

Wildlife diversity and identification of potential zoonosis around the Sumatran Rhino (*Dicerorhinus Sumatrensis Harrisoni*) sanctuary, East Kalimantan, Indonesia

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Abstract. Emergency rescue for the Sumatran rhino in East Kalimantan is through consolidation into a sanctuary. This study aimed to analyse wildlife diversity and to identify potential zoonosis in the Sumatran rhino sanctuary located in Hutan Lindung Kelian Lestari (Kelian Lestari Protection Forest). Wildlife diversity observation was done by installing some devices (camera traps, small trap mammals, mist nets) and establishing transects. Zoonosis data was carried out by collecting blood samples and faeces of wildlife and domesticated animals. Our findings showed that there were 18 species of wildlife belonging to 13 family and 16 genus. Bearded pigs, malayan porcupines, and southern red muntjak were among animals with the highest RAI (Relative Abundance Index). Identification of potential zoonosis revealed that *Salmonella* was commonly found in faeces of both wildlife and domesticated animals. Furthermore, the most noticeably helminth parasites found in domesticated animals were *Paramphistomum*, *Fasciola*, and *Emmeria*, whilst *Toxocora* and *Trichostrongylus* were more common in wildlife. *Theileria* was blood parasites only detected in domesticated animals.

Keywords: The Sumatran rhino, sanctuary, wildlife, zoonosis, conservation

1. Introduction

Dicerorhinus sumatrensis harrissoni is subspecies of Sumatran rhino endemic to Kalimantan [1, 2]. This mammal is considered as high priority for conservation, listing as critically endangered species based on IUCN RedList [3]. Its population is extremely small so that it is prone to extinction. The remnant of the Sumatran rhino's habitats in Kalimantan is secondary forests located in logging concessions [4]. Therefore, one of strategies in rescuing this subspecies is by consolidating individual rhino into a sanctuary (captive breeding) to increase reproduction rate [5].

Kelian Lestari Protection Forest (here after HLKL) is a suitable location for the Sumatran rhino's sanctuary in East Kalimantan [5]. The area is an ex-gold mining concession which has experienced revegetation and succession [6]. HLHK is stated according to SK Menteri Kehutanan No: 554/Menhut-II/2013 with total area of 6,750 ha. A part of HLKL, which is 403 ha, is dedicated to the sanctuary [5]. Recently, the sanctuary holds a female rhino rescued in November 2018 [7].



A biophysical condition of the sanctuary, including wildlife diversity and the risk of zoonosis, is a crucial issue to consider [8, 9, 10]. In natural habitat, the Sumatran rhino interacts with diverse wildlife in utilising habitat for example, resulting in the probability of the disease transfer [10]. Mohammad *et al.* [10] and Ahmad *et al.* [11] reported that a mortality case of the Sumatran rhino in Malayan Peninsula was obviously due to the disease transfer and sanitation. Several studies which relate to zoonosis caused by parasitic helminth had also been done towards the Sumatran rhino in Sumatra [12, 13] and the Javan rhino in Ujung Kulon National Park, West Java [14].

To date, study about wildlife diversity and potential zoonosis around the Sumatran rhino sanctuary in East Kalimantan has not much been treated yet. Boer [6] reported wildlife diversity in HLKL, but it just concerned on birds. Information on wildlife diversity and its potential zoonosis is imperative since it is beneficial for mitigating transferable diseases [12, 13]. Furthermore, identification of zoonosis can also be expanded to domesticated animals owned by surrounding community [12, 14].

The objective of this research was to analyse wildlife biodiversity and identify potential zoonosis around the Sumatran rhino sanctuary in HLKL. We hope our study could be a reference to manage the Sumatran rhino sanctuary, particularly from ecological and medical aspects.

2. Materials and methods

2.1. Location of the study site

Research was carried out in HLKL, Kutai Barat Regency, East Kalimantan Province of Indonesia. HLKL is situated in the ex-largest gold mining company in East Kalimantan, PT. Kelian Equatorial Mining (KEM). The Indonesian government has converted that ex-mining into protection forest through SK Menteri No: 554/Menhut-II/2013 with a total area of 6,750 Ha. Approximately 403 Ha out of the total area is stipulated as the Sumatran rhino sanctuary.

2.2. Tools and materials

In this study, we used several tools and materials for data collection, including alcohol 70%, formaline, spirit, un-utilized newspapers, mist nets, small mammal traps, knives, faeces tubes, blood tubes, spatula, gloves, microscopes, cooler boxes, binoculars, camera traps, digital cameras, stationary, and tally sheets.

