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ONCE CONSIDERED THE MOST IMPORTANT CONSERVATION AREA FOR SUMATRAN RHINOCEROS IN PENINSULAR MALAYSIA, TAMAN NEGARA NATIONAL PARK NO LONGER HOLD THIS CRITICALLY ENDANGERED SPECIES

***Mohd Samsudin Mohd Suri, Muhammad Fadlli Ab Yazi, Hazril Rafhan Abdul Halim & Pazil Abdul Patah**

Biodiversity Conservation Division, Department of Wildlife and National Parks (PERHILITAN), Km 10 Jalan Cheras, 56100 Kuala Lumpur.

*Corresponding author's e-mail: msamsudin@wildlife.gov.my

ABSTRACT

Taman Negara National Park (TNNP) comprises an area approximated at 4,343 km^2 making it the largest protected area and home to critically endangered Sumatran rhinoceros in Peninsular Malaysia. However, the lack of evidence of the historical habitat distributions of this species suggests that Sumatran rhinoceros no longer exist in Malaysia. This claim was based on the results from indirect evidence and camera trapping data collected by the Department of Wildlife and National Parks (PERHILITAN) from the long-term Sumatran Rhinoceros Survey (SRS), Sumatran Rhinoceros Rapid Survey (SRRS), the Tiger Survey (TS), the National Biodiversity Inventory Programme (NBIP), Biodiversity Data Collection, Management and Dissemination (BDCMD) programme and the National Park Enforcement Team Patrolling (ETP) undertaken between the years 2012 and 2016. Poaching pressure may be the main factor contributing to the declining of the Sumatran rhinoceros population throughout its range in Peninsular Malaysia. The decimation of the population during the 1990s - 2000s gave rise to the Allee effect and affected the survival of this species in TNNP.

Keywords: National Park, Sumatran rhinoceros, indirect evidence, camera trapping, poaching, small population, non-viable population, Allee effect

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INTRODUCTION

Taman Negara National Park (TNNP) encompasses the states of Pahang, Kelantan, and Terengganu and has a total area of 4,343 km^2. Taman Negara Pahang is the largest (2,477 km^2), followed by Taman Negara Kelantan (1,043 km^2) and Taman Negara Terengganu (853 km^2). It was established in 1938-1939 as an important habitat for critically endangered Sumatran rhinoceros (*Dicerorhinus sumatrensis*). Historically, Sumatran rhinoceros tracks were found along the rivers in TNNP, with the number as low as 2-4 individuals (Hislop, 1966; Stevens, 1968) in the early 1960s. In the 1980s, tracks were found along many rivers in Taman Negara Pahang including Sungai (Sg.) Tahan, Sg. Yong, Sg. Tanum, Sg. Ulu Atok, upper Sg. Trenggan, upper Sg. Keniam, upper Sg. Sat and upper Sg. Sepia with the number ranging from 9-10 individuals (Shariff, 1983), 8-12 individuals (Flynn & Abdullah, 1984), and 24-36 individuals (Khan, 1987). Later, Khan (1990) reported between 30-46 rhinoceros in TNNP after the discovery and including numbers found around the rivers in Taman Negara Kelantan and Taman Negara Terengganu (Figure 1). This record is probably the highest estimate of Sumatran rhinoceros in TNNP. Khan also suggested that TNNP holds the largest rhinoceros population in Peninsular Malaysia, recognising it as the most important conservation area for this species. However, during the rhinoceros survey (years 1991-1995) in Taman Negara Pahang, only 2-5 individuals were discovered (Zainuddin, 1995). This survey covered 25% of the area. Following this, the Sumatran Rhinoceros and Large Mammal Surveys team of PERHILITAAN conducted a series of surveys between 2002 and 2003 and reported 8-12 individuals (DWNP, 2002; 2003) in TNNP. Since then, no scientific surveys were conducted to verify the status of rhinoceros in these areas, and no reasonable explanation was given for the drastic decline of this species population. In 2009, a mother rhinoceros with calf footprints were discovered near the Aring River in Taman Negara Kelantan (DWNP, 2009). This discovery promised a hope that TNNP still supported the survival and breeding of the rhinoceros population. Nevertheless, the fate of this species is uncertain since there have been no sightings reported. The constant low estimate of the rhinoceros population in TNNP signifies that the species is in a critical situation. The sudden change from a considerable viable population in the 1990s (as claimed) to the current threat of non-existence has not been documented.

