Large Mammals surveyed in Taninthayi Nature Reserve, Myanmar

Friends of Wildlife

[National Consultant]

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Executive Summary

Taninthayi Nature Reserve (TNR), with an area of (1700) km^2 is well known for its biodiversity and has the great potential to serve as National Model for Myanmar Wildlife and Ecosystem Conservation. From November 2015 through April 2016, the FOW collaboration with TNR staff conducted a large mammal survey project to design and implement long-term monitoring of their large mammal populations. Three main methods, 1) interview survey for the selection of intensive study area, 2) track and sign survey, and 3) trap camera deployment were used.

We selected the Yebone Local Operating Unit (LOU) area as intensive study-site and applied two key methods to study large mammal species. Compared to previous surveys' efforts at TNR, FOW focused the intensive sampling in Yebone LOU where mammal species are most abundant in TNR. A total of 37 trap-cameras were deployed across 25 grid cells of Yebone zone evenly. Inside 25 grids, track and sign survey was carried out along the forest and stream trails. Overall, a relatively high number of camera trap photographs was obtained for Asian Black Bear *(Ursus thibetanus)*, Sun Bear *(Helarctos malayanus)*, Serow *(Capricornis milneedwardsi)*, and Clouded leopard *(Neofelis nebulosa)*. A total of 30 medium-large mammal species were recorded by both surveys. Of a total survey effort of 3327 camera-trap nights and a total of 130 km transect walks, no tigers *(Panthera tigris) and* no leopards *(Panthera pardus)* were detected by camera traps and transect lines, we suggested that there is a small, non-viable tiger/leopard population if tiger and leopard were still surviving in Yebone LOU, TNR. This survey was able to describe the relative abundance indices (RAIs) for certain mammal species and some ecological data for 12 mammal species.

Hunting is major threat to medium-large mammals in study area, and this survey strongly recommended that TNR should continue future study and monitoring activities, formulate the best survey design based this experiences, carry out the necessary training course on data analysis for field staff, encourage the ecology studies collaboration with university students and conduct more effective SMART patrols.

Keyword: camera trapping, line transect, large mammal, population, Taninthayi Nature Reserve.

Acknowledgement

On behalf of “Friends of Wildlife”, we would like to express my gratitude to the officials from the Ministry of Natural Resource and Environmental Conservation for giving this opportunity to work in the TNRP as a National Consultant.

We are very grateful to Dr. U Nyi Nyi Kyaw - Director General; U Kyaw Kyaw Lwin - Deputy Director General; and members of TNRP steering committee; of the Forest Department to granting us permission to undertake this fieldwork. We believe this is great opportunity for FOW because FD officials trust us to assign this task although FOW had no experiences working with some mammal species.

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Finally without any assistance of all the peoples mentioned above, we would not have accomplished this task.

1. Introduction

To conserve the tropical rain forest and its flora and fauna, Taninthayi Nature Reserve (TNR) was declared as Nature Reserve under Protected Areas System (PAS) in 2005 with a total area of 1605km ^{2}. It consists of three reserves, the eastern parts of *Kaleinaung* Reserve and *Heinze* Reserve, and *Luwaing* Reserve. These reserves were declared as Reserve Forests in 1885, 1902 and 1932 respectively which are one of the oldest reserved forests consisting of tropical rain forests in Myanmar. The endangered mammals species such as Tiger (*Panthera tigris*), Leopard (*Panther pardus*), Asian Elephant (*Elephas maximus*), Asian Black Bear (*Ursus thibetanus*), Sun Bear (*Helarctos malayanus*), Gaur (*Bos frontalis*), primates species and Malayan Tapir (*Tapirus indicus*) can be found in TNR (Ye Htut *et al* .,2008). And also 244 species of birds (Nay Myo Shwe *et.al, 2008*) and 82 species of reptiles and amphibians are recorded in TNR. (Vindum, 2010)

Regarding mammal surveys in TNR area, a total of 5 surveys were carried out during 13 years:

-The 1st survey was done in 2002-2003 using interview and track/sign methods for large mammals, and live-traps for small mammals. The survey recorded 15 large and 43 small mammal species (Win Maung 2003).

-The 2nd survey in 2008 used questionnaire, track/sign and trap camera methods. A total of 69 species were recorded (Ye Htut et al., 2008), however of those, some species (about 5) were doubtful.

-The 3rd survey studied on elephant distribution, density, and ecological factors using line transect based distance sampling, trap camera, questionnaire, and ecological surveys methods (Hla Myo Aung 2011). The survey results indicated the distribution of elephant in TNR as 3 categories, High/Medium/Low density area and estimation.

- The 4th survey was for tiger and their prey species. Trap camera, track and sign, questionnaire and carnivore-scat collection methods were applied (Myint Maung 2011).

-the 5th survey targeted the Tapir. It was conducted in 2012 and used trap camera, track and sign, questionnaire and herbivore carnivore-scat collection methods (Nay Myo Shwe 2011).

