Primate Conservation 2018 (32): 193-203

The Status of Primates in the Southern Mentawai Islands, Indonesia

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Abstract: Populations of the primates native to the Mentawai Islands—Kloss' gibbon *Hylobates klossii*, the Mentawai langur *Presbytis potenziani*, the Mentawai pig-tailed macaque *Macaca pagensis*, and the snub-nosed pig-tailed monkey *Simias concolor*—persist in disturbed and undisturbed forests and forest patches in Sipora, North Pagai and South Pagai. We used the line-transect method to survey primates in Sipora and the Pagai Islands and estimate their population densities. We walked 157.5 km and 185.6 km of line transects on Sipora and on the Pagai Islands, respectively, and obtained 93 sightings on Sipora and 109 sightings on the Pagai Islands. On Sipora, we estimated population densities for *H. klossii*, *P. potenziani*, and *S. concolor* in an area of 9.5 km², and *M. pagensis* in an area of 12.6 km². On the Pagai Islands, we estimated the population densities of the four primates in an area of 11.1 km². *Simias concolor* was found to have the lowest group densities on Sipora, whilst *P. potenziani* had the highest group densities. On the Pagai Islands, *H. klossii* was the least abundant and *M. pagensis* had the highest group densities. Primate populations, notably of the snub-nosed pig-tailed monkey and Kloss' gibbon, are reduced and threatened on the southern Mentawai Islands.

Key words: Population surveys, Southern Mentawai Islands, *Hylobates klossii*, *Presbytis potenziani*, *Macaca pagensis*, *Simias concolor*, Sipora, Pagai Islands

Introduction

The Mentawai archipelago of Siberut, Sipora, and North and South Pagai is part of an island chain that runs northwest to southwest along the west coast of Sumatra. Although the islands are only about 7,000 km², they are extraordinarily rich in biodiversity and have a unique indigenous cultural heritage. Siberut is the northernmost and largest island with an area of 4,030 km² (Whitten *et al*. 2000), whilst Sipora is the smallest island, only 845 km² (Fuentes and Ray 1995). The North and South Pagai islands are separated by a narrow strait, and together have an area of 1,674 km² (Whittaker 2006; Fuentes and Tenaza 1996). The natural vegetation of these islands is lowland tropical rain forest, similar to but not as diverse as Sumatra's lowland rain forest (Whitten and Whitten 1982; Whitten 1983), with a very high rainfall of about 4,500 mm/year (Tilson 1980; Tenaza and Fuentes 1995; Whitten *et al*. 2000). In a recent taxonomic review of Mentawai's primates, based on comparative analysis of genetic and molecular data, there are five endemic species in four genera: the snub-nosed pig-tailed monkey with two subspecies (*Simias concolor concolor* and *S. c. siberu*); the Mentawai langur with two subspecies (*Presbytis potenziani potenziani* and *P. p. siberu*); two species of Mentawai macaques (*Macaca pagensis* and *M. siberu*); and the Mentawai gibbon or Kloss' gibbon (*Hylobates klossii*) (Waltert *et al.* 2008). *Simias c. concolor*, *P. p. potenziani*, and *M. pagensis* occur on the three smaller islands of Sipora, North Pagai Island and South Pagai Island, while *S. c. siberu*, *P. p. siberu*, and *M. siberu* are confined to the largest island, Siberut (Kitchener and Groves 2002; Roos *et al*. 2003, 2014). *Hylobates klossii* occurs on all the main islands of the archipelago (Tenaza 1987; Whittaker 2005, 2006). As a result, the Mentawais are one of the richest areas on Earth for primate diversity and endemism per unit area. The Mentawai primates occur in all forest habitat types, from lowland swamp to dry and hill lowland forests (Quinten *et al*. 2010).

All five Mentawai primates are threatened—*Simias concolor* (both subspecies) and *M. pagensis* are Critically Endangered and the others are classified as Endangered on the IUCN Red List (Eudey 1987; IUCN 2018). *Simias concolor* has been placed among the world's 25 most threatened primates (Mittermeier *et al.* 2007). During the Indonesian Primate Conservation Assessment and Management Plan (CAMP) workshop of 20–23 February 2008, Indonesian primatologists

