

A Review of the Proboscis Monkey (*Nasalis larvatus*) in Borneo, with Reference to the Population in Bako National Park, Sarawak, Malaysian Borneo

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Received: 28 August 2014; Accepted: 14 November 2015

Abstract.— The Proboscis Monkey (*Nasalis larvatus*) is endemic to the Island of Borneo. It dominates from the coastal areas to the headwaters of some major rivers. In Sarawak, its distribution occurred in coastal and swamp areas based on previous studies. The population in the Bako National Park, Sarawak is fluctuating when compared to previous studies. The total population of the proboscis monkeys is estimated about 306 individuals compared to the lowest of 111 individuals in 2005. The fluctuating numbers of *N. larvatus* population is assumed to be at the optimum carrying capacity Bako National Park. There are still large areas of habitat outside the Bako National Park that can support the increasing population size that must be secured to protect a viable population in the long term.

KEY WORDS: Bako National Park, population, distribution, *Nasalis larvatus*, proboscis monkey, malaysian Borneo

INTRODUCTION

The total number of proboscis monkeys living in Borneo is widely believed to number in the tens of thousands and number of publications and GIS information all pointed to the fact that proboscis monkey habitats are declining at the rate of about 2% per year (Manansang et al., 2005). Population size and trend in population size have been found to be major indicators of population health and viability (Reed et al., 2003; O'Grady et al., 2004). So there is a big question about how and why particular ecological factors influence primate individuals, groups and population (Wrangham, 1980; van Schaik, 1983; Isbell 1991; Sterck et al., 1997). While primatologists have used a variety of approaches to address

these questions, the study of a particular taxon across a range of ecological conditions provides a particularly useful framework for investigating key questions about the interactions between primates and their habitats (Strum and Western, 1982; Davies, 1994; Doran et al., 2002; Morrogh-Bernard et al., 2009; van Schaik et al., 2009). Furthermore, habitat quality can have important implications for primate populations on the individual, group and population levels (Manansang et al., 2005). For example, habitat quality can influence individual reproductive success, group size, and a population's probability of persistence over the next generations.

In Sarawak, based on information of more than two decades, less than 1,000 animals are believed to be remaining in

sparsely and patchily distributed populations that are due to habitat loss and illegal hunting (Bennett and Sabastian, 1988). The areas found with existing *N. larvatus* populations are in Bako National Park, Samunsam Wildlife Sanctuary, Kuching Wetland National Park, Maludam National Park, Limbang-Lawas, Ulu Sebuyau and isolated areas outside national parks such as mangrove at Kampung Bako. The numbers is declining due to the opening of coastal areas for massive logging, shrimp farming and oil palm plantations (Bennett, 1988; Boonratana and Sharma, 1992; Yeager, 1992; Sebastian, 2000; Meijaard and Nijman, 2000a; Soendjoto 2004; Agoramoorthy, 2007). Some areas might be due to die back of mangrove forest due to natural causes, anthropogenic disturbances and illegal encroachment (Meijaard and Nijman, 2000).

In Sarawak, there are several areas that had been gazetted as totally protected areas such as national parks, wildlife sanctuaries and nature reserves, such as Bako National Park, Samunsam Wildlife Sanctuary, Kuching Wetland National Park (previously known as Sarawak Mangrove Forest Reserve), Sebuyau National Park, Maludam National Park, Rejang Mangrove National Park and Niah National Park are totally protected areas with sizeable populations of *N. larvatus*. However, some areas have no recent records or study being done, such as in Niah National Park, Maludam National Park, Rejang Mangrove National Park and Sebuyau National Park. It was reported by Salter and Mackenzi (1981) that the populations are much dispersed, probably occurring as at least three and possibly more subpopulations with no migration or emigration. The distribution reported to be in the areas of Rejang Delta, Sungai Suai and Niah areas in Miri, while the Limbang-

Lawas areas where their populations are continuously with that in Brunei. It is also reported by questionnaire survey in 1979 by Sarawak Forest Department that it occurred in Ulu Baram (Long Laput and Long Kasih) and Ulu Limbang (Long Salidong) but there is no known historic distribution of this monkey recorded in those areas.

Kuching Wetland National Park previously was designated as a Ramsar Site on the 8th November 2005. A study in this area by William and Andrew (2010) found the existence of *N. larvatus* isolated but secured as totally protected area although the surrounding area is undergoing rapid development and human settlement (Beavitt and Tuen, 2010).

Sebuyau National Park was constituted and gazetted on the 25th March 2010 has recorded the presence of *N. larvatus*. In 2013 a sighting of the monkey was reported by staff of Forest Department on field duty in that area (Wan Omar Wan Wek per. com.). This peat swamp area is known to be the habitat of the Proboscis Monkey that can support the survival of the population although the surrounding areas were logged and cleared for agriculture plantations. (Salter and Mackenzi, 1981)

The Maludam National Park is one of the largest peat swamp area constituted as totally protected area still support a viable population of *N. larvatus* despite the recent invasion by illegal loggers. It was previously reported that the minimum population was 47 animals based on their highest simultaneous count (Salter and Mackenzi, 1981).

N. larvatus was not detected in Rajang Delta which is now known as Rajang Mangrove National Park (Salter and Mackenzi, 1981). In 11 June 1981, one skin of the monkey is seen in the logging camp

by Forest Department (Salter and Mackenzi, 1985).

