A preliminary study of bird and mammal diversity within restoration areas in the Gunung Gede Pangrango National Park, West Java, Indonesia

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ABSTRACT

Since 2008, Conservation International Indonesia (CI Indonesia) has been working together with Gunung Gede Pangrango National Park (GGPNP) to develop ecosystem restoration program in extended critical land area of National Park. More than 120,000 trees of 8 native species trees planted in an area of 300 hectares. Now the ecosystem has been restored and provides multiple benefits including become a new habitat for wildlife. A preliminary study on birds and mammals diversity in restored area was conducted from April to May 2018 in Nagrak Resort, GGPNP. The aim of this study is to assess the diversity of birds and mammals within ecosystem restored in the GGPNP. Bird surveys use point counts method, and mammals use camera trap. The results showed a total of 33 bird species of 22 families with the total number recorded of 1,881 individuals. A total of 10 mammal species of 7 families were captured in the study area with a total of 623 trap days produced 113 independent photos of mammals. The species of mammals consist of Javan leopard (*Panthera pardus melas*), Leopard cat (*Prionailurus bengalensis*), Common palm-civet (*Paradoxurus hermaphroditus*), Small indian-civet (*Viverricula indica*), Javan gold-spotted mongoose (*Hervestes javanicus*), Muntjac (*Muntiacus muntjac*), Long-tiled macaque (*Macaca fascicularis*), Javan porcupine (*Hystrix javanicus*), Wild boar (*Sus scrofa*), and Malayan field rat (*Rattus tiomanicus*). The results obtained are evidence that restoring ecosystems is important not only for social and economic aspects but also ecology for wildlife. The data gathered in this study will provide an important basis for future research and conservation management, and also provide support for biodiversity monitoring.

ABSTRAK

Sejak tahun 2008, Conservation International Indonesia (CI Indonesia) bersama Taman Nasional Gunung Gede Pangrango (TNGGP) mengembangkan program pemulihan ekosistem di area perluasan taman nasional. Lebih dari 120.000 dari 8 jenis pohon jenis asli taman nasional telah ditanam di luasan 300 hektar. Kini kondisi area telah menjadi hutan kembali dan menyediakan berbagai jasa ekosistem termasuk menjadi habitat satwa liar. Studi pendahuluan tentang keanekaragaman jenis burung dan mamalia di area restorasi dilakukan selama 2 bulan yaitu dari bulan April hingga Mei 2018 di Resot Nagrak TNGGP. Survei burung menggunakan metode *point count*, sedangkan mamalia dengan menggunakan *camera trap*. Hasil menunjukkan sebanyak 33 jenis burung dari 22 famili dengan jumlah total tercatat 1.881 individu. Terdeteksi 10 jenis mamalia dari 7 famili di area penelitian dengan total 623 hari rekam dan menghasilkan 113 foto independen mamalia. Jenis mamalia tersebut yaitu Macan tutul jawa (*Panthera pardus melas*), Kucing hutan (*Prionailurus bengalensis*), Musang luwak (*Paradoxurus hermaphroditus*), Musang rase (*Viverricula indica*), Garangan jawa (*Hervestes javanicus*), Kijang (*Muntiacus muntjac*), Monyet ekor panjang (*Macaca fascicularis*), Landak jawa (*Hystrix javanicus*), Babi hutan (*Sus scrofa*), dan Tikus belukar (*Rattus tiomanicus*). Hasil yang diperoleh menjadi bukti bahwa memulihkan ekosistem penting tidak hanya dalam aspek sosial dan ekonomi namun juga ekologi bagi satwa liar. Data yang dikumpulkan dalam penelitian ini akan memberikan dasar penting untuk penelitian masa depan dan manajemen konservasi, dan juga menyediakan dukungan untuk pemantauan keanekaragaman hayati.