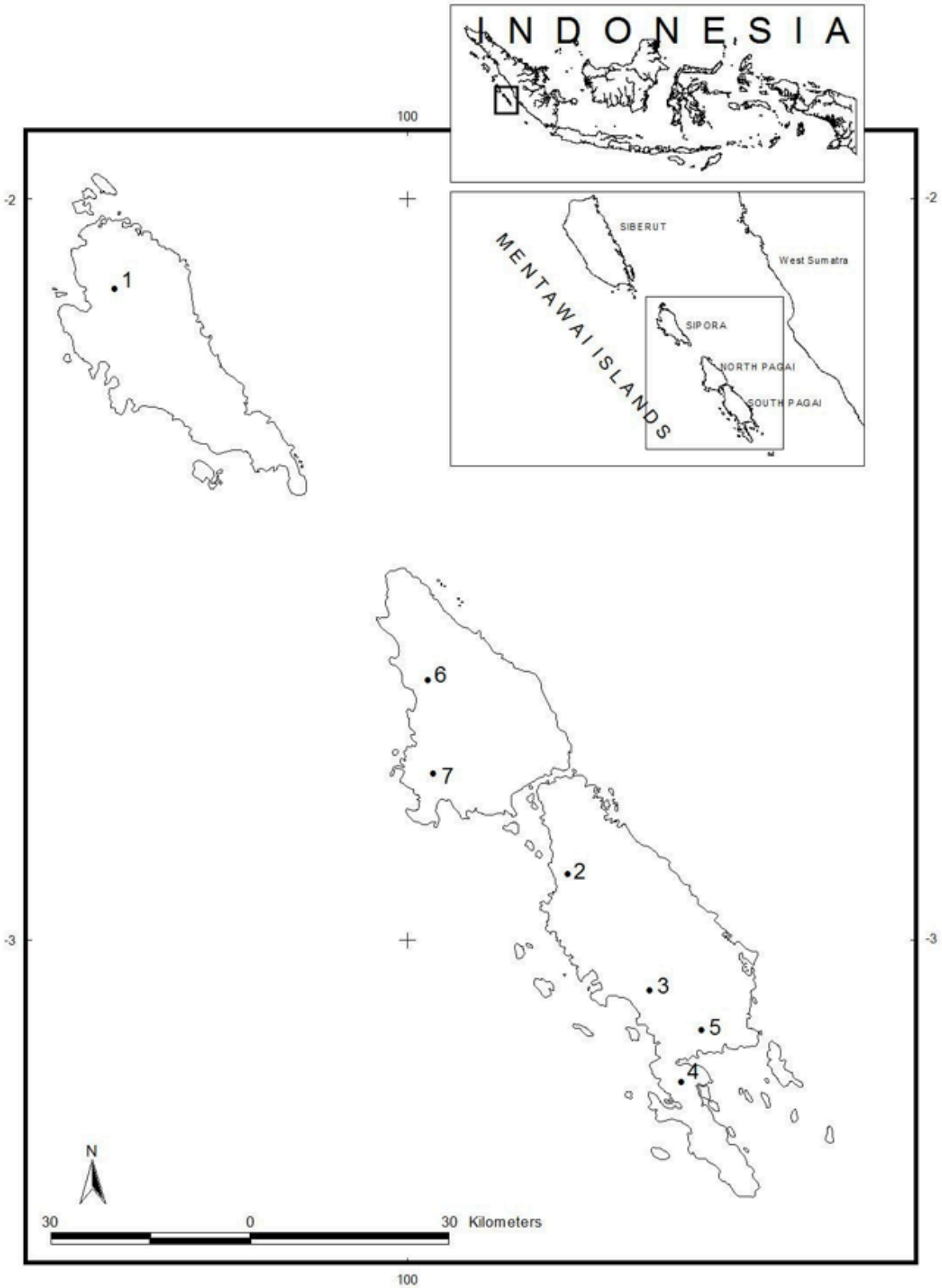

Figure 1. The southern Mentawai Islands (Sipora, North Pagai and South Pagai) showing the survey sites for native primates; 1. Saurienu, 2. Purorogat, 3. Bulasat, 4. Matotonan, 5. Bagatcarai, 6. Silabu, and 7. Betumonga.

confirmed that Kloss' gibbon is near to extirpation on Sipora, while the populations on the North and South Pagai islands are declining rapidly due to habitat loss. The Mentawai Islands, with their distinctive history and remarkable endemism, should be viewed in the same light as the Galapagos Islands and considered a prime candidate for future World Heritage status.

The Mentawai primates are entirely dependent on forests that are now critically threatened by legal and illegal logging, forest clearance and resource extraction. They are hunted by local people for food and for the illegal pet trade. Much of the forest is highly disturbed due to industrial-scale logging by companies present on all four islands. Consequently, habitat for the primates on the Mentawai Islands has decreased by at least 50% in the last 25 years (Chivers 1986). Fortunately, Siberut still has considerable forest cover (Waltert *et al*. 2008), and half of the island has been declared a national park (about 190,000 ha). All the endemic primate species can be saved within this park. By contrast, the southern islands of the archipelago (Sipora, and North and South Pagai) do not have any adequate protected forest (Tenaza 1987; Fuentes and Ray 1995; Yanuar *et al.* 1998) to save the local species (*Macaca pagensis*) and subspecies *Simias c. concolor* and *Presbytis. p. potenziani*. Hence, establishing new protected areas and habitat corridors among remnant forests is essential to save the endemic and unique species of these islands. Sipora and the Pagai islands' forests are suffering from rapid deforestation and land degradation.

No complete surveys of the four endemic primates of the southern islands of Mentawai have been carried out—there are only a few brief studies (Kawamura and Megantara 1986; Tenaza 1987, 1989; Olson 1992; Fuentes and Ray 1995; Tenaza and Fuentes 1995; Paciulli 2004). The southern islands of the Mentawai archipelago are still a treasure house for the four species and the extraordinary diversity of the Mentawai Islands' fauna and flora. Ground and aerial surveys of distributions and population sizes of endangered primates in the wild have become vital tools to help plan and manage conservation (Ancrenaz *et al.* 2004; Matthews and Matthews 2004). Population surveys and constant habitat monitoring are crucial for the protection of the wildlife of the southern islands of Sipora, North Pagai and South Pagai.