In the western area of Miri, Sungai Suai and Sungai Niah, there were reports of *N. larvatus* individuals. Recently researchers from Universiti Malaysia Sarawak reported sighting of the monkey during the field trip in 2012 in the area and cannot be confirmed whether it was in the Niah National Park area (Millawati Gani and Ho Licia, pers. comm.).

Another distribution record occurred in Limbang-Lawas area, where the population is continuous with that in Brunei and possibly Sabah (1981). This is because these three areas are sharing border with each other and along the border are forested areas that might be the habitat of proboscis monkey. Recently study reported the sighting of *N. larvatus* at Kuala Lawas (Sundai, 2004). The existence of *N. larvatus* are known outside the totally protected area, in fragmented area, disturbed habitat and area that had been opened for agricultural plantations. There is immediate threat to the populations that are found outside protected area and are prone to illegal poaching. Recently, it was reported by locals of Sangkalan in Simunjan area that illegal hunters killed *N. larvatus* although there is no record or history of the existing of the monkey in the area. However the emergence of the monkey in the area may due to the effect of the forest clearance for agriculture plantations, therefore, forcing the monkey populations into smaller areas of less suitable habitat. High densities can also be an artifact of habitat fragmentation, forcing proboscis monkey populations into smaller areas of suitable habitat (Sha, 2006).

Proboscis Monkey is endemic to Borneo occurring in Brunei, Indonesian Kalimantan and Malaysian states of Sarawak and Sabah, dominating the whole area of coastal habitat

as well as on the satellite islands of Berhala, Sebatik and Pulau Laut (Groves, 2001; Meijaard et al, 2008). In Sabah, large populations are in the Kinabatangan flood plain and around Dewurst Bay in the Eastern Deltas. Brunei supports one population in the estuaries. But the species is in greater abundance in Kalimantan (Indonesian Borneo) with the population size range from 100 to 1,000 individuals (IUCN 2012). The Indonesian populations might be declining depending on the past and current threats due to conversion of the coastal swamps to shrimp farming and Pulau Kaget Nature Reserve population in South Kalimantan has reportedly been extinct since 1997 (Meijaard and Nijman, 2000).

Within Kalimantan large populations are reported from Danau Sentarum Wildlife Reserve, Gunung Palung National Park, Tanjung Puting National Park and Mahakam delta (Sabastian, 1994, Yeager and Blondal, 1992). There are still other areas remain unprotected with relatively large populations of *N. larvatus* which includes the delta of Sungai Sesayap, Sungai Sembakung, Sungai Sebuk, Mahakam Lake area, the freshwater and peat swamp forest areas of Central Kalimantan and the Kendawangan area (Meijaard and Nijman, 2000). In 1987, the estimated populations within Kalimantan (Mackinnon, 1987) were more than 250,000, with *ca.* 25,000 protected inside reserves. Considering the figure is too high, Yeager and Blondal (1992) made an adjustment to < 5,000 animals inside protected reserves. Recent study by Clem and Hemanath (2007) estimated the number of 7,500 animals (Table 1). A reliable field survey with standardized method could validate those populations in Kalimantan.

In Sabah, a higher population of 2-3000 animals was found in Kinabatangan River and Dent Peninsula areas (Bennett and Gombek, 1993). Study estimated about 5,907 individuals (Sha, 2006) (Table. 1) which is much higher than the previous estimates of 2,000 (Davies and Payne, 1982) and 3,000 individuals (IUCN 1978). Habitat loss and fragmentation cause by expansion of human settlements, degradation due to excessive extractive logging and conversion of land to agriculture and aquaculture farming are identified as the major threats to the *N. larvatus* populations in Sabah (Bennett and Gombek, 1993). In Brunei (Salter and Mackenzie, 1985) reported about 420 individuals (Table. 1) dominating the coastal swamp of the Brunei Bay.

This present study updates current information on the distribution and population of *N. larvatus* in Bako National Park, Sarawak, and provide some information on threat on its long term population viability and also identify the implication from the loss of mangrove forest and the non-appearance of monkey population in areas outside the park that there are regularly present, particularly, Kampung Selabat.

TABLE 1. Population estimations of *N. larvatus* by from previous authors

Region	Numbers	Reference	Year
Brunei	420	Salter and MacKenzie	1985
Sarawak	1,000	Bennett et al.	1987
Sabah	5,907	Sha	2006
Kalimantan	7,500	Clem and Hemanath	2007

MATERIALS AND METHODS

Study area

Bako National Park is located about 30 km or 40 minutes' drive and by boat northeast of Kuching, lies between longitudes 110°26' to 110°36' E and latitude 1°42' to 1°44' N, and altitude ranges from sea level up to 244 meters (Hazebrock and Abang Kashim 2000). Bako comprises a site of 2,728 hectares (27.4 km²) and known as the first and smallest national park in Sarawak (Hazebrock and Abang Kashim 2000). The area is diverse with seven forest types, namely, mangrove forest, *kerangas* forest (keruing-ronang), *kerangas* (fire padang and sempilor), riverine forest, mixed dipterocarp forest (MDF), beach forest and cliff vegetations and unstable slopes with 25 vegetation types (Ashton, 1971; Hazebrock and Abang Kashim 2000, Zaini and Ilias, 2005). The park is inhabited by not only proboscis monkeys but also 23 species of mammals, such as bearded pig (*Sus barbatus*), silver-leaf monkey (*Presbytis cristata*), long-tailed macaques (*Macaca fascicularis*) and colugo or flying lemur (*Galeopterus variegatus*), 150 species of birds and 24 species of reptiles (Hazebrock and Abang Kashim 2000; Dzulhelmi and Abdullah, 2009a, 2009b; Thayaparan et al., 2013) including 22 species of bats in the area were also recorded (Khan et al., 2007).

