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Status and Conservation of Proboscis Monkeys (*Nasalis larvatus*) in Sabah, East Malaysia

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Abstract: The proboscis monkey (*Nasalis larvatus*) was surveyed in the East Malaysian state of Sabah to establish its population status and to assess threats to its survival. It was found to be more widespread and abundant than previously thought, with a minimum population size of *c.* 5,907 individuals found along major coastal river systems in Sabah. The distribution of proboscis monkeys appeared highly fragmented, with only five major centers of continuous distribution and numerous small isolated populations. Existing proboscis monkey habitats are increasingly threatened by human activities. Of particular concern is the clearing and conversion of important riparian and coastal mangrove habitats to plantations and human habitation, which result in fragmentation of otherwise continuous populations along rivers, and local extinction of remnant populations trapped in small forest fragments. Only 15.3% of the population estimated in this study was found within protected forest reserves, with much of the species' diminishing range habitats exposed to further conversion, extraction and disturbance. Urgent mitigating strategies are necessary to ensure the long-term survival of proboscis monkeys in Sabah. Immediate actions are needed to prevent small isolated populations from local extinction, and long-term efforts must be undertaken to protect important proboscis monkey habitats and re-establish connectivity between fragmented populations.
Key words: Proboscis monkey, *Nasalis larvatus*, Sabah, status, conservation

Introduction

Proboscis monkeys (*Nasalis larvatus*) are endemic to the island of Borneo. They are classified as Endangered on the *IUCN Red List of Threatened Species* (IUCN 2008) and listed under Appendix I of CITES (UNEP-WCMC 2007). Proboscis monkeys have a flexible social structure with one-male multi-female groups as the basic social unit, peripheral males sometimes forming all-male groups (Bennett and Sebastian 1988; Yeager 1990; Boonratana 2002) and a secondary level of association with fission-fusion of stable one-male groups within bands (Yeager 1991, 1992). They are largely restricted to coastal lowland mangrove, riparian, and swamp forests (Kawabe and Mano 1972; Wolfheim 1983; Salter *et al.* 1985, Boonratana 1993; Bernard 1995) up to 750 km inland, but usually less than 55 km from the coast, and at altitudes below 350 m above sea level (Medway 1977; Salter and Mackenzie 1985; Bennett and Sebastian 1988; Meijaard and Nijman 2000). Proboscis monkeys are closely associated with waterways, traveling inland to forage (generally up to 1 km) and returning to their sleeping sites along the river edge every evening (Bennett 1988; Bennett and Sebastian 1988; Yeager 1989; Boonratana 2000; Matsuda 2008).

Populations of proboscis monkeys are known to exist mainly in the fresh water wetlands around Dewurst Bay, along the Kinabatangan, Segama and Sugut rivers in the eastern deltas and in the Klias Peninsula on the west coast (Davies and Payne 1982). Previous estimates of the species in Sabah put the total population at *c.* 3,000 (IUCN 1978) or *c.* 2,000 (Davies and Payne 1982). In the last decade, independent observers have suspected these earlier projections to be underestimates. Goossens *et al.* (2002) found a population of 3,430 in the Kinabatangan floodplains alone, albeit estimated by extrapolation, while Boonratana (1993) indicated a minimum population of 832 and an actual population size likely to double this figure (R. Boonratana pers. comm.). Bernard and Zulhazman (2006) estimated a population of 569 in Klias Peninsula, and Rajanathan (1995) indicated a population of at least 1,056 in Segama.

Comparisons of proboscis monkey abundance from different studies are fraught with difficulties, due mainly to time lag, and differences in methodologies and sampling effort.

Few studies have focused on their population status, and those reported were mainly conducted in a small number of known localities of important populations. While there are indications that proboscis populations have been declining over the past decades (e.g., Chapman and Peres 2001; Fuller *et al*. 2004), the lack of holistic and updated information on their current population status has frustrated any attempt at a successful systematic evaluation of the conservation status of the species. A Population and Habitat Viability Assessment (Manansang *et al*. 2005) originally planned to cover the species' entire range concluded that the basic data needed to draw up accurate range maps and estimate population numbers were insufficient, particularly for Malaysian Borneo. In this study, we aim to address this information gap that is crucial to an assessment of the current conservation status of the proboscis monkey, to understand the threats the species is facing, and to allow for the identification of key areas and strategies for their protection in Sabah.

Methods

Study area

The Malaysian state of Sabah (76,000 km²) is situated between latitudes 4°8' and 7°22' north of the equator on the northeastern tip of Borneo. The western and eastern regions are divided by the Crocker Range, which runs almost parallel to the west coast, extending from the southern end of Marudu Bay in the north and southwards along the western part of the state to the Sarawak border. Like most parts of Borneo, human activities have had a considerable impact on Sabah's vegetation in recent decades, with the inevitable increase in agricultural crop cultivation, logging and expansion of human habitation (Primack and Hall 1992). The narrow western lowland plains contain areas of low, flat ground that is densely populated, while eastern Sabah is characterized by low dissected hills, gentle slopes and poorly drained flatland and low lying swampy zones that have been extensively logged and converted to permanent agriculture where soil and terrain is suitable (Payne 1988).

Forest type classification

The main forest and land use type classification for Sabah was defined according to Fox (1978) and the Sabah Forestry Department (1989). Two different classification maps were used to illustrate forest type and land use: (1) a 1997 vegetation cover map of Sabah, rectified and updated with a mosaic of Landsat ETM+ ranging from 1999 to 2002 in MrSID format (ERDAS Imagine 8.6 and ArcGIS 8.3); and (2) a SPOT-Vegetation satellite image of coarse spatial resolution (1 km) generated from satellite images acquired for the period 1998 to 2000 (Stibig *et al.* 2002). We classified habitats as suitable and unsuitable according to known occurrence of proboscis monkeys in habitat types. Suitable proboscis monkey habitats include mangrove and nipah forest, riverine forest or mixed lowland dipterocarp forest along rivers, and swamp forests that consist of freshwater swamp, peat swamp and swampy grassland, a unique habitat comprising mostly of herbaceous scrubs and swampy grasses found only in the Klias Peninsula. In total, mangrove, freshwater swamp, and undisturbed mixed dipterocarp forests account for 7,467.3 km² or about 9.8% of the total land area (Sabah Forestry Department 2002). Unsuitable habitats are characterized by montane and highland dipterocarp forest, developed land and permanent agriculture (mostly coconut, oil palm and rubber), thickets, shrubs and dry grassland.

Forest reserve classification

Forest reserves in Sabah (Forests Amendment Enactment 1984) total 35,940 km² or 48.8% of the total land area (Sabah State Government 1998), and are divided into seven classes. Class I Protection Forest, Class VI Virgin Jungle Forest and Class VII Wildlife Reserve total about 8% of the land area, and consist of protected forests conserved for the protection of watersheds and the maintenance of the stability of essential climatic and other environmental factors, as well as research on and protection of wildlife. Logging is strictly prohibited in these areas. Class II Commercial Forest, Class III Domestic Forest, Class IV Amenity Forest, and Class V Mangrove Forest total about 41.8% of the land area, and consist of various forests allocated for logging, consumption by local communities, provision of amenities, and recreation for local inhabitants, as well as to guarantee a supply of mangrove, timber and other produce to meet general trade demands.