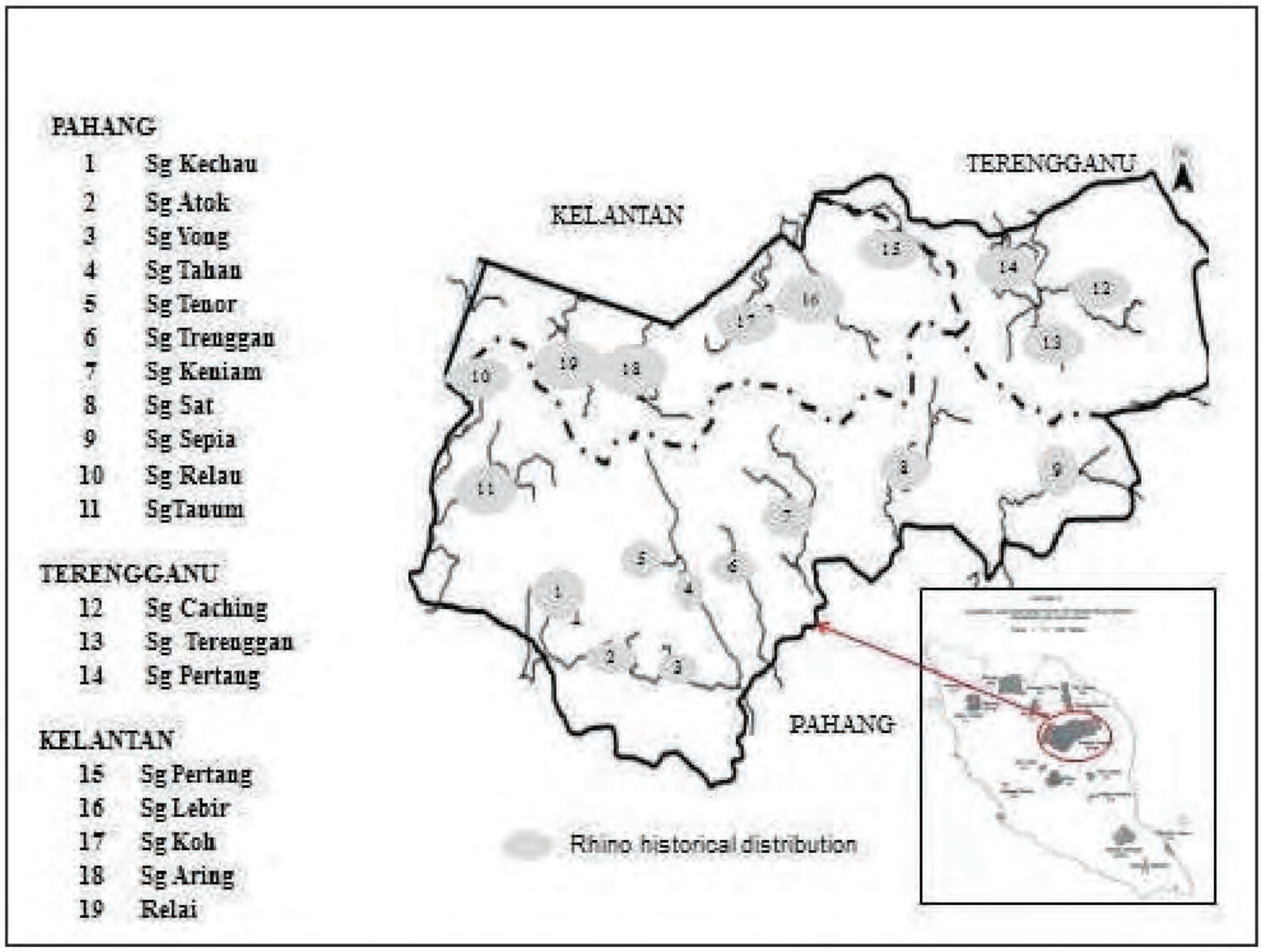

Figure 1. Rhinoceros historical distribution in Taman Negara National Park since the 1960s.

MATERIALS AND METHODS

In order to assess the current population status of the Sumatran rhinoceros in TNNP, we gathered and analysed the information from various field surveys and enforcement patrolling data undertaken by PERHILITAN in TNNP from the year 2012 to 2016. These include the Sumatran Rhinoceros Survey (SRS), Sumatran Rhinoceros Rapid Survey (SRRS), the Tiger Survey (TS), the National Biodiversity Inventory Programmes (NBIP), Biodiversity Data Collection, Management and Dissemination (BDCMD) programme, and the Enforcement Team Patrolling (ETP). The results from both indirect evidence and camera trapping during these field surveys and programs were analysed to reveal the current status of the Sumatran rhinoceros population in TNNP.

Indirect Evidence and Camera Trapping

Sumatran Rhinoceros Survey (SRS)

A long-term SRS were executed at 23 locations in TNNP from the years 2012 until 2016 to assess the status of Sumatran rhinoceros (Figure 2). The species historical distribution databases and their previous discovery locations (the year 2001-2009) were used to locate the survey sites. Each location (sampling plot) covered 5 km x 10 km and was surveyed by a team comprising 5-6 of well- trained PERHILITAN staff. In total, four teams were organised for the survey, and they were assigned to look for indirect evidence while tracking on foot towards and inside their sampling plot. Only fresh and clear rhinoceros footprints including faecal, urine, twisted sapling and twigs, scraped soil or wallows count as "new evidence". Any of these typical signs, if observed and recorded but is too deprived, will not be used to confirm its presence. A total of 38 camera traps were also deployed in the strategic location during this SRS.