Study method

Population estimation was done by direct observation and by interviewing local communities living around the Bako National Park where *N. larvatus* was commonly sighted (Fig. 1). The study period was from December 2011 to December 2012 to collect field data and information in and around Bako National Park. Most of the observations were done by

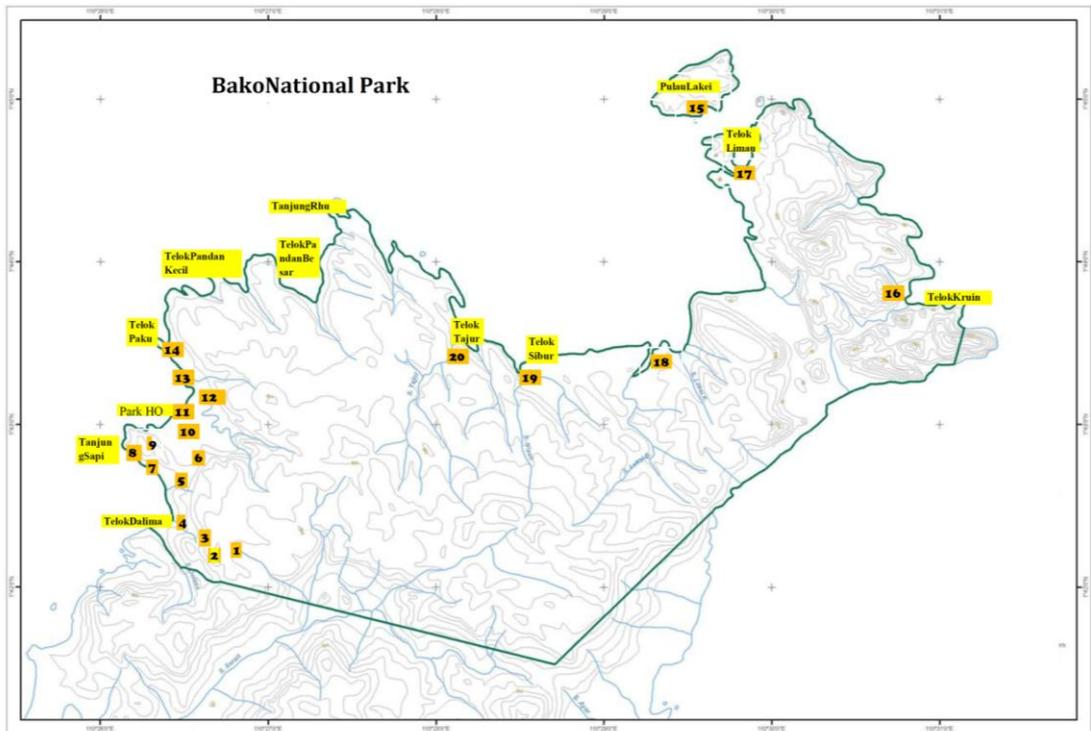


FIGURE 1. Sampling sites: 1 to 3: Ulu Asam, 4: Telok Dalima, 5 and 6: Lintang Trail. 7 and 8: Cliff vegetation, 9: Beach Tg Sapi, 10 and 11: Beach at Park Hq, 12: Sungai Asam, 13: Mnagrove Telok Asam, 14: Telok Paku, 15: Pulau Lakei. **Site and location where no sighting of *N. larvatus*:** 16: Telok Kruing, 17: Telok Limau, 18: Sungai Lakei 19: Telok Sibur, 20: Telok Tajur.

land transects, only some part of the park like Pulau Lakei, Telok Keruing, Telok Gador, Telok Tajor, Telok Limau, Telok Sibur and Kampong Selabat mangrove where we used outboard motor boat to reach these places. Then on foot was mostly done to follow every group that was sighted. Some areas or locations of sighting were feature with vertical cliff, huge boulders and steep terrain could not be traversed and observations were cancelled.

Survey was also done outside the park area where *N. larvatus* was found to be common. With a large area of healthy green mangrove in Kampong Selabat was reported to be a raging area and commonly present even around the forested area in the village.

Interviewed local people on the status and activities were also carried out.

RESULTS

Twelve land transects with a total of 26.6 kilometer in length were surveyed in Bako National Park. But of 12 transects only seven recorded the sightings of proboscis monkeys (Table. 2). The number of individual proboscis monkey per kilometer is estimated at 0.15 with the total number of 306 individuals recorded. Two transect at Tanjung Sapi and Telok Delima had the highest number of abundance per kilometer between 14 to 15 individuals.

TABLE 2. Population estimated at different transect at Bako National Park, Sarawak.