River surveys

Preliminary information about possible locations of proboscis monkeys and about threats and other historical and current data were collected through questionnaire interviews of selected respondents knowledgeable about their areas. They included wildlife officers and local residents. River surveys using boats were conducted in areas identified through the information obtained, along with other literature sources, to census proboscis monkeys from sunrise to about 08:30 and about 16:30 to sunset with slight variations according to local conditions. Survey routes were largely random and dictated by logistical or environmental constraints such as the course of the river, low water levels due to tide timings, or blocked river passages. The short survey timings available each day (just after dawn before monkeys move into the forest and before dusk, after they return to sleeping sites) made it impossible to complete large areas in one survey, particularly in some areas that have long rivers. Due to the time and budget needed for the large survey effort, a single boat census with no replicates was used whereby as much river as possible was covered in one survey and continued in the next survey at the point where the previous survey left off. Rivers and tributaries that were close to each other were preferentially covered in one session or on consecutive days to reduce the probability of replicate counts. Each survey consisted of at least one boatman and one assistant to assist in spotting. As soon as a monkey group or individual was sighted, the boat engine was switched off and paddled to near the group to record the number of individuals,

their age-class and sex. Ecological and other habitat variables, including weather condition and habitat type, were also noted. Groups were defined by their close proximity to sleeping sites and coordination of movement within a group (Bennett and Sebastian 1988; Yeager 1991, 1995) and distinguished from separate groups by the presence of a prominent dominant male (in harem groups) and a distance criterion of at least 50–100 m between them (Kern 1964; Kawabe and Mano 1972; Macdonald 1982; Salter *et al.* 1985). Exact locations of sightings and transect routes traversed were recorded using a Differential Geographic Positioning System, DGPS (Trimble™ XRS) and Trimble™ Recon Data Logger. Spatial and attribute data were overlayed on georeferenced vegetation and land use maps for analysis using a Geographic Information System, GIS (ESRI® ArcGIS™ 8.3, Environmental Systems Research Institute, USA).

We used Analysis of Covariance (ANCOVA) to test for a relationship between proboscis monkey abundance and the major habitat types they were found in, while controlling statistically for survey distance. All analyses were done using the Statistical Package for the Social Sciences version 13.0 (SPSS Inc., Chicago, Illinois). Statistical significance was set at $p<0.05$.

Results

Eighty-two boat surveys, covering a distance of 1220.6 km, were conducted over 98 field days during 6 months from June to November 2005. The mean (±SD) distance covered per boat survey was 13.27±3.42 km (range 5.4 to 20.2 km). The mean number of groups sighted per survey was 5.81±3.84 (range 0 to 18). Groups were found at localities from 0 to 110 km inland with 2.0% of group sightings along the coast, 79.2% less than 50 km from coast, 17% between 50 to 100 km, and 1.8% at distances greater than 100 km. A total of 5,907 individuals in 477 sightings was recorded in this survey (mean group size 12.38±4.82; range 1 to 28) and made up of 435 harem groups, 31 all-male groups, and 12 single-male sightings.

The distribution of the proboscis monkey is shown in Figure 1 and referenced in Table 1. On the west coast, populations of proboscis monkeys were found in the Klias Peninsula (five sub-populations of 818 individuals in 75 groups) [1-5]. On the east coast, populations were found at Tangkarason and Paitan (90 individuals in eight groups) [6,7]; Sugut River (787 individuals in 58 groups) [8]; Beluran (317 in 30 groups) [9]; Sandakan (three sub-populations of 326 in

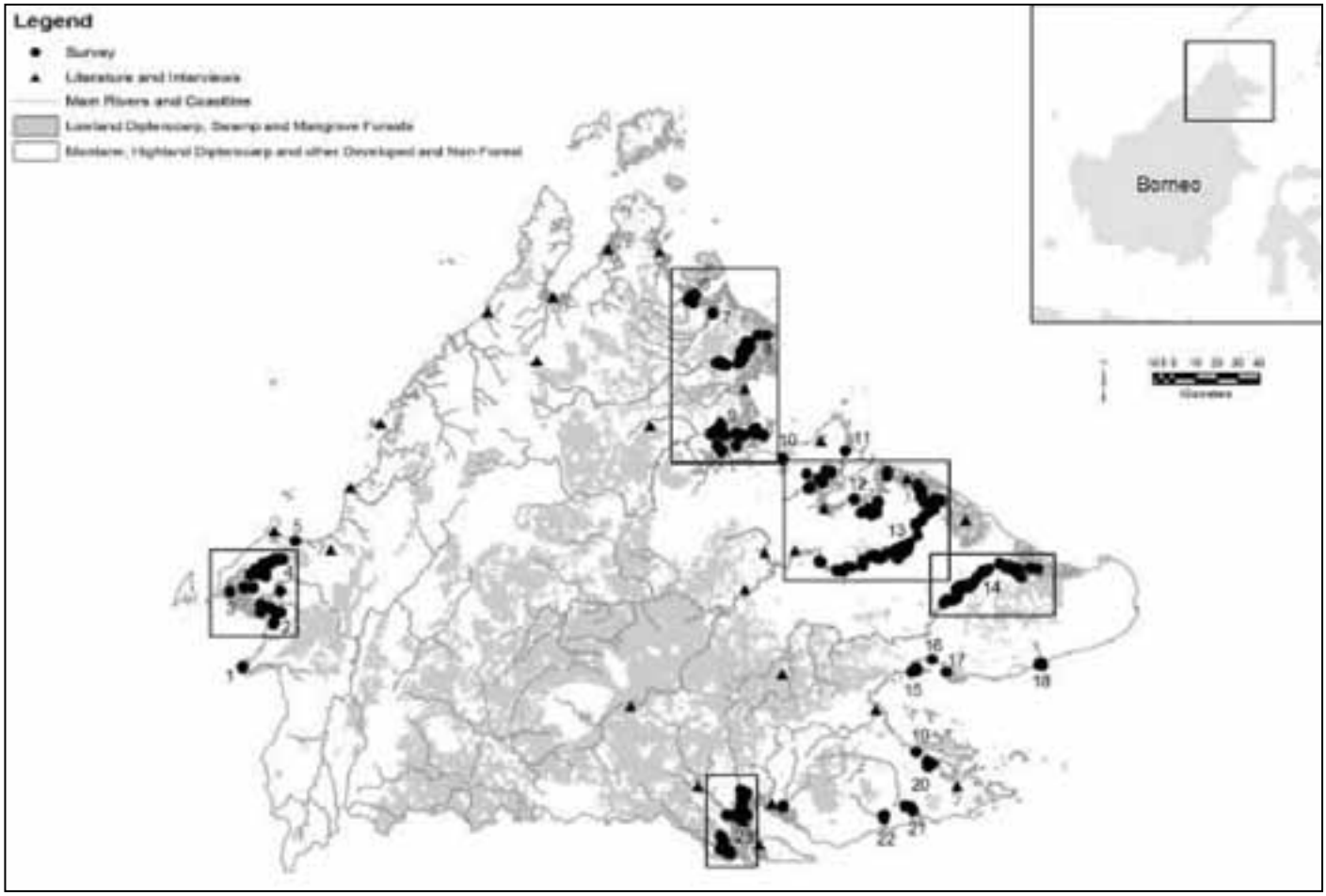

Figure 1. Distribution of proboscis monkeys in Sabah. "Survey" indicates locations of sightings from this study, "Literature and interviews" indicate sightings from literature, interviews and other sources that were not verified in this study. "Boxed" areas are identified major centers of continuous distribution.