Those surveys were very informatics and very valuable to support TNR for establishment and long term implementation of the Reserve. According to the recommendations of those surveys and decision of the TNRP management steering committee, the sixth large mammals survey was planned to carry out during 2015-2016 budget year. It was conducted by a national conservation NGO, “Friends of Wildlife”, closely collaboration with TNRP officials and field staff during November 2015 to April 2016.

2. Objectives

This survey was carried out with the following objectives:

- ❖ To understand species richness of large mammal in TNR.
- ❖ To identified occupancy of some large mammals in study area.
- ❖ To support the ecological data and distribution of large mammal for TNR species management plan.

3. Study Area

3.1 Location

Taninthayi Nature Reserve – TNR covers 1605 km ^{2}, located between Ye -Dawei (*Tavoy*) road in the west along with the Andaman Sea and Myanmar - Thailand border in the east. TNR is located administratively in Yebyu and Dawei townships of Dawei district in the northern part of Taninthayi Region in the south of Myanmar (see Figure 1). TNR is geographically located between 14˚20´50˝ N and 14˚57´55˝ N and 98˚ 5´10˝ E and 98˚ 31´32˝ E (Anon, RS & GIS, FD, 2007).

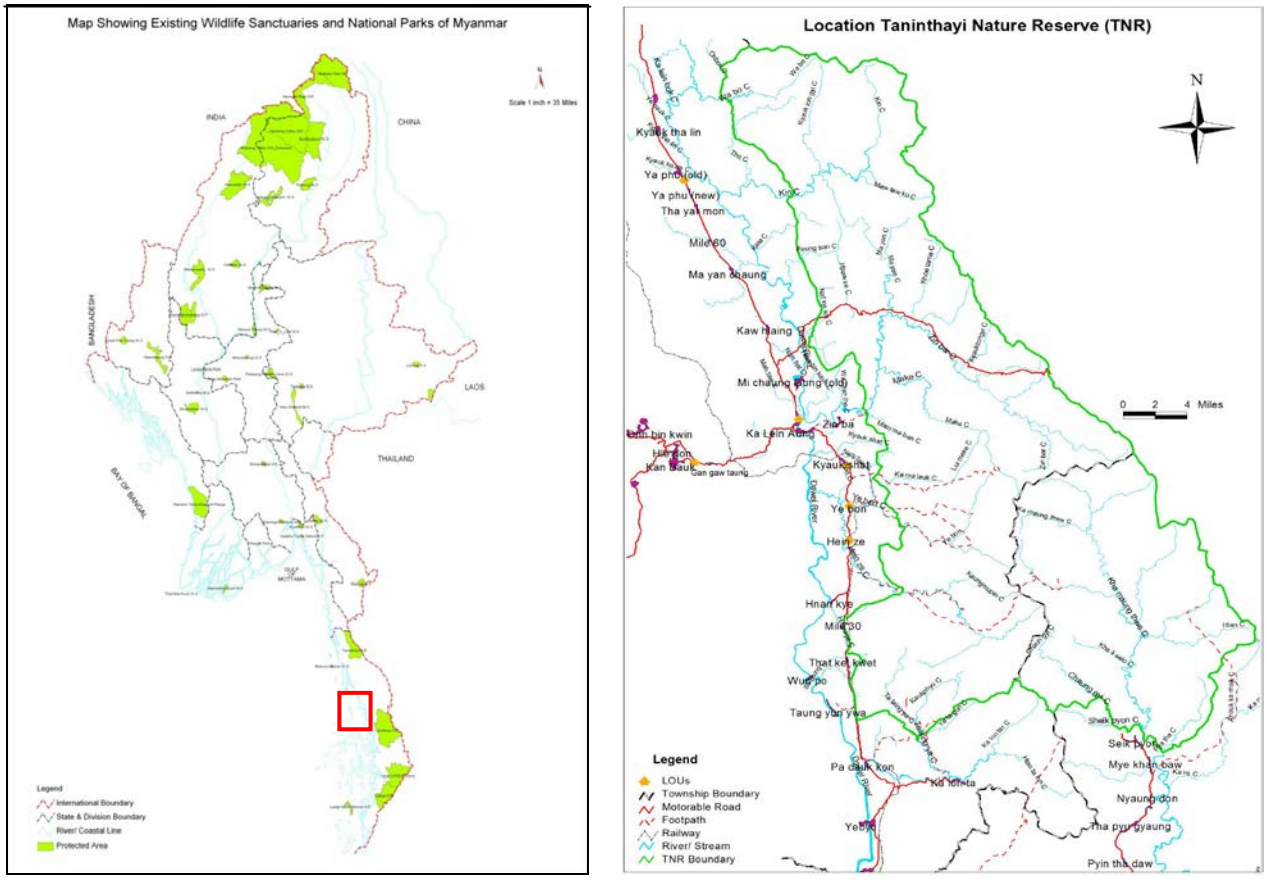


Figure 1: Location Map of the Taninthayi Nature Reserve

3.2 Type of vegetation

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 as shown in land use and land cover map of TNR (Table 1 and Figure 5). According to Maxwell (2001), Anon, RS & GIS, FD (2007), Smith (1926) the composition of flora in the study site is briefly described as follows: "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." *(Hla Maung Thein, 2007)*

