only occupied large tree trunks with the diameter of breast height was more than 50 cm. This indicates that an intact

natural forest is an important factor for Pangolins during their breeding/reproduction period, and the existence of this type of forest is well related to Pangolin existence in the future (Lim 2008). □

#### **The estimation of Pangolin distribution and abundance**

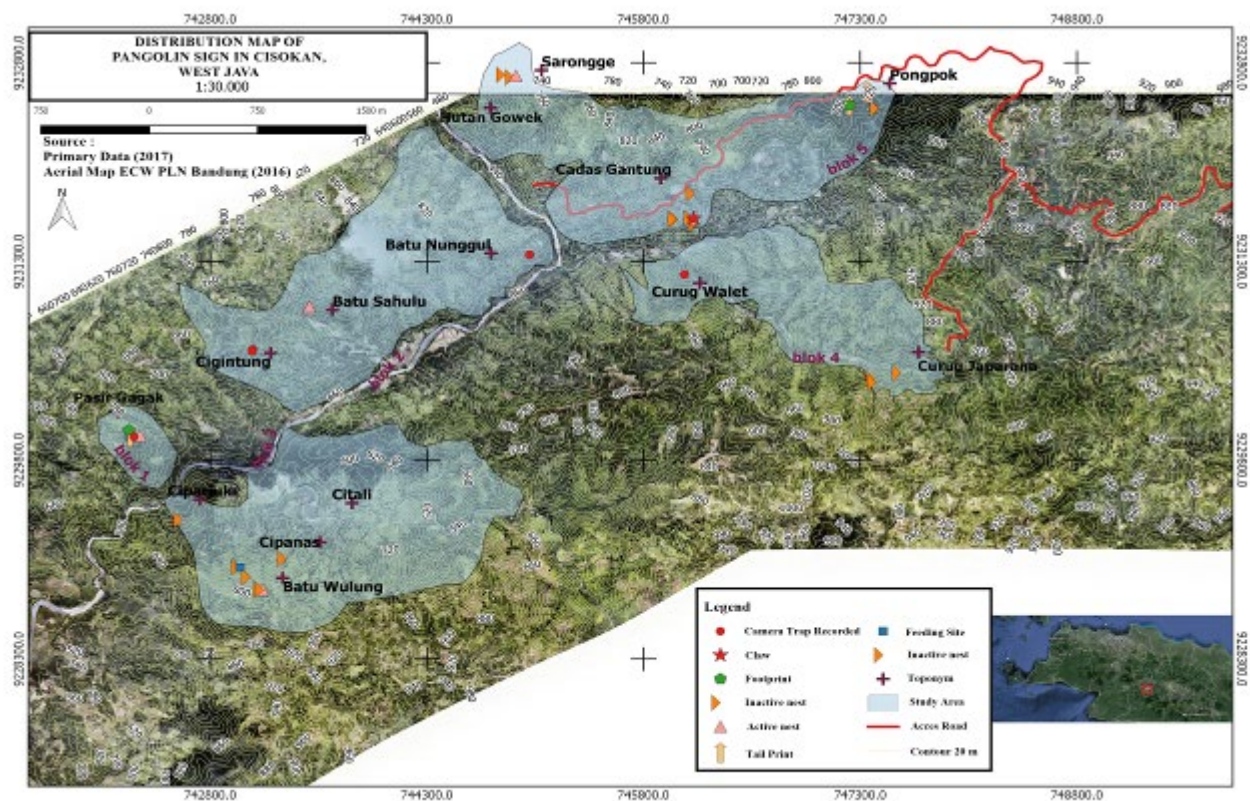
Based on the estimation of four factors, i.e. location and roaming area, time of sign found or camera trap recording, Pangolin body size on camera trap recording and movement direction, the estimation data of Pangolin abundance and distribution were shown in Table 5 and Figure 8. From the data collection carried out during February until April 2017, 45 sign data and 12 camera trap data were obtained. From the whole data, it was estimated that the Pangolin population found were 6-20 individuals. The estimation was undertaken based on the analysis of location, time, and individual morphology. Based on the location and roaming area found, Pangolins in Cisokan were distributed into five different locations. Individual estimation based on camera trap recording referred to the recording time, direction of movement, and individual size. Generally, estimation based on the sign referred to the body size, time encountered, and Pangolin's movement direction. Meanwhile, nest-based estimation was based on the assumption that one active nest was occupied by single Pangolin to a maximum of four individuals under an assumption that a female Pangolin has three younglings (Nowak 1999).

Based on the distribution map where Pangolin traces were found, it showed that the Pangolin existence could be divided into five different location (Figure 8). The first location covering Pasir Gagak, Cigintung, Batu Nunggul, and Batu Sahulu had an estimation of 2-4 Pangolins existence. The minimum estimation was based on the camera trap recording where Pangolin in different time sighted at the same location. The maximum estimation (four Pangolin individuals) was based on the camera trap recording and active nests. There were four camera traps recording on different time at three location, i.e. Pasir Gagak, Batu Nunggul, and Batu Sahulu; each camera recorded one active nest. □