Surveys on the Mentawai Islands

We surveyed the population status and distribution of endemic primates in Sipora and the Pagais (North and South Pagai islands) in different sites using the line-transect method. The sites varied in elevation, vegetation and human activities and threats. Most of our work was in production forests in north-central Sipora and North Pagai, but also close to ongoing logging in central South Pagai. We surveyed seven locations in all (Fig. 1), some of which have been visited by other researchers, including: Saurienu (Whittaker 2005; Keith *et al*. 2009; Dirk Meiyer and Ambang Wijaya, pers. comm. 2008); Matotonan (Tenaza 1987); Betumonga (Fuentes 1994; Olson 1992; Paciulli 2004; Whittaker 2005); and Purorogat/Malakopa (Keith *et al*. 2009). These locations represent some of the most promising remaining forest patches on the islands and are likely to support viable primate populations.

Sipora

Only about 85–127 km² of forest remains on this island (Fuentes and Ray 1995), and largely in the north-central part. Sipora is the most developed island of the archipelago and the capital, Tua Pejat, is the administrative center of the West Sumatra province (Whittaker 2006). We selected the Saurienu forest as a survey site based on advice from forestry authorities of Tua Pejat and information we obtained from the literature.

Saurienu

The primary and secondary forests of Saurienu were selected as the main survey area because populations of all four species of Mentawai primates occur there. These sites are situated in north-central Sipora, about 15 km from Tua Pejat. The neighboring primary forests around Saurienu, such as the Siberimanua, Tua Pejat, and Betumonga areas, have been logged intensively since the 1970s. Smaller-scale, illegal logging activities have continued until recently, resulting in the fragmentation of the forests. The pristine forests still remaining in this area are located near the watershed of the Saurienu River, and adjoin other forest fragments extending to the south, north, and southwest of the island. These remnants are interrupted by small patches of agricultural land, and by logging roads. There are still a number of large trees, mostly dipterocarps. Bamboo and nibung palms (*Oncosperma* sp.) were also occasionally found on the hillsides.

Topographically, the area is hilly and naturally covered with dipterocarp lowland rainforest. There are steep inclines to numerous small streams draining into the Saurienu River, the largest and longest river on the island of Sipora. Elevations range from 120 to 220 m above sea level, about 10 km from the local village of Saurienu.

Illegal hunting of primates and other wildlife for meat was evident, although this area has not been logged because the local villagers did not allow it. The villagers themselves, however, occasionally cut down large trees to build houses or dugout canoes.

South Pagai

Today only about 900 km² of forest remains on South Pagai, and much of it has been affected by logging since the 1970s. The forests are predominantly old secondary growth with relatively little pristine old growth lowland forest. Almost 70% (600 km²) was made a production forest by the forestry authority of west Sumatra. There were several forest fragments separated by village gardens and former logging roads, creating gaps in the canopy. Topographically, the area is lightly undulating, lowland, with steep inclines to small

streams. Flatter areas were predominant, however, with elevations ranging from 0 to 300 m above sea level.

The four main forest remnants were selected as survey sites on the basis of their different histories, but each at similar elevations (50–200 m above sea level) where populations of Kloss' gibbon, snub-nosed pig-tailed monkey, Mentawai langur, and Mentawai macaque were present. Hunting, the shooting of gibbons and monkeys, was very evident in some areas. Native villagers still eat them, although some have stopped (Interviews of local people, 2009).

Bulasat

Bulasat is located in the southwest of the island, in a logging concession, about 40 km from the town of Sikakap, the administrative town of the sub-district of South Pagai. Most of the forests there have been logged since the 1980s, and no pristine forest remains, only a little of the original lowland forest, which is now predominantly old and young secondary growth. There are several large and small fragments, split up by logging, in the southwest of the island. Local people create clearings to plant crops—felling the trees and planting vegetables for local consumption.

The area is slightly undulating with lowland rain forest, and steep inclines to some streams. The elevation of the survey trails ranged from 50 to 150 m above sea level, and most of the survey transects were set up along human-made or animal paths and old logging roads.

Purorogat/Malakopa

Sadly, the survey trails of the area have been destroyed by logging companies since the 1980s. Commercial logging has largely wrecked the primary forest of South Pagai; only about 30% remains. Some small forest fragments have clearings for subsistence farming. Villagers have planted mostly cacao (*Theobroma cacao*), banana (*Musa paradisica*), and patchouli (*Pogostemon cablin*) trees. The timber company has also planted commercial trees, such as silk trees *Albizia*, in logged areas. All the Mentawai primate species were seen in the primary forest but only Mentawai macaques and langurs occasionally visited secondary forest with mixed traditional plantations to raid local gardens in and around the villages of Purorogat and Malakopa. Kloss's gibbon and the Mentawai langur were reported to occasionally visit *Albizia* trees while they were foraging, resting and travelling.

The area is similar to Bulasat in its topography, with mostly lowland and predominantly old and young secondary forests. We observed native villagers of Purorogat killing and cooking an adult Kloss's gibbon, but the snub-nosed pig-tailed monkey was their favorite, although in sharp decline and now hard to find (Interviews of local people, 2009).

Bagatcarai

Forest cover of this area was predominantly old secondary forest; about 30% was secondary. The pristine forest of this area has been wrecked by logging but there are still populations of all the primate species there. In the past there were log ponds built on the beach to resettle timber before shipping to Sumatra or Java. The status of the primary forest in this area is production forest, under concession to a logging company. Many areas have been cleared for agriculture and gardens and have suffered disturbance by villagers. Topographically, the area is undulating, slightly flatter on the hill tops, with lowland forests. Mangrove forest was common along the beach.