Table 1: Land covers percentage of TNR (Source: TNR management plan)

No.	Land use class	Acre	Hectare	%
1.	Evergreen_(closed)	256942	103983	61.17
2.	Evergreen_(open)	70241	28426	16.72
3.	Scrub land	50994	20637	12.14
4.	Bamboo	33156	13418	7.89
5.	Grass land	4690	1898	1.12
6.	Agri/ horticulture land	3034	1228	0.72
7.	Sand	27	11	0.01
8.	Water body	986	399	0.23
	Total	**420,070**	**170,000**	**100.00**

Photos 1: Habitats of large mammals in Yebone study area

3.3 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.

3.4 Types of soil

Geological formation in the *Kleinaung* and *Heinze* reserves consists mostly of granite intrusion, and weathering of granite gives rise to gravelly soil on which giant evergreen forest is found (Smith, 1926). The soil type in the study site falls into yellow and red brown forest soil zone. The red brown and well structured forest soils have a good drainage with the pH value ranging from 5.5 to 6.5 occur on the well drained hill slopes at the elevation from 300 m to 1,200 m above sea level. The region of gentle slopes of low hills and foot hills at the elevation of 100 m to 500 m above sea level are covered by the yellow brown forest soils.

4. Methods

The following methods were applied for this survey.

1. Stratification
2. GIS program
3. Grids
4. Questionnaire survey
5. Intensive study site selection
6. Track and sign survey
7. Camera trapping
8. Data analysis

4.1 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 large mammal 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 2: Zonation of TNR; and **Figure 3:** Grid cells (2x2 Km each) formulated by WCS

-Zonation, study Site selection and grid cells

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.

4.2 GIS program

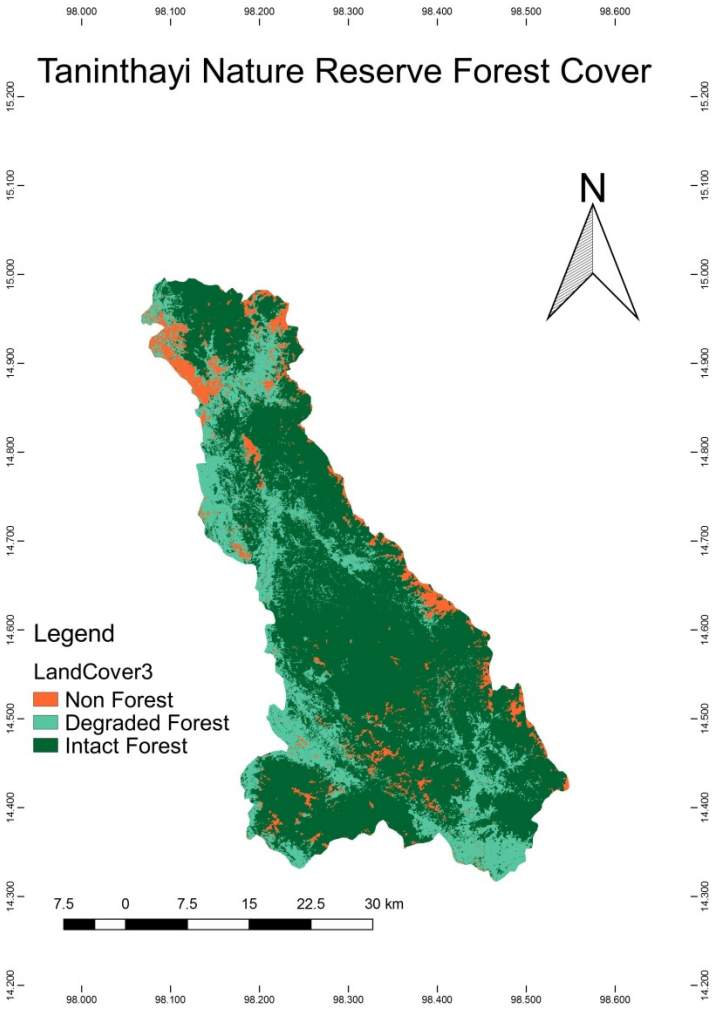
We used QGIS program to identify the forest covered, elevation and other data. *According to the classification reported by Hla Maung Thein (2007), we found 4 major different forest types in TNR; 1) evergreen forest closed (EFC), 2) evergreen forest open (EFO), 3) semi-evergreen forest (SEF), and 4) bamboo forest (BF). Dominant species were described detail in the report of Hla Maung Thein (2007).* Taking the data and information from MIMU from LandSat Satellite Image analysis (Jnuary 2016), we analyzed the status of forest cover inside TNR as three categories. The

results indicated that vast and intact forests were found in Kyauk-shat and Yebone LOU areas (See Figure 4). Of two LOUs, Ye-bone was less human disturbance than Kyauk-shat according to ground information.