28 groups) [10-12]; Kinabatangan River (1,454 individuals in 101 groups) [13]; Segama River (1040 individuals in 83 groups) [14]; Lahad Datu (four sub-populations of 188 individuals in 16 groups) [15-18]; Semporna Peninsula (four sub-populations of 169 individuals in 16 groups) [19-22]; and Tawau Bay (718 individuals in 63 groups) [23] on the east coast. The range limits of proboscis monkeys are likely to extend much further inland as far as Danum Valley (Marsh 1995) *c.* 170 km and Maliau Basin (Bennett and Gombek 1993) *c.* 200 km. There are also recent inland records in the vicinity of Serinsim near Marak Parak in Kota Marudu (Shultz and Beck 1999); and in Ulu Tungud Forest Reserve and Deramakot Forest Reserve (Sabah Wildlife Department 2003). Locations where proboscis monkeys are likely to be still present but not directly verified in this study include: on the west coast—Bongawan (Bernard and Zulhazman 2006), Tempurong, Rampayan, Pulau Gaya, Rampayan; north coast—Pitas, Marudu Bay; and east coast—Bongaya, Labuk Bay, Gum Gum, Sekong Bay, Mumiang, Lokan (Goossens *et al.* 2002), Dewhurst Bay (Davies and Payne 1982), Kulamba FR (T.S. Liew pers. comm.), Tinkayu, Silam, Pulau Sebatik (Bennett & Gombek 1993) and Kalabakan FR (Malim *et al.* 1999).

Table 1. Locations of proboscis monkey sightings in this survey, corresponding population sizes, sighting frequency, forest type, reserve classification, threats and local extinction risk.

Name of Locality		Reference (Fig. 1)	No. Groups/ Sighting frequency per km		No. Individuals/ Sighting frequency per km		Forest Type[1]	% groups in forest reserves (Forest reserve type classification)/% protected[2]	Threats[3]	Local Extinction Risk[4]
Klias Peninsula	Menggalong	1	3	**75/0.41**	33	**818/4.47**	Mangrove and Nipah	59.2% (Class I, IV, V) / 1.3%	HLFA, HLFF, HLFH, H, T	Very high
	Weston	2	12		114		Mangrove and Nipah, Freshwater and Peat Swamp			Low
	Menumbok	3	6		73		Mangrove and Nipah			Low
	Garama and Kota Klias	4	53		578		Mangrove and Nipah, Riverine, Swampy Grassland			Low
	Binsulok	5	1		20					Very high
Tangkarason and Paitan		6,7		**8/0.17**		**90/1.9**	Mangrove and Nipah	87.5% (Class V) / 0%	HLFA, HLFF, HLFL, H	High
Sugut		8		**58/0.61**		**787/8.28**	Mangrove and Nipah, Riverine	5.2% (Class II, V) / 0%	HLFA, HLFF, HLFL	Low
Beluran		9		**30/0.31**		**317/3.23**	Mangrove and Nipah, Riverine, Freshwater and Peat Swamp	76.7% (Class II, V) / 0%	HLFA	Low
Sandakan	Samawang	10	1	**28/0.16**	18	**326/1.92**	Mangrove and Nipah	75% (Class V, VI) / 14.3%	HLFA, HLFL, HLFH	Very high
	Sibuga	11	1		14					Very high
	Sandakan Bay	12	26		294					Low
Kinabatangan		13		**101/0.55**		**1454/7.89**	Mangrove and Nipah, Riverine	75.2% (Class V, VI) / 62.4%	HLFA, T	Low
Segama		14		**83/0.57**		**1040/7.15**	Mangrove and Nipah, Riverine	12.0 (Class V, VI) / 7.2%	HLFA, HLFL	Low
Lahad Datu	Sakar	15	65	**16/0.21**	6	**188/2.41**	Mangrove and Nipah	36.1% (Class V) / 0%	HLFA, HLFL, HLFH, H	High
	Bikang	16	22		1					Very high
	Silabukan	17	7		1					High
	Tungku	18	94		8					Very high
Semporna	Sipit	19	1	**15/0.28**	12	**169/3.15**	Mangrove and Nipah	100% (Class V) / 0%	HLFA, HLFL, HLFH, H	Very high
	Balung	20	4		57					High
	Kalumpang	21	4		51					High
	Sapang	22	6		49					Very high
Tawau		23		**63/0.37**		**718/4.91**	Mangrove and Nipah	96.8% (Class V) / 0%	HLFA, HLFH	Low

[1] Forest type classification according to Fox (1978) and SFD (1989), verified from SPOT-Vegetation satellite image (Stigbig *et al.* 2002) and Landsat ETM+ vegetation cover map of Sabah (1999–2002).

[2] Percentage in forest reserves. Classification according to Forests Amendment Enactment (1984). Class I, VI, VII are considered strictly protected.

[3] Threats classified as: (HLFA) Habitat loss and/or fragmentation due to agriculture/aquaculture; (HLFF) Habitat loss and/or fragmentation due to fire; (HLFL) Habitat loss and/or fragmentation due to logging; (HLFH) Habitat loss and/or fragmentation due to human habitation; (H) Hunting; (T) Tourism.

[4] Local Extinction Risk classified as: *Very high:* with small isolated populations that are very likely to go locally extinct; *High*: with larger populations in bigger habitat fragments but sufficiently small and isolated to be at risk in the near future; *Low:* with large continuous populations with a broad geographic distribution.

Mean sighting frequency of proboscis monkeys was 0.39 groups/km and 4.84 individuals/km, and was highest for the Sugut River followed by Kinabatangan River and Segama River. Highest numbers of proboscis monkeys were found in riparian forest (48.0%), followed by mangrove and nipah forest (44.9%) and swamp forest (7.1%). Sighting frequency was, however, higher in swamp forests (0.86 groups/km and 10.86 individuals/km), followed by riparian forest (0.64 group/km and 8.43 individuals/km), and lowest in mangrove and nipah forest (0.26 group/km and 2.98 group/km). Irrespective of more groups and individuals recorded with increasing survey distance covered (ANCOVA: groups – $R^2 = 0.793$; $p = 0.000$; individuals – $R^2 = 0.743$; $p = 0.001$), group and individual abundance in riparian forest was significantly higher than in mangrove forest (ANCOVA: groups – df = 3,12; $F = 5.626$; $p = 0.012$; individuals – df = 3,12; $F = 5.215$; $p = 0.016$).

Discussion

Status of proboscis monkeys in Sabah

Proboscis monkey populations were found along most coastal river systems throughout Sabah where suitable habitats still exist. The estimate of *c.* 5,907 individuals in this study is a minimum population estimate for Sabah, bearing in mind that not all areas of possible proboscis monkey occurrence were completely surveyed, in particular, large tracts of mangrove forests in the Bongaya, Mumiang, Dewhurst Bay, Marudu Bay and Muara Kalabakan areas, and farther inland along long rivers such as the Kinabatangan and Segama. Other inland records from literature showed that remnant populations are still present and may represent the actual distribution range limits of proboscis monkeys in Sabah. This is not unlikely as the proboscis monkey range from the coast can be greater than 300 km and as far as 750 km along the courses of major rivers (Meijaard and Nijman 2000), and there are morphological and biogeographical indications that proboscis monkeys are well adapted as an inland species (Brandon-Jones 1996). It is, however, not expected that large populations persist in those areas, and may be limited by historical fragmentation leaving small inland populations isolated from major populations nearer the coast.