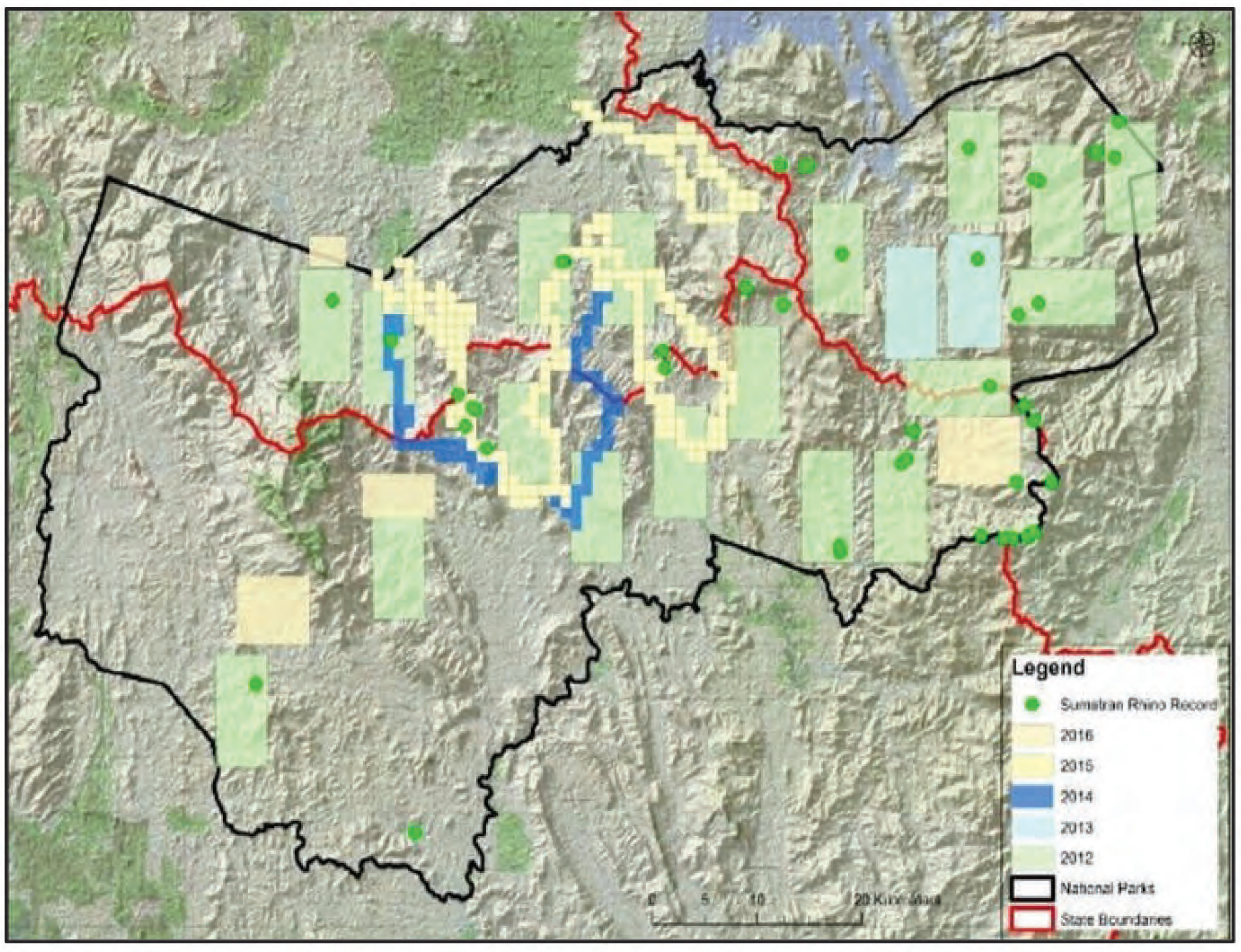

Figure 2. Sumatran Rhinoceros Survey locations in Taman Negara National Park between 2012-2016.

Tiger Survey (TS)

The TS team conducted a series of systematic camera trappings in TNNP from the years 2013 to 2015 to assess the status of the Malayan tiger population in Peninsular Malaysia. During this programme, a total of 228 plots (each plots measuring 2.5 km x 2.5 km) covering more than 50% areas of TNNP (Figure 3) were deployed with camera traps. Each plot was set with two cameras which were put in pairs with a distance of 7-10 m apart. All the cameras were mounted approximately 50 cm from the ground. The locations of the camera traps were marked using a Global Positioning System (GPS). All camera traps were positioned for at least three months. Along with camera trap installation, the team was assigned to collect indirect evidence of Malayan tigers and other important wildlife species, including rhinoceroses.