Keywords: *Birds, camera trap, diversity, mammals, restoration*

INTRODUCTION

Land degradation is one of the major environmental issues of the 21st century because of its impact on biodiversity, food security and environmental quality (Butchart et al., 2005). Ecosystem restoration on a landscape level, alongside the sustainable management of other land-use types including agriculture, pasturelands, forestry, and the expansion and consolidation of protected areas, is increasingly recognized as a necessary part of a package of activities for biodiversity conservation, enhanced ecosystem services and sustainable development (Aronson and Alexander, 2013; Menz et al.,2013a; Rey Benayas et al., 2009; Bullock et al., 2011).

Restoration activities are not typically conducted with the goal of restoring a single ecosystem service. Rather, there is an implicit understanding that 'healthy' of ecosystems provide a large number of services and can serve to increase multiple ecosystem services (Bernhardt et al. 2005). Restoration can be enhancing

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native ecosystem functions and avoiding further reduction or conversion of natural habitat cover, or loss in other natural ecosystems (Latawiec et al., 2015).

Many protected areas are embedded within human-modified landscapes, where agriculture and urbanization have determined landscape structure and may represent major disturbances to natural ecosystems. Habitat loss and fragmentation are a major threat to biodiversity conservation in this context (Melo et al., 2013a).

The restoration of areas next to forest fragments should reduce edge effects as well as provide additional habitat, which should result in an increase in population size for several species, reducing the chances of future extinction. A small number of cases have demonstrated that restored areas can indeed provide additional suitable habitat for forest species (Donner et al., 2010; Reid et al., 2014).

In general, there is a lack of studies on the recovery of wildlife in reforested areas (Block et al., 2011), possibly because it is assumed that if the flora is re-established then wildlife will return to the reforested areas (Thompson and Thompson, 2004). However, animals provide important ecosystem function and if restored areas are to be implemented to reduce habitat loss and improve biodiversity, reforested areas also need to provide appropriate habitat to native fauna (Santos et al., 2016).

Many bird species can be highly dependent on forests (Seaman and Schulze, 2010; Gillies and Clair, 2008). These species occur exclusively or preferentially in the forest interior, suggesting that their performance is directly related to tree size and density (Seaman and Schulze, 2010). Birds are widely used as bioindicators for the monitoring of ecosystems under restoration, as they commonly present fast responses to forest development (Morrison et al., 2010; Lindell et al., 2012), and perform important ecological functions such as pollination, seed dispersal, and predation (Slocum and Horwitz, 2000; Zamora and Montagnini, 2007). Furthermore, mammals play an important role in ecosystems by providing essential services, such as regulating insect populations, seed dispersal, pollination, and ecosystem engineering (Beck, et al., 2010). They also act as indicators of general ecosystem health and are sensitive to anthropogenic disturbances that cause changes in the environment (Feldhamer et al., 2014).

According Supriatna (2006), an island of about 130,000 km², Java has been overcrowded for the last 200 years. Most of the natural forests remaining are in national parks or other, variously effective, forms of protected areas, including those for watershed conservation. Large areas of forest cover on the island are tree plantations (teak, pine, and others), mixed community forests, or forest research areas (silviculture). Java continues to lose its forests - significantly so following the Indonesian government's decentralization of forest management to the regencies. The major cause of natural forest loss today is not, however, industrial-scale logging, but encroachment and depredation by smallholders - tree cutting for subsistence plots, collection of firewood, forest fires, and charcoal production.

As a conservation area in West Java province, Gunung Gede Pangrango National Park (GGPNP) plays an important role as a biodiversity reserve. It was recorded that about 900 native and 30 exotic plants species, 1,500 species of flower plants, 400 species of ferns, 250 species of birds, 300 species of insects, 110 species of mammals, 75 species of reptiles, and five species of primates (Wiratno et al., 2004). In 2003, there were 7,655 hectares expansion of ecosystems in the GGPNP, consist of former tree plantations managed by Perhutani (Forestry State Enterprise), and bare or degraded lands. Species of the plantation are Merkus pine (*Pinus merkusii*), Rasamala (Altingia excelsa), and Dammar pine (Agathis dammara). Several parts of the expansion area are being encroached by local communities for small scale agricultural activities. The land that is being encroached on are typically on the slopes of the mountain, with steepness of more than 300°, and are very sensitive to landslides and soil erosion.