Although the estimate in this study is much higher than the previous estimates of 2,000 (Davies and Payne 1982) and 3,000 individuals (IUCN 1978), it should not be taken that the population has actually increased, but rather is a result of a more comprehensive review of the baseline population size that is corroborated with the higher abundances reported by independent researchers at various localities in recent years. We cannot conclude whether the population has increased or decreased over the last 20 years. However, there is strong evidence that the extant population is highly fragmented, with only five major centers of continuous distribution and numerous small isolated populations. The Klias Peninsula population is the only major center of proboscis monkey distribution on the west coast and is separated from the east coast populations by the highland areas of the Crocker Range. On the east coast, populations in Tangkarason, Paitan, Sugut and Beluran appeared connected by coastal mangroves from the west of Pitas up to the Samawang area in Sandakan. Populations in Sandakan Bay and Kinabatangan are likely continuous along narrow coastal mangrove strips. The population along the Segama River is probably completely isolated. Satellite image data showed extensive habitat loss in Kulamba Forest Reserve, which would otherwise provide an important corridor between major populations in Kinabatangan and Segama. Tawau Bay has a continuous population along the extensive mangrove habitat, which is possibly connected with the major population of the delta of the Sesayap, Sembakung and Sebuku rivers in Kalimantan identified by Meijaard and Nijman (2000).

Relative abundances in different habitat types indicated that densities may be comparatively much higher in riparian forest compared to mangrove forest, and can be even higher in swamp forest. This finding agrees with those of other studies (for example, Salter *et al.* 1985; Salter and Mackenzie 1985; Yeager and Blondal 1992; Rajanathan 1991; Boonratana 1993). However, high densities can also be an artifact of habitat fragmentation, forcing proboscis monkey populations into smaller areas of suitable habitat. In Garama and various other localities, for example, large numbers of proboscis monkeys were found in narrow strips of forest that are at times less than 20 m in width. In Kalimantan, E. Meijaard (pers. comm.) indicated that the Mahakam Delta, which had extensive mangroves and tidal swamps up until the early 1990s, presently has only a few forest fragments left which are now invariably overpopulated with proboscis monkeys.

Threats

Habitat loss and fragmentation is identified as the major threat to proboscis monkey populations in Sabah. Loss of habitat due to expansion of human settlements is most marked in the coastal mangrove areas of Sandakan, Lahad Datu and Semporna (Appendix A). 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 Mackenzie 1985; Salter *et al.* 1985); in a rubber plantation (Soendjoto 2003); and we have seen them in coconut plantations (feeding on the inflorescences). This 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. The local extinction of proboscis monkey populations as a result of habitat loss has been recorded in Papar (Davies and Payne 1982) and in Kunak (Anon. 2003). This is likely to be only the tip of the iceberg with many other populations disappearing unrecorded.

Habitat fragmentation and degradation due to logging and conversion of important riparian habitats to agriculture/aquaculture is highly evident along major rivers such as the Kinabatangan and Segama (Appendix B), where an

intervening matrix of cultivated land, human settlement or grassland areas, between fragments may impede movement, dispersal and social activities of groups at important resting sites. Forests near or along rivers that are converted to oil palm or other cultivated crops significantly reduce the quality of the habitat for proboscis monkeys, and may increase inter-specific resource competition, which favors more omnivorous species such as the macaques. Pig-tailed and long-tailed macaques were more abundant in disturbed secondary habitats, and pig-tailed macaques were particularly common along the river in the upper reaches of Segama River in forests converted to oil palm with the consequent reduction or complete displacement of proboscis monkeys in these areas. In Kinabatangan, proboscis monkeys were observed to alter their normal ranging patterns up to 500 m inland during an extended flood season due to hydrological changes probably induced by extensive planting of oil palm near river banks (I. Matsuda pers. comm.). Other short-term impacts of fragmentation include increasing encroachment activities such as hunting by plantation workers with easy accessibility to proboscis monkeys trapped in forest fragments.

During the *El Niño* event of 1997–1998 almost 30,000 km² forest was lost in Kalimantan (Fuller *et al.* 2004), and riparian forest was particularly heavily affected, causing the proboscis monkeys to lose a greater percentage of its remaining habitat than any primate species in Borneo (Yeager and Frederiksson 1998). Fires that resulted in habitat loss and degradation in Sabah are evident in Klias, Sugut, Tangkarason and Paitan (Appendix C). Proboscis monkeys do not use areas of extensively burnt dryland forest but may use secondary growth on burnt swamp forests, as indicated by the population in the swampy grasslands of Garama. However, these sub-optimal habitats may not be able to support populations in the long term, and the detrimental effects of habitat loss may only be evident over a longer period of time.

Hunting of proboscis monkeys appears less common in Sabah where existing populations are found mainly in predominantly Moslem areas but, as in Kalimantan (Meijaard and Nijman 2000), it may have historically exterminated populations in some areas of otherwise suitable habitat. Although locals do not usually hunt, they often facilitate this activity by renting boats and imparting knowledge about the location of proboscis monkeys to others. There is anecdotal evidence of hunting by police or army personnel and recreational sport hunters in areas such as Sebatik Island, Sandakan Bay, Tangkarason and Brontian. Proboscis monkey meat is rumored to be sold for food in Kota Marudu and Sandakan. One account told of a proboscis monkey used as crocodile bait in the Klias Peninsula (J. Augustine pers. comm.), and a proboscis monkey we saw being kept as a pet may have been a result of hunting.

Tourism presents an indirect threat in accessible areas of large, easily sighted populations. In Garama (Klias Peninsula) and Sukau (Kinabatangan), there has been a proliferation of large- and small-scale tourist establishments over the last 5 to 10 years to cater to the increasing tourist volume. Although community-based ecotourism can bring significant benefits (for example, income for local communities and incentives for policy makers to protect the species), lack of proper evaluation and control mechanisms often lead to unethical and irresponsible mass tourism activities by profit-oriented establishments. Increasing proximity of humans to proboscis monkeys may result in disturbance and altered behaviors that are detrimental to the long-term conservation of this sensitive species.

Conservation recommendations: Translocation of populations at risk of local extinction

Increasing loss of suitable habitats for proboscis monkeys is resulting in many remnant populations facing local extinction. Clearing of the remaining forest habitat of the Kunak population in 2003 resulted in the displacement of 30 or so monkeys and the death of an infant, and the Labuk Bay Proboscis Monkey Sanctuary population was almost exterminated by forest clearance for oil palm plantations. Translocation in this case may be the only recourse, even though there are risks. Translocation of sensitive species remains highly controversial due to associated high mortality rates, introduction of diseases or parasites, and the disruption of food resources and their social structure (Yeager and Silver 1999; Fisher and Lindameyer 2000). An example can be found in the difficulties that were encountered during the translocation scheme of the Pulau Kaget Nature Reserve population (Meijaard and Nijman 1999). However, for highly isolated proboscis monkey populations that are facing displacement or extermination, translocation would be the only logical step, at least on compassionate grounds.

