Ministry of Natural Resource and Environmental Conservation

Forest Department

Taninthayi Nature Reserve Project

Report

On

Taninthayi Langur *(Trachypithecus barbei)* Survey

In Taninthayi Nature Reserve

Friends of Wildlife

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Abstract

From November 2015 to April 2016, a wildlife survey on Taninthayi Langur ***(Trachypithecus barbei)*** (TL) was conducted in Taninthayi Nature Reserve (TNR). The 3 main field methods were conducted for the survey: 1) questionnaire survey and QGIS program were used to identify the study site selection; 2) girds (2 x 2 km each) were used for intensive study; and distance sampling method using line transects were applied to obtain the estimated density of TL groups and some ecological and biological data.

The survey team was able to identify the distribution and estimated abundant of TL species in 9 Local Operating Unit (LOU) areas which use in TNR management. Out of 9 LOUs, Yebone LOU area was selected for intensive survey.

Although observation frequency of TL groups was low (n=29), we analyzed the density and other ecological factors of TL species. The density of study TL species resulted as 1.35 group/km^2 according to distance software program 6.2, with the results of a total of 423 groups in Yebone area. The survey also failed to record some data on behavior, counting group size, etc., but was able to indicate that group size ranged from 8+ to 30+ animals and there was viable population of TL species in TNR. The TL groups were seen between 377m and 1001 m asl, and fruits and leaves of 12 flora species were consumed by TL. Out of 4 main forest types, three habitat types (55% in closed evergreen forest, 34% in open evergreen forest, and 10% in semi-evergreen forest) were used by TL groups, and the survey team did not observe TL group in bamboo forest. TL breeding seasonality appears timed to maximize fawn survival and fawning season is during November to January. TL species also responded to changes in human disturbance, fire and phonological events, and therefore, recommendations for future actions were made in this report.

Key Words: line-transect, distance sampling, group density, TL leaf monkey, conservation

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Introduction

The survey site, Taninthayi Nature Reserve (TNR) is situated between Yephu and Dawei Townships, Taninthayi Division and located between N 14° 20' 50'' to 14° 57' 55'' and E 98° 5' 10'' to 98° 31' 32''. It is notified as the Taninthayi Nature Reserve (TNR) on 30th March 2005 in order to protect its richness of biodiversity and rain forest ecosystem. It has an area of 1605 square kilometers and covered with extensive evergreen forests containing large mammal including Asian Elephant (*Elephas maximus*), Asian Tapir (*Tapirus indicus*) and Sambar (*Cervus unicolor*), etc. Out of many surveys which support TNR for establishment and long term implementation of the Reserve, Taninthayi langur (TL) survey is one of the essential components of biodiversity assessment in TNR toward the development of TNR Management Plan.

The Taninthayi Langur (***Trachypithecus barbei***) (TL) is a taxon recently elevated to species level from the similar Dusky Langur (*Trachypithecus obscurus*). This TL species is restricted to a very small range in southeastern Myanmar and a neighboring portion of southwestern Thailand. The species is likely to be at risk due to its limited range, loss of forest habitat, hunting and apparently naturally low densities.

The specific objectives of this survey were:

1) To determine the population abundance, distribution and ecology of Taninthayi Langur in the TNR.

2) To assist the long term management of the Taninthayi Langur population within TNR.

3) To provide reliable data of Taninthayi Langur species to the TNR Project so as to assist future revisions of Operational Management Plan.

4) To make recommendations for future biological surveys of Taninthayi Langur.

The survey was carried out during November 2015 to April 2016 closely collaboration with TNRP staff.

Literature review on study species

Myanmar is one of home countries to a large diversity of primates. With currently 22 described primate taxa, Myanmar is a country with one of the highest primate diversities in Southeast Asia. Knowledge about the taxonomy, distribution and conservation status of primates is still limited. Considering rapidly increasing threats caused by illegal wildlife trade and habitat loss, due to rapidly increasing investment in infrastructure and plantation development, taxonomic and conservation status research is urgently required. Moreover, the taxonomy and distribution of Myanmar's primates rely mainly on museum records and new data are missing. It is likely that scientifically undescribed primate taxa and ecological data can still be discovered in Myanmar.

In TNR, the 1st large/small mammal survey was carried out in 2002-03, but the report did not mention about the primate species (Win Maung 2003). The 2nd Mammal survey was conducted in 2008, and according to questionnaire survey, call and visual observations, a total of 12 primate species were recorded in TNR area (Ye Htut et. al. report 2008). However, TL monkey was not listed in the report (Table 1).

Table 1: List of primate species recorded during 2nd Mammal survey in 2008

QS=questionnaire survey; (Source: Reported by Ye Htut et. al., 2008)

No.	Common Name	*Scientific Name*	Remarks
1	White-handed Gibbon	*Hylobates lar*	QS, Call
2	Hoolock Gibbon	*Bunopithecus hoolock*	QS, Call
3	Banded Langur	*Presbytis femonalis*	QS, Visual
4	Dusky Langur	*Trachypithecus obscurus*	QS
5	Silvered Langur	*Trachypithecus cristatus*	QS
6	Pig-tailed Macaque	*Macaca nemestrina*	QS
7	Stump-tailed Macaque	*Macaca arctoides*	QS
8	Rhesus Macaque	*Macaca mulatta*	QS, Visual
9	Long-tailed Macaque	*Macaca fascicularis*	QS
10	Slow loris	*Nycticebus coucany*	QS

11	Sunda Colugo	*Cymocephalus variegatus*	QS
12	Tree-shrew	*Tupaia belangeii*	QS

The primate training conducted by Flora and Fauna International (FFI) in 2013, mentioned about 4 primate species such as Stump-tailed macaque (*Macaca arctoides*), Northern pig-tailed macaque (*Macaca leonina*), Tenasserim langur (*Trachypithecus barbei*) and White handed gibbon (*Hylobates lar*). However, the report mentioned about distribution and ecology of TL very briefly. The TL leaf monkey (*Trachypithecus barbei*) is a range limited species to Myanmar and Thailand (Thomas Geissmann, Colin P. Groves & Christian Roos 2004).

Within the Asian leaf monkey genus *Trachypithecus,* traditionally five species groups (T. *pileatus, T. vetulus, T. francoisi, T. cristatus* and *T. obscurus)* were recognized, mainly due to differences in fur colouration, behaviour, ecology and distribution (Groves, 2001).

However, recent genetic investigations have shown that the *T. vetulus* group is actually a member of the genus *Semnopithecus* and that the *T. pileatus* group might be the product of ancestral hybridization between *Semnopithecus* and *Trachypithecus* (Geissmann et al., 2004; Karanth et al., 2008; Osterholz et al., 2008). Thus, only three species groups, *T. francoisi, T. obscurus* and *T. cristatus,* remain as true members of the genus *Trachypithecus* (Osterholz et al., 2008).

Each of these three species groups include taxa that are genetically closely related to each other (Geissmann et al., 2004; Osterholz et al., 2008; Roos, 2003; 2004; Roos et al., 2007; 2008), and which are also similar in fur colouration, behaviour and ecology (Brandon-Jones et al., 2004; Groves, 2001; Nadler et al., 2003).