2.3. Procedures

Combination of camera traps, small mammal traps, mist nets, and the transect method was used to collect data of wildlife diversity. We placed 10 camera traps purposively around the sanctuary for 123 days. We also installed small mammal traps systematically (25 traps for 7 days) close to the sanctuary in order to obtain targeted animals such as rats and squirrels. Furthermore, 2 mist nets also used to trap bats for 7 days. In addition, the transect method was applied to explore the sanctuary by following existing trails. During exploration, we recorded all sighted animals directly and indirectly (sound, footprints, dungs, scratches).

Zoonosis data collections were done towards both wildlife and domesticated animals (cows, goats, pigs) owned by community in the 5 nearest villages, namely Bigung Baru, Melapeh Baru, Linggang Melapeh, Purwadadi, and Tutung. For wildlife animals, we sampled blood (for small mammals) and faeces found during observation using the transect method. For domesticated animals, we sampled blood and faeces as well. All samples were then put on plain tubes and tubes containing formaline 10% for further analysis.

2.4. Data analysis

Data of wildlife diversity was analysed descriptively by grouping into family, genus, species, and conservation status. Data derived from camera traps was analysed using RAI (Relative Abundance Index) formula introduced by [15]:

$$RAI = \frac{ni}{\sum TN} \times 100$$

Where: RAI = Relative Abundance Index per 100 days

ni = numbers of pictures or videos of independent species i

ΣTN = numbers of active days of camera traps

In similar, data of potential zoonosis was done descriptively using descriptive statistic based on parameter identification, such as bacteriology (*Salmonellosis, Brucellosis*), blood parasites (*Anaplasma, Babesia, Trypanosoma, Theileria*), and parasitic helminths. Those diseases are transferrable and may infect the rhino in the sanctuary just like the Sumatran rhino in other places. All zoonosis identification was carried out in Laboratorium Balai Besar Veteriner Banjarbaru, South Kalimantan.

3. Result

3.1. Wildlife diversity

We found 18 species of wildlife, belonging to 13 family and 16 genus, around the Sumatran rhino sanctuary (table 1). Ten species were identified by camera traps, 4 species were based on the transect method, 2 species were based on small mammal traps, and 1 species was identified by mist nets. Four out of 18 species were identified by both camera traps and the transect method. The number of mammals may increase if monitoring is continued by expanding coverage area and time of observation. It is noteworthy that our survey just concerned on the area of the sanctuary with total area of 403 Ha.

Camera traps recorded 698 pictures. Unfortunately, one out of 10 camera traps failed to record the object. Bearded pigs, southern red muntjak, and Malayan porcupines had the highest RAI value, which were 24.9; 24.00; and 21.14, respectively (figure 1 and 2).