Conservation recommendations: Protecting important proboscis monkey habitats

The natural forest cover in Sabah was reduced from an estimated 86% in 1953 (Fox 1978) to 57.4% by 2001 (FAO 2002). Immediate action is required to halt the decline of existing habitats. Although an estimated 9.8% of suitable habitat is still found throughout Sabah, the majority of proboscis monkeys are found near coastal areas and rivers, where available habitat is decreasing rapidly. The largest population in Kinabatangan — about 25% of the total population — is surviving in only an estimated 0.7% of the total forested area. The current network of forest reserves in Sabah harbors 57.2% of the proboscis monkeys recorded in this survey (Table 1). If only strictly protected reserves are considered, only 15.3% of the total population qualifies, with major populations in the Segama, Sugut and Garama area in Klias not within forest reserves land (Appendix D). Riparian habitats in particular are not sufficiently protected, compounded by the fact that most human settlements are closely associated with river systems. Although the strip of 20 m of riparian forest perpendicular to the river is legally protected (Water Resources Enactment 1998), this is insufficient for proboscis monkeys. They can range up to 1 km from the riverbank to forage in just a day. It is imperative that land use planning

take into account the urgent need to protect the habitats of the proboscis monkeys, especially those that are severely underrepresented in the existing forest reserve system. Bernard *et al*. (2006) provided a framework for a system of reserve networks in the Klias Peninsula through extension of protection to small but important proboscis monkey habitat areas between existing forest reserves. An extension conservation area linking three small reserves within the Klias Peninsula was successfully gazetted as the Bukau-Api Api Protection Forest Reserve under a United Nations Development Programme/Global Environment Facility (UNDP/GEF) funded peat swamp forest project. More important populations and habitats need to be protected and ideally conferred strict protection such as national parks or wildlife sanctuaries. It is also important to ensure the integrity and effectiveness of existing protected areas through increased enforcement and local community participation.

Conservation recommendations: Re-establishment of forest and river corridors

The current distribution of proboscis monkeys in Sabah is fragmented, with many isolated populations and large populations that are themselves fragmented into sub-populations by various forms of land conversion. Fragmentation of river systems is most severe along the Kinabatangan, Segama and Sugut rivers, where the remaining large populations exist. The strategic plan for forest resource development of the Sabah Forestry Department (Forestry Department 1998) recognized that extensive reforestation is now necessary as a result of overexploitation of natural forests. It is also encouraging that there is renewed impetus by the State Government to identify the severity of the problem of riparian reserve encroachment along state rivers by planters, and establish plans to rehabilitate forest along rivers that have been converted to oil palm plantations (Anon. 2006). Greater efforts must be dedicated to restoring remnant habitat patches as well as re-establishing corridors along fragmented river systems, preferably linking major populations through a protected area network, as part of a conservation strategy that extends beyond borders for the protection of the species across its range.