4.3 Grid cells

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.

Figure 4: Forest cover of TNR showing 3 categories; non-forest, degraded, and intact forests



4.4 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 and support the selection of study design. Surveys were conducted at villages located around TNR, particularly to obtain indirect information on the past and present status of large mammals 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 LM species found in Myanmar. Using the wildlife photos is very helpful to the interviewees in species identification.

Photos 2: Interviewing the local people, hunters and forest guides



4.5 Intensive study site selection

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 (100 sq.km) were covered by field team's activities. Other grids located in Eastern side of Yebone LOUs were excluded because of security reason.

Actually, we tried to follow the WCS's suggestion that was to conduct the activities in unsurveyed areas of TNR. However, we assumed that it is not possible to conduct the survey to cover 20% of TNR because of time limit (4 months) and security condition. Therefore, we decided to conduct the survey in the best part of TNR. We selected the Yebone zone because of 4 reasons.

1) Interview survey resulted that Yebone LOU is the high abundant areas of large mammal species in TNR.
2) GIS data also indicated that Yebone LOU contains the highest percentage of intact forest cover
3) Yebone area had less human disturbance
4) Security condition was bad in Kyauk-shat LOU area during our study period (KNU was trying to extract timber) and only Yebone area was safe for survey team.

4.6 Track and sign survey

Trail sampling was used for detection of mammals in different habitats of the study area. These trails were identified with slight modification from conventional transects (Burnham et al. 1981). Track and sign surveys along trails, ridges and streams (Bennett et al. 1940) were carried out. Trail sampling (n= 35; length 2 to 5 km) within the intensive study area (Figure 3) was conducted, and collection of the data on tracks/signs of medium and large size mammal species was carried out.

During 34 days we conducted a total of 130 km of diurnal trail transect census in 25 grid cells. To provide a representative sample, trails were distributed throughout the grid cells and encompassed a variety of forest habitats.

Census was not conducted during heavy rainfall but did occur during light showers i.e. when observers could walk comfortably without wearing protective clothing. Census was carried out during the morning and afternoon (7:00 AM - 2:30 PM), with times varying due to logistical constraints and weather conditions. During our trail transect surveys we recorded tracks and signs of wildlife species that were visible along the trails. In cases where species identity was uncertain we took photos that were sent to experienced persons for confirmation. Any tracks that could not be reliably identified were not included in our analysis.

Photos 3: conducting track and sign survey

4.7 Camera Trapping

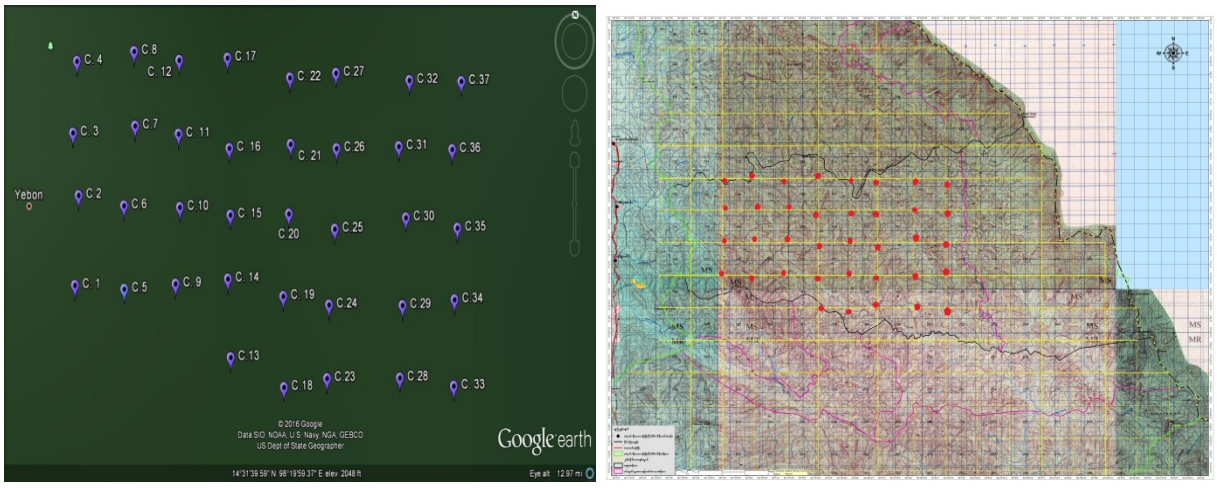
From December 2015 to April 2016 we installed digital camera-traps in Yebone LOU area. Our design intended to allocate the trap cameras across the study area evenly. We tried to set up the

cameras at near corner of gird cells. It means that the average spacing of the camera traps was about 2 km each. However, due to the steep topography, the distance between cameras was effectively about 1800-2200 m.