Matotonan

Forests of this area have never been logged on a large scale. The area is situated in the southern part of the island, known as the rat tail of South Pagai. Unfortunately, the area of pristine forest has now declined due to small-scale illegal logging for remnant commercial timbers, with a logging road to the islet of Sinakak. The area has been formally declared a nature reserve to save the endemic primates, with a total area of about 4,833 ha. Richard Tenaza and his team proposed that an area of 20,000 ha in the southern part of South Pagai that included terrestrial and marine ecosystems, be made into a nature reserve of the southern Mentawai Islands (Tenaza 1987).

The area is slightly undulating, lowland, with steep inclines to small streams, although it was predominantly flat at elevations of less than 80 m above sea level. Survey transects were mostly along human-made and animal paths, and there were some shallow slopes where transects were conducted in deep forest. All endemic primate species occupy these areas. Hunting primates to eat has decreased (Interviews of local people, 2009), and the little that still occurs there is by outside hunters.

North Pagai

Like South Pagai, North Pagai (about 700 km²), has had much of its original forest logged and converted for other purposes. Small-scale illegal logging still occurs, felling the remaining commercially valuable timber. Together with South Pagai the forest cover of these islands has decreased drastically from 900 km² in 1980 to 200 km² in 2005 (Whittaker 2006).

There are a number of sites on North Pagai where Mentawaian non-human primates were studied intensively. Agustin Fuentes (1994), Lisa Paciulli (2004), and Sasimar (2004) carried out their dissertation research in and around the region of Betumonga and Muntei in the southwest of North Pagai. Thus, we selected the Betumonga region and Silabu forests for our primate surveys to represent the North Pagai populations. Unfortunately, both areas are not formally protected by the forestry authority. Today, the habitats of the endemic primate species are in production forests and logging concessions.

Silabu

Forest profiles of the survey site include primary dipterocarp and mixed forests, as well as secondary forest; there were plenty of strangling figs (Moraceae) and other fruit trees

with more closed canopies in deep forest. The primary mixed dipterocarp forest of this area was relatively untouched by logging and farming, especially on hills and along ridge tops. Secondary forest was predominant in the flatter areas. Village hunters from outside the area sometimes visited the forest in and around Silabu to shoot and trap monkeys and Kloss' gibbon. Local people were also found collecting forest products, such as felled logs and rattan manau in the deep forest.

Betumonga

Similar to Silabu, the area has been logged by a commercial timber company, namely PT Minas Pagai Lumber. The original forest remnant of this area is located in the former study area (about 600 ha) of Paciulli (2004) in the southwest of North Pagai island. Various vegetation types can be observed, from beach to mangrove, pandanus and palms, to peat-swamp and lowland dry forests. A couple of forest fragments joined these forests to those of the nearby survey area of Silabu. Strangling figs (Moraceae), lianas, vines, and epiphytes were occasionally seen along forest transects. Populations of all endemic primate species inhabited Betumonga's forest.

There are rural settlements, namely Betumonga Timur, Betumonga Barat, Betumonga Tirik, and Sabeu Gukguk, surrounding the Betumonga survey area. Similar to conservation areas in southern South Pagai island, Betumonga's forest has been officially proposed as a protection area to save the native endemic primates and other fauna and flora in North Pagai. Unfortunately, attempts by scientists to protect the area, such as those of Agustin Fuentes and Lisa Paciulli, were unsuccessful due to overlap with the logging concession.

Methods

Line transects

We used the line-transect method to estimate the density and population status of each primate species through direct visual observation. We conducted the surveys in September 2008, with two teams, and from December 2008 to January 2009, with three teams in Sipora, as well as surveys in South Pagai and North Pagai from May to June 2009, consisting of three teams. The teams were assisted by local helpers, who were familiar with the primates, the methods, and the terrain.

We derived our methods for the census of diurnal primates from those published by Brockelman and Ali (1987), Burnham *et al.* (1980), Eberhardt (1968), Marsh and Wilson (1981), NRC (1981), and Peres (1999), and adapted them to the field situation. Normally, existing human or animal paths were used. Trail lengths were measured by pacing or using a pedometer calibrated to the observer's stride. Trails were on average 0.5–1.0 m wide in dense forests and 1.0–1.5 m wide in secondary forest, but trails were wider in recently logged forests as they followed old logging roads.

Teams walked slowly (average speed <1 km/h) in a straight line, and also frequently stopped for several minutes to listen for animal sounds and to record detailed notes on each group encountered: group size and group spread, as well as the distance between the observer and animal, the shortest or perpendicular distance from the animal to the transect, and the angle of observation between animal and path. Census walks started in the morning, between 06:30 and 07:30 h, and ended at midday.

Detection Distance and Estimated Strip Width (ESW)

There are a number of ways to determine the transect width, or effective strip width (ESW), namely the maximum sighting or perpendicular distance of sightings, mean distance of all sightings and some distance between the maximum and mean or reliable distance (NRC 1981; Brugière and Fleury 2000). We used the maximum reliable detection distance (1/2 ESW) for density calculations for each species, estimated using Kelker's method, based on the animal nearest the trail, or perpendicular distance. The maximum reliable perpendicular detection distance is determined from the frequency distribution curve of sightings, which usually shows an obvious plateau, followed by a marked drop in frequency (Marsh and Wilson 1981; NRC 1981; Brockelman and Ali 1987; García 1993; Brugière and Fleury 2000). We estimated this distance as the last distance category before a drop of 50% in sighting frequency (NRC 1981).