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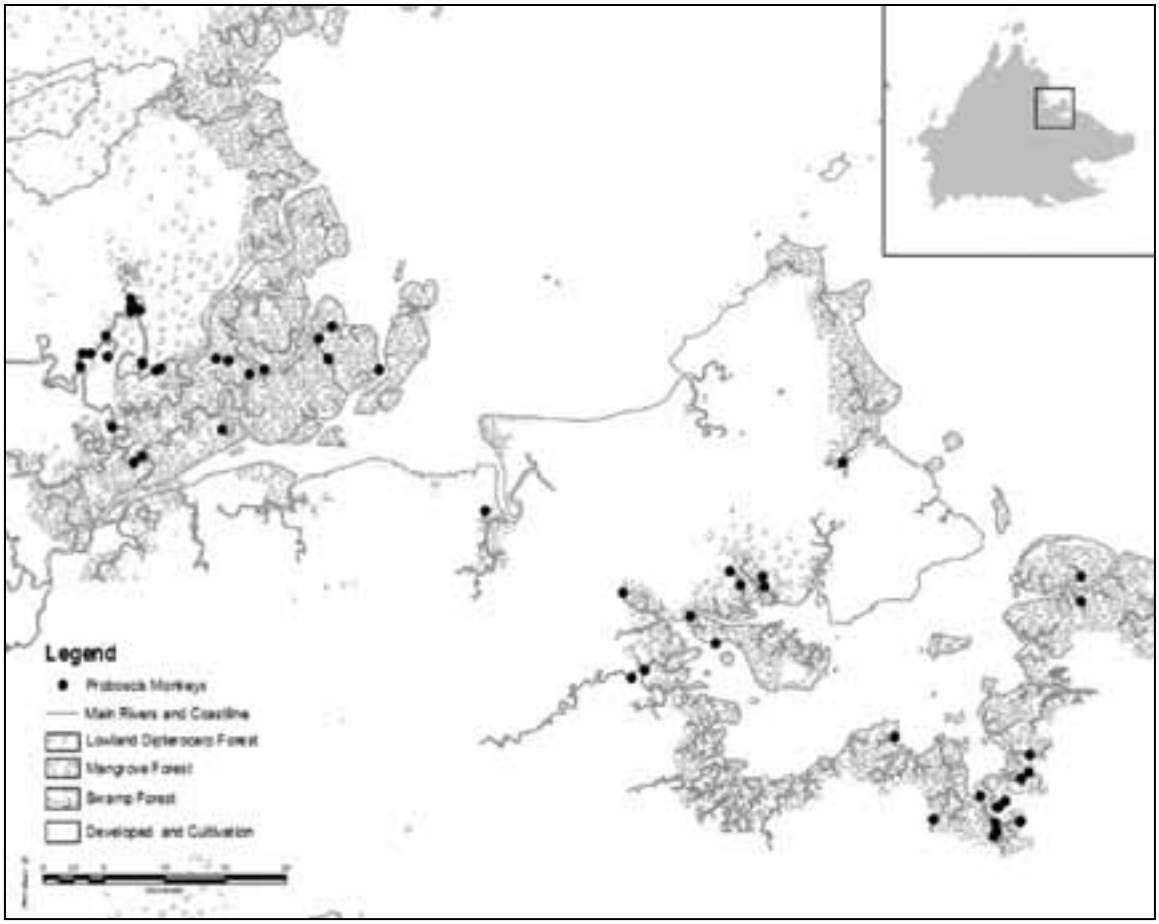
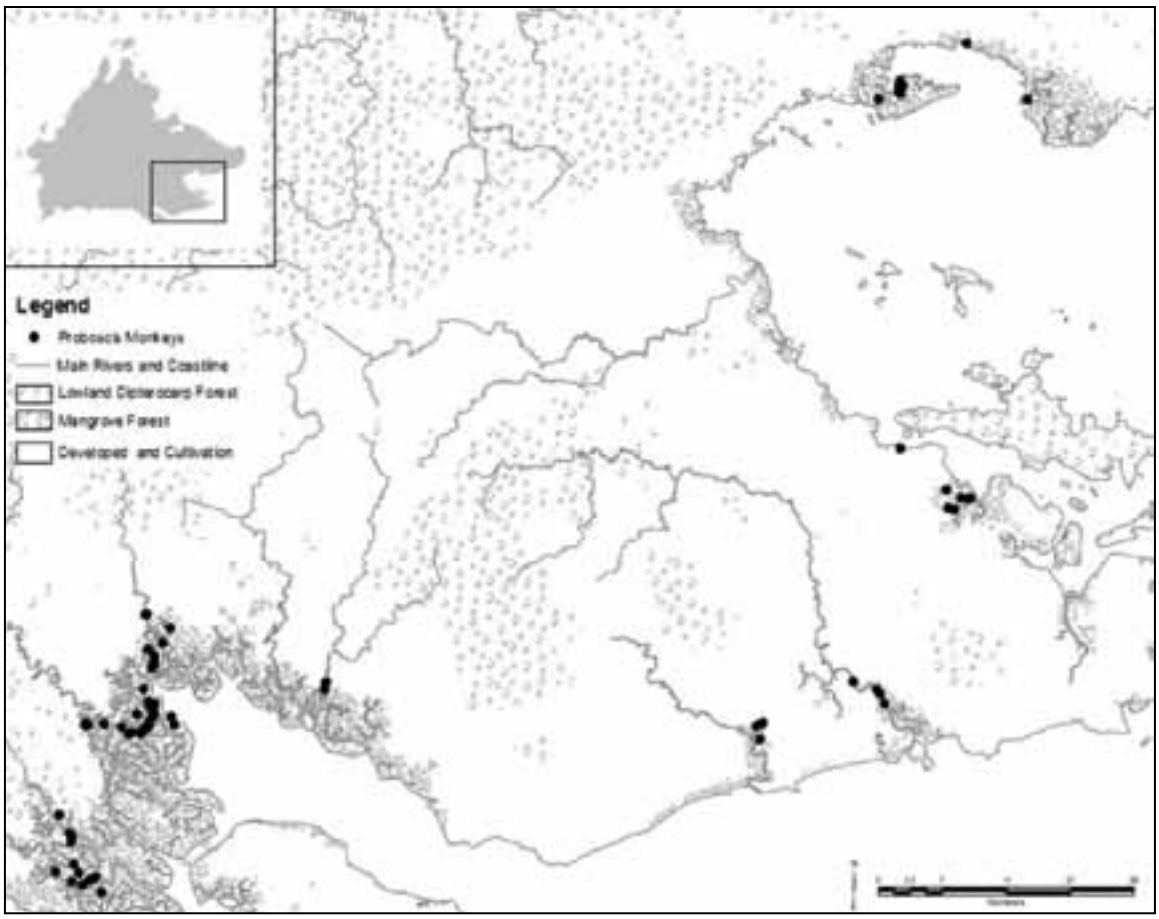
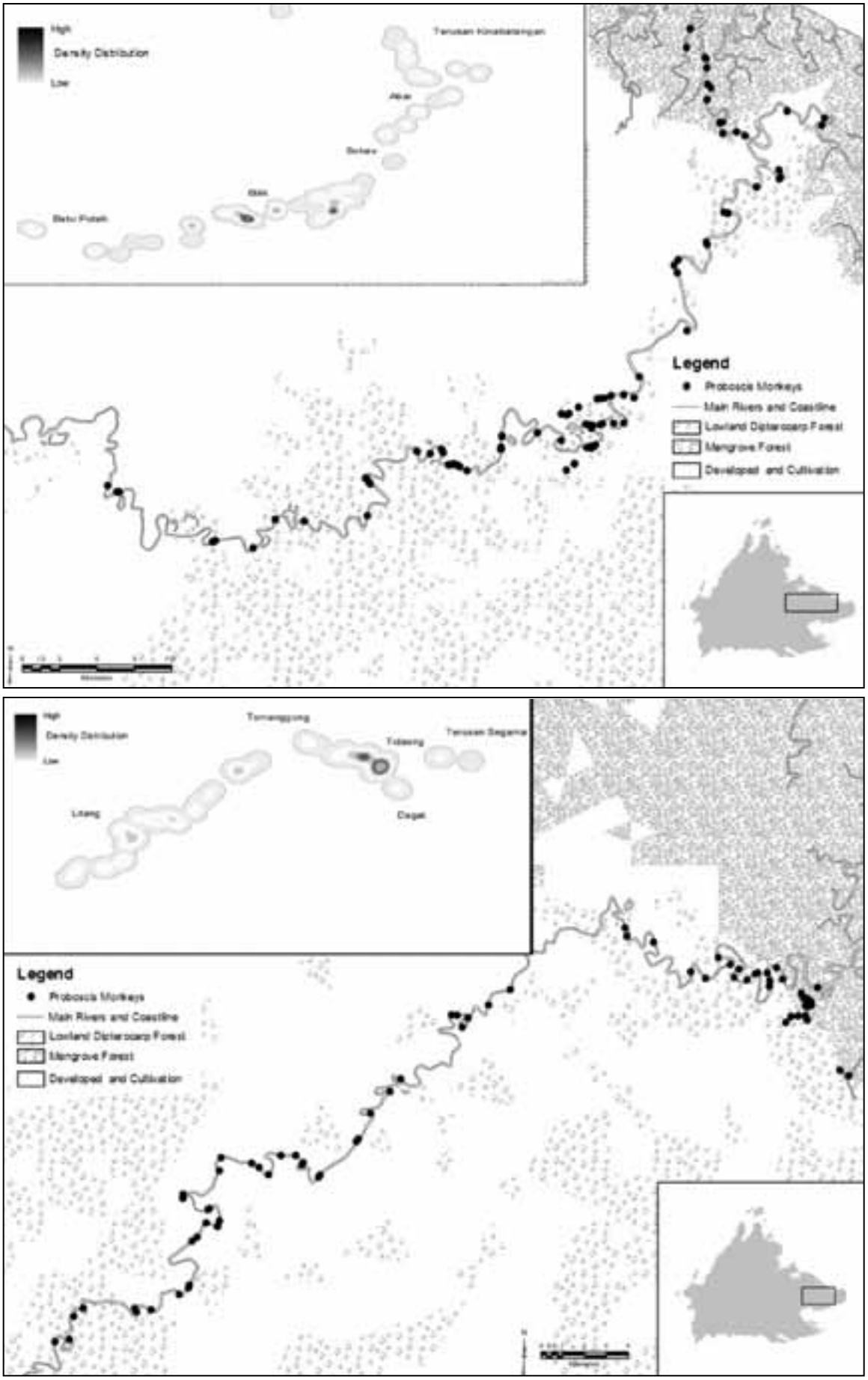
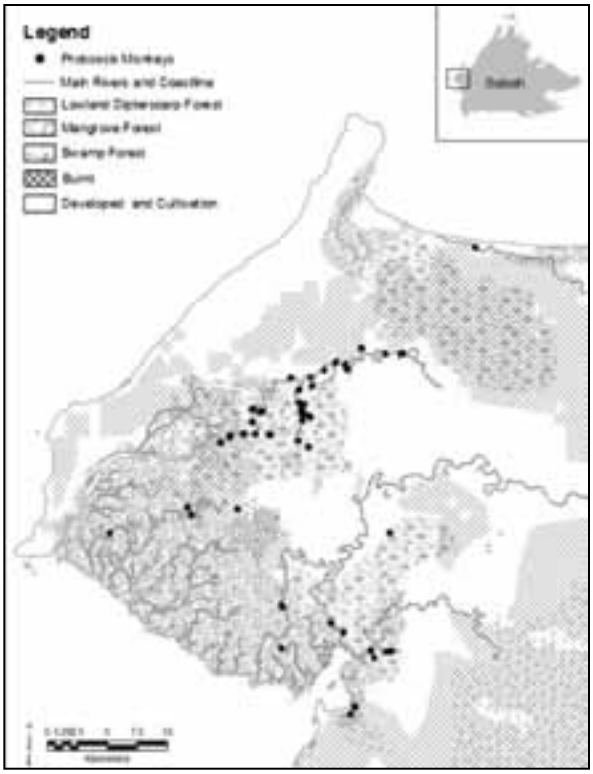