Vegetation on the bare lands typically consists of shrubs and tall grasses and often cleared by the communities to be used for short-term agriculture activities.

Since 2008, Conservation International Indonesia (CI Indonesia) has been working together with GGPNP to develop of "the green wall" ecosystem restoration program to restore ecosystems of 300 hectares at critical land in extended area of national park. The green wall is a comprehensive restoration approach that integrates the planting trees efforts with community empowerment, education/outreach and biodiversity monitoring surveys, and putting the people as the main actors and beneficiaries of the ecosystem restoration. There were 120,000 native species of trees and additions 15,000 fruit trees planted as a green belt in an area of 300 hectares. Consequently, today, the ecosystem has been restored and provides multiple benefits to the communities, i.e fresh water, landslide preventions, habitats of wild and endangered animals, locations for education and research, recreation areas and alternative livelihoods. After 10 years, a variety of research will inform and support the ecosystem restoration program in GGPNP. Biodiversity monitoring system is in place to update and enrich the scientifically based biodiversity information for restored sites are required. Therefore, the aim of this study is to assess the current diversity on mammals and bird within ecosystem restored in the GGPNP.

Table 1. List of bird diversity on six-point observations.

Family	Common name	Scientific name	Local name	Point 1 (N)	Point 2 (N)	Point 3 (N)	Point 4 (N)	Point 5 (N)	Point 6 (N)
Nectariniidae	Javan sunbird	*Aethopyga mystacalis*	Burung madu jawa	4	5	6	5	1	5
	Little spiderhunter	*Arachnothera longirostra*	Pijantung kecil	12	20	8	12	12	6
Cuculidae	Plaintive cuckoo	*Cacomantis merulinus*	Wiwik kelabu	6	12	0	6	12	0
	Lesser coucal	*Centropus bengalensis*	Bubut alang-alang	24	0	0	6	12	0
	Rusty-breasted cuckoo	*Cacomantis sepulcralis*	Wiwik uncuing	18	6	0	6	6	0
Silviidae	Olive-backed tailorbird	*Orthotomus sepium*	Cinenen jawa	42	12	12	36	0	12
	Bar-winged prinia	*Prinia familiaris*	Perenjak jawa	30	13	12	8	18	7
Dicruridae	Ashy drongo	*Dicrurus lecophaeus*	Srigunting kelabu	6	7	0	6	1	0
	Black drongo	*Dicrurus macrocercus*	Srigunting hitam	7	6	1	6	6	0
Dicaeidae	Scarlet-headed flowerpecker	*Dicaeum trochileum*	Cabai jawa	13	6	13	0	25	0
	Orange-bellied flowerpecker	*Dicaeum trigonostigma*	Cabai bunga api	20	0	13	0	7	0
Alcedinidae	Javan kingfisher	*Halcyon cyanoventris*	Cekakak jawa	18	2	6	7	12	0
	Collared kingfisher	*Todirhamphus chloris*	Cekakak sungai	14	6	0	13	18	1
Picidae	Fulvous-breasted woodpecker	*Dendrocopos macei*	Caladi ulam	24	14	0	21	0	6
	Sunda woodpecker	*Dendrocopos moluccensis*	Caladi tilik	18	0	18	12	18	12
Accipitridae	Black eagle	*Ictinaetus malaiensis*	Elang hitam	12	12	0	0	0	0
	Javan-hawk eagle	*Nisaetus bartelsi*	Elang jawa	6	0	0	0	0	0
Pycnonotiidae	Sooty-headed bulbul	*Pycnonotus aurigaster*	Cucak kutilang	48	6	18	24	24	30
	Yellow-vented bulbul	*Pycnonotus goiavier*	Merbah cirukcuk	39	14	18	25	6	38
	Black-capped bulbul	*Pycnonotus melanicterus*	Cucak kuning	50	3	27	30	30	0
Chloropseidae	Common iora	*Aegithina tiphia*	Cipoh kacat	30	0	18	24	12	8
Apodidae	Little swift	*Apus affinis*	Kapinis rumah	18	6	12	24	0	0
Ploceidae	Javan munia	*Lonchura leucogastroides*	Bondol jawa	39	0	12	30	5	0
Zosteropidae	Common white-eye	*Zosterops palpebrosus*	Kacamata biasa	8	2	11	2	11	6
Accipitridae	Changeable hawk-Eagle	*Nisaetus cirrhatus*	Elang brontok	12	6	0	0	0	0
Sittidae	Velvet-fronted nuthatch	*Sitta frontalis*	Munguk beledu	0	12	12	0	6	0
Artamidae	White-breasted wood-swallow	*Artamus leucorhynchus*	Kekep babi	6	12	0	0	18	0
Cuculidae	Red-billed malkoha	*Phaenicophaeus javanicus*	Kadalan kembang	6	6	6	12	0	0
Strigiformes	Collared scopsowl	*Otus lempiji*	Celepuk reban	0	0	6	0	6	0
Phasianidae	Chestnut-bellied partridge	*Arborophila javanica*	Puyuh gonggong jawa	24	6	0	24	12	6
Timaliidae	Horsfileld's babbler	*Melacocincla sepiarium*	Pelanduk semak	6	6	18	0	24	0
Columbidae	Spotted dove	*Streptopelia chinensis*	Tekukur biasa	30	0	12	24	6	6
Laniidae	Long-tailed shrike	*Lanius schach*	Bentet kelabu	6	6	6	0	0	0
				596	206	265	363	308	143