Primate Density

The estimation of mean group density of the diurnal Mentawai primate species is calculated from the number of groups of species sighted divided by the areas of the surveys, derived from the length of transect line and the estimated strip width on both sides of the transect line (Burnham *et al*. 1981; Brockelman and Ali 1987). Density = number of animal groups observed / $2w \times l$, where $2w$ = the strip width (twice the transect width) and l = the length of the transect line.

Density estimates for each primate species were calculated from data collected from a combined total of 185.6 km of 16 line transects in six locations on the Pagais and 157.5 km of six transect lines in one location on Sipora with the same habitat type (tropical lowland forest). The group densities estimated in the two main sites (Sipora and the Pagais) were compared using the Mann-Whitney U-test, as well as by combining six survey sites of Pagais using the Kruskall-Wallis test. Significance was set at $p < 0.05$ (Siegel 1956).

Results

Perpendicular distance

The maximum perpendicular detection distance recorded for *H. klossii* was 30 m (mean = 21.0, SD = 9.81, n = 21 for Pagais and mean = 21.5, SD = 9.48, n = 22 for Sipora), thus ESW was 60 m. *Presbytis potenziani* was frequently found in the forest's of Southern Mentawai. It had a maximum reliable perpendicular detection distance within 30 m for all survey trails (mean = 22.2, SD ±10.42 m, n = 30 in the Pagais, and

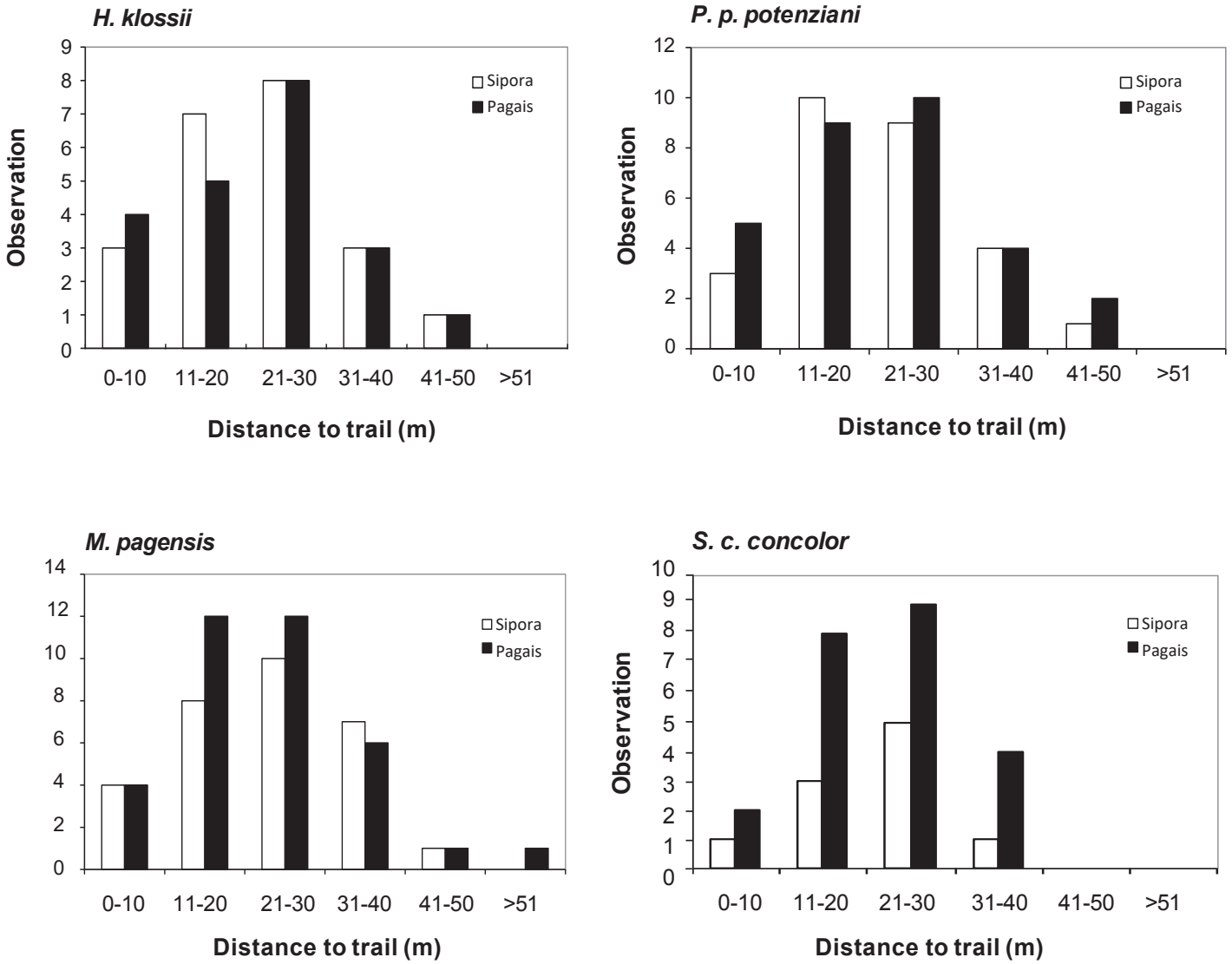

Figure 2. Observed perpendicular detection distances of native primate species in southern Mentawai archipelago.