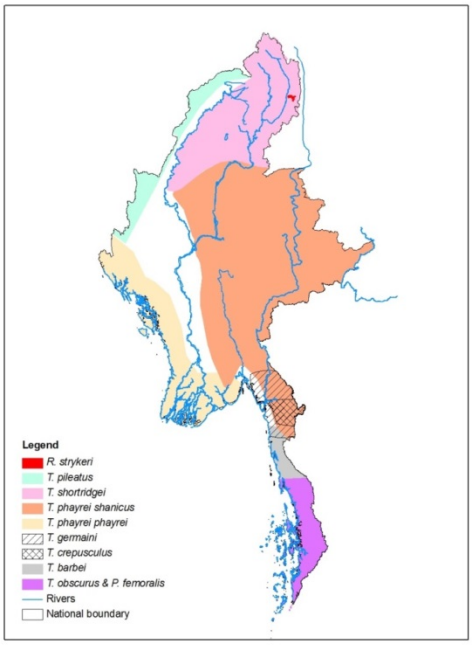
Accordingly, *T. francoisi, T. poliocephalus, T. delacouri* and *T. laotum* are combined in the *T. francoisi* group (Osterholz et al., 2008; Roos, 2003; 2004; Roos et al. 2007), *T obscurus, T. phayrei* and *T. barbei* in the *T. obscurus* group (Geissmann et al., 2004; Osterholz et al., 2008; Roos et al., 2007), and *T. cristatus, T. auratus, T. mauritius, T. margarita* and *T. germaini* in the *T. cristatus* group (Nadler et al., 2005; Roos et al., 2008).

Distribution of Trachypithecus barbei

According to the old reference shown in Figure (1), there may be only two leaf monkey

species found in TNR and surrounding areas and but majority species was TL. Figure (1) showed that the general information on distribution of 9 leaf monkey species in Myanmar. The type locality of *T. barbei* (Blyth, 1863) was Ye, Mon State. The distribution is limited to a small area of far western Thailand and adjoining parts of Myanmar, between about 14° and 15°30'N and from the Bay of Bengal as far east as 98°30'E in the northern end of the range and 99°E in the southern end.

Figure 1: Distribution of leaf monkey species in Myanmar (Source: Fodden 1976)



To the north occurs *T. phayrei,* to the south *T. obscurus*, to the southeast *T. germaini*. Fooden (1976, Figure 3) mapped these species' ranges, but included both *T. barbei* and *T. germaini* under *Presbytis cristatus*. In Fooden's map, the three westernmost localities of "*cristatus*" (localities 13, 14 and 18) represent *T. barbei.* They have been depicted as such in Figure 3. The Huay Kha Khaeng Reserve, where *T. barbei* may be affected by gene-flow from *T. phayrei,* is well to the east of Ye, and not far southwest of Kata Taek, one of Fooden's (1976) localities for *T. phayrei,* and not far northeast of Fooden's localities 15 and 16 for the same species.

The study of Geissmann et al. for the first time accurately assessed the geographical

distribution of *T. barbei*, although the data were available in various previous reports. From this it becomes clear that the distribution range was indeed extremely restricted, somewhere between 10,000 and 12,000 km^2 (possibly larger if the species' range extends north- and/or southwards). This may be the smallest distribution range of any *Trachypithecus* species. Because species with small distribution areas are more vulnerable than species with large distribution areas, and because the range of *T. barbei* is located in the centre of the Indo-Burmese region - a biodiversity hotspot which has already lost 95.1% of its primary vegetation (Mittermeier et al., 1999; Myers et al., 2000) - an evaluation of the species' conservation status should urgently be carried out.

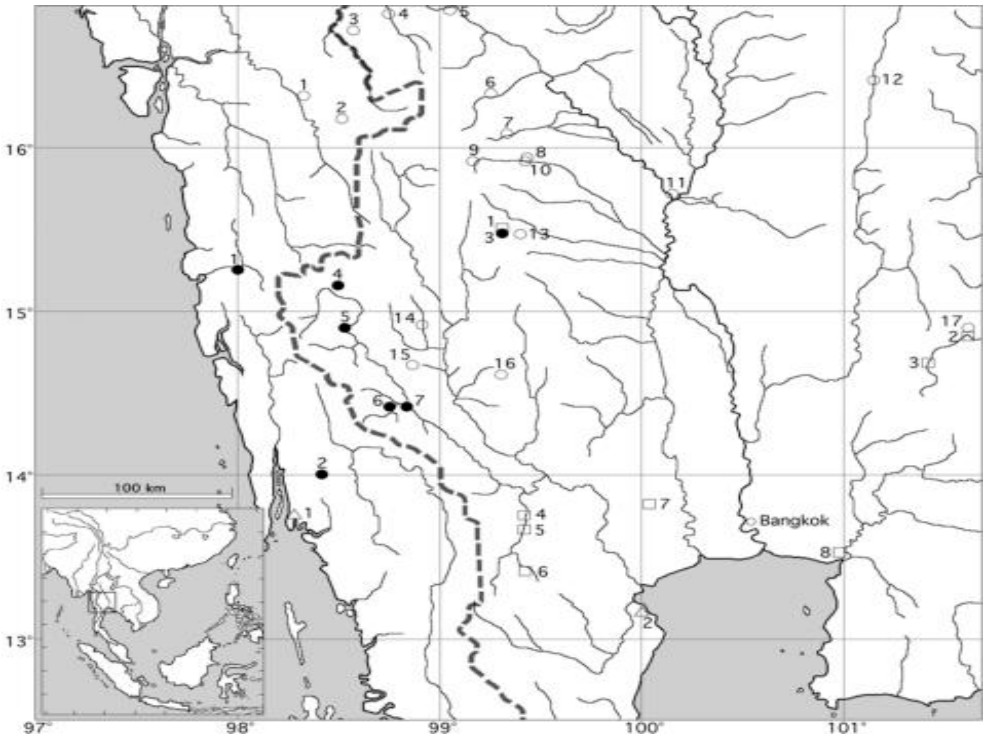


Figure (2): Distribution range of four *Trachypithecus* species in the southern parts of Myanmar and central Thailand. (Source: Geissmann et al, 2004)

Black circles: localities for *Trachypithecus barbei.*

BURMA: 1 - Ye Forest, Ataran Division; 2 - Nwalabo Taung (= Mt. Nwalaboo). THAILAND: 3 - Khao Yai, Huay Kha Khaeng Game Reserve; 4 - Ban Kerng Chada; 5 - Ban Tamrong Phato; 6 - Phlu, Khao; 7 - Ban Huai Maenam Noi, and Huai Mothimo (= H. Maw Tee Maw).

Open circles: localities for *T. phayrei.*

BURMA: 1 - Lampha; 2 - Mulayi Taung. THAILAND: 3 - Mae Sot; 4 - Ban Mae Lamao; 5 - Tha Chang Tai; 6 - Ban Pong

Nam Rong; 7 - Khlung, Khlong; 8 - Ko Keow; 9 - Wong, Nam Mae, 40 mi E of Um Pang; 10 - Wong, Nam Mae, 53 mi E of Um Pang; 11 - Ban Pak Nam Pho; 12 - Phetchabun; 13 - Kata Taek; 14 - Ban Muang Baw Ngam; 15 - Chongkrong; 16 - Khao Kamphaeng; 17 - Lat Bua Khao.

Squares: localities for *T. germaini.*

THAILAND: 1 - Khao Yai, Huay Kha Khaeng Game Reserve; 2 - Lat Bua Khao; 3 - Pak Chong, Sathani; 4 - "Siam", 13°45', 99°25'; 5 - "Siam", 13°40', 99°25'; 6 - Phachi, Mae Nam; 7 - Nakhon Pathom; 8 - Tahkamen, Bang Pakong R.

Triangles: localities for *T. obscurus*.

BURMA: 1 - Tavoy. THAILAND: 2 - Phet Buri.