METHODS

Study Area

The study was conducted from April to May 2018 in Nagrak Resort, Gunung Gede Pangrango National Park (GGPNP) West Java, Indonesia. GGPNP is a conservation area that has management system to protects the last of the remaining tropical rain forest remnants in Java. and one of the few conservation areas in the region that is well preserved. Established in 1980 as one of the first national parks in Indonesia, it has been declared one of six Biosphere Reserves in Indonesia by UNESCO (Wardojo, 1997). The GGPNP has a total area of 24,270 hectares and contains high biodiversity, as home to the endangered Javan gibbon (Hylobates moloch), Javan hawk eagle (*Nisaetus bartelsi*), Javan leopard (*Panthera pardus melas*), Grizzled leaf monkey (*Presbytis comata*), Javan slow loris (*Nycticebus javaniscus*), and many other threatened endemic species. A majority of the park consists of tropical mountain forest ecosystem at an altitude between 700-3,019m asl. The study area covered 300 hectares (106°50’13.55” E / 06°49’08.57” S) at an altitude range from 600 -700m asl (Figure 1).

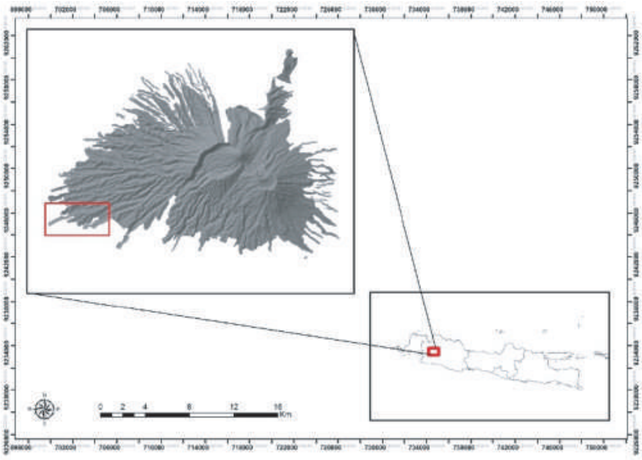

Figure 1. The map of study area at restored areas in GGPNP.

Data collection and Analysis

For bird survey, data were collected using point count method (Bibby et al., 2000) on 20 days, in the beginning with increased bird activity (6:00-10:00 a.m.) and late afternoon (3:00-5:00 p.m). Six-point counts were surveyed once per day in each morning and afternoon. The time for sampling in each point was 15 minutes, and another 15 minutes was the time necessary for the displacement of the observer from one point to another. Only birds seen were recorded in study area. Bird richness and abundance were defined as the total number of species and total number of contacts respectively.