mean = 22.7 m, SD ±10.91, n = 28 in Sipora). Thus. the ESW was 60 m for lowland forest of Sipora and the Pagai islands. *Macaca pagensis*, however, could be confidently detected only within 30 m in the Pagais (mean = 22.6 m, SD ±10.38, n = 36) with the ESW recorded between 21 and 30 m. In Sipora, the maximum reliable perpendicular detection distance was up to 40 m (mean = 23.45, SD ±10.22, n = 31), hence we used 80 m as the ESW. *Simias s. concolor* was the rarer species and was seen within 30 m (mean = 20.4, SD ±7.52, n = 22 in the Pagais, and mean = 19.6, SD ±8.98 in Sipora), with a marked drop in perpendicular detection distance between 21 and 30 m (Fig. 2). As with *H. klossii* and *P. p. potenziani*, we used an ESW of 60 m (Fig. 2) for surveyed transects of *S. c. concolor* in the southern islands' forests.

Primate Densities

The number of observations and the survey areas on Sipora and the Pagais are shown in Table 1. Of the four diurnal endemic Mentawai primates surveyed, *S. c. concolor* appeared to have the lowest average group densities estimated from the hill lowland rain forest of Saurienu on Sipora Island, whilst *P. p. potenziani* had the highest densities estimated, followed by *M. pagensis* and *H. klossii*. By contrast, *H. klossii*, less abundant on the Pagais, had the third highest group densities on Sipora (Table 1). Moreover, *M. pagensis*, had the highest group densities in the Pagais, followed by *P. p. potenziani* and *S. c. concolor*. There were no significant differences in comparing areas in Sipora and Pagais for each group density estimated (U = 7.000, p = 0.773, Mann-Whitney U-test).

With regard to group densities estimated for each surveyed site in both the North and South Pagai islands, *H. klossii* and *P. p. potenziani* had higher mean group densities in North Pagai (Silabu 3.1 groups/km² and Betumonga 3.6 groups/km², respectively) than in South Pagai, whilst *M. pagensis* (4.2 groups/km² in Bagatcarai) and *S. c. concolor*

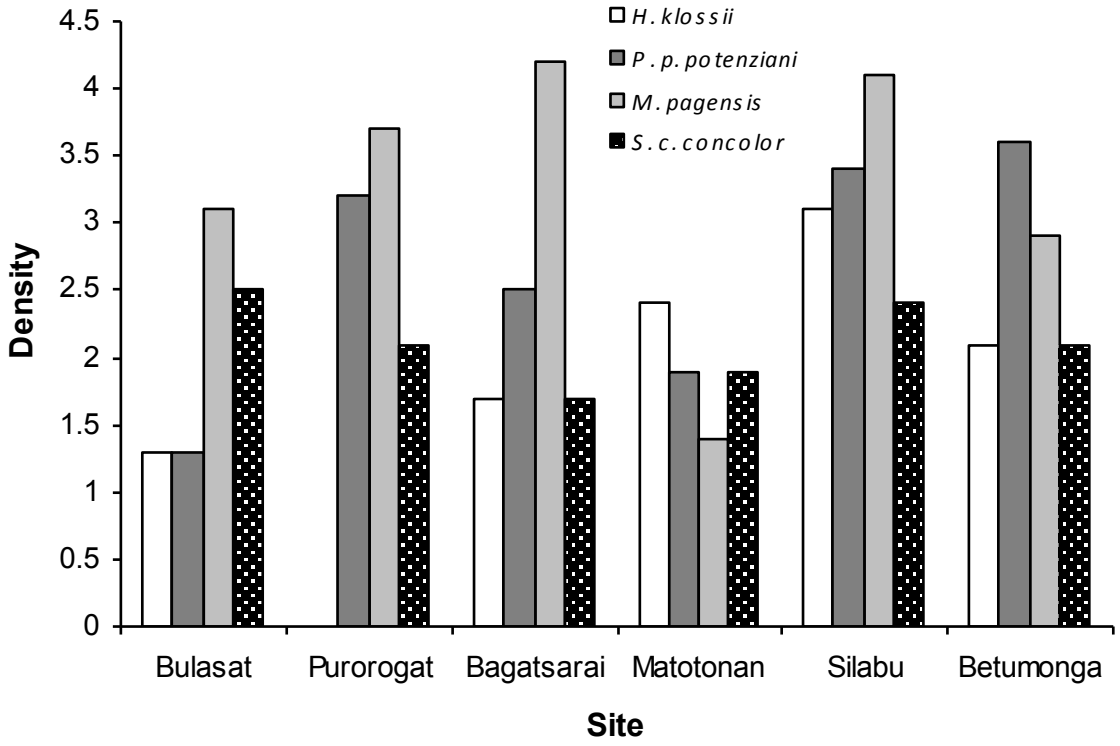

Figure 3. Group densities estimated for *Hylobates klossii*, *Presbytis p. potenziani*, *Macaca pagensis*, and *Simias c. concolor* at each survey site in North and South Pagai.

(2.5 groups/km² in Bulasat) were more abundant on South Pagai than on North Pagai (Fig. 3). There was no significant difference in group densities estimated in all six survey sites of the North and South Pagai islands (H = 6.641, df = 3, p>0.08, Kruskall-Wallis).