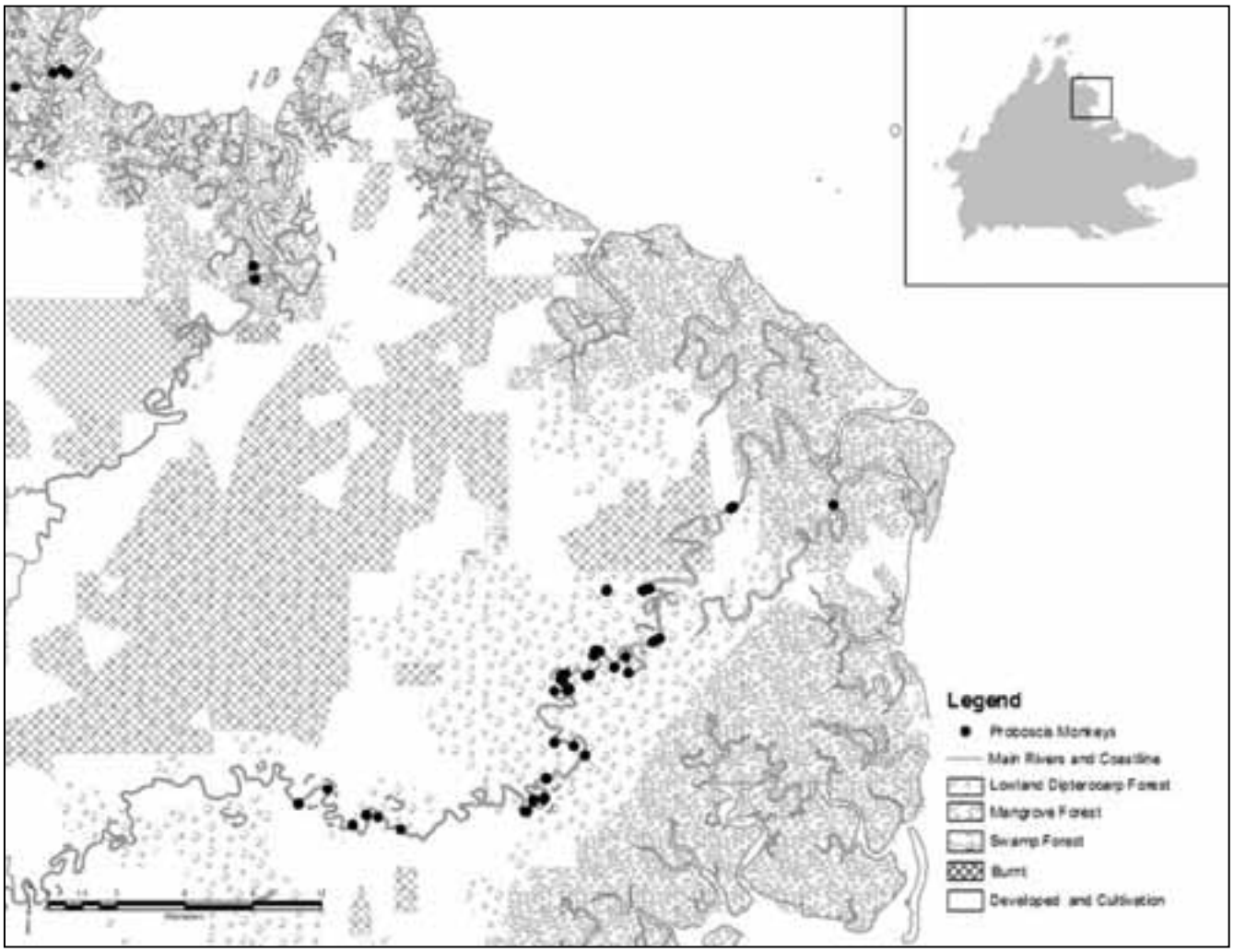


Appendix A. Loss and fragmentation of coastal habitats in Sandakan (top) and Semporna Peninsula (bottom).

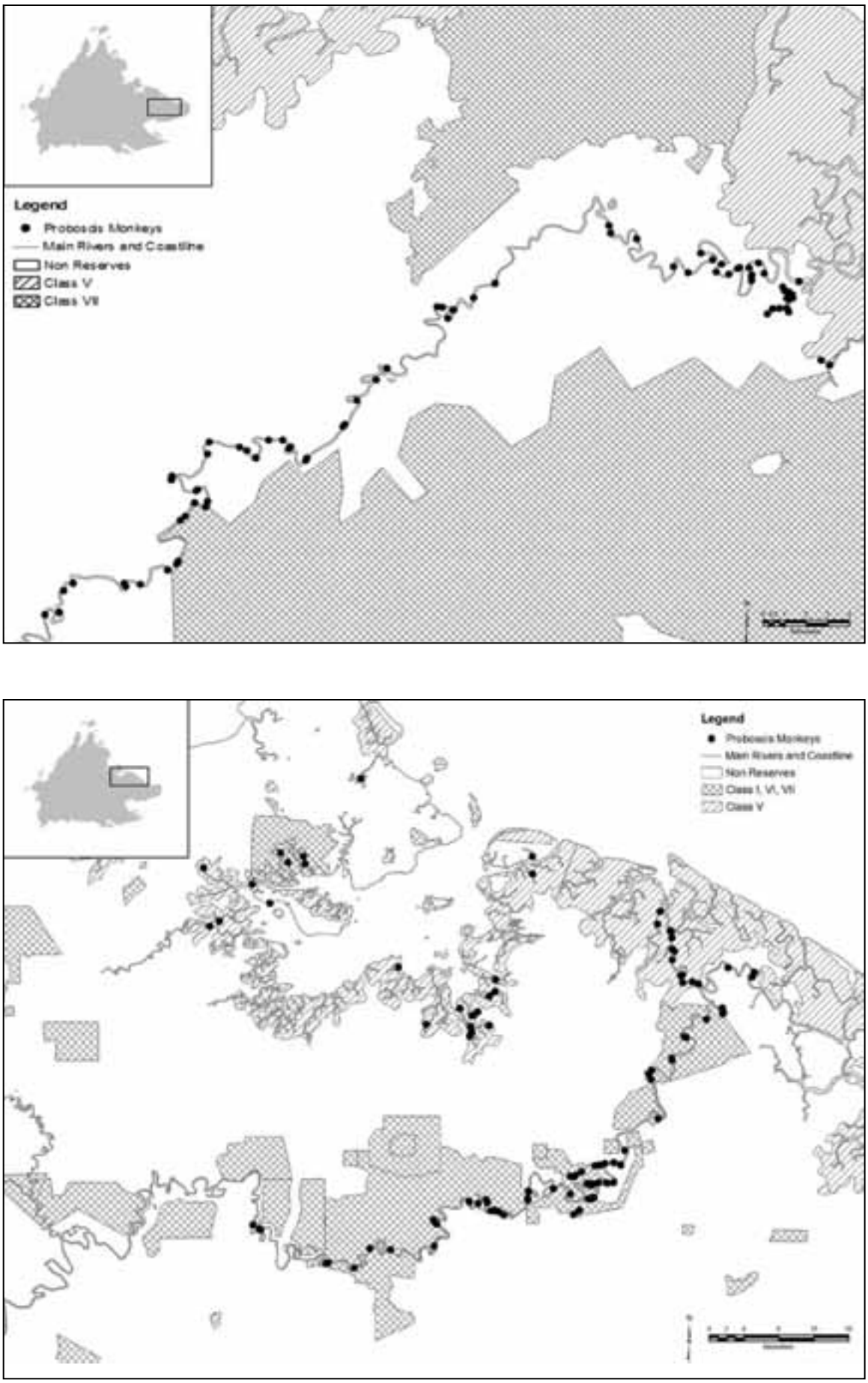


Appendix B. Fragmentation along Kinabatangan (top) and Segama (bottom).