No.	Transect	Length (km)	Frequency of survey	No. of individual	Abundance (per frequency/survey)	Abundance (individual/km)
1.	TelokAsam	2.0	12	185	15.42	3.85
2.	TelokAsam Mangrove	0.5	1	8	8.0	8.0
3.	Lintang Trail	5.25	6	6	1.0	0.1
4.	TanjungSapi	0.5	1	15	15.0	15.0
5.	UluAsam	0.8	6	42	7.0	4.38
6.	TelokDalima	0.25	1	7	7.0	14.0
7.	TelokPaku	0.8	3	35	11.67	7.29
8.	PulauLakei (Pa' Amit)	1.0	2	8	4.0	2.0
9.	TelokLimau	5.75	1	0	0	0
10.	TelokKruin	1.5	1	0	0	0
11.	TelokSibur	0.8	1	0	0	0
12.	TelokTajor	2.75	1	0	0	0
13.	Kampung Selabat	5.0	3	0	0	0
Total		26.6	39	306	7.85	0.15

The highest numbers of individuals at 15.42 were recorded at Telok Asam sampling site followed by 15 individuals at Tanjung Sapi and Telok Paku with 11.67 individuals. For Pulau Lakei, Telok Asam Mangrove, Telok Dalima, Ulu Asam and Lintang Trail it ranged from 4 to 8 individuals per survey.

From the 13 locations where the proboscis monkeys were found, in seven sites the monkeys were directly sighted and in four others it was by indirect observation i.e. vocalisation was heard as we entered the areas. In one location at Kg Selabat it was only reported by local villagers on its existence but no proboscis monkey was sighted during the survey. Most of the sighting sites had the interference of human and some group of proboscis monkeys were habituated with the modified environment.

The mean sighting of proboscis monkeys was 0.15 individuals / km, and was highest for the Tanjung Sapi followed by Telok Asam mangrove and Telok Dalima. Highest numbers of proboscis monkeys were found

in Telok Asam (15.42 individuals per survey occasion) and followed by Telok Paku (11.67 individuals per survey occasion). These areas consist of two types of forests which are beach and mixed dipterocarp forests. These two type forest offered a diversity of plant species as food resource and densely vegetation not only for feeding but also to rest and night roosting. Sighting frequency was, however, higher in these areas due to the factor of availability of foraging resources.

For the beach forest and the Park Headquarter a group of one-male consisting of 12 individuals sighted and this group had been habituated to the environment of the present human around. Earlier sighted the group only consists of 8 individuals with only one adult male (Fig. 2) but increased in number to 12 individuals with two adult males, 8 sub-adult males and two juvenile males in the group. The behavior of fusing and merging among the individual in the group happened hence adding the number of individual in the group.



FIGURE 2. Adult male in the all-male group

The chance of sighting was very difficult even though we could hear the vocal calls of the male proboscis monkeys. So, the observation seems to be more frequently in the areas of Telok Asam, Lintang Trail and Ulu Asam because of the direct sighting of proboscis monkey can be easily done in those areas.

Pulau Lakei which is part of Bako National Park, possess the land features with large boulders, cliff and kerangas type of forest. The number of *N. larvatus* sighted on the island is estimated at 3-5 individuals which probably migrated (Fig. 3) from the mainland about 100 meters distance. The morphological feature, such as webbing fingers and toes of this monkey is well adapted for its swimming ability (Kombi and Abdul, 2013).

The site adjacent to Lakei Island at Sungai Lakei Besar, Sungai Lakei Kecil and

Sungai Tajor, there was no sighting of *N. larvatus* in the areas although mangrove forest at Sungai Lakei Besar are well established to be the habitat of the monkey. There was a call heard at Sungai Lakei Kecil but it was too distant to confirm its identity. The area of Telok Keruing where there are patches of mangrove forest reported to be the feeding area but *N. larvatus* wasn't sighted.

Apart from Bako National Park, observation was also done outside the park area at Kampung Salabat where a large and healthy mangrove forest was present. Although there were reports by residential villagers of the presence of *N. larvatus* around the forested area but during our survey there *N. larvatus* was not sighted (Table. 3).



FIGURE 3. Proboscis monkey at Pulau Lakei

Threats

Hunting and farming are the threats to the population of *N. larvatus* in Borneo. Wildlife hunting appeared to be an important supplement to rural people's diet including *N. larvatus* when opportunity arises (Pfeffer, 1958, Caldecott, 1992). Either than for food *N. larvatus* is sometimes hunted for the highly valued bezoar stones which are sometime found in the intestines of this and other colobine species. Habitat loss and fragmentation due to expansion of human settlements is identified as the major threat to proboscis monkey populations in Sabah (Sha, 2006). Proboscis monkeys have been recorded in disturbed habitats of secondary growth near human settlements; in remnant tidal forest close to agricultural land, in selectively felled forest (Kawabe and Mano, 1972,

Jeffrey, 1982, Salter and Mackenzi, 1985, Salter et al., 1985); in a rubber plantation (Sha, 2006); and we have seen them in coconut plantations, thereby indicates a certain degree of dietary plasticity and habitat adaptability, but they are not known to use many habitats, in particular, farmland and permanent cultivations such as oil palm (Sha, 2006). Habitat fragmentation and degradation may impede movement, dispersal and social activities of groups at important resting sites (Sha, 2006).

In Bako National Park, threat of hunting and loss of habitat does happen in and around the park. Hunting may not be done by local people living around the park as they are all Muslims and consumption of monkeys is forbidden. Hunting is usually done by the Dayak people coming from outside the surrounding area of the park and

TABLE 3. Estimated population of *N. larvatus* based on previous authors and this study at Bako National Park, Sarawak.

	Salter & Mackenzie (1985)	Brundellet. al. (1990)	Zaini et. al. (2004)	Zaini and Ilias (2005)	Mohammad ShahfizAzman (2005)	Present study (2013)
Population Estimated	106-144	213	275	111	235	306

hunting is done in area of Kg Selabat mangrove and at Telok Keruing and Telok Limau. This area seems to secluded part of the parks which is seldom visited by visitor. Due to this activity the species are rare or absent like the area in Kg Selabat mangrove which is common places for the monkey.