**Table 5.** Estimation of number of Pangolin individuals in the study area of Cisokan, West Java, Indonesia

Location No.	Location (BIA/Corridor)	Data type							Number of individual
		CT	Fc	FP	TAPI	FS	Sc	Br	
1	Pasir Gagak	2-4	-	1	1	1	-	1-4	2-4
	Cigintung	1-4	-	-	-	-	-	1-4	
	Batu Nunggul	1	-	-	-	-	-	-	
	Batu Sahulu	-	-	-	-	-	-	1-4	
2	Batu Wulung	-	-	-	-	1	-	1-4	1-4
3	Curug Japarana	-	-	-	-	-	-	1-4	1-4
4	Curug Walet	1	-	-	-	-	-	-	1-4
	Hutan Gowek	-	-	-	-	-	-	1-4	
5	Cadas Gantung	-	-	-	-	-	1	1-4	1-4
	Pongpok	-	-	1	1-2	-	-	1-4	
Total									6-20

Note: CT: Camera Trap; Fs: Feces; FP: Foot Print; TP: Tail Print; FS: Feeding Site; Sc: Scratch/claw marks; Br: Active Burrow/nest

**Figure 8.** Distribution map of Pangolin sign found in the study areas of Cisokan, West Java, Indonesia

In the second to the fifth location, the camera trap only recorded Pangolin in the third location and only sighted once, therefore, the maximum estimation was in accordance to the sign of active nests. The estimated number of individuals in this area was then accumulated in order to estimate the total population. Even though there was no exact number of Pangolin directly observed in the study site, it was estimated that the number of Pangolin was no less than 16 individuals. This was based on the

assumption that the study site area was approximately 723 Ha and each Pangolin individual might occupy 6.97-43.3 ha of roaming area (Lim and Ng 2008). The estimated number of Pangolin population in the study area was also based on the average roaming area 5-7 Ha (PLN-LPPM UNPAD 2014). The present study could only estimate the total number of individual, but could not distinguish sex and age because of the limitation of the signs and camera trap recordings.



### The impact of human activities toward the Pangolin population

Human activities threatening the existence of Pangolins in the study area were illegal hunting and habitat destruction. Hunting activity practiced by local people at the beginning was intended to get Pangolin meat for self-consumption and for Pangolin's scale that could be used as repellent lemur pest in rice field. During the early 2000, local people began to understand that Pangolin's scales have a high economic value, and the hunting activities started to change its purpose from self-consumption to commercial. Scales price could be as high as Rp 100,000/kg, while living Pangolin could reach Rp 200,000-Rp 250,000/kg. Pangolin hunter sold to outsiders (from Sukabumi and Cianjur Regencies) at the average price of Rp 300,000/kg.

Factors affecting Pangolin habitat fragmentation in Cisokan area, in general, was landslide caused by the development of access road and land clearing for agriculture. Access road facilitated motorcycle that might produce noise from the engine. Local people stated that the development of access road using explosive materials caused landslide so that Pangolin could be buried accidentally. Other informant confirmed that when the explosive was used, some Pangolins were caught, which were then taken by local people for sale. **Figure 9** illustrates the abandoned nest of Pangolin located under the access road development area and buried by debris of landslide.

Land clearing had been conducted since a long time ago by local people with the intention of making area for plantation, rice field, cash crop garden, *huma*, and *talun* to cultivate foods and fibers to fulfill daily needs. The cultivated land was usually given a fallow period after being used for several years. During the fallow period, shrubs and bushes would emerge which was called "*reuma*" by locals, and would be reopened after one or two year. Human activity in land cultivation might cause disturbance to Pangolins and led to the Pangolin's inability

for nesting in the disturbed site. Pangolin is a sensitive wild animal reacting to human activity. They tend to make their nests/burrows at least 1000 m from the disturbance sources. This is because Pangolins cannot adapt well to noisy situation. The noise coming from other animal or livestock and human voices would interrupt Pangolin activity and mostly would scare them off resulting in stress for the Pangolin (Wu et al. 2003; Sawitri et al. 2012). Other evidence shows that Pangolin is a very sensitive animal because Pangolin is unable to be habituated when there are humans around after one month of habituation process (Lim 2008). *Huma*, rice field and cash crop gardens were found in almost every part of the study site suggesting that high human activity is taking place in every land block. Only in Hutan Gowek (Block 5) *huma*, *talun*, rice field, or cash crop gardens were not present. However, at Hutan Gowek shrubby vegetation indicating land clearing for local people's plantation in the past could be found. Land clearing activity could also cause other disturbance for Pangolin aside from habitat destruction, like increasing the chance of Pangolin hunting.

In conclusion, type of Pangolin nests found within the study area could be differentiated into three, namely tree nest, rock nest, and ground nest. Based on the sign survey and camera traps, Pangolin population within the designated area of PLTA Cisokan, West Java, were approximately 6-20 individuals. This estimated number was distributed in five different areas; the first area covered Pasir Gagak, Cigintung, Batu Nunggul, and Batu Sahulu; the second area was Batu Wulung; the third area was Curug Japarana and Curug Walet; the fourth area consisted of Hutan Gowek and Cadas Gantung; and the fifth area was Pongpok. The threats experienced by Pangolins originated from human activities might affect Pangolin's existence, population, and distribution. Illegal hunting, habitat destruction and fragmentation caused by land use change from forest to *huma*, cash crop gardens, and *talun*, and also the development of access road could fasten Pangolin extinction in the study area. □



**Figure 9.** Pangolin hole covered by landslide in Cisokan, West Java, Indonesia

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