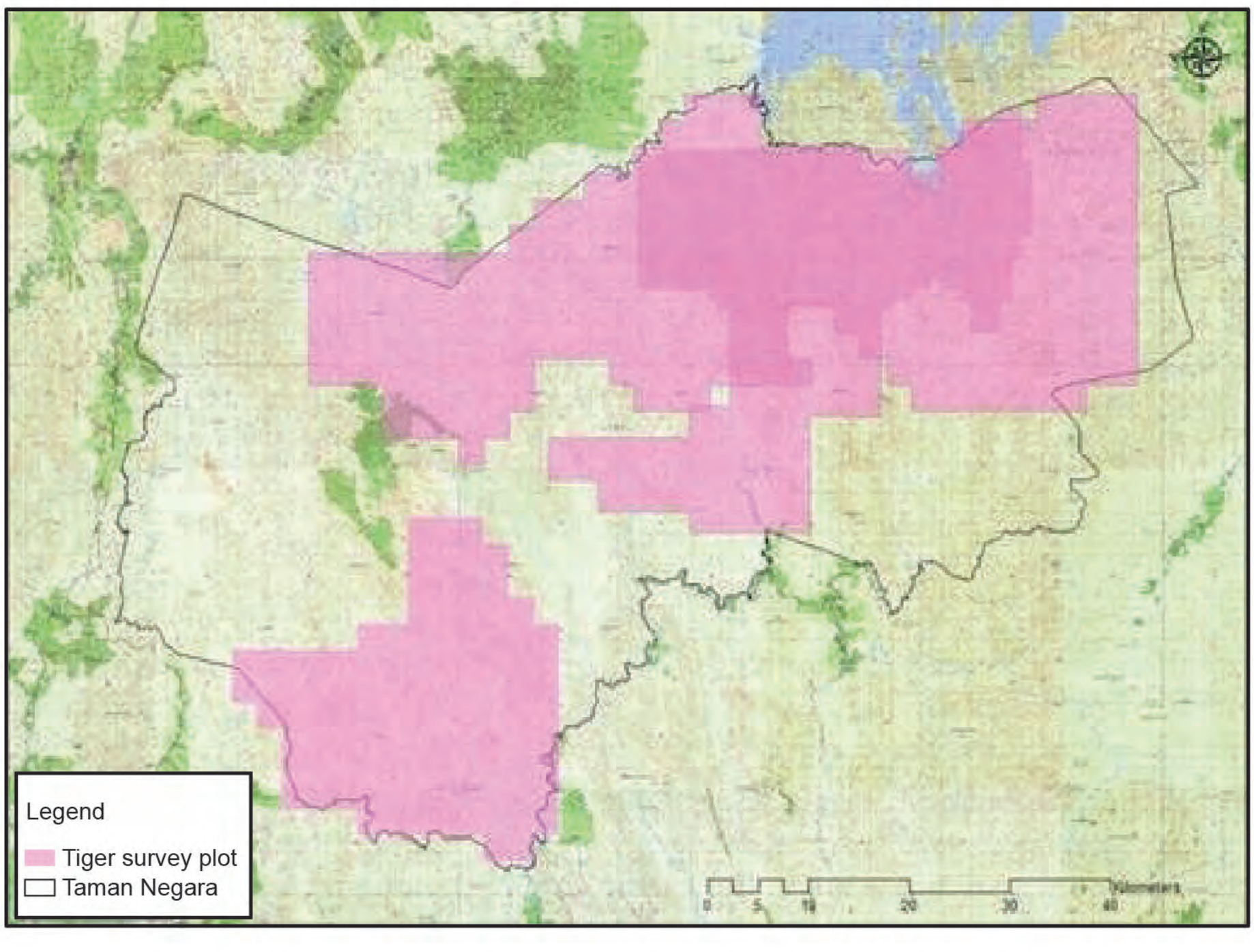

Figure 3. Tiger Survey (camera trapping) in Taman Negara National Parks (2013-2015).

Sumatran Rhinoceros Rapid Survey (SRRS)

Between September to November 2012, a total of 24 camera traps (Uway-250 & Reconyx, USA) were deployed by SRRS team in two locations (A, B) (Figure 4) in Taman Negara Terengganu, covering 150 km^2 for three months. A total of 36 cameras (Uway-250) were deployed at three locations (1, 2 & 3) in Taman Negara Pahang between February to July 2016. Each plot covering an area about 7 km x 7 km for three months. While five camera traps were set up purposely at location 4 (near to plantation boundary) in Taman Negara Kelantan to trace an adult Sumatran rhinoceros which was reported sighted by a plantation worker in June 2016. Based on PERHILITAN's Annual Report in 2009, rhinoceros footprints were discovered near Sg. Aring in Taman Negara Kelantan (DWNP, 2009). All camera traps installation throughout the survey followed the standard protocol practised by PERHILITAN.