As at Telok Asam mangrove, the die-off mangrove regarded as the loss habitat for *N. larvatus*. The area of feeding ground and common places in Bako National Park to observed or see the monkeys. The shortage of this essential resources and limited food availability and competition with other primates in a long term of period will affect the population in the area. Although Bako National Park is a totally protected area, a natural destruction on the habitat cannot be avoided and beyond control and so as hunting, negligence in enforcement will create opportunity to illegal poaching. Even though Bako National Park is totally protected area cover under Rules and Regulation, so as *N. larvatus* a totally protected animal, IUCN (2013) and listed under CITES Appendix I, if measured is not taken to prevent or control what had happened now the extinction of species could happen.

DISCUSSION

There are many processes that can cause fluctuations in population size such as variation in the environment such as

weather, food supplies, predation and decimation of the population or its habitats by humans (Gilpin and Soulé, 1986). The species may have the risk of extinction and the existing populations seem too small to be viable in the long term due to highly isolated from population outside the park.

The estimate of 306 individuals in this study is a minimum population estimate for Bako National Park, bearing in mind that not all areas in the park of suitable proboscis monkey habitat and were excluded from this survey. Although the estimate in this study is much higher than the previous authors (Table 2), it should not be taken that the population had actually increased. We cannot conclude whether the population has increased or decreased over the last 20 years. The proboscis population of Bako National Park is probably considered completely isolated where surrounding the park are human settlement and area converted for agriculture purposes which before would provide an important coastal migration corridors from Bako, Kuching Wetland to Samunsam. However, there is strong evidence that the extant populations are highly fragmented, with some individuals still exist outside the park.

Shaffer (1981) identified various factors that threaten viability or persistence of the population and categorized it into demographic stochasticity, environmental variability, catastrophic variation, genetic drift and inbreeding. These entire factors

could threaten the persistence of the population that falls below the minimum viable size or MVP where the each factor involve process which causes the small population to undergo fluctuation and possibly further decline (Robert, 1993). Soule (1980) suggested that the number of 50 and 500 individuals were effectsizes for short term and Franklin (1980) for long term. As for Bako National Park with 306 estimated individuals can be categorized in this concept of MVP but under the probabilistic nature of the extinction process on some population are estimated over time periods for designated population that exposed to a specific scenario of environment conditions, threat to persistence and future management actions (Brussed, 1985; Starfield and Bleloch, 1986; Soule, 1987; Simberloff, 1988; Gilpin, 1989; Shaffer, 1990; Boyce, 1992; Burgman et al., 1993). Gilpin and Soulè (1986) stresses that the destabilizing stochastic processes are synergistic various of demographic, environmental and genetic processes can exacerbate the instability caused by other factors, causing what has been depressingly referred to as extinction vortices. Shaffer (1981) first defined an MVP as the size at which a population has a 99% probability of persistence for 1000 years, but it might be more meaningful biologically to consider it to be the size below which a population's fate becomes determined largely by the stochastic factors that characterize extinction vortices.

Based on a genetic study by Licia and Abdullah (2014), on control region fragment, 13 out of 15 haplotypes are clustered together and with the highest haplotype diversity ($h = 0.926$) compared to other populations. Apparently, this Bako NP population may constitute an evolutionary significant unit (ESU) that must be

preserved by the wildlife authorities in Sarawak.

The park is an important site for the conservation of proboscis monkey especially the rocky coastline area which comprises mangrove trees that includes young leaves and growing tips of the mangrove *Sonneratia* peat swamps and riverine forests (Rothschild, 1971; Kombi and Abdullah, 2013) (Fig. 4). Bako National Park is an important eco-tourism site, and the park is regularly visited by local and foreign tourists in which the popular species is proboscis monkey.

CONCLUSION

The fluctuation number of population of *N. lavartus* at Bako National Park seem to be normal when compare to the study done since 1981 (Salter and Mackenzi, 1981). There is no drastic increased or decreased in number of population estimation done by all researchers until 2012. The different in number of estimation could be an error of methodology that cannot be avoided. The number of estimation might be the number of caring capacity of the habitat that accommodates the population in Bako National Park.

The activity of illegal poaching should be given priority to prevent and avoiding extinction of this species (Meijaard and Nijman, 2000). Surveillances in the area reported to be prone to the activity of illegal poaching. However large areas of habitat protected cannot ensure the survival of the species without persistent law-enforcement. The large areas of habitat outside the park should be gazette either as buffer zone or as totally protected area to ensure that the habitat is not convert or develop for the purposed of agricultural. Reforestation of mangrove area which had been naturally



FIGURE 4. Young leaf grown on the trunk

loss due to natural causes should be done to restore the habitat of the proboscis monkey. Community-based ecotourism can bring significant benefits to local communities with proper evaluation and control mechanisms can avoid unethical and irresponsible mass tourism activities (Sha, 2006). For ecotourism the species may serve as the flagship for protected wetland areas as long as ecotourism is well-guided and disturbance levels can be kept low (Meijaard and Nijman, 2000). Proximity of humans to proboscis monkeys should be prevented to avoid disturbance and alteration of behaviors that are detrimental to the long-term conservation of this sensitive species (Sha, 2006)

ACKNOWLEDGEMENTS

We would like to thank to the Director, Forest Department Sarawak, COE of Sarawak Forest Corporation and Bako