Affinities of T. barbei

There were previously unknown whether *Trachypithecus barbei* has pale face markings around the eyes and around the mouth. Therefore, the affinities of TL species remained controversial, and a close relationship to both the *T. obscurus* group and the *T. cristatus* group were suggested (e.g. Groves, 2001). The examination of Geissmann' study (2004) reveals that the white facial markings are present though the mouth patch is not sharply demarcated, suggesting a closer affinity with the *T. obscurus* group than with the *T. cristatus* group. According to genetic data, their findings support recognition of the TL *(T. barbei)* as a distinct species (Khajuria and Agrawal, 1979; Groves, 2001; Geissmann 2004).

This species is listed as Data Deficiency in IUCN/SSC, and has been protected by Myanmar's Wildlife and Protected Areas Conservation Law since 1994. Little is known, however, about its conservation status in Myanmar natural forest areas. No comprehensive study has been conducted in Myanmar and this is the first event for TL.

Study period

The survey was operated during November 2015 to April 2016.

Description of survey area

Most area in TNR is undulation and high elevation of terrain in the range of above sea level from 15 m in low land to 1400 m at the ridge top. The mountain ranges are running north to south and the slope rises almost west to east. Streams, small rivers base on the ridges and flow from east to the west.

Heize and Kaleinaung reserves consists mostly of granite intrusion, and yellow and red brown type of soil also occur. Foot hills and low range mountains are covered with yellow or brown forest soil.

The climate is the seasonal and tropical monsoon type with high rainfall. Average rainfall may be between 4000 mm to 5000 mm and normally it received rain from May to October. The hottest month is March and the coldest month is January.

Types of vegetation

The forest types in TNR varies as dense evergreen forest in the high altitude and semi evergreen in the lower slopes, and patches of bamboos and degraded semi deciduous forest occur in low land areas. According to Hla Maung Thein (2007), TNR is almost completely covered by tropical rain forest in the higher elevation of the mountain range. The forest is associated with deciduous hardwood and bamboo forest in the lowland. The canopy layer is occupied by evergreen tree species with the height ranging from 40-60 m. Some evergreen canopy species include *Dipterocarpus costatus, Dipterocarpus turbinatus, Hopea odorata, Dysoxylum excelsum, Sweintonia schwenkii* in association with deciduous species, are *Parkia sumatrana* and *Tetrameles nudiflora* in the study area. Understory species are mostly evergreen in which the common understory species are *Polyalthia simiarum, Shima wallichii, Diospyros brandisiana* and *Cinnamomum iners* while some of shrub and tree let species includes *Microtropis bivalves, M. discolor, Leea indica, L. xora and L. diversofolia.* Some species of evergreen woody climbers are *Ancistrocladus tectorious, Sphenodesme involucrate* and *Premna latifolia,* and some ground herbs are *Aglaonema simplex, Hypolytrum nemorum* and the ferns *Asplenium apogamus.* Several rattan species of the genus *Calamus,* and some bamboo species such as *Dentrocalamus longispathus* and *Gigantochloa apus* of bamboo species were found in the study area.

Topography

Most areas in TNR are of high elevation and the range of the terrain varies from 15 m above sea level in lowlands to 1400 m at the ridge to the Myanmar / Thai border. The slopes in most parts of the area exceed 37 %. The mountain range runs from north to south while the

slope rises from west to east towards the ridge top and is oriented to the western aspect. Streams at north, west and south western part of the reserve flow into Dawei River. *Kamaungthwe* and *Pya tha* streams started from mid-eastern part of reserve and flows towards Taninthayi River. The area is generally described as rolling to hilly along the border areas and most of the southern portions are considered as rugged to very steep and mountainous.

Methodology

(1) Stratification

According to large area of TNR, terrain and high elevation/altitude, dense forests, duration of study period and security reasons, the survey team decided to select the suitable site for intensive study on TL species. After discussion and consulting with TNR officials and field staff and WCS scientists, we followed the zonation of TNR management (9 LOUs), and tried to choose the best site for intensive study.

Figure 3: Zonation of TNR, and Figure 4: Grids (2x2 Km each) formulated by WCS

-Zonation, study Site selection and grids

We followed the zonation of TNR management. The nine Local Operating Units (LOUs) are formed in TNR management namely *Ale-sakan, Yaphu, Mayanchaung, Michaunghlaung, Kyauk Shat, Ye bon, Heinze, Myaekhanbaw and Thet-ke-kwet.* Major responsibilities of LOUs are area protection, wildlife crime control and community development, etc. Of 9 LOUs, Yebone LOU is the largest area and more intact forest available (See Table 2).

Table 2: LOUs of TNR and its area

No.	Name of LOU	Area (Sq.km)	Remark
1	Ale-sakan	127.25	
2	Yaphu	138.73	Human settlement/plantations are inside LOU.
3	Mayanchaung	132.86	
4	Michaunghlaung	172.23	Pipe line area included
5	Kyauk-shat	209.08	Insurgent area included
6	Yebone	313.67	Insurgent area included
7	Heinze	159.01	Insurgent area included
8	Myaekhanbaw	260.15	Insurgent area included
9	Thet-ke-kwet	92.17	
	TOTAL	**1605.15**	

Based on the results of interview survey and information from GIS analysis, we chose the Yebone zone as for intensive study area. The area is divided by 2 x 2 km grids formulated by WCS. In Yebone LOU area, a total of 25 grids (100sq.km) were covered by field team's activities. Other grids located in Eastern side of Yebone LOUs were excluded because of security reason.

(2) GIS program

We used QGIS program to identify the forest covered, elevation and other data. The GIS data were collected from MIMU website. According to the classification reported by Hla Maung

Thein (2007), we found 4 major different forest types in Ye-bone area; 1) evergreen forest closed (EFC), 2) evergreen forest open (EFO), 3) semi-evergreen forest (SEF), and 4) bamboo forest (BF). Dominant species were described detail in the report of Hla Maun Thein (2007).

(3) Grids

We followed the guidelines of WCS to use the grids (2 x 2 km each). It was provided by WCS in time. We had chosen the intensive study area and used the grids.

(4) Questionnaire survey

Interview surveys are one of important tools if large and insecure region cannot be surveyed using field teams. Interviews also are suitable for historical information on specific species. Surveys were conducted at villages located around TNR, particularly to obtain indirect information on the past and present status of TL and other primate wildlife. Interviews were mainly conducted with hunters, elderly man and persons who mostly spend their life in the forest. In this context, we used the zonation map of TNR and the photos of primate species found in Myanmar including TL's photo. Using the wildlife photos is very helpful to the interviewees in species identification.

Photos: Interviewing the local people, hunters and forest guides



(5) Distance sampling

During the consultation meetings with Project Director (TNRP) and WCS officials in November 2015, they encouraged us to use the distance sampling method for TL survey.

Among the different methods devised to generate such vital information (e.g., Brockelman and Ali 1987; Whitesides *et al.* 1988), line-transect distance sampling is considered a relatively simple, rapid, cost-effective, and robust method in terms of accuracy and precision (Burnham *et al.* 1980; Buckland *et al.* 1993, 2001, 2010).

Line-transect distance sampling proved to be particularly suitable for estimating the density and abundance of forest-dwelling, group-living primates (Defier and Pintor 1985; Chapman *et al.* 1988; Garcia 1993; Peres 1999; Brugiere and Fleury 2000; Plumptre and Cox 2006; Marshall *et al.* 2008).

In this sampling method, observers walk along a series of relatively straight transect lines, and record, for each encounter with the study objects, the perpendicular distance(s) from the line to each object detected or to the estimated center of the group formed by all objects detected (Whitesides *et al.* 1988; Hassel-Finnegan *et al.* 2008; Marshall *et al.* 2008).