We used Shannon-Weiner diversity index H’ (Shannon, 1948), and followed Kiros et al., (2018) to analyse bird diversity was calculated as:

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right) \times \ln\left(\frac{ni}{N}\right)$$

Where H’ = index of species diversity, ni is the number of individuals in a species, S is the total number of species (species richness), and N is the total number of individuals. With the criteria: H'<1 a low level of species diversity, 1 <H'<3 a moderate level of species diversity, H'> 3 indicates a high level of species diversity.

Evenness index (J’) was calculated by following the equation:

$$J' = \frac{H'}{\ln S}$$

Where: H’ = Shannon Weiner diversity index and S = Number of species. With the criteria: J’ ≤ 0.4 low evenness, 0.4 < J’<0.6 moderate evenness, J’≥ 0.6 high evenness.

Richness index (D) was calculated by the following equation:

$$D = \frac{S-1}{\ln N}$$

Where: D = Richness index, S = Total number of species and N = Total number of individuals. With the criteria: D <2.5 a low level of species richness, 1.5> D> 4 a moderate level of species richness, D> 4 a high level of species richness.

For mammal survey, we deployed a single of 10 camera traps at 10 trapping stations on the study area, encompassing an area of approx. 15 km^2. We deployed camera traps a location with evidences of mammal’s presence e.g. footprints, faeces, urine, as well as scratch on the trees to maximise the chances of positive recording. We visited checked camera conditions, replaced batteries and memory cards approx. once every month. All results were entered into database for monthly sampling categories. Relative abundance Index (RAI) of mammals species was determined using encounter rates that give basic ordinal scales of abundance (O’Brien et al., 2003; Kawanishi and Sunquist, 2004). It was calculated as:

RAI= SF/TD*100

Where: RAI = Relative Abundance Index; SF = number of species photograph, TD = trap days

RESULTS

Birds diversity

Of 1,881 bird observed, there were 22 bird families and 33 species recorded in the six point sites sample (Table 1). The total number was recorded of 596 bird individuals consist of 31 bird species at point 1 (596 individuals). Meanwhile, there were 25 bird species recorded from point 2 (206 individuals), 22 birds from point 3 (265 individuals), 23 birds from point 4 (363 individuals), 25 birds from point 5 (308 individuals), and 15 birds from point 6 (143 individuals) (Table 1).

Based on Shannon Weiner analysis showed the level of diversity is a moderate at point 3,4,6 to high at point 1,2,5 category. The level of evenness is high found at point 1-6 category, and the level of species richness is low (point 6), moderate (point 3-4), and high (point 1-2) (Table 2).

Mammals diversity

A total of 10 mammal species of 7 families were captured in the study area. From April to May 2018, a total of two survey periods and 4 samplings were undertaken. A total of 623 camera trap days produced 113 independent photos of mammals (Table 3).

Table 2. Overall diversity, evenness and species richness indexes birds.

Point	S	N	H'	Category	J'	Category	D'	Category
1	31	596	3.206	High	0.934	High	4.695	High
2	25	206	3.084	High	0.958	High	4.129	High
3	22	265	2.970	Moderate	0.961	High	3.764	Moderate
4	23	363	2.932	Moderate	0.935	High	3.733	Moderate
5	25	308	3.020	High	0.938	High	4.188	High
6	15	143	2.221	Moderate	0.820	High	2.821	Low

(S)=total number of species, (N)=total number of individuals
(D')=species richness index, (J')=Evenness index and (H')=Shannon diversity