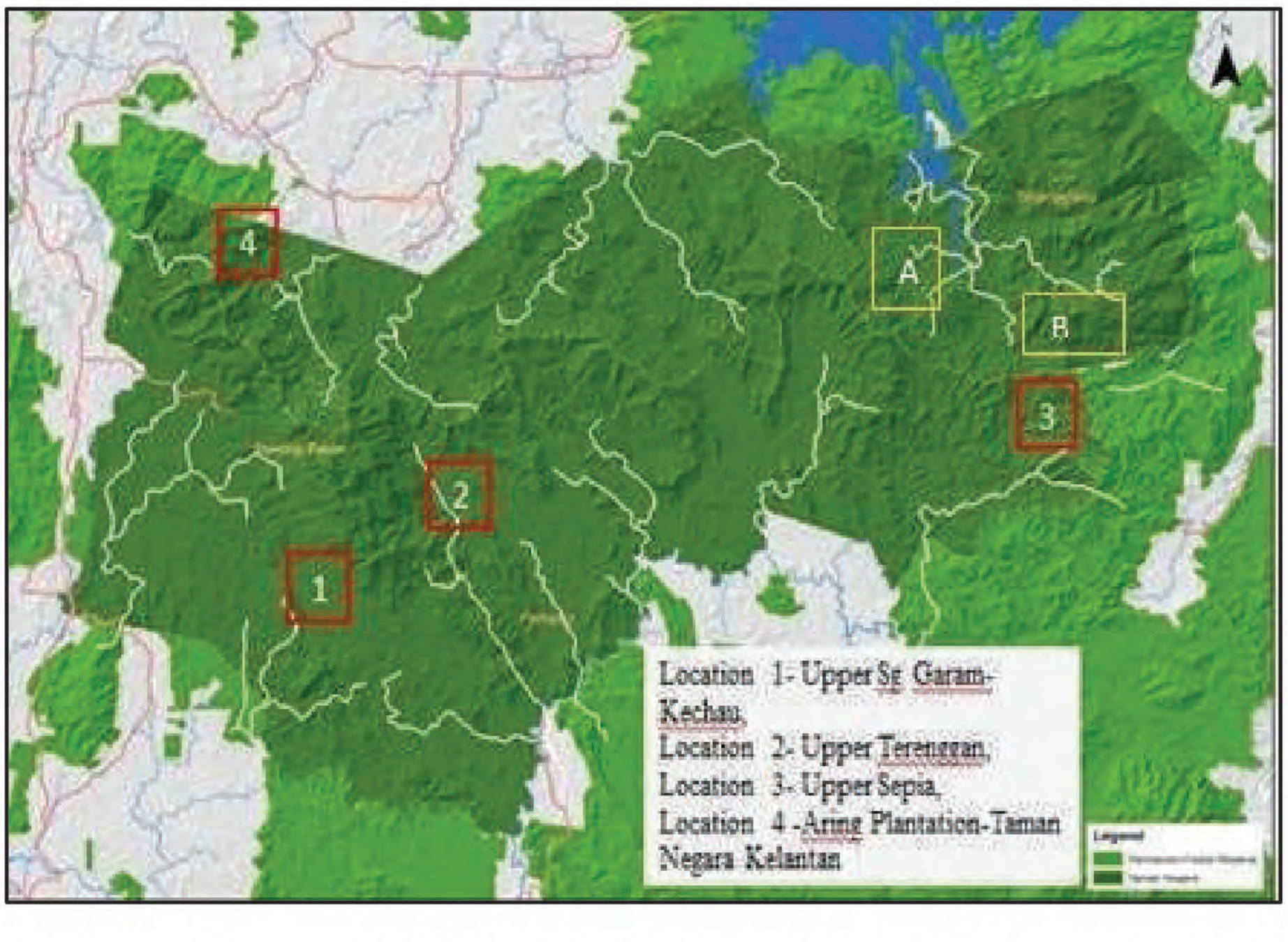

Figure 4. Sumatran Rhinoceros Rapid Survey (camera trapping) locations in Taman Negara Terengganu (A-B) in 2012. Taman Negara Pahang (1-3) and Taman Negara Kelantan (4) in 2016.

Biodiversity Data Collection, Management and Dissemination (BDCMD) Programme

During PERHILITAN's BDCMD programme in 2016, a total of 52 camera traps (Reconyx, USA) were deployed to cover about 90 km^2 of Sg. Sepia area of Taman Negara Pahang. The cameras were installed at a 2 km distance from each other and operated for the duration of three months. Sg Sepia is known as one of the important habitats for rhinoceros distribution in TNNP.

Indirect Evidences

Enforcement Team Patrolling (ETP)

PERHILITAN's ETP was assigned as a new initiative to strengthen an enforcement operation in protected areas, including TNNP. This patrolling team collaborates with the Malaysian Armed Forces (MAF) and other government agencies to boost enforcement in preventing encroachments and extraction of the country's biodiversity resources, especially by foreign nationals. During the patrolling operation, the ETP monitors not only illegal activities but also wildlife presence along their patrolling route. The team uses a ranger-based data collection system such as Management Information System Tool (MIST) and Spatial Monitoring And Reporting Tool (SMART) to collect and record their findings, including the wildlife presence during their patrolling movement. Information from this MIST and SMART based patrolling is used for rhinoceros assessment (Figure 5). If there is direct or indirect evidence of the presence of rhinoceros during the ETP program, it will be investigated by the SRS and/or SRRS team.

National Biodiversity Inventory Programmes (NBIP)

NBIP is a programme carried out by PERHILITAN in order to document the Malaysian biodiversity information involving multiple disciplines such as flora, fauna, ecotourism, ecology and sosio-economy. A total of eleven NBIP were conducted using the occupancy study along with rapid assessment at the southwest of Taman Negara Pahang (Sg. Kechau) from April to September 2012. Another rapid assessment was conducted in Sg. Sepia area in Taman Negara Pahang under this programme from May to August 2016. An indirect evidence technique was employed during the rapid assessment. Although both surveys are relatively small scale, they were conducted within the Sumatran rhinoceros distribution range.