We selected the suitable places for camera setting within around 200-300 diameters of GPS positions of corners of grid cells. A total of 37 cameras were set up., but one (No. 4) was missed where was closed to boundary (See figure 5). Site selection focused on mineral salt licks, existing animal trails, feeding ground and mountain ridge were explored and identified to determine adequate locations for the placement of trap-cameras inside at the corner points of grid cells in Yebone LOU. We attached cameras to trees at a height of ≈ 40 cm above the ground. The area in front of cameras was cleared of green foliage and herbs to prevent sunlight reflections damaging image quality.

The data from 36 cameras (Bushnell Cam model) were used for analysis. Cameras were mounted on a sturdy tree about 5 meters away from the place to be monitored. The distance and sensing angle were tested before setting up the cameras. And clock set and time stamp was “on” to imprint the date and time on every photo**.** No bait or lure was used to attract the animal toward the camera stations. All camera traps were operational 24 hours per day, recorded time and date for each exposure, and had a 5-second delay between photographs.

Figure 5: Locations of trap cameras in Yebone LOU, TNR.



The number of trap nights was calculated for each camera location from the day the camera was mounted to until the day it was retrieved. Capture rate per trap night is provided in Appendix 3.

Photos 4: Camera trap setting at TNR

4.8 Data analysis

At the end of the survey period, all cameras were retrieved. Camera trapping images were transferred to storage devices, and then uploaded and imported into excel file for data management and analysis. Animal species were identified with the aid of experienced persons. The global and regional conservation status of each species was determined based on the IUCN Red List of Globally Threatened Species (IUCN 2014), as well as Myanmar National key protected wild animal list (1999).

To avoid sequences of photos of a particular individual a time period of 1 hour was used to differentiate the individual mammal photographs. Unfocused, incoherent, or photographs where only parts of the animal had been photographed were excluded from the analysis. Other photographs excluded from the analysis such as small mammals, including shrews, squirrels, and rats which were not our priority and not possible for consistent positive species identification, along with all birds which were outside of the scope of the study. It was also the same in tracks and survey data analysis.

Activity patterns, for some mammal species that were relatively frequently captured (>12 in-

dependent photographs), were represented by a percentage of the total number of photographs recorded during daytime and nighttime intervals. Based on the photographs automatic time stamp, photos grouped into either daytime (ranging from 06:00-09:00, 09:00-12:00, 12:00 12:00-18:00 hours) or nighttime (ranging from 18:00 to 06:00 hours). Then, categorized into two categories, diurnal, and nocturnal based on the total percentage of daytime and nighttime photos.

Relative abundance indices (RAIs)

To compute the RAI for each species, all detections for each species are summed for all camera traps over all days, multiplied by 100, and divided by the total number of camera trap nights. We calculated RAI for each species as the number of photo captures per 100 trap nights to facilitate comparisons with previous studies at the same site. Animal detections were considered independent if the time between consecutive photographs of the same species was more than 0.5 hours apart.

The camera trapping data were inputted into program PRESENCE (version) as 1s and 0s indicating presence and absence, respectively. Occupancy modeling was conducted on detection/non-detection data for species with more than 15 independent detections including Chinese serow, sambar, wild boar, etc. We used GIS (Geographic Information Systems) analysis (QGIS) to calculate elevation, distance to boundary at each camera trap, and Akaike's Information Criterion (AIC). For analyzing differences in mammal RAIs between the edge of the park and the park's interior, we performed a two-sample t-test.

To offer a baseline to interpret our camera-trapping results, we tried to compare our RAIs for all photographed species to data from previous camera-trapping surveys done at TNR during last decade. It is difficult to compare RAIs between projects because of differences in detection probabilities at different locations; therefore, we only included sample locations that we could pair directly with locations from the previous survey by Ye Htut et al. 2008. Camera traps also recorded human traffic and domestic animals. Poachers were identified if they were carrying a gun, a carcass, or animal parts, a bag to transport plant material/tree bark, etc.

5 Results

5.1 The results of Interview survey

We asked the interviewees about large mammal species distributed in 9 LOU zones during the survey. The questions included the present, absent and estimation on species abundance of large mammals in each LOU. 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%.