Table 3. Mammals diversity undertaken by camera trap during April to May 2018

Family	Common name	Scientific name	Local name	Number of pictures	%	RAI
Felidae	Javan Leopard	*Panthera pardus melas*	Macan tutul jawa	4	3.54	0.64
	Leopard cat	*Prionailurus bengalensis*	Kucing hutan	10	8.85	1.61
Viverridae	Common palm-civet	*Paradoxurus hermaphroditus*	Musang Luwak	15	13.27	2.41
	Small indian-civet	*Viverricula indica*	Musang rase	6	5.31	0.96
Herpestidae	Javan gold-spotted mongoose	*Hervestes javanicus*	Garangan jawa	10	8.85	1.61
Hystricidae	Javan porcupine	*Hystrix javanicus*	Landak jawa	6	5.31	0.96
Suidae	Wild boar	*Sus scrofa*	Babi hutan	30	26.55	4.82
Cervidae	Muntjac	*Muntiacus muntjac*	Kijang	2	1.77	0.32
Cercopithecidae	Long-tiled macaque	*Macaca fascicularis*	Monyet ekor panjang	22	19.47	3.53
Muridae	Malayan field rat	*Rattus tiomanicus*	Tikus belukar	8	7.08	1.28

RAI=Relative Abundance Index

Figure 2. The condition of restoration areas, before and after.

RESULTS

The one of objective of reforestation program is to restore the forest ecosystem in the GGPNP, that provides habitat healthy for birds and mammals and other wildlife. After 10 years, the program achievement are 120,000 forest trees planted in an area of 300 hectares (Table 4), and the area now turned into a forest area (Figure 2). Number of indicators based on the monitoring in 2018 showed that the ecosystem functions has been restored, including the living of wildlife animal in the region.

Based on last annual monitoring that was carried out in November 2017, data on the development of trees planted were growth, namely 114,000 (95%) in good / living conditions and 6,000 (5%) trees that no growth or dead. All dead trees are always replaced with new ones (embroidery). Based on routine monitoring, three tree species were recorded that were quite strong even

Table 4. Native species of trees planted period 2008-2018

Native species	Number of trees
Rasamala (*Altingia excelsa*)	9,000
Puspa (*Schima wallichii*)	5,200
Manglid (*Maglonia blumei*)	41,700
Suren (*Toona sureni*)	20,500
Kisireum (*Syzigium rostrattum*)	2,200
Salam (*Eugenia clavimirtus*)	16,400
Janitri (*Elaeocarpus pierrei*)	15,000
Lame (*Alstonia scholaris)*	10,000
Total	**120,000**

in bad weather conditions, namely Manglid (*Maglonia blumei*), Kisireum (*Syzigium rostrattum*), and Salam (*Eugenia clavimirtus*). Until now it is known that the average plant growth of each species per year ranges from 57 to 120.5 cm and the average growth of stem diameter per species per year ranges from 6.5 to16.2 cm.

Birds are commonly used as indicators of biodiversity, especially where numbers of species are high (Larsen et al.,2012). Birds are widespread around the world, diverse and sensitive to changes lower down in the food chain and persistent pollutants. Furthermore, bird ecology is on the whole well understood, making it easier to interpret their fluctuations (Gregory, 2006).

The average overall species richness, abundance and density were high at Sooty-headed bulbul (*Pycnonotus aurigaster*) (Figure 3), Yellow-vented bulbul (*Pycnonotus goiavier*), Black-capped bulbul (*Pycnonotus melanicterus*), and Javan munia (*Lonchura leucogastroides*). In this study, the three bulbul species were the most common species along in the restored area. These bird species are commonly found on the edge of the forest, which are types of fruit feeders, seeds and insects, and are tolerant of habitat changes.

Several of bulbul species are known for their tolerance for human-disturbed areas and secondary forest (Corlett and Hau, 2000). As facultative frugivore consumers, bulbuls are important as seed dispersers and colonists (Corlett, 1998) as they eat the small fruits of pioneer trees (Thornton, 1997). Their high abundance observed in the forest edge may be as an indicator that regeneration of the forest edge is slowly taking place.

The level of restoration, i.e low, moderate and high categories can be influencing to the condition of the restored area. Tree planting time in the 300-hectares area is divided into two periods. First period was 2008-2010 and the second period was 2010-2012. The next period which began in 2013 was used to maintain the trees that had been planted. Therefore, the level of tree growth in the restoration area varies. Trees planted in the initial period have growth rates reaching more than 10 m trees high and tree canopies have been sustained, such as at point posts of 1,2, and 5. Whereas trees planted in the last period of tree growth rates are below 10m high, such as at point locations 3, 4, and 6.