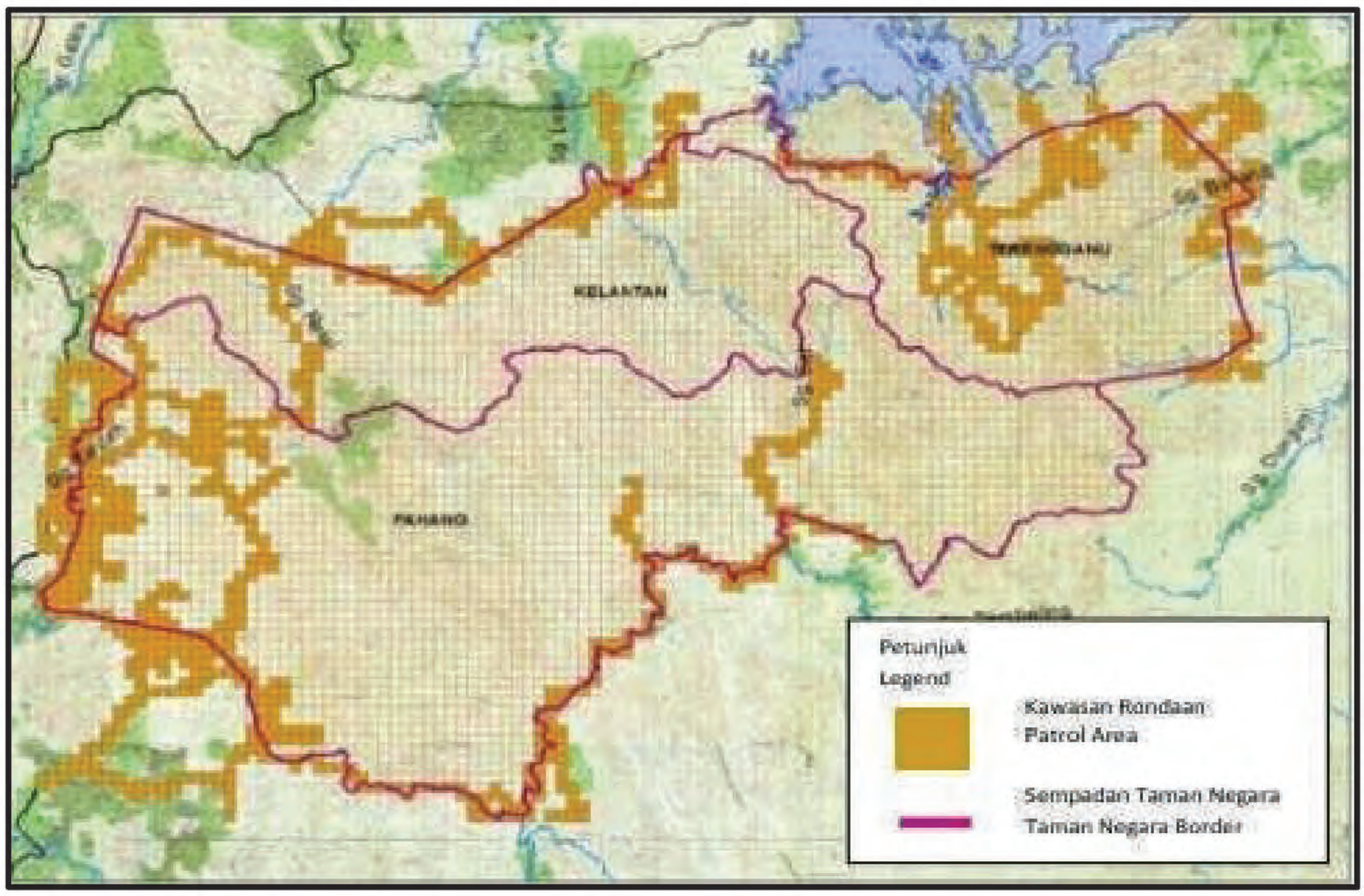

Figure 5. Enforcement Team Patrolling tracks in Taman Negara National Parks (DWNP, 2013).

RESULTS

Indirect Evidence

A total of 6,062 km^2 were covered by -SRS, TS, ETP, NBIP, BDCMD, and SRRS team throughout the years 2012-2016, encompassing all the rhinoceros's historical distribution areas. SRS team also covered all the Sumatran rhinoceros's specific locations (Appendix 1). However, no-new evidence of the existence of Sumatran rhinoceros was reported by the survey team across all the programs in TNNP between 2012-2016 (Table 1). SRS team reported many old (disused) wallows and Malayan tapir evidence such as footprints, eaten plants and faeces throughout the survey. As only fresh tracks or footprints will account for rhinoceros assessment, other typical evidence, especially an old wallow was ignored. Other team surveys revealed a similar result.

Table 1. Field survey programmes undertaken in Taman Negara National Park (2012-2016).

Year	Programme	Area Coverage (km^2)	Rhinoceros presence	Sign of illegal activity
2012-2016	SRS	1,150	Not detected	Camp sites, tree marking
2013-2015	TS	2,204	Not detected	Camp sites, tree marking
2010-2016	ETP	1,898	Not detected	Camp sites, snares, tree marking
2012 and 2016	NBIP	413	Not detected	Camp site, snares, tree marking
2016	BDCMD	90	Not detected	Camp sites, snares, bullets,
2012 and 2016	SRRS	307	Not detected	Camp sites, snares, bullets,
	Total	**6,062**		

Notes: SRS= Sumatran Rhinocerous Survey; TS= Tiger Survey; ETP= Enforcement Team Patrolling; NBIP= National Biodiversity Inventory Programmes; Biodiversity Data Collection, Management and Dissemination Programme and SRRS= Sumatran Rhinoceros Rapid Survey (SRRS).

Camera Trap Images

A total of 60,568 photos were captured by 611 camera traps over a coverage area of 2,701 km^2 during all the camera-trapping programs undertaken from 2012 to 2016 (Table 2). No Sumatran rhinoceros image was captured by camera trapping (zero detection) set up largely by the TS in TNNP. Other camera trapping programmes (SRRS, SRS and BDCMD) also revealed zero detection of rhinoceros.

Table 2. Camera trapping programmes in Taman Negara National Park (2012-2016).

Programme	Year	Area at TNNP	No. of camera trap	Total trap night	Total study area (km^2)	Total photo recorded	No. of species detected	No. of rhinoceros detected
SRS	2012- 2016	Pahang Terengganu Kelantan	38	1,872	100	1,874	25	0
TS	2013*	Pahang	456	4,103	360	6,433	26	0
		Terengganu		3,062	175	3,211	26	0
		Kelantan		1,266	200	7,747	27	0
	2014**	Terengganu		8,682	600	4,728	32	0
		Kelantan		7,585	338	6,457	28	0
	2015***	Pahang		9,690	531	13,495	31	0
BDCMD	2016	Pahang	52	6,552	90	12,272	25	0
SRRS	2012	Terengganu	24	5,436	150	1,018	25	0
	2016	Pahang	36	1,668	147	2,730	30	0
		Kelantan	5	1,050	10	603	3	0
Total			**611**	**50,966**	**2,701**	**60,568**	**278**	**0**

Notes: SRS=Sumatran Rhinocerous Survey; TS=Tiger Survey; BDCMD=Biodiversity Data Collection, Management and Dissemination Programme and SRRS=Sumatran Rhinoceros Rapid Survey.
*Camera traps model - Uway 250 & Super Scouter; **Camera traps model - Uway 250, Super Scouter, Panthera; ***Camera traps model - Reconyx

DISCUSSIONS

The absence of fresh Sumatran rhinoceros either through indirect evidence or camera trapping suggests that the Sumatran Rhinoceros population in TNNP may have become extinct in all their historical distribution areas. Poaching and small population (Allee effect) would have disrupted the Sumatran rhinoceros population.