National Park managers (Siali Aban and Abang Mutalib Abang Zainudin) and staffs (especially Khalid Zakaria) for their warm hospitality, permission and permits to conduct research; the Universiti Malaysia Sarawak (UNIMAS) for the administrative and logistic support in conducting this study. Thank you to Anuar Japar and Halik Akop for assisting in collecting of data and searching and tracking of the proboscis monkeys. Very special thanks are due to all members of Proboscis Genome Project (Nur Aida Mohd Tamrin, Mohd Hanif Ridzuan, Wahap Marni, Madinah Adrus, Mohd Isham Azhar, Ho Licia, Millawati Gani, undergraduate and postgraduate students of Department of Zoology, UNIMAS) for sharing their information and knowledge, review and comments to improve the initial draft of this paper. Dr Faisal Anuarali Khan commented the initial drafts of the paper. Mr. Karim Hercus and Dr Lim Boo Liat chance meeting over coffee and roti in 2010 had given us a window of opportunity and

faith for us to initiate this research project. The research was supported by the UNIMAS-MGI-MoSTI-MGRC Proboscis Genome Project lead by Professor Dr. M.T. Abdullah, Associate Professor Yuzine Esa and Associate Professor Dr. Ramlah Zainuddin. MBK collected and analyses the field data and co-wrote the paper while MTA conceptualized research, co-wrote and edited the drafts. This work formed part of the MSc thesis by MBK at UNIMAS and full support by the genome grant.

LITERATURE CITED

- Agoramoorthy G.2007. Conservation status of proboscis monkeys in disturbed mangrove forests in Sabah, northern Borneo. Tigerpaper, 34(3): 1-4
- Ankel-Simons F. 2007. Primate Anatomy: an introduction, 3rd Ed. Academic Press, San Diego.
- Ashton, P.S. 1971. The plants and vegetation of Bako National Park. Malayan Nature Journal, 24: 151-162.
- Azman, S. A.2005. Population Estimation of Proboscis Monkey (*Nasalis larvatus*) at Bako National Park. BSc Final Year Report, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Kota Samarahan.
- Beavitt, W. and Tuen, A. A. 2010. Swamp Kuching Wetlands National Park. Universiti Malaysia Sarawak, Kota Samarahan.
- Bauchop, T. and Martucci, R. W.1968. Ruminant-like digestion of the langur monkey. Science, 161: 698-700.
- Bennett, E. L.1986. Proboscis monkeys in Sarawak: Their ecology, status, conservation and management. WWF-Malaysia/NYZS. Kuala Lumpur.
- Bennett, E.1988. Proboscis monkeys and their swamp forests in Sarawak. Oryx 22(1): 69-74.
- Bennett, E. L. and Gombek, F.1993. Proboscis Monkeys of Borneo. Natural History Publications (Borneo) Sdn. Bhd. and Koktas Sabah Berhad, Kota Kinabalu.
- Bennett, E. and Sebastian, A.1988. Social organization and ecology of proboscis monkeys (*Nasalis larvatus*) in mixed coastal forest of Sarawak. International Journal of Primatology, 9(3): 233 - 255.
- Bernard, H.1996. The distribution and abundance and some aspects on behavior and ecology of the proboscis monkey (*Nasalis larvatus*) in the Klias Peninsula, Sabah. MSc Thesis, University of Reading, White knights Reading.
- Bernard, H.2005. Conservation status of proboscis monkey (*Nasalis larvatus*) in Sabah, North Borneo: Part I: Klias Peninsula. Report for Universiti Malaysia Sabah short-term research grant, B-0804-11-ER/UO61.KotaKinabalu.
- Boobratana R, and Sharma D.S.1992. Conservation of proboscis monkeys in the lower Kinabatangan, Sabah. In: Thierry b, Anderson JR, Roeder JJ, Herren schmidt N, editors. Current primatology, volume I: ecology and evolution. Strasbourg (FR): Universite Louis Pasteur. p93-100
- Boonratana, R.1993. The ecology and behaviour of the proboscis monkey (*Nasalis larvatus*) in the Lower Kinabatangan, Sabah. PhD Thesis. Faculty of Graduate Studies, Mahidol University, Bangkok.
- Boonratana, R. 2002. Social organisation of proboscis monkeys (*Nasalis larvatus*) in the Lower Kinabatangan, Sabah, Malaysia. Malayan Nature Journal, 56 (1): 57-75.
- Boyce, M.S. 1992. Population viability analysis. Annual Review of Ecology and Systematics, 23: 481-506
- Brundell, P., Patrick, R., Healey, G., Garbutt, N., and Hannah, G., 1990. The Conservation of Proboscis monkeys in the Bako National Park Sarawak. Unpublished report, Nottingham University, United Kingdom.
- Brussard, P. 1985. Minimum viable population: how many are too few? Restoration and Management Notes, 3: 21-25.
- Burgman, M., S. Ferson and H.R., Akcakaya..1993.Risk Assessment in Conservation Biology. Chapman and Hall, New York.
- Caldecott, J. 1992. Hunting pattern and their significance in Sarawak. In: Ismail, G., Mohamed, M., Omar, S. (Eds.), Forest Biology and Conservation in Borneo. Center for Borneo Studies Publication No. 2. Kota Kinabalu.
- Davies, A.G. and Oates, J.F., 1994. Colobine Monkeys: Their Ecology, Behaviour Evolution. Cambridge University Press, Cambridge.
- Davies, G., Payne, J. 1982. A Faunal Survey of Sabah. World Wild-life Fund Malaysia, Kuala Lumpur.
- Dzulhelmi, M.N and M.T Abdullah. 2009a. Foraging Ecology of the Sunda Colugo (*Galeopterus variegatus*) in Bako National Park, Sarawak, Malaysia. Malayan Nature Journal, 61 (4), 285-294.