These distances are used to estimate a detection function (i.e. the probability that an object is detected, as a decreasing function of its distance from the line), which, in turn, allows for the calculation of the density of objects (or groups of objects) within the study area, after combining with the encounter rate, defined as the number of objects (or groups of objects) detected per unit length of line (Buckland *et al.* 1993).

Line-transect distance sampling theory is not based on the critical assumption that all objects within a specific area are detected; particularly relevant in forest habitats where the probability of detecting an object decreases rapidly with increasing distance from the observer.

According to this sampling method, and with special reference to surveys of forest-dwelling primate groups, the accuracy of the density estimates is based on only four basic assumptions: 1) groups whose centers are located directly over or very close to the transect are detected with certainty (i.e. they are not missed); 2) groups are detected at their initial locations, prior to any movement in response to the observer, and are not double- counted during a census; 3) encounters are independent events; and 4) distances are measured accurately (Buckland *et al.* 1993, 2010).

We used the grids (2 x 2 km each) supervised by WCS to conduct the transect lines. In each grid, we walked 3 line transects with a total length of 1 km each and also replicated those

transects. A total of 75 transects in 25 grids (total length of transects were 150km) were carried out to observe the TL and collected the data such as sighting degree, sighting distance, date, time, no. of TL, habitat type, behavior of TL group, etc. We used the distance sampling 6.2 program software to analyse the data.

We also tested the point count method in the field, but the data were insufficient. Therefore, we did not use those data in analysis.

(6) Data collection

We walked a total of 75 transects spread through 25 girds in Yebone LOU area. We also replicated it. Each transect was 1 km long. Each transect was walked and halted at every 200 m interval for 5 minutes for detection and listening the TL's movement and voices. A total distance sampled of 150 km was walked by survey team. We used the jungle trails to collect the data. Although the use of trails or paths of least resistance as transects for distance sampling was not recommended by Buckland *et al.* (1993), Hiby and Krishna (2001) argued that the curvature of the trails poses no serious theoretical or practical problems provided the radius of curvature was minimal, and a substantial proportion of detections occurred within the radius of curvature, which was the case in our study.

Photos: Data collection activities

In other words, "the fact that detection distances are generally short in forested habitats and that there is a natural tendency for paths and trails to avoid sharp turns suggests

that, in terms of curvature, most would be suitable as transects" (Hiby and Krishna 2001). The only modification required is to record, as the detection distance, the minimum distance from the trail to the target instead of recording the perpendicular distance (Hiby and Krishna 2001).

To ensure that perpendicular distances would be estimated accurately, our field observers were trained on evaluating distances by eye prior to the onset of the study, and with the same distance intervals as those used during the study. Data collection started only after they reached 95% of accuracy, when compared these evaluated distance intervals with the distances measured by using a tape.

During our transect walks, we used the repeated line-transect distance sampling technique, recording the perpendicular distances from the transect line to the estimated center of the groups seen (Buckland *et al.* 1993, 2001). We also occasionally used binoculars to determine group sizes.

We recorded the following data for each encounter: 1) date, 2) time, 3) GPS coordinates of the detection point on the transect, 4) distance walked from the starting point, 5) the perpendicular distance, estimated by eye, from the transect line to the position on the ground directly under the center of the group of individuals, 6) general information on the (group of) individual(s) detected, such as group size and spread (defined as the largest and smallest diameters of the ellipse occupied by the group, when at least four individuals were detected), and 7) the possible co-presence of other primate species within 50 m of the center of the TL leaf monkey group, 8) Habitat type, 9) elevation, etc. We also recorded the presence and location of logging, whether current (i.e., taking place during our sampling) or in the past.

We recorded a total of 29 encounters during the transect walks. An encounter was defined as the visual detection from the transect of at least one individual belonging to the study species. The number of individuals seen by the observer during each encounter was referred to as group size. In the context of such transect sampling, we were not interested in determining whether the groups we detected were social units or temporary foraging parties/subgroups. We did not collect the data and information on forest types and species composition. We used the data of forest types from flora survey reported by Hla Maung Thein (2007).

(7) Data analysis

We used a computer software "program distance 6.2" to estimating of density and abundance of monkeys. Actually the data sampled should reach enough encounter number for the requirements of analysis in this program, minimum 40-60 observations are needed for fitting the detection function (cf. Junker et *al,* 2009). However, we had only 29 observations. We tested the following issues to four combinations of regular and efficient detection function models (Buckland et *al,* 1993; Thomas et *al,* 2010; Leca et *al,* 2013): 1.uniform key with cosine adjustments; 2.half-normal key with cosine adjustment; 3. negative exponential with hermit polynomial adjustment; and 4.hazard-rate key with simple polynomial adjustment.

Finally, we adopted "half-normal and uniform" with cosine adjustment for our survey. To select the type of detection function model that best fits our data set, we used the following series of criteria (Buckland et *al,* 1993, 2001; Thomas et *al,* 2010): 1) the smallest Akaike's Information Criterion (AIC) values 2) the smallest ratio of the x^2 goodness of fit statistic divided by its degree of freedom; 3) a few parameters to avoid large bias but not so many that precision is lost. We choose of best model on looking for which gives the smallest ratio of goodness in detection function of probability, the density of the group and the group size of each species calculated. In our case, we did not use adjustment terms in the models to avoid implausible, non- monotonic function results (Marques *et al,* 2007; Nakashima *et al,* 2013). We knew that a total of our 29 observations were low for distance sampling (line transect) analysis. However, we were not able to continue the survey because of time limit, local guide availability and fund constraint.

Results

Interview results

We asked the interviewees about 9 LOU zones during the survey. The questions included not only present/absent of TL, but also their estimation of TL species abundance. A total of 140 persons from 12 villages/locations were interviewed (Table 3). Of those, local hunters were 11%, local forest guide 41%, Local people 36% and government staff 11%.

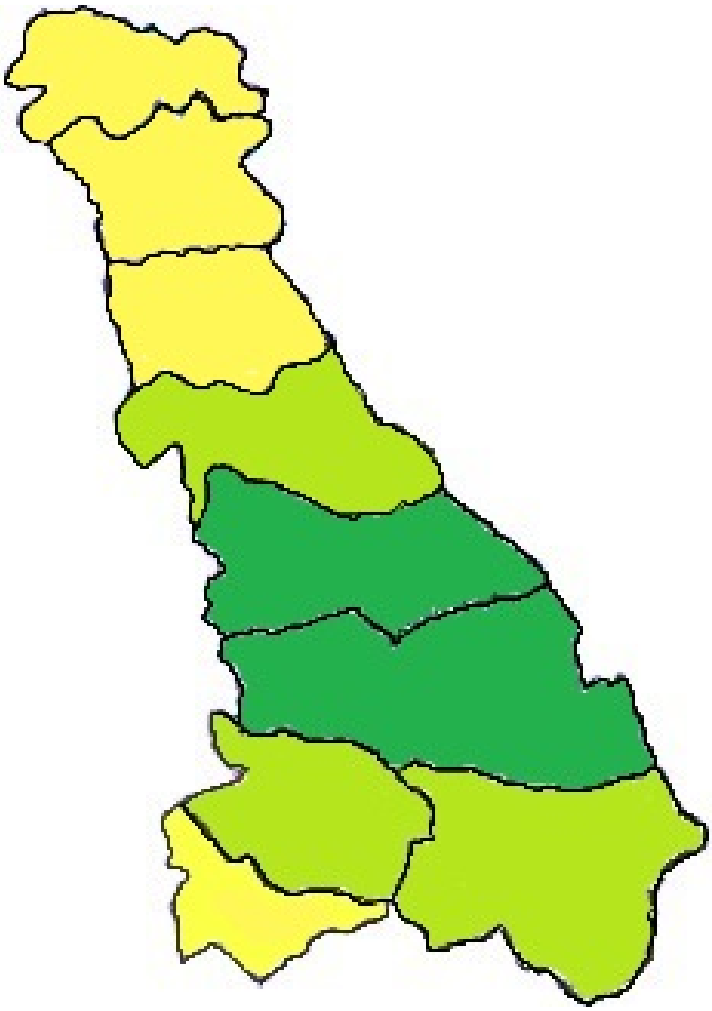
About 70% of the interviewees had encountered TL very clearly. It was also found that 35% of them was very shy to identify the TL species. But 25% of the interviewees had seen TL in captive. According to interview results, most Karen are knowledgeable about primate species' distribution, physical characteristics, behavior, habit and some ecological factors, while others such as *Mon* and *Bamah* are less familiar with wildlife species. When we showed the photos of different primate species, we observed that some local people could not able to identify the some primate species. Some did know the TL clearly. However, the Interview Survey yielded the best map for distribution and abundance of TL in TNR area (see Figure 5). Out of 9 LOUs, Kyauk-shat and Yebone LOUs were indicated as most abundant areas for TL species.