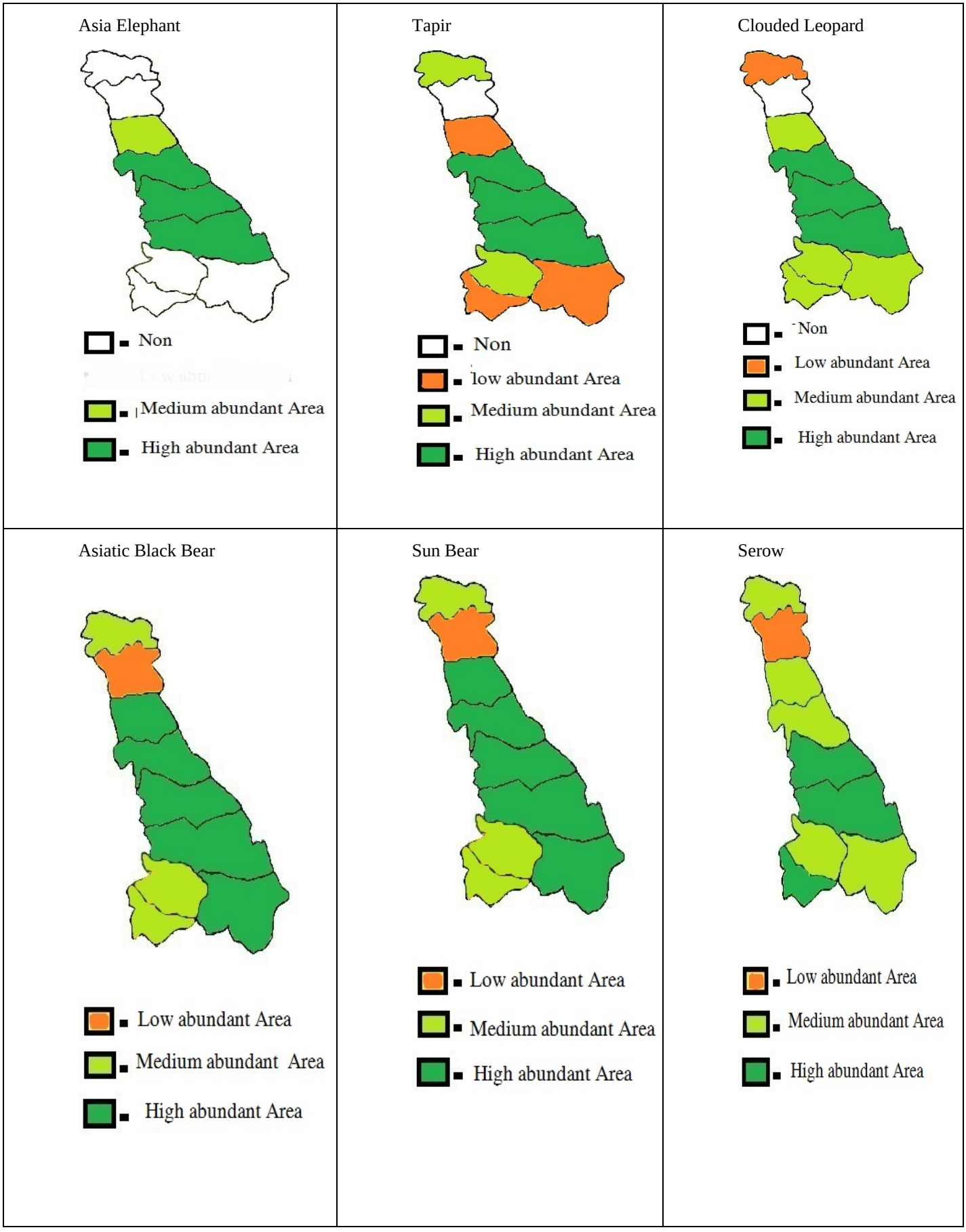
Table 3: List of Interviewees around TNR.

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

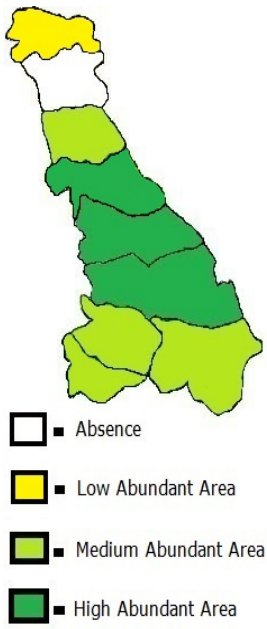
According to interview results, most Karen are knowledgeable about large mammal species' distribution, physical characteristics, behavior, habit and some ecological factors, while others such as *Mon* and *Bamah* are less familiar with wildlife species. When we showed the photos of different large mammal species, we observed that some local people could not able to identify the some cat species. However, the Interview Survey yielded the best maps for distribution and abundance of some medium and large size mammals in TNR area (see Figure 6). In overall conclusion, out of 9 LOU areas, Ale-skan, Yaphu, Mayanchaung, Thet-ke-kwet LOUs had many habitat disturbance by human activities and were less abundant of wildlife species; Michaunglaung, Heinze and Myakhanbaw LOUs were medium abundant and Kyauk-shat and Yebone LOUs are the most abundant areas for medium-large mammal species. In terms of tiger distribution, local people indicated that this species can be found in 3 zones, Yebone, Kyauk-shut and Michaunglaung.

Figure 6: Result of Interview survey- distribution and abundant of some large mammal species in LOUs.