- Dzulhelmi, M. N and M .T. Abdullah. 2009b. An Ethogram Construction For The Malayan Flying Lemur (*Galeopterus Variegatus*) In Bako National Park, Sarawak, Malaysia. *Journal of Tropical Biology and Conservation*, 5: 31 – 42.
- Franklin, I.R. 1980. Evolutionary change in small populations. In: *Conservation Biology: An Ecology/Evolutionary Perspective*, M.E. Soule and B.A. Wilcox (eds.), pp.135-149. Sinauer Associates, Sunderland, Massachusetts.
- Gilpin, M.E. 1989. Population viability analysis. *Endergered Species Update* 6: 15-18.
- Gilpin, M.E., and M.E. Soulé. 1986. Minimum viable populations: processes of species extinction. Pages 19 – 34 in: Soulé, M.E. (ed.). *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer Associates, Sunderland.
- Groves, C. P. 2001. *Primate taxonomy*. Smithsonian Institution Press, Washington D.C.
- Hazebroek, H.P. and A.M. Abang Kashim. 2000. *National Parks of Sarawak*. Natural History Publication (Borneo), Kota Kinabalu.
- Jeffrey, S. 1982. Threats to the proboscis monkey. *Oryx* 16: 337-339.
- Kawabe, M. and Mano, T. 1972. Ecology and behaviour of the wild proboscis monkey, *Nasalis larvatus* (Whurmb) in Sabah, Malaysia. *Primates*, 13: 213-228.
- Khan, F.A.A., S.N. Sazali, V.K. Jayaraj, S. Aban, K.M. Zaini, K. Besar, R.R.J. Jeffrine, A.M. Julaihi, L.S. Hall, and M.T. Abdullah. 2007. Survey of bats in the tropical lowland dipterocarp forest of Bako National Park, Sarawak, Malaysian Borneo. *Sarawak Museum Journal*. 84:267-300.
- Kombi, M and Abdullah, M.T. 2013. Ethogram of the free ranging *Nasalis larvatus* in Bako National Park, Sarawak. *Malayan Nature Journal* 65 (2 & 3), 1-21.
- Kuhn, H. J. 1964. Zur Kenntnis von Bau und Funktion des Magens der Schlankaffen (Colobine). *Folia Primatol*, 2: 193-211.
- Licia, H. and Abdullah, M.T. 2013. Comparative study on the genetic diversity of proboscis monkey (*Nasalis larvatus*) from selected populations in Malaysian Borneo. Presented in 10th Malaysia Genetic Congress, 3-5 December 2013, IOI Palm Garden Hotel, Subang, Malaysia.
- MacDonald, D.W. 1982. Notes on the size and composition of groups of proboscis monkey (*N. larvatus*). *Folia Primatologica*, 37: 95-98.
- MacKinnon, K., 1987. Conservation status of primates in Malaysia, with special reference to Indonesia. *Primate Conservation*, 8: 175-183.
- Manansang, J., K. Traylor-Holzer, D. Reed and Leus, K. (eds.). 2005. Indonesian Proboscis Monkey Population and Habitat Viability Assessment: Final Report. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley.
- McKey, D. B., Gartlan, J. S., Waterman, P. G. and Choo, G. M. 1981. Food selection by black colobus monkeys (*Colobus satanas*) in relation to plant chemistry. *Biological Journal of the Linnean Society*, 16: 115-146.
- Meijaard, E. and Nijman, V. 2000. Distribution and conservation of the proboscis monkey (*Nasalis larvatus*) in Kalimantan, Indonesia. *Biological Conservation*, 92: 15-24.
- Meijaard, E., Nijman, V. and Supriatna, J. 2008. *Nasalis larvatus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.3. <www.iucnredlist.org>. Downloaded on 27 July 2013.
- Napier, J. R. and Napier, P. H. 1967. *A Handbook of Living Primates*. London: Academic Press.
- Napier, P. H. 1985. *Catalogue of primates in the British Museum (Natural History) and elsewhere in the British Isles. Part III. Family Cercopithecidae, Subfamily Colobinae*. British Museum (Natural History), London.
- Napier, J. R. and P. H. Napier. 1985. *The Natural History of the Primates*. MIT Press, Cambridge.
- O'Grady, J.J., Reed, D. H. B., Brook, W. R. and Frankham, R. 2004. What are the best correlates of extinction risk? *Biological Conservation*, 118: 513-520.
- Onuma, M. 2002. Daily ranging patterns of the proboscis monkey, (*Nasalis larvatus*) in coastal areas of Sarawak, Malaysia. *Mammal Study*, 27 (2): 141-144.
- Pandong, J. J. G. 2005. Habitat use and population density of proboscis monkeys (*Nasalis larvatus*) at Samunsam Wildlife Sanctuary, Sarawak.
- Parra, R. 1978. Comparison of foregut and hindgut fermentation in herbivores. In: Montgomery, G G. (Ed.) *The ecology of arboreal foliovores*. Smithsonian Institution Press, Washington D.C. pp. 205-229.
- Payne, J., Francis, C. M. and Phillipps, K. (1985). *A field guide to the mammals of Borneo*. Sabah Society and WWF, Kota Kinabalu. 332 pp.
- Pfeffer, P. 1958. Situation actuelle de quelques animaux menacés d'Indonésie. *La Terre et la Vie* 105, 128±145.
- Rajananthan, R and Bennett, E. L. 1990. Notes on the social behaviour of wild proboscis monkey (*Nasalis larvatus*). *Malayan Nature Journal*, 44: 35-44.