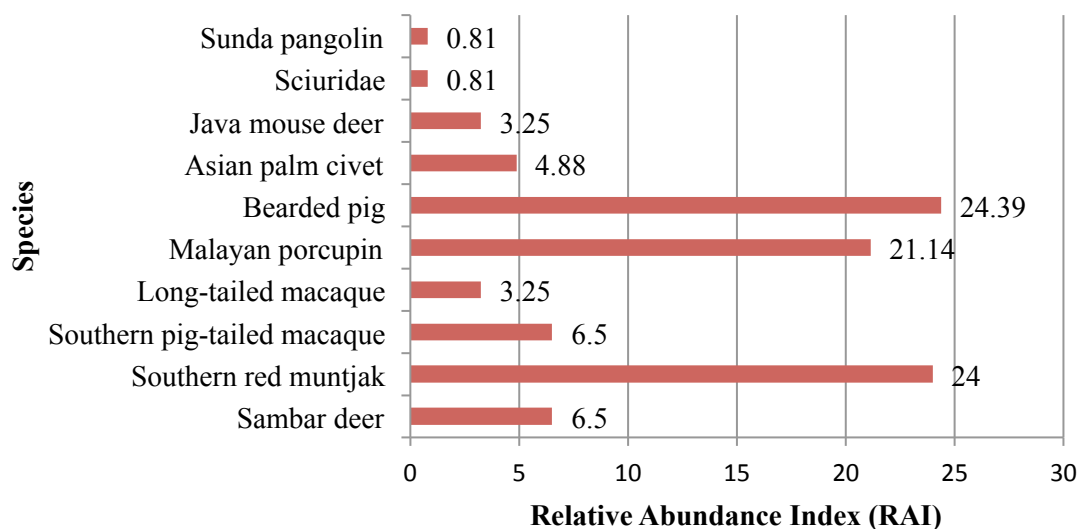


Figure 1. RAI of wildlife based on camera traps

Table 1. Identified wildlife around the Sumatran rhino sanctuary

No	Common name	Scientific name	Conservation status		
			PermenLHK No. P.106 (Regulation in Indonesia)	IUCN Red List	CITES
	Cervidae				
1	Sambar deer	<i>Rusa unicolor</i>	√	Vulnerable	
2	Southern red muntjak	<i>Muntiacus muntjak</i>	√	Least concern	
	Cercopithecidae				
3	White-fronted langur	<i>Presbytis frontata</i>	√	Vulnerable	
4	Southern pig-tailed macaque	<i>Macaca nemestrina</i>		Vulnerable	
5	Long-tailed macaque	<i>Macaca fascicularis</i>		Least concern	
	Felidae				
6	Leopard car	<i>Prionailurus bengalensis</i>	√	Least concern	App.I
	Hystricidae				
7	Malayan porcupin	<i>Hystrix brachyuran</i>		Least concern	
	Hylobatidae				
8	Muellers gibbon	<i>Hylobates muelleri</i>	√	Endangered	App.I
	Manidae				
9	Sunda pangolin	<i>Manis javanica</i>	√	Critically Endangered	App.I
	Muridae				
10	Rajah spiny rat	<i>Maxomys rajah</i>		Vulnerable	
11	Black rat	<i>Rattus rattus</i>		Least concern	
	Sciuridae				
12	Prevost's squirrel	<i>Callosciurus prevostii</i>		Least concern	
13	Unidentified	-			
	Suidae				
14	Bearded pig	<i>Sus barbatus</i>		Vulnerable	
	Ursidae				
15	Sun bear	<i>Helarctos malayanus</i>	√	Vulnerable	App.I
	Viveridae				
16	Asian palm civet	<i>Paradoxurus hermaphrodites</i>		Least concern	
	Tragulidae				
17	Java mouse deer	<i>Tragulus javanicus</i>	√	Data deficient	
	Vespertilionidae				
18	Lesser bamboo bat	<i>Tylonycteris pachypus</i>		Least concern	



Figure 2. A bearded pig (above) and Malayan porcupines (below) were recorded by camera traps

3.2. Potential zoonosis and identification

Our findings that relate to zoonosis is presented in table 2, 3, and 4, consecutively. Furthermore, identified zoonosis diseases are shown in table 5. The result of our study revealed that *Salmonella* was commonly found in faeces of both wildlife and domesticated animals. Furthermore, the most noticeably helminth parasites found in domesticated animals were *Paramphistomum*, *Fasciola*, and *Emmeria*, whilst *Toxocora* and *Trichostrongylus* were more common in wildlife. *Theileria* was blood parasites only detected in domesticated animals.

Table 2. Identified bacteria from sampled domesticated animals

No	Bacteria	Σ Positive samples			%		
		Cow (n=24)	Goat (n=32)	Pig (n=16)	Cow	Goat	Pig
1	<i>Brucella abortus</i>	0	0	0	0.00	0.00	0.00
2	<i>Brucella militensis</i>	0	0	0	0.00	0.00	0.00
3	<i>Salmonella</i>	7	4	6	29.17	12.50	37.50
	Total	7	4	6			
	Mean	2.33	1.33	2			
	St. Deviation	4.041	2.309	3.464			

Remark: n is the number of sample

Table 3. Identified helminth from sampled domesticated animals

No	Helminth species	Σ Positive samples			%		
		Cow (n=30)	Goat (n=32)	Pig (n=4)	Cow	Goat	Pig
1	<i>Trichuris</i>	0	0	0	0.00	0.00	0.00
2	<i>Trichostrongylus</i>	0	0	0	0.00	0.00	0.00
3	<i>Toxocora</i>	0	0	0	0.00	0.00	0.00
4	<i>Paramphistomum</i>	2	14	2	6.67	43.75	50.00
5	<i>Oesophagostomum</i>	3	0	0	10.00	0.00	0.00
6	<i>Moniezia</i>	0	0	0	0.00	0.00	0.00
7	<i>Haemonchus</i>	0	2	0	0.00	6.25	0.00
8	<i>Fasciola</i>	7	11	1	23.33	34.38	25.00
9	<i>Eimeria</i>	8	8	0	26.67	25.00	0.00
10	<i>Cooperia</i>	0	0	0	0.00	0.00	0.00
11	<i>Bunostomum</i>	0	0	0	0.00	0.00	0.00
12	<i>Ascaris</i>	2	0	0	6.67	0.00	0.00
	Total	22	35	3			
	Mean	1.83	2.92	0.25			
	St. Deviation	2.855	5.071	0.621			