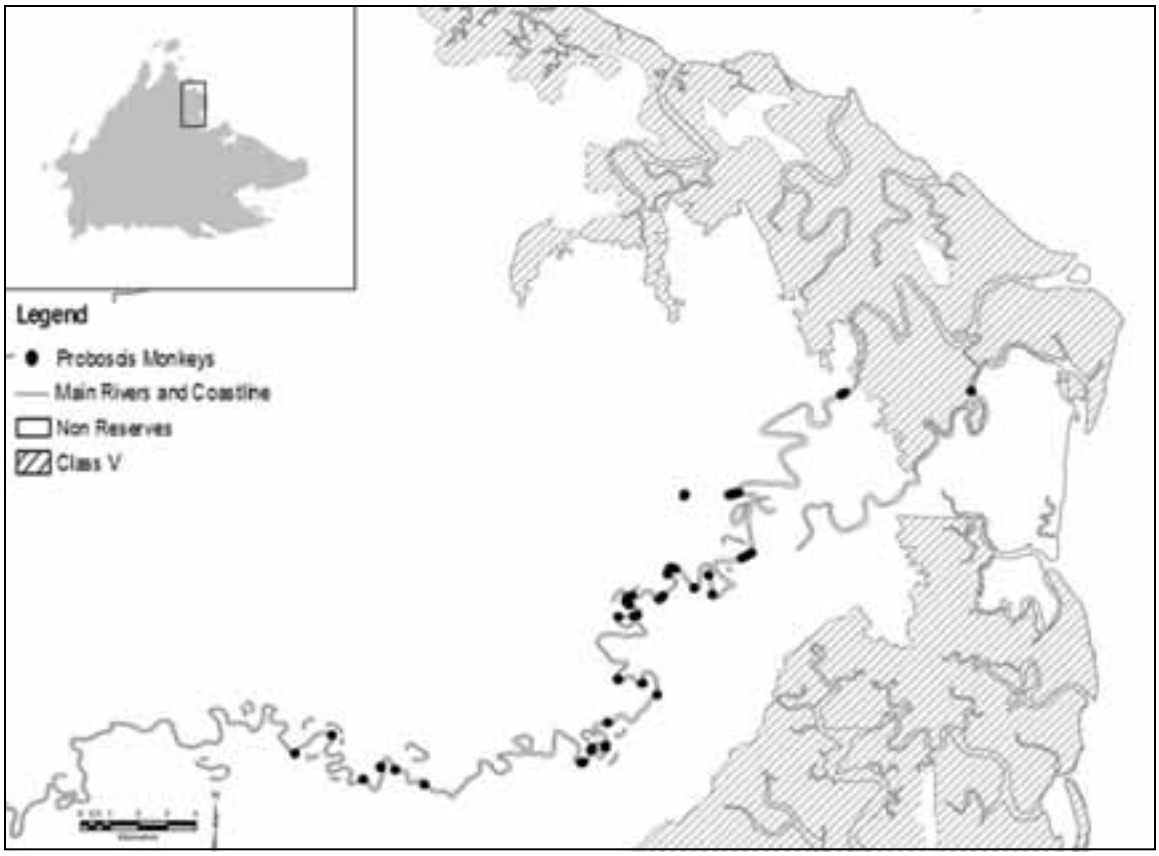


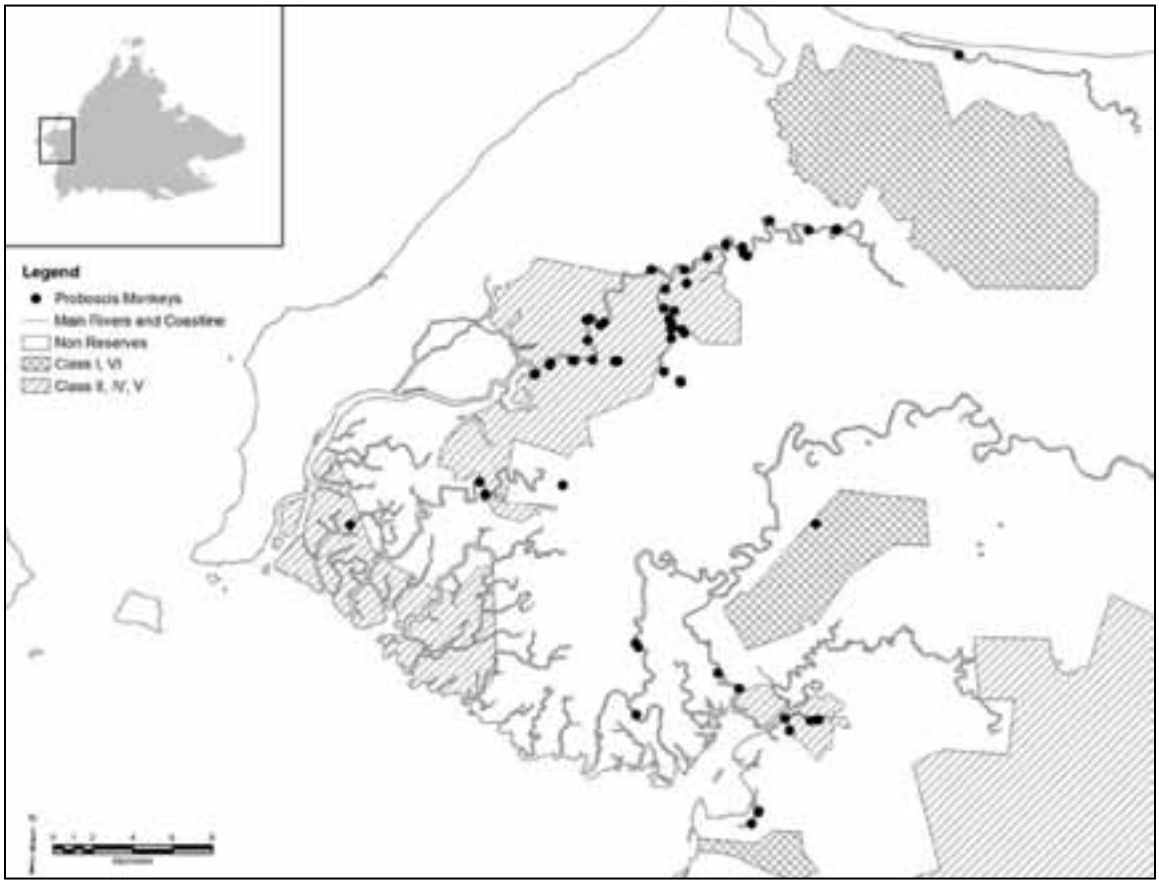


Appendix C. Areas affected by forest fires in Klias Peninsula (top) and Sugut, Tangkarason, Paitan (bottom).



Appendix D. Proboscis monkey distribution in forest reserves. Segama (top) and Kinabatangan (bottom). Sugut and Klias Peninsula).





Appendix D. Proboscis monkey distribution in forest reserves. Sugut (top) and Klias Peninsula (bottom).