- Reed, D. H., J. J. O'Grady, B. W. Brook, J. D. Ballou, and Frankham, R. 2003. Estimates of minimum viable population sizes vertebrates and factors influencing those estimates. *Biological Conservation*, 113: 23-34.
- Rothschild, G. 1971. Animals in Bako National Park. *Malayan Nature Journal*, 24: 163-169.
- Rubis, J. M. 2001. Current Densities and Conservation Status of Primates in Samunsam Wildlife Sanctuary, Sarawak: Preliminary Findings. *Hornbill*, 5: 2-13.
- Sebastian, A.C. 1994. A preliminary investigation of the proboscis monkey population in Danau Sentarum Wildlife Reserve, Western Kalimantan, Indonesia. Directorate General for Forest Protection and Nature Conservation (PHPA) and Asian Wetland Bureau, Bogor.
- Salter, R. and Mackenzi, N. 1981. Habitat-Use Behaviour of the Proboscis Monkey (*Nasalis larvatus*) in Sarawak. Forest Department, Kuching.
- Salter, R. and MacKenzie, N. 1985. Conservation status of proboscis monkey in Sarawak. *Biological Conservation* 33: 119 - 132.
- Salter, R.E., MacKenzie, N.A., Nightingale, N., Aken, K.M., Chai, P.P.K., (1985). Habitat use, ranging behaviour and food habits of the proboscis monkey *N. larvatus* (van Wurmb) in Sarawak. *Primates* 26, 436-451.
- Schultz, A. H. 1942. Growth and development of the proboscis monkey. *Bulletin of the Museum of Comparative Zoology, Harvard College*, 161(2):45-78.
- Sebastian AC. 2000. Proboscis monkeys in Danau Sentarum National Park. *Borneo Research Bulletin*, 31:359-371.
- Sha, C. M. 2006. Distribution, Abundance and Conservation of Proboscis Monkey (*Nasalis larvatus*) in Sabah, Malaysia.
- Shaffer, M.L. 1981. Minimum population sizes for species conservation. *Bio Science*, 31: 131-134
- Shaffer, M.L. 1990. Population viability analysis. *Conservation Biology*, 4: 39-40.
- Simberloff, D.A. 1988. The contribution of population and community biology to conservation science. *Ann. Rev. Ecol Syst*, 19: 473-511
- Soendjoto, M. A. 2003. Adaptasi bekantan (*Nasalis larvatus*) terhadap hutan karet: Studikasuk di Kabupaten Tabalong, Kalimantan Selatan. Usulan Penelitian. Program Pasca Sarjana, Institut Pertanian Bogor.
- Soendjoto, M.A. 2000. A new record on habitat of the proboscis monkey (*Nasalis Larvatus*) and its problems in south Kalimantan, Indonesia. *Tiger paper*, 31(2):17-8.
- Soule, M.E., (ed). 1987. *Viable Populations for Conservation*. Cambridge: CambridgeUniversity Press.
- Soule, M.E., and Wilcox, B.A. 1980. *Conservation Biology: An Evolutionary-Ecological Perspective*. Sinauer, Sunderland.
- Starfield, M.A. and Bleloch, A.L. 1986. *Building Models for Conservation and Wildlife Management*. Macmillan, New York.
- Sundai, S. 2004. A study on primates of Kuala Lawas. Biodiversity and Conservation Department Protected Areas and Biodiversity Conservation Unit Sarawak Forestry Corporation.
- Thayaparan, S., I Robertson, F Amran, L Su'ut, and Abdullah, M.T. 2013. Serological prevalence of leptospiral infection in wildlife in Sarawak, Malaysia. *Borneo Journal of Resource Science and Technology*, 2 (2), 79-82.
- Yeager, C. P. 1989. Feeding ecology of the proboscis monkey. *International Journal of Primatology*, 10 (6): 497-530.
- Yeager, C.P., and Blondal, T.K., 1992. Conservation status of the proboscis monkey (*N. larvatus*) at Tanjung Putting National Park, Kalimantan Tengah, Indonesia. In: Ismail, G., Mohamed, M., Omar, S. (Eds.), *Forest Biology and Conservation in Borneo*. Center for Borneo Studies Publication No. 2, Kota Kinabalu, pp. 220-228.
- Yeager C.P. 1992. Changes in proboscis monkey (*Nasalis larvatus*) group size and density at Tanjung Putting National Park, Kalimantan Tengah, Indonesia. *Tropical Biodiversity*, 1(1):49-55.
- Zaini, M.K., Aban, S., Ilias, A., Sogod, G., Zakeria, M.K., Jomis, A., and Aris, J. 2004. Laporan Kajian Orang Belanda (*Nasalis larvatus*) di Taman Negara Bako. Bako National Park. Protected Areas and Biodiversity Conservation (PABC). Sarawak Forestry Corporation, Kuching, 16 p.
- Zaini, M. K., and Ilias, A. 2005. Survei Taburan Orang Belanda (*Nasalis larvatus*) di Taman Negara Bako. Bako National Park, Protected Areas and Biodiversity Conservation, Sarawak Forestry Corporation, Kuching, 10 p.