Discussion

Most population density and abundance estimates of Mentawai primates are from Siberut. They include those by Tilson (1980), Watanabe (1981) and Waltert *et al.* (2008). The most current information on primate densities on Siberut was provided by Quinten *et al.* (2010), with emphasis on the peat-swamp forest of northern Siberut. Paciulli (2004) reported the current status of all endemic primates in North Pagai island, while Whittaker (2006) and Keith *et al.* (2009) carried out population surveys of Kloss' gibbon using the triangulation method on South Pagai island. In this study, we used the line-transect survey method for the three southern Mentawai Islands (Sipora and the Pagais), encompassing all four endemic primate species.

Our results showed that populations of Mentawai primates still persist in the disturbed and undisturbed forests, and forest fragments there. *Macaca pagensis* and *P. potenziani* were frequently observed in all areas surveyed but were scarcer on southern South Pagai. *Simias concolor* was less abundant on Sipora. The explanation for these differences are possibly ecological. Macaques can generally live near human settlements (Wilson and Wilson 1975; Rodman 1978; Wheatley 1980) and in varied habitat types (Crockett and Wilson 1980) and can be observed in secondary forest and even become serious crop-raiders. In contrast, *S. concolor* is the easiest to hunt and the favorite for local hunters to shoot—by poison arrows or poison-pellet air rifles. They, therefore, avoid, or are hunted out, of forest near human settlements. *Hylobates klossii* is entirely arboreal and is generally restricted to good-quality habitat such as undisturbed primary forest. Similar to other gibbons, the survival of *H. klossii* relies on dipterocarp forests where they eat mostly sugar-rich, succulent fruit pulp of juicy fruits (Gittins and Raemaekers 1980), especially of strangling figs and canopy trees, which 'house' and feed them throughout the year, and provide for their travel routes.

Higher mean densities of *H. klossii* were observed in Saurienu, Sipora, while in the Pagais they were recorded in Silabu, North Pagai island, and in Matotonan, South Pagai island. The Saurienu, Silabu and Matotonan survey sites were predominantly in undisturbed forests. It is now believed that the local populations of wild gibbons in South and Southeast Asia will continue to decline due to habitat alteration and loss (MacKinnon and MacKinnon 1980); all are now threatened, and the future of these gibbons is extremely bleak. The Javan silvery gibbon (*H. moloch*), native to Java, has suffered the greatest declines (Sugardjito *et al.* 1997; Supriatna 2006), with only 4% of their original rain forest habitat remaining

Table 1. Mean group density estimates and group size for *Hylobates klossii*, *Presbytis p. potenziani*, *Macaca pagensis*, and *Simias c. concolor* in the southern Mentawai islands.

	Number of groups		Area Surveyed (km²)		Group density		Group size ±SD	
	Sipora	Pagais	Sipora	Pagais	Sipora	Pagais	Sipora	Pagais
H. klossii	22	21	9.5	11.1	2.3	1.9 ±1.1	3.0	2.5
P. p. potenziani	27	30	9.5	11.1	2.8	2.7 ±0.9	3.6	3.8
M. p. pagensis	30	36	12.6	11.1	2.4	3.2 ±1.0	5.3	7.0
S. c. concolor	14	22	9.5	11.1	1.5	2.1 ±0.3	2.9	3.2

(MacKinnon 1986 Kool 1992; Asquith 1993; Nijman, 2001); most of its habitat is forest fragments.

The density of *H. klossii* recorded in northern Siberut island was higher than in Sipora and the Pagais (Whittaker 2006). We estimated 2.3 groups and 1.9 H. *klossii* groups/km² in the large fragmented forests of Sipora and the Pagais, respectively; numbers that are lower than those of Waltert *et al*. (2008), who estimated 3.5 groups/km² in Paleonan, northern Siberut. Quinten *et al*. (2010) recorded only 0.3 groups/km² permanently resident in peat-swamp forest on Siberut. Kloss' gibbon is evidently not common in the peat-swamp forest, and, in some cases, it is used only as a marginal habitat for foraging (Whitten and Whitten 1982; Quinten *et al*. 2010). Conversely, the agile gibbon (*H. agilis*) is a permanent resident in the swamp forest of Sumatra (Marshall and Sugardjito 1986). The mean group density of Sumatran siamang (*Symphalangus syndactylus*) in forest fragments has been found to be low in a large forest patches, 0.9 groups/km²−1.4 groups/km², but higher in the smaller fragment forests, 7.1 groups/km² (Yanuar 2007). Like *S. syndactylus*, *H. klossii* is quite susceptible to heavy forest disturbance and fragmentation because gibbons are known to be selective eaters and territorial, and need continuous canopy for ease of movement. As a result, we consider that *H. klossii* is the most endangered species in the southern Mentawai Islands, and should be classified as Critically Endangered on the IUCN Red List. An effective management plan for the conservation of Mentawaian gibbons is essential for the remaining populations in the remnant natural habitats in the southern Mentawai Islands, and this must include an assessment of habitats for their long-term viability.