Table 3: List of Interviewees around TNR.

No.	Location/Village	Occupation				Total
		LH	LG	LP	GS	
1	Alel-sakhan	-	-	6	2	8
2	Law Thyl	-	5	4	-	9
3	Kaw Hlang	1	4	3	-	8
4	Mayanchaung	-	4	3	1	8
5	Michaung Hlaung	-	4	4	5	13
6	Zinn Ba	5	9	12	-	26
7	Kyauk Shut	1	3	3	2	9
8	Yebone	4	18	1	3	26
9	Heinze	1	3	3	2	9
10	Kyae Zuu Taw	2	3	3	-	8
11	Hnann Kyae	1	3	4	-	8
12	Thet Kel Kwat	1	1	5	1	8
TOTAL						140

LH= Local Hunter, **LG**= Local Guide, **LP**= Local People, **GS**= Government Staff

Figure 5: Result of Interview survey on the distribution and abundant of TL.

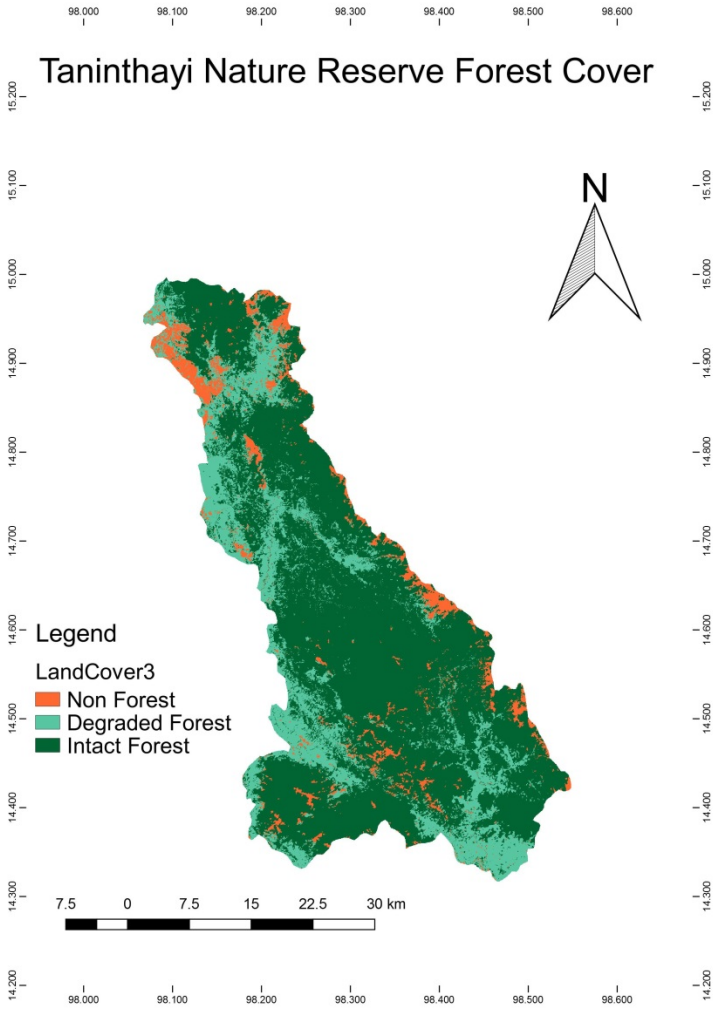


(Dark green = high abundant area, Light green = medium abundant area, Yellow = low abundant area)

GIS analyze on forest cover

We used QGIS to analyze the forest cover of TNR. Taking the data and information from MIMU data from LandSat satellite image analysis (January 2016), we analyzed the status of forest cover inside TNR as three categories. The results indicated that vast and intact forests are found in Kyauk-shat and Yebone LOU areas (See Figure 6). Of two LOUs, Ye-bone is less human disturbance than Kyauk-shat.

Figure 6: Forest cover of TNR showing 3 categories; non-forest, degraded, and intact forests



We selected the Yebone Zone for intensive survey of TL species because of 6 reasons:

1) the research paper of Thomas Geissmann, et. al., in 2004.

2) the report of primate training 2013 mentioned that TL can be found in Yebone LOU area.

3) interview survey resulted that Yebone LOU is one of high abundant areas of TL in TNR.

4) GIS data also indicated that Yebone LOU contains the highest percentage of intact forest cover among the LOUs of TNR,

5) Ye-bone is in less human disturbance and

6) security condition was bad in Kyauk-shat LOU area during our survey period (KNU was trying

to extract timber) and Yebone Zone was safe for survey team.

Photos 2: Habitats of TL in Yebone study area

Spatial distribution of TL leaf monkeys in Yebone LOU area

Figure (7) shows the grids TL group found during the survey period. Out of 25 study grids, we observed TL groups in 15 grids. The habitat types TL used were EFC, EFO and SEF. The intact forests were 100% used by TL. We did not observe the TL group in bamboo forest anymore.

Figure 7: Showing the locations of transects and the grids (light green color) that TL groups found in Yebone area

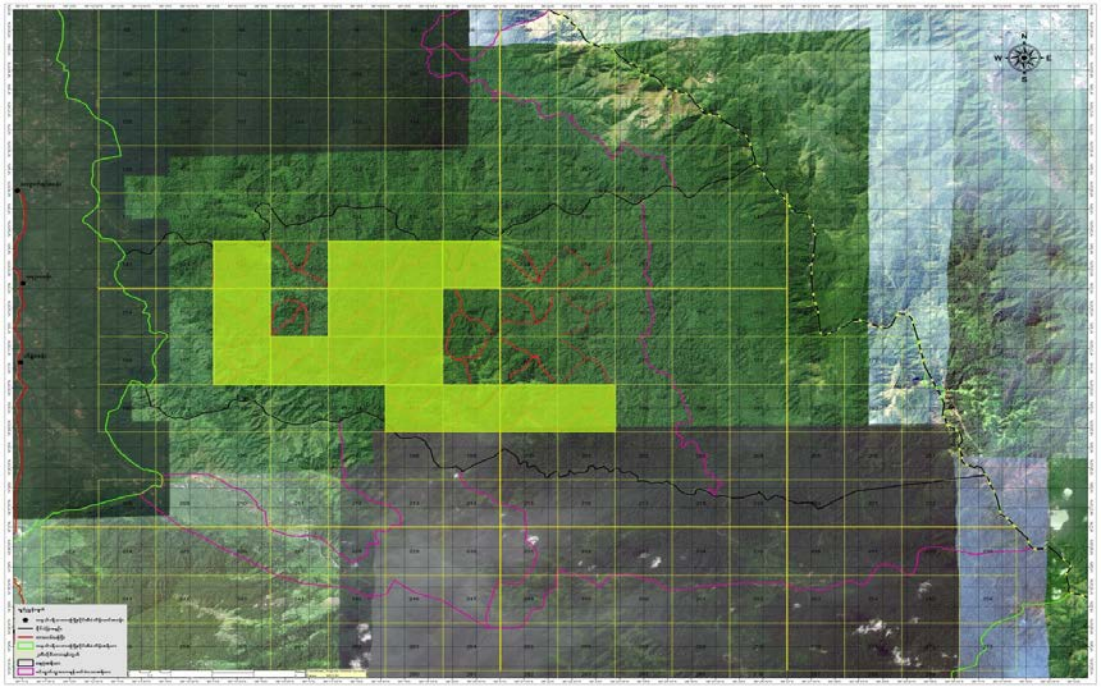


Figure 8: Showing the numbers of grids where conducted distance sampling. Numbers were given by WCS. Yellow colored Grids that TL monkeys were found during survey period.