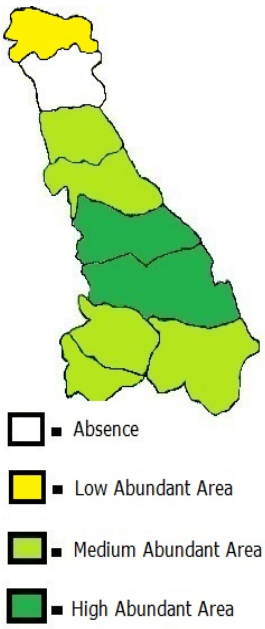


Gaur

Dhole

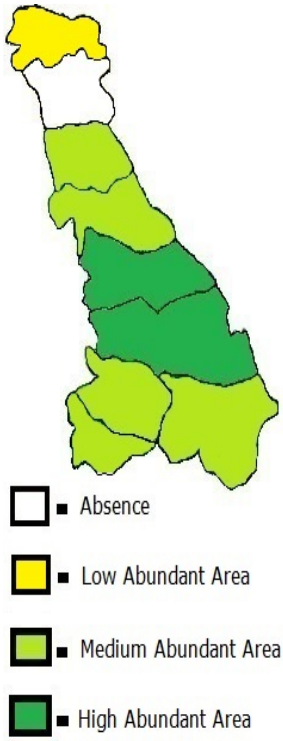


Leopard

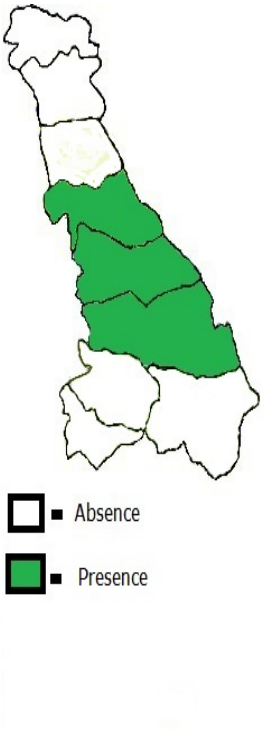


Fea's muntjac

Golden cat



Tiger



5.2 The results of track and sign survey

We walked a total of 130 km along the jungle trails in 25 study grids. This track and sign survey recorded a total of 17 mammal species (Appendix 2). We did not find any signs of tigers and leopards. In accordance with the encounter rate per km, wild boar, bear, elephant were recorded as the most abundant in Yebone LOU area.

Figure 7: Distance encounter rate for some medium-large mammal species

	Bear	Elephant	Wild boar	Serow	Muntjac	Tapir	Gaur	Sambar	Civet
Total number of encounters	99	36	116	9	5	1	3	20	31
Encounter rate/ total Km 130	0.76	0.28	0.89	0.07	0.04	0.01	0.02	0.15	0.24

5.3 The results of trap camera method

Key species recorded by camera trapping

A total of 37 cameras had attempted to be deployed into the field within study period. One camera (No. 4) was missed. There had been a total of 36 stations which successfully recorded 59-121 camera trap nights of data in the field (Appendix 3).

The total camera trapping effort was 3327 camera trap nights. The average number of nights was 92 nights. In total, 2064 digital photographs were captured. We excluded photos of other small mammal species in data analysis. Only we focused on medium-large mammals. Of 2064 photos, 1338 were medium-large mammal photographs (Fig. 2). The mean elevation of the camera stations was 619 m. The highest elevation was 960 m, and the lowest elevation 189 m.

The species with the highest camera trap rate was stumped-tailed macaque 13.8 photographs/100 trap nights, wild boar 6.8 photographs/100 camera trap nights, red muntjac 4.1 photographs/100 trap nights, Fea's muntjac 3.7 photographs/100 camera trap nights, Chinese serow 2.34 photographs/100 camera trap nights, black bear 1.68 photographs/100 camera trap nights. These 6 species combined together to account for 32% of all mammal photographs.

Mammals captured by the most number of cameras, were wild boar (26 cameras), stumped-tailed macaque (25 cameras), Fea's muntjac (24 cameras), Asiatic black bear (20 cameras), Chinese serow (18 cameras). Some species had fewer than 4 photographs and represent the least number of species present including marbled cat (4 photographs) and gaur (2 photographs).

Trap nights and Species accumulation

Camera traps recorded 1338 medium-large mammal photographs, of which 67% (n = 906) were of non-carnivorous and 33% (n = 432) were of carnivore mammals. We could not determine species in 0.6% (n = 20) of the photographs due to poor focus, lighting, or angle.

Carnivores and non-carnivorous mammals

Based on camera-trapping, we found 9 carnivore species (medium-large mammals) in the Yebone area. Of these species, only one species (dhole) is globally Endangered species. The number of photos per

carnivore species ranged from 4 for marbled cat (RAI = 0.01; Appendix 3) to 227 for wild boar (RAI = 6.8), followed by Asiatic black bear (n = 56; RAI = 1.68), sun bear (n = 46; RAI = 1.38) and clouded leopard (n = 29; RAI = 0.9). Camera traps did not detect tigers and leopards. In terms of non-carnivorous mammals, barking deer, Fea's muntjac, and serow were the most common herbivore species detected during camera trap surveys (Appendix 3)

Human traffic

In addition to documenting the presence and distribution of wildlife, camera traps also recorded human traffic (poachers). The poacher photographs were taken by camera number 115 and 116.