Remark: n is the number of sample

Table 4. Identified blood parasites from sampled domesticated animals

No	Blood parasites	Σ Positive samples			%		
		Cow (n=16)	Goat (n=31)	Pig (n=2)	Cow	Goat	Pig
1.	<i>Anaplasma</i>	0	0	0	0.00	0.00	0.00
2	<i>Babesia</i>	0	0	0	0.00	0.00	0.00
3	<i>Trypanosoma</i>	0	0	0	0.00	0.00	0.00
4	<i>Theileria</i>	2	4	0	12.50	12.90	0.00
	Total	2	4	0			
	Mean	0.50	1.00	0.00			
	St. Deviation	1.000	2.000	0.000			

Remark: n is the number of sample

Table 5. Zoonosis identification towards wildlife

No	Species	Σ Sample	Identification					
			Blood parasite	Σ positive sample	Helminth parasite	Σ positive sample	Bacteria	Σ Positive sample
1	<i>Rattus rattus</i>	20	Negative	0	Negative	0	<i>E. coli</i>	3
							<i>Bacillus</i>	3
2	<i>Tylonycteris pachypus</i>	1	Negative	0	Negative	0	<i>Salmonella</i>	1
3	<i>Rusa unicolor</i>	2	-	-	Negative	0	<i>E. coli</i>	1
							<i>Bacillus</i>	1
							<i>Salmonella</i>	1
							<i>Shigella</i>	1
4	<i>Macaca nemestrina</i>	3	-	-	<i>Toxocora</i>	1	<i>E. coli</i>	1
							<i>Bacillus</i>	1
					<i>Trichostrongylus</i>	1	<i>Salmonella</i>	1
							<i>Shigella</i>	1
5	<i>Presbitys frontata</i>	3	-	-	<i>Toxocora</i>	1	<i>E. coli</i>	1
							<i>Bacillus</i>	1
							<i>Salmonella</i>	1
							<i>Shigella</i>	1
6	<i>Hylobates muelleri</i>	4	-	-	<i>Ancylostoma</i>	1	<i>E. coli</i>	2
							<i>Bacillus</i>	2
							<i>Salmonella</i>	2
							<i>Shigella</i>	2
7	<i>Sus barbatus</i>	5	-	-	<i>Echinochasmus</i>	1	<i>E. coli</i>	2
							<i>Bacillus</i>	2
							<i>Salmonella</i>	1
8	<i>Paradoxurus hermaphrodites</i>	8	-	-	<i>Trichuris</i>	1	<i>Salmonella</i>	5
					<i>Echinochasmus</i>	1	<i>Amoeba</i>	1
					<i>Schistosoma</i>	4	<i>Shigella</i>	1
					<i>Ancylostoma</i>	1	<i>E. coli</i>	2
9	<i>Prionailurus bengalensis</i>	2	-	-	Negative	0	<i>Bacillus</i>	1
							Negative	0
Total Sample		48						

Remark: (-) is not analyzed

4. Discussion

Wildlife with high RAI is able to tolerate and adapt to various environmental condition. Naturally, they present in primary forests, secondary forests, palm oil plantations, forest plantations, and community garden [16, 17, 18]. Bearded pigs and Malayan porcupines are even considered as pest in many palm oil plantations due to their abundance and foraging behaviour which tends to omnivore and herbivore [16]. In the sanctuary, bearded pigs and Malayan porcupines appear to mainly occur in fruiting trees, forest edges, river banks, and lakes surrounded by shrubs. In ideal habitat, these animals will leave more offspring per birth. For example, bearded pigs and Malayan porcupines gave birth more than 2 offspring in each period of birth [19].

Diverse wildlife around the Sumatran rhino sanctuary is likely to indicate that forest is in a good condition so that it benefits conservation. In fact, some of identified animals are protected and susceptible to extinction, such as *Manis javanica* and *Hylobates muelleri*. As known, *Hylobates muelleri* is endemic to Kalimantan threatened by hunting and habitat loss, resulting in decreased population by 71,103 individuals [20]. It was also reported that in HLKL, *Neofelis nebulosa* still presents as top predator in Kalimantan (Rahman, Pers Comm). The occurrence of *Neofelis nebulosa* and its prey implies that food chain and ecosystem stability is naturally well maintained.