The high number observed of Black-capped bulbuls at the forest edge suggests that the species could play an important role in restoration of secondary forest (Wunderle, 1997). Forest edge may be able to attract seed dispersing birds will be depended on agricultural gardens, where food availability remains high (Parrotta et al.,1997).

In addition to the common birds, during the observation, there were 3 species of eagles, namely Javan hawk eagle (*Nisaetus bartelsi*), Black eagle (*Ictinaetus malaiensis*) and Changeable hawk-eagle (*Nisaetus cirrhatus*). These three species are predator whose existence is found when perched on the study area. Their presence is due to the restoration area adjacent to the national park's natural forest which is known as the habitat of the three species of eagles.

Figure 3. Sooty-headed bulbul (*Pycnonotus aurigaster*) in study area (Photo by CI).

Reforested areas usually have a lower number of bird species that prefer forest habitats and recolonizing bird species tend to be opportunists, as well as generalist species (Critescuetal, 2012). Birds tend to respond well to reforested areas will usually present similar bird richness to reference forest areas, however, bird composition will usually be different (Munro et al., 2011; Catterrall et al., 2012; Freeman et al.,2015).

In Table 3 shows the highest of relative abundance index (RAI) in two species of mammals, e.g wild boar (*Sus scrofa*) and long-tailed macaque (*Macaca fascicularis*). These two species are tolerant mammals and are commonly found on the edge of the forest even to village areas and are occasionally considered as pests because they damage agricultural products of the village community. Beside both species are in group and produce many offspring.

The wild boar (*Sus scrofa*) is one of the most widely distributed ungulates in the world due to its high reproductive rate, adaptability, and opportunistic feeding (Herrero et al., 2006; Cuevas et al., 2010; Ballari and Barrios-García, 2014). In many places wild boars are considered as a pest species because they damage food crops, transmit diseases to livestock (Meng et al., 2009). At the same time, the wild boar is an important prey base for endangered large carnivores (Karanth and Sunquist, 1995) as well as a robust species for hunting that can relieve pressure on other wildlife species (Barrios-García and Ballari, 2012).

Long-tailed macaques (*Macaca fascicularis*) have the third most widespread geographically distribution among primates, after human and rhesus macaques (*M. mulatta*), distributed over a wide area of Southeast Asia, including the Indo-Malay Peninsula and islands of Indonesia, Malaysia and the Philippine (Fooden,

Figure 4. The Javan leopard captured by camera trap in restoration area.

1995). They inhabit a wide variety of habitats, including primary lowland rainforests, disturbed and secondary rainforests, riverine, swampy and coastal forests of nipa palm and mangrove. Typically, they have been observed in the disturbed habitats and the forest periphery. They adapt well to human settlements and are considered animals pests where can damage farms and gardens around villages (Aggimarangsee, 1992; Fooden, 1995).

The presence of mammals, especially top predators in the forests is an indicator of the state of conservation of the site, following the rationale that wildlife species require a habitat with sufficient carrying capacity for their biological requirements (Farneda et al., 2015; Herna´ndez-Huerta, 1992) and because top predator mammals promote biodiversity by regulating meso predator density (Ripple et al., 2013; Ritchie and Johnson, 2009). One species of mammal that is unexpectedly captured by camera trap was the Javan leopard in study area (Figure 4). It seen as a young leopard wandering in search of territory. In addition, prey that lives in the restoration area encourages the leopard to approach the prey. In IUCN Red list, the javan leopard it as Critically Endangered (Ario et al., 2008). Javan leopard in the GGPNP was first captured by camera traps on 2002, where since 1980, the presence of javan leopard in GGPNP was found based on their footprints, feces, food scraps, urine, and scratches on trees (Ario et al., 2018). The finding in this study will provide an important basis for future research and conservation management, and also provide support for biodiversity monitoring in GGPNP.

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