Poaching

TNNP is a protected area, and turning it into other land-use forms or activities is prohibited. In the absence of habitat loss or fragmentation, poaching probably accounts for the loss of the Sumatran rhinoceros population throughout its distribution in TNNP. Although there was no report of a Sumatran rhinoceros killed by firearms, the loss of the animal most probably due to snare traps. Large mammals such as rhinoceros are very susceptible to be trapped or killed by snares if set up along their trails. Poaching by means of snares would disrupt Sumatran rhinoceroses population throughout it ranges. *The Asia Rhino, An Action Plan For Their Conservation* (Foose & Van Strien, 1997; Khan, 1989) was formulated to conserve the three Asian rhinoceroses species, including Sumatran rhinoceros in Peninsular Malaysia. The plan has included TNNP as one of the areas considered reasonably viable for long-term genetic management. PERHILITAN has increased the protection of Sumatran rhinoceroses by establishing the Rhinoceros Protection Unit (RPU) following recommendation as stated in the action plan to improve the effectiveness of law enforcement throughout the species range. This protection unit has been operating in rhinoceros habitat in Peninsular Malaysia since 1995 (Abdul Kadir, 2009). Several snare traps were confiscated or destroyed. RPU function, however more on monitoring and collecting Sumatran rhinoceros information and less focusing on anti-poaching measures.

Enforcement patrolling has been strengthened through a series of Jelai Operations, a joint patrolling initiative undertaken between PERHILITAN and Malaysian Arm Forces (MAF), since 2002 for combating intruders and destroying snares in TNNP. Intruders or poachers that were apprehended will be charged in court for wildlife-related offences (DWNP, 2002). Evidence of TNNP encroachments such as grounded campsites, marking on trees, leftover food and medicines, chopped agarwood trees, and ammunition was found during enforcement operations (DWNP, 2015). An old marking on trees is a good example to indicate that poaching may have taken place around the 1990s and prior. Intensive rhinoceros survey between 1991-1995 also confirmed the presence of many immigrants intruders/poachers in TNNP and in Dec 1995, 15 of them were discovered in a base camp while around 30-40 were already inside the park as claimed by the park personnel (Zainuddin, 1995). The group

of skilled intruders would spend longer time in the forest and organised themselves in remote areas with good networking. PERHILITAN took the initiative to monitor the remote areas using a helicopter with copious evidence of poaching and encroachments (DWNP, 2013). During a regular ETP program known as Jelai Operation and then 1MBEON (DWNP 2015), a lot of evidence on human illegal activity was gathered. A camera trap assessment of terrestrial vertebrates in Taman Negara Kelantan and Terengganu revealed the detection of 485 (5.49%) images of Orang Asli and illegal poachers in both studied areas (Jambari *et al*., 2015). This detection highlighted that poaching was still rampant despite the presence of strict regular enforcement patrolling in TNNP. Presumably, poaching activities were already taking place much longer since the National Park establishment, especially in the absence of strict patrolling enforcement or anti-poaching initiatives. Rhinoceros is one of the most poached large mammals in the world. Rhinoceros are poached due to the high value and demand for their body parts, particularly its horn, for medical purposes (Stevens, 1968). It can be speculated that many rhinoceroses would have been killed by snare traps set up in their home range.

Small and Non-viable Population (Allee Effect)

Although the Sumatran rhinoceros inhabit TNNP, the largest protected areas in Peninsular Malaysia, the population may not be large enough for long-term survival. The number of rhinoceroses had not increased significantly since the 1980s, and no substantial breeding was observed. Probably, the only evidence of rhinoceros breeding was a footprint of young rhinoceroses that was found at the western part of TNNP (Shariff, 1983). Lack of recruitment, as concluded by Zainuddin (1995), indicates that natural breeding rarely happened. Natural breeding not to occur within Sumatran rhinoceros population in TNNP probably due to demography problem (imbalance sex ratio, overage, isolated etc.). The adult size footprints (22-23cm) gathered during field survey around the 1990s would probably overaged or full-grown rhinoceroses with lack of breeding productivity. Sumatran rhinoceroses live an estimated 30 - 45 years in the wild (Van Strien, 2005). Supposing that many individual rhinoceroses were overaged during the data collection, their current survival would be minimal. Unfortunately, the age evaluation of Sumatran rhinoceroses in TNNP has not been conducted. Moreover, pressure of illegal human activities may break up the population and push individual moving into more remote areas and displaced limiting potential for pairing during breeding season. Female with no chance of mating may suffer internal reproductive problem due to no pregnancy for long time. This could explain why there was lack of recruitment for Sumatran rhinoceros in TNNP. The minimal rhinoceros' population in TNNP can also be viewed by the scarce reports of their sighting. The only report of a rhinoceros sighting was in Kuala Tahan in the 1980s (Flynn & Abdullah, 1984). The last

sighting occurred at the upper Ulu Keniam River when an adult rhinoceros was seen crossing the river as claimed by PERHILITAN staff in 1997, but the report on this was not available.