Identified browser animals in this study is unlikely to have ecological interaction in terms of habitat utilization with the Sumatran rhino undergoing a breeding program. This is because species management applied in the sanctuary uses paddock at interval of 10-20 Ha so that there is no food competition between the Sumatran rhino and other wildlife. Nevertheless, the Sumatran rhino is still at the risk of transferable diseases due to the presence of other wildlife around the sanctuary [12, 13].

Salmonella has been found around the Sumatran rhino sanctuary, infecting not only wildlife but also domesticated animals. This bacteria is the main cause of *Salmonellosis* which can infect human, domesticated animals, and wildlife such as birds, reptile, mammals, and insects [21]. Rhinos infected by *Salmonella* are fatal, such the African black rhino [22], the indian rhino and the African white rhino [23], as well as the Sumatran rhino [11]. The infected rhinos will exhibit some symptoms such as gastroenteritis and sepsis (fever, anorexia, and amnesia) [23]. The occurrence of *Salmonellosis* relates to environmental health. Using antibiotic in healing infected animals is not effective, resulting in resistance to the disease [21, 23]. Therefore, keeping the sanctuary clean and healthy is important to prevent the infection of *Salmonella*.

Paramphistomum, *Fasciola*, and *Eimeria* have commonly been detected in domesticated animals, whereas *Schistosoma* and *Toxocara* are dominant in wildlife faeces. Previous studies reported that *Fasciola* and *Paramphistomum* were found in faeces of the Sumatran rhino in Way Kambas National Park [12, 13]. Moreover, Tiuria *et al.* [14] found that *Fasciola* and *Schistosoma* existed in the Javan rhino inhabiting Ujung Kulon National Park. This phenomenon indicates that the Sumatran rhino in the sanctuary is potential being infected by those parasites. However, the probability of helminth parasite infection in the sanctuary is lower than that of in the aforementioned study sites since the absence of grazing near the sanctuary [13, 14].

Fasciola, *Paramphistomum*, and *Schistosoma* belong to class of Trematoda. Infected animals would not show clinical symptoms. Nevertheless, prolonged infection leads to reduced reproduction capability, and even death [14]. Distribution and life cycle of Trematoda are correlated with definitive and intermediate hosts. Snails are mostly known as an intermediate host of trematode [24, 25]. Apparently, infected wildlife and domesticated animals are due to the consumption food contaminated by cercaria previously developed in intermediate hosts [24]. Thus, infection of trematodes in the Sumatran rhino sanctuary should be prevented with increasing rhino's immunity and nutrition, managing paddock, and using anthelmintic.

Our findings show that there were no blood parasites infecting wildlife captured, such as rats and bats. Domesticated animals also exhibited the same pattern, except for *Theileria* detected in cows and goats. *Theileria* had been reported in the black and white African rhino [23, 26]. An individual rhino infected sometimes does not show clinically symptoms, but it can lead to death, depending on immunity [26]. *Theileria* is mostly transmitted by ticks [16, 26]. Otiende *et al.* [26] stated that translocation process might to increase the distribution of *Theileria* vectors. The increase in stress hormones during translocation contributes to the decrease in immunity, causing *Theileria* infection.

Another blood parasite causing serious illness in the Sumatran rhino is *Trypanosoma*. Historically, this blood parasite has been known as a source of the surra outbreaks attacking the Sumatran rhino in the Malayan Peninsula sanctuary [10]. In this study, there was no sign of *Trypanosoma* both in wildlife and domesticated animals. Nevertheless, prevention is important through regular monitoring. *Trypanosoma* could be transmitted by *Tabanus* sp [10, 27], which has been detected to present around the sanctuary.

Conclusion

The area around the Sumatran rhino sanctuary in East Kalimantan plays an important role as favourable habitat for diverse protected and unprotected wildlife. Bearded pigs, Malayan porcupines, and southern red muntjak were several noticeable animals with the highest RAI. Some of potential zoonosis that need attention are *Salmonellosis*, helminth infection, and *Theileria*. Mitigation, such as regular monitoring and keeping environmental health is essential to reduce the chance of disease transmission. We also suggest that surveillance be carried out over a wider area. Implementation of One Health/Eco Health is likely to be effective in preventing zoonosis.

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