144	145	146	147	148	149	150
156	157	158	159	160	161	162
168	169	170	171	172	173	174
			185	186	187	188

Detection Rate and Group Density

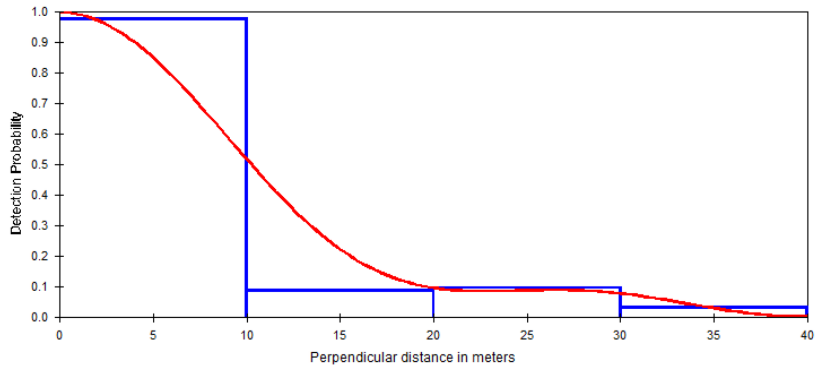
We covered the distance of 150 km, and had recorded 29 sightings of TL. So encounter rate was 0.19/km as a result in Yebone study area. Our survey resulted that the group density in Yebone area is 1.35 group/km used by Half-normal model and 1.13 group/sq.km sued by Uniform model. We used the result of Half-normal model (1.35 group/sq.km) because the value of Delta AIC was 0.00. Therefore, total TL groups in Yebone area were 423 (Table 4). If we know the average of animals/group, we can estimate population abundance of Yebone area. But we failed to estimate the average group size.

Table 4: TL abundance estimates for Yebone area (313.67km2).

Total length of transects	150 km
Number of TL groups detected	29 groups
Encounter rate	0.19/km

Estimated group density (distance program 6.2)	1.35 groups/sq.km
Estimated TL groups in Yebone area (313.67sq.km)	423 groups

Figure 7: Density results of Half-normal cosine model.

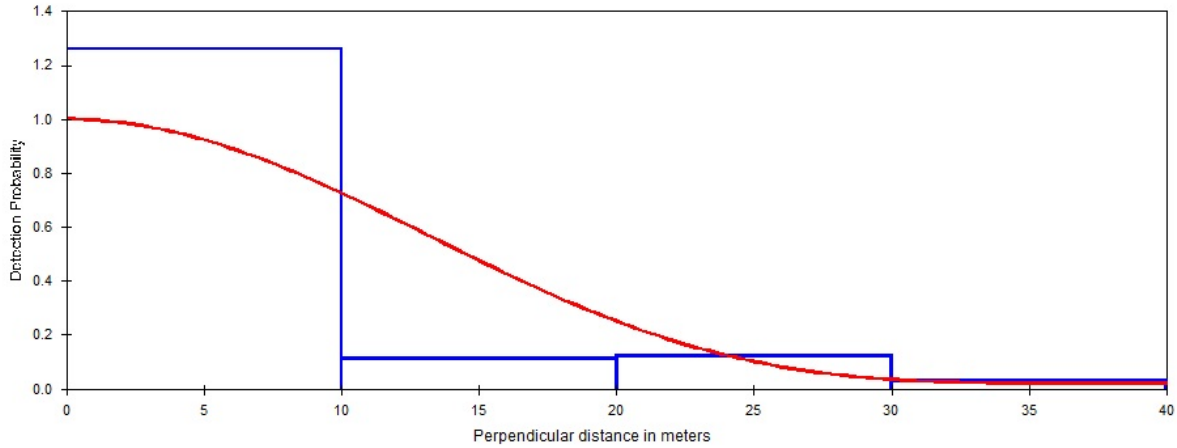


Estimate %CV df 95% Confidence Interval

Half-normal/Cosine

D	1.3485	6.26	149.00	1.1918	1.5258
N	479.00	6.26	149.00	423.00	542.00

Figure 8: Density Results of Uniform cosine model.



Estimate %CV df 95% Confidence Interval

Uniform/Cosine

D	1.1298	5.75	148.00	1.0086	1.2657
N	401.00	5.75	148.00	358.00	449.00

Table 5: Comparison of the results of two models (Distance Sampling program 6.2)

Model	Delta AIC	AIC	ESW/EDR	Density
Half-normal	0.00	236.79	12.27	1.35
Uniform	9.24	243.78	15.92	1.13

Impact of human disturbances

During our transect walks, we recorded seven spots where there were past logging and human signs. They were all in the grid number 144, 156 and 168. A total of 16 gun sounds were received by our team, and those were in grid numbers 145, 156, 149, 150 and 162. Most of gun sounds were from grid number 156 near boundary. We also never found TL leaf monkeys within grids where we heard gun sound except in grid no. 156.

144	145	146	147	148	149	150
156	157	158	159	160	161	162
168	169	170	171	172	173	174
			185	186	187	188

Red grids: grids that heard gun sound; Green: mix-species with lar gibbon; Blue: found mix-species with pig-tailed and stump-tailed monkeys

Rate of mixed-species spatial co-occurrence

Three groups of stump-tailed macaques were found within 50 m of the group of TL leaf monkeys 3 times in grid number 144, 156, and 168. Another species pig-tailed macaques were also found near TL group in grid number 146 and 158. In addition, we also observed five times as mixed-species together with gibbon and TL in grid number 171, 187, and 188. In all cases, the stump-tailed macaques were on the ground, whereas the TL leaf monkeys were in the trees.

In terms of gibbon-TL mixed species, gibbon gave alarm calls as we approached, which resulted in TL leaf monkeys moving away from us. We saw no other types of interaction between the two species.

The elevation

Our observations indicated that TL groups were living between 377m and 1001m above sea level (ASL). Average ASL used by TL groups was 612m.

Feeding behavior

Survey team observed that most of TL groups were also found in the trees within the high-level of 10 m and 40 m. A variety of fruits are abundant in study area during our survey period (November 2015 to April 2016). Survey team recorded that the fruits of twelve flora species were eaten by TL groups. We only saw that TLs were eating the young leaves of Ficus species.

Table 6: List of some fruits eaten by TL.