Average group size of the Mentawai langur, *P. potenziani*, ranged from 1.5 to 2.1 individuals in northern Siberut (Waltert *et al*. 2008; Quinten *et al*. 2010), to 3.3 individuals on South Pagai (Tenaza 1987); 3.6 individuals on North Pagai (Fuentes 1996); and 3.6−3.8 individuals in this study. Group sizes of langurs in peninsular Malaysia are larger; 14 individuals (Curtin 1976; Chivers and Davies 1978; Bennett and Davies 1994), while in Sumatra they generally comprise about eight individuals (Wilson and Wilson, 1976), and in Borneo six (Bennett and Davies 1994). Larger group sizes are needed to protect the group members from competitors and predators (Van Schaik *et al.* 1983)

The group densities of the other southern Mentawai islands' colobine, *P. p. potenziani*, appears to be slightly lower than in the Paleonan forest of northern Siberut, which generally has the highest densities of primates in the Mentawai Islands (Waltert *et al*. 2008). The densities at sites surveyed on Sipora and the Pagai islands, were a little higher compared to those in the peat swamp forest of northern Siberut: 1.8 groups/km² (Quinten *et al*. 2010) versus 2.8 and 2.7 groups/km², in this study. Mentawai langurs feed mainly on climbers/lianas, vines and trees of *Ficus*, *Dipterocarpus*, and *Shorea*, and commonly rest in the upper canopy and emergent trees (Fuentes 1994), which are scarce in peat swamp forest (Quinten *et al*. 2010).

Colobines are flexible and adaptable, occupying a variety of habitat types. They are widespread in both primary and secondary habitats and tolerate being close to human settlements. Like *Macaca*, they can be serious pests in raiding crops and small gardens and are thus susceptible to being hunted, trapped and killed.

In the southern Mentawai islands, the estimated group densities of *P. potenziani* on Sipora were 0.9% higher than in the Pagais. Fuentes and Ray (1996) reported that *P. potenziani* was common in primary, secondary, swamp, and Barringtonia forests in North Pagai, while on the island of South Pagai it occurred in disturbed forest and near human settlements (Tenaza 1987).

Like other macaques, *M. pagensis* lives in large groups with sizes ranging from 5 to 25 individuals (Fuentes and Olson 1995). The mean group sizes reported by Waltert *et al.* (2008) and Quinten *et al.* (2010) in northern Siberut were 3.2 and 2.6 to individuals, respectively. In our surveys, the group sizes were larger: 5.3 individuals in Sipora and 7.0 in the Pagai islands. It was not easy to assess group size, however, since these macaques are semi-terrestrial, and groups can be spread out. Occasionally, groups split into smaller subgroups when foraging (Whitten and Whitten 1982; Fuentes 2002).

We estimated that the mean group density for *M. pagensis* was higher in the Pagai islands (3.2 groups/km²) than in Sipora, but slightly lower than *M. siberu* in Paleonan, north Siberut (3.8 groups/km²: Waltert *et al.* 2008) where the density was similar to that estimated by Paciulli (2004) for *M. pagensis* in 10–20-year-old logged forest on North Pagai.

The highest density was recorded in the peat-swamp forest of Paleonan: 13.9 groups/km² (Quinten *et al.* 2010). Pig-tailed macaques generally occur at their highest densities in undisturbed lowland and hill rain forests, and it would seem that they are not regular residents of swamp forest, although they occasionally range into secondary forest, far from primary forest, to raid crops (Crockett and Wilson 1980). *Macaca pagensis* is also reported to quite often enter secondary forest near human settlements to raid local gardens and slash-and-burn areas in Sipora and the Pagai islands (Interviews of local people, 2009).

Waltert *et al.* (2008) and Quinten *et al.* (2010) reported that the mean group density of *S. c. siberu* in Peleonan, northern Siberut was probably >50% higher than our estimates in Sipora and Pagai islands, measured by line-transect, although we used transects chosen randomly rather than systematically. Moreover, *S. concolor* seemed prefer to live in peat-swamp forest (Fuentes and Tenaza 1996) with the highest mean group density of 21.1 groups/km², compared to lowland rainforest (Quinten *et al.* 2010). Tenaza (1987) also reported a high abundance of *S. concolor* on the Simalegu islet, which is dominated by peat-swamp forest. The pig-tailed langur is mostly folivorous, and often eats leaves of nibung palms (*Oncosperma* spp) (Tenaza 1987), which are abundant in peat-swamp forest. Sadly, the population densities of this species on Simalegu have declined drastically due to hunting (Yanuar *et al.* 1998). This species is also now rarely seen in the deep forests of Saurienu, north-central Sipora, due to heavy hunting for food. *Simias concolor* is not hunted in Peleona, northern Siberut, and there the population remains healthy (Waltert *et al.* 2008).

Acknowledgments

Funding for this research was provided by the Margot Marsh Biodiversity Foundation and Dr. Seuss Enterprises of Lorax. We would like to thank the Regency of Mentawai Islands, the Forestry of Mentawai Islands, and the Nature Conservancy of West Sumatra for sponsorship, support, and permission to undertake this research on Sipora and the Pagai Islands. We thank Adam Smith Bago, Herik Kiswanto, Syafriwandi, Haris Kuswandi, and Reno Julianto for their enthusiastic help and participation in the first, second and the third surveys. We are grateful to Bonnie Dewantara for his help in training of GIS in Padang, and Dr Herwasono Soedjito and Iwan Wijayanto CI-Indonesia. And Kristin Berganzt for her help writing the article. Finally, we thank Dr. David J. Chivers for many helpful comments on this manuscript.

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Received for publication: 19 April 2017
Revised: 18 November 2018