The number of Sumatran rhinoceros in TNNP had not enough to have reached the viability level. Although the reported 30-45 individuals in the 1990s, it is a census estimation that is open to error. In those days, indirect evidence was the practical technique in conducting the rhinoceros census. However, identifying rhinoceros presence in its home range is sometimes problematic, especially with the presence of tapirs. Tapir evidence, such as footprints and consumed plants, may misinterpreted as rhinoceros evidence due to close resemblance. In the same way, footprints that were detected in other locations (multiple records) within the rhinoceros home range distance of ~30 km^2 (Van Strien, 1985) would be recorded as from a different individual. A good example, rhinoceros evidence discovered in Terengganu (Sg. Cicir) was probably the same rhino that was roaming from Sg. Sepia, Pahang (Figure 1) but was recorded as a new finding in 1990. Number of rhinoceros were added to the previous estimate when more evidence was detected at Taman Negara Kelantan and Terengganu. The rhinoceros census population in TNNP should not indicate to have reached the viability level. We should be more concerned about their effective population for long-term survival. From a genetic point of view, the rhinoceros population will be at risk if the effective population (not the census population) is low. According to the principle of conservation biology, in the natural population, a genetically effective population is only a fraction (25-75%) of the census number. A minimum number of 50 (effective size) rhinoceroses is required, as suggested in the preliminary analysis of the population biology of Asian rhinoceros (Foose *et al*., 1995), Thus, 70-200 actual animals are required to achieve a genetically effective population of 50. A genetically effective population depends on the number of animals reproducing, the sex ratio of the reproducing animals and relative lifetime of offspring in the population.

The Sumatran rhinoceros population had not been in the genetically effective population since the establishment of TNNP. Continual low and small populations lead to its local extinction. The conservation biology model suggested that a population smaller than 25-50 total individuals are seriously at risk due to demographic and genetic problems (Foose *et al*., 1995). When populations become small and fragmented, they become vulnerable to extinction for genetic and demographic reasons, in addition to the direct threats of habitat disturbance and poaching. Moreover, the smaller the population, the greater these genetic and demographic threats become (Foose *et al*., 1995) and the more susceptible it is to extinction from various causes (Shaffer, 1981).

Another suitable term to express the local extinction of Sumatran rhinoceros in TNNP would be the Allee effect as a result of small population. Allee effects

are broadly defined as a decline in individual fitness at low population size or density, which can result in critical population thresholds below which population crash to extinction (Courchamp *et al*., 2008). The Allee affected small population with a lack of breeding activities unable the species to sustain for a longer-term in their natural habitat. As far as stochastic variables are concerned, the Allee effect is the likely impact on small isolated wild populations (Ahmad *et al*., 2013).

TNNP, the largest protected area, did not accommodate the viable Sumatran rhinoceros population. The number of Sumatran rhinoceros has never achieved the proposed effective size. Protected areas have been created for the rhinoceros, and other in situ conservation efforts have increased, but the species has continued to go locally extinct across its range (Havmøller *et al*., 2015). In-situ protection in the natural habitat for a small and inviable population alone is not the right conservation strategy to save the species from extinction. Some conservationists and experts have even said that a small population is the most serious threat, even in the absence of poaching. Hence the use of advanced technology is highly suggested (Ahmad *et al*., 2013). Conservation intervention should have been practised long before when the population of Sumatran rhinoceros was seen below the minimum genetically effective size ~7.5 - 25 individuals (by reducing 25-75% of the minimum 30 population census) and they facing high poaching pressure. The best strategy is to permit the translocation of the wild individuals into semi-in-situ captive breeding programs managed within the park itself. Unfortunately, this was not applied to the Sumatran rhinoceros in TNNP.

CONCLUSION

It is not possible that a viable population of rhinoceros still exists in TNNP when no definitive evidence was found throughout an extensive ground survey and patrolling program. Sumatran rhinoceros in TNNP was practically small and considered non-viable in genetic and demographic terms. The high threat of poaching on the rhinoceros population more than a decade ago further worsened the scenario. It can be concluded that the localised extinction of Sumatran rhinoceros in TNNP is very likely due to several factors, mainly poaching and the small population (Allee effect). The combination of both gives a more devastating result.

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Appendix 1

Sampling location during long-term Sumatran rhinoceros survey in Taman Negara National Park (2012-2016). Presence of rhinoceros was not detected.

Year	Date	Location	Specific location	Distance (km)
2012	18-31 March	Taman Negara (TN) Pahang	Hulu Sg. Keniam Besar	24
			Sg. Keniam Besar	27
			Sg. Jintoh	21
			Sg. Sat	19
	12-27 April	TN Pahang	Hulu Sg. Aring	31
			Sg. Jujor	29
			Sg. Koh	27
			Sg. Lebir	26
	16-31 May	TN Pahang	Sg. Trenggan	24
			Sg. Garam	23
	17-30 June	TN Pahang	Sg. Rook	26
			Sg. Sepia	20
	16-27 July	TN Terengganu	Sg. Pertang-Sg. Cacing	34
	10-25 September	TN Terengganu	Sg. Terenggan	28
			Sg. Cacing	25
			Gunung Mandi Angin	30
	4-19 October	TN Terengganu	Hulu Sg. Cacing	22
			Gunung Padang	31
			Sg. Berang	23
	28 Nov - 14 Dec.	TN Terengganu	Gunung Padang	27
2013	12-24 May	TN Pahang	Gunung Gagau/ Sg.	26
			Gunung Gagau/ Sg. Sat	24
	7-13 July	TN Terengganu	Sg. Trenggan	21
			Sg. Cacing	20
2014	16-28 February	TN Pahang	G. Penumpu	30
			Bkt 1108	32
	16-28 March	TN Pahang	G. Perlis	33
			Bkt 1083	29
			Pdg Limau	24
			Hulu Sg. Badong	27
2015	13-24 May	TN Terengganu	Sg. Alor/Sg Pertang	32
			Sg. Pakoh/Gunung	33
2016	28 February March	TN Pahang	Sg. Kechau	25
			Sg. Keniam	25
			Sg. Sepia	25
	June & September	TN Pahang & Kelantan	Boundary TN Kelantan	25
			Gunung Badong	On site