No.	Local name	*Scientific name*	Family name	Life form
1.	Taung-Thayaet	*Swintonia floribunda Griff.*	Anacardiaceae	T
2.	Taw-Kyetmauk	*Nephelium Lappaceum L.*	Sapindaceae	T
3.	Ye-Thapan	*Ficus glomerata Roxb.*	Moraceae	T
4.	Nyaung-thabye	*Ficus obtusifolia Roxb.*	Moraceae	T
5.	Genus Ngwe-Pan	*Globba coronariun Koenig.*	Zingiberaceae	H
6.	Taung-Peinne	*Artocarpus Chaplasha Roxb.*	Moraceae	T

Photos: some fruits eaten by TL

Mango

Taung-pain-ne

Ngwe-thi

Fruits of Ficus species

Tha-phan

Unknown

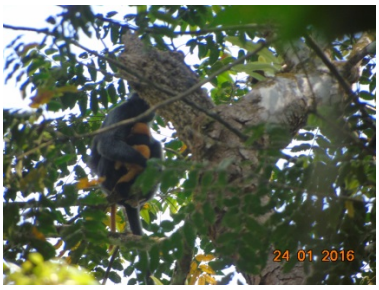
Unknown

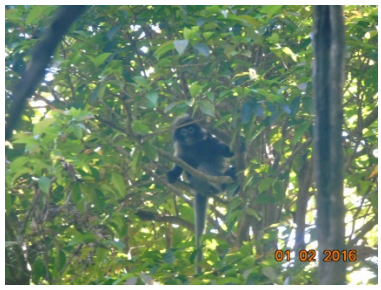
Unknown

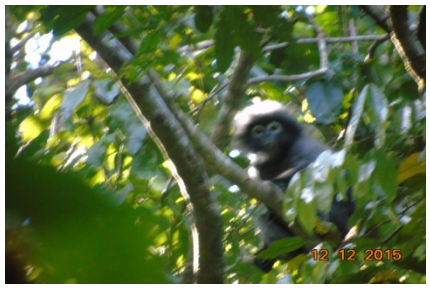
Habitat use

The habitat type mostly used by TL was closed evergreen-forest (55%, n=16), and followed by evergreen (open) (34%, n=10) and semi-evergreen (10%, n=3). We did not find TL in bamboo forest.

Photos: some photos of TL







Group size

-according to our team's observations, group size of TL varied from 8+ to 30+ individuals. It may be problem due to the field members' experiences and visibility of forest status.

Breeding season

-Survey team observed young-babies in all sighting groups during survey period. In addition, on 21-1-2016, survey team found a TL baby (male) together with umbilical cord on the ground. We did not know the reason why the mother left him. It indicated that this is the breeding season of TL species. It is coincided the information resulted from interview survey. However, it is needed a year-round survey to approve this assumption.

Distance to human disturbance

The survey team also noted that the TL groups found near boundary, (grid no. 144, 156, 168, etc.) ran away from us immediately when they saw the survey team. It was not easy for survey team to count/estimate the number of TL individuals. However, the TL groups found in grid no. 159, 171, 185, located in less human disturbance, did not run away immediately and they also looked at the survey team from the trees. Therefore, it was easy to count/estimate the number of TL in the group. This behavior indicated that the status and distribution of TL species were

depended on disturbance especially hunting activity.

Major Threat to TL

We did not find the new sign of logging activities in Yebone area during survey period. But it seems that hunting is major threat to TL species. As per discussion with hunters and local forest guides during interview period and survey period, we came to know that TL is the most favorite target species among primate species in this area. Local people especially Karen tribes like to eat it and Dawei people also as well. The curry called “Myauk-chi-kha” which is cooked of the whole intestine and stomach of TL. It is good taste for local tribes and famous among them. The local people use to eat the whole body except tail. Therefore, TL is the most hunted species and major threat to TL. Interviewees also told us their hunting stories including TL species.

Discussion

Population

A population is considered to be a number of animals that form a discrete breeding unit. Our survey results indicated that TNR which contains significant amounts of evergreen (closed) and evergreen (open) forests is no doubt of great importance in the conservation of TL species in the world. Although our result on the population size of the TL in TNR may over estimated than reality, the results of our survey confirmed that the number of TL population may be increasing (because babies were seen in all groups, less hunting), and it was a viable population of this species in the wild, and TL distributed throughout the study area.

Social organization

Although we failed to study on social organization and life-history traits of TL, we assume that TL will not differ from other tropical leaf monkey species in the extent to which they exhibited large daily and seasonal movements, tightly synchronized seasonal breeding, and seasonal variation in group size. The term “home-range” used here follows Jewell (1996) as being the “area over which an animal normally travels in pursuit of its routine activities such as feeding, mating, sleeping, care of young and avoidance of predators”. We assume that home

ranges will be similar estimates for leaf monkey species.

Most of home range differences within wildlife species were probably due to differences in body size. It was also suggested that males had significantly larger home ranges than females. Regarding leaf monkeys, there was only one record available for T. obscurus (Home Range= 5-20 ha.). Therefore, TL in TNR has no data to compare the home range of other species including TL in other areas.

Table 7: Comparison of some Leaf monkey species

No	Species Name	Home Range (ha.)	Body Weight (kg)	Body Length (cm)	Tail Length (cm)	Group size	Life span (yrs)	GP (days)	Mating season	Sex maturity (yrs)	Breeding season	IUCN Red List
1	T. barbei	?	?	50-70	70-80	?	?	?	?	?	?	DD
2	T. pileatus	?	?	50-70	80-100	2-15	?	200	Sept-jan	-	Dec-March	VU
3	T. obscurus	5-20	6.5 -7.5	42-61	50-85	5- 20	25	145	Whole years	3- 4	Whole years	NT
4	T. shortridgei	?	?	60- 75	90- 150	?	?	?	?	?	?	EN
5	T. phayrei	?	6 – 9	52- 62	60- 85	7- 22	20	200-208	Whole year	3 - 4	Whole-year	EN

(Source: Mammals of South-East Asia and various references)

Seasonal movement

In many tropical species, the seasonal changes in the environment were main factors that determine movement patterns and home-range sizes (Geist 1998; Mitchell et al. 1977). TL eats primarily on the new leaves and fruits. Ungulate species depend on leaf monkey to get fruits where fall down from the tree. Our team saw wild boar eating the fruits fall down to the ground due to TL group. Human activities may have short-term or seasonal impacts on TL movements. TL groups found near the sanctuary boundary (near human developments), ran away very quickly, not like the TL groups found inside TNR.

Breeding

Our findings indicated that TL monkeys are seasonal breeders, and peak breeding occurs during the cold season (November – January). It also observed that TL groups may be using

dense vegetation as “cover”. Several primates are known to increase group size with dense cover, and this may be an anti–predator avoid strategy. Hunting caused significant mortality within this population, so hiding cover may be important. Fawn mortality may be depended on human disturbance, may not fire because babies can be run away from fire actively when fire started in Hot-dry season.

The exact timing of primate births was difficult to determine in the field because mothers hide their young immediately after birth among dense vegetation cover. If fawns were born in November-January and gestation period will be lasted about 30 weeks if TL is similar to T. pileatus., that gestation period is about 200 days. This would indicate that mating may be in March-May. Although systematic field data still are lacking for most of leaf monkeys, the restricted mating season for TL appears to be comparatively short.

For TL, timing of birth may be a tradeoff between nutrition and predation. The vegetation quality and fruit availability will be very important in TL’s biology especially on baby’s weaning time.

In the temperate region the reproduction is rely on the seasons. In the tropic, the rainfall is closely effected the vegetation production and the breeding cycles of many wildlife species (Delany 1979). Our observations indicated that the breeding of TL was seasonality and they produced their fawns during the early cool season after the highest rainfall. It may be an adaptive strategy where young were protected from high rains and hunting (local people do not enter the forest and hunt during heavy rains).

Why do TL give birth at cool season? Our assumption! If they gave birth during rain and hot-dry seasons, the survival rate of babies may be low due to the rain and fire. When fire was occurred in hot-dry seasons, the fawns were 3 months old and can shift other place actively. If fawning time were in rainy season, the mortality rate of fawns will be high during heavy rain period.

Threats

During study period, human disturbances were occurred near the sanctuary boundary. Local villagers always use minor forest products of the sanctuary and this was a historic practice of TNR. According to interview survey, most of the activities were happened from November to

July such as NTFP collection, Logging, fuel-wood and fence-pole collection, fishing, hunting for small animal, leaf and mushroom collection. Some interviewees said that the large numbers of villagers can be observed during December-March.

In conclusion, phenology of flora species, human disturbance and fire are the parts of the ecosystem of TL. **The shape and the size of TNR, habitat composition and the abundance of vegetation are very good for long term conservation of TL species.** But human disturbance is an important factor in effecting the parameters of TL population such as group size, home range, movement pattern, mortality etc. and these may constitute the excessive pressure on TL survival. To review the encroaching/hunting human pressure is urgently needed at present.

Overall, this survey provided new, broad, and valuable information on the density, abundance, geographical distribution, and some ecological data of TL leaf monkey in TNR. We hope that:

1) our data will be considered by park manager and other researchers in their decision-making for a better survey of this species and a more accurate assessment of the species' population and ecological status throughout TNR;

2) our findings will provide a baseline for future replicable census surveys of TL leaf monkeys in the same area, Ye-bone LOU.

We suggest three main directions for future efforts devoted to the monitoring of the population of TL leaf monkeys in the TNR.

- First, to assess trends in rates of population change over time, we urge for the replication of the exact same survey design at least every five years if budget is enough.
- Second, to evaluate seasonal variation in the distribution/movements of TL leaf monkeys.
- Third, to estimate how the population size may be affected by environmental or anthropogenic factors, future studies should stratify the study area and conduct distinct line-transect sampling within each major habitat type (degraded forest, intact forest, human settlements, agricultural/pastoral areas, etc.). Such anthropogenic factors include the subsistence activities of local villagers for example, activities in Community Forest areas. Our preliminary finding suggested that the occurrence and prevalence of illegal logging should be considered in these analyses.

The TNR is the only PA which is effectively conserving the TL in Myanmar so far. The flora and fauna in TNR is still diverse. It seems that the carrying capacity and basic parameters such as food, water and cover for TL in TNR is sufficient.

-Our TL survey in TNR was representing only part of the reserve due to many constraints.

-TL population is still threatened in and around TNR. The major threats to TL are hunting and habitat degradation.

Our survey clearly indicated that out of 9 LOU zones in TNR, Ye-bone zone is the best area for TL species in terms of habitat quality, population abundant, etc. So we recommend that future TL survey should also focus on Ye-bone zone.

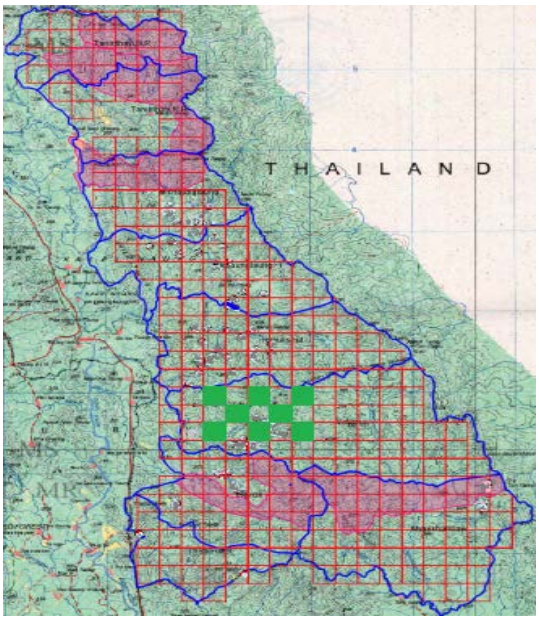
We did not find other langur species in Yebone LOU area during survey period. We occurred other old-world monkey species, pig-tailed and stump-tailed monkeys. Therefore, we also assume that TL is not a hybrid species. For primates, information about hybridization is still scare compared to that for fishes, birds or other mammals, but recent investigations have uncovered natural hybridization events for primates (Arnold & Meyer, 2006; Arnold, 2008).

We failed in behavior study because we have no experience on this species. Therefore, for future survey and research, well-trained field assistants are required who are able to conduct survey work without local supervision. TNR should provide appropriate training and field gear/equipment to them.

Among the other Protected Areas in Taninthayi Region, TNR is the only one area properly managed with staff, budget and other field gears for effective ecosystem and wildlife conservation. Therefore, we hope that TNR will be the best area for TL conservation, and the program on research, survey and monitoring of TL should be included in the management plan of TNR. The followings are our recommendations.

- Continuation and comprehensive studies on TL species not only in Ye-bone, but also in other 3 (Kyauk-Shat, KZT, KS) LOUs are strongly recommended. FD should allow the university students to involve in TL survey and research to upgrade their academic education and professional livelihood in wildlife conservation in future. And also should provide appropriate field equipment such as Cameras, binoculars, GPS, etc., and proper transportation arrangement.

- GPS locations of TL's sighting and information shared by SMART patrol and local informants/guides should be maintained for long term analyze and evaluation for effective reserve management strategies.
- For future monitoring, we would like to propose 8 grid cells (highlighted by green color) in Yebone area for long-term study & monitoring on the population trend of TL species by distance sampling method in future. It can cover the habitat and area of TL species in Yepone LOU and will save time, manpower and money. (See figure 9)



144	145	146	147	148	149	150
156	157	158	159	160	161	162
168	169	170	171	172	173	174
			185	186	187	188

- To use the “software program distance 6.2” for better and proper results, the data on >40 observations of TL groups should be collected in future surveys.
- To collect the data on 40 observations of TL groups To formulate the educational material about TL to the public not only to TNR but also to TL range of Myanmar.
- To reduce hunting inside TNR by local people, negotiation and engagement with Myanmar Army/KNU should be made in peace talks and other social/environmental events.
- More patrolling and surveillance plans should be developed to prevent the hunting at TL recorded areas
- To conduct conservation talks and awareness campaigns about the TL, directed towards communities around PAs and relevant authorities.
- Although our team members did practices to estimate the sighting distance between transect lines and TL before survey, the Laser Range Finders should be used in future survey for accuracy and precision.

Out of 4 objectives of this survey, we were able to fulfill 3 objectives such as estimating the population density of TL species in Yebone area, the distribution of TL throughout the TNR, describing some ecological factors of TL to assist the management of TL within TNR, recommendations for future biological survey.

Finally we would like to mention that as the National Consultant for Taninthayi Langur Survey, FOW was able to accomplish the following tasks assigned by TNRP contract:

1. Conducted a comprehensive interview survey with local communities to understand known distribution of TL populations and prioritize areas were selected for surveys.
2. Conducted transect based survey for TL along trails and streams in Yebone LOU area, based on information from local informants
3. Abled to make documentation exact location, for every observation of TL langurs. We tried to carefully observe groups for as long as possible, however we failed to document recurring behaviors as well food, exact group size and composition
4. We had documented habitat types and ASL of TL found along transects.
5. We were able to record the use of grids (like forest compartments) to understand and

map distribution of langurs across the Yebone LOU, not nature reserve.

6. Through interview survey, the document for all local uses of langurs and their parts was recorded.
7. We were also able to document the observation of other primate species during the work.

We believed that this survey built up the capacity of TNR field staff and FOW members.

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