Our model contained three co-variables. We analysed it for 10 species. Most of species fit different models such as Elevation, Edge (see Table 8). Wildlife detections increased as elevation increased, distance to boundary increased.

Table 8: Multiple regression models used in predicting wildlife presence using three environmental variables. The lowest AICs were highlighted.

Model	Dhole	Sam	AGC	CL	CS	WB	FM	RM	SB	ABB
Edge*+Forest_type+Elev**	**77.1**	71.6	58.2	203.2	274.1	477.3	366.7	135.8	329.9	196.0
Edge*+Forest_type	82.6	**59.8**	57.5	205.1	272.5	475.3	364.7	134.4	327.9	194.0
Edge*+Elev**	81.4	71.2	**56.3**	206.4	272.5	475.3	364.7	134.0	327.9	193.9
Forest_type+Elev**	84.0	69.6	62.0	**201.9**	272.3	475.3	364.7	138.6	327.9	194.0
Forest_type	82.1	80.6	61.2	204.5	**270.5**	473.3	362.7	138.5	325.9	192.0
Edge*	82.1	71.2	57.2	205.9	270.7	**469.2**	**354.2**	**133.4**	**312.4**	192.0
Elev**	82.2	74.8	60.2	206.6	270.9	473.2	362.7	136.6	325.9	**191.9**

Edge*= Distance To boundary, Elev= Elevation**

DH = Dhole, Sam = Sambar, AGC = Asian Golden Cat, CL = Clouded Leopard, CS = Chinese Serow, WB = Wild Boar, FM=Fea's Muntjac, RM= Red Muntjac, SB= Sun Bear, ABB=Asiatic Black Bear,

Mammal distribution and assemblage

We found a significant difference in mammal species RAIs between the areas near western boundary and inside areas of the Yebone LOU. It was 95% sure that more interior grids of the Yebone zone supported a larger species diversity than grids near western boundary (t = 4.53, n=6, 6).

According to Strategic Planning Meeting on 17-18 October 2015, TNR management authorities defined the nine Key Mammal Species for long-term monitoring: 1) Asian Elephant, 2) Malayan Tapir, 3) Tiger, 4) Taninthayi Langur, 5) Dhole, 6) Wild Pig, 7) Sambar, 8) White-handed Gibbon and 9) Gaur.

However, in this report, we described and discussed about twelve medium-large sized mammal species based on the results of our surveys.

Activity patterns of major species

We also analyzed activity patterns of 10 medium-large mammals recorded with more than 10 photographs (Table 9). It indicated that dhole was classified as diurnal and golden cat species as nocturnal.

Table 9: Activity patterns of some medium-large mammal species from trap camera data

Species	No. of Photos (N)	Day Time %			Night time %	
		06:00 – 09:00	09:00 – 12:00	12:00 – 18:00	18:00 – 00:00	00:00 – 06:00
Clouded leopard (*Neofelis nebulosa*)	**30**	23.33	6.67	13.33	13.33	43.33
Asiatic Black Bear (*Ursus thibetanus*)	**55**	27.27	36.36	29.09	3.63	3.63
Asian Golden Cat (*Catopuma temmimckii*)	**12**	0.00	0.00	8.33	41.66	50.00
Sun Bear (*Helarctos malayanus*)	**46**	19.56	10.86	36.95	17.39	15.21
Chinese Serow (*Capricornis milneedwardsi*)	**77**	19.48	3.90	25.97	31.17	19.48
Sambar (*Rusa unicolor*)	**35**	2.86	28.57	28.57	40.00	0.00
Red Muntjac (*Muntiacus muntjak*)	**137**	21.9	8.76	27.01	35.03	7.3
Fea's Muntjac (*Muntiacus feae*)	**120**	24.17	3.22	48.33	17.5	6.67
Wild Boar (*Sus scrofa*)	**226**	28.76	19.47	35.51	7.96	8.29
Dhole (*Cuon alpinus*)	**12**	50.00	33.33	16.67	0.00	0.00

Some Ecological factors of some mammal species

(1) Asian Elephant (*Elephas maximus*)

The team found the signs (dungs and foot prints) in 11 of 25 grid cells (Figure 10). It was about 44% of study area. The encounter rate was 0.27 per Km (Appendix 2). Elephant signs were found in closed evergreen and bamboo forests. Track and sign surveys indicated they are one of the most relatively abundant species and widely distributed species throughout Yebone zone.

The team found the dung and signs of foot prints of baby elephants. It indicated that the population of this species seems going to breeding in Yebone area. We did found only old pit-falls used to capture wild elephant last decade. However, the trap cameras did not detect and not get any photos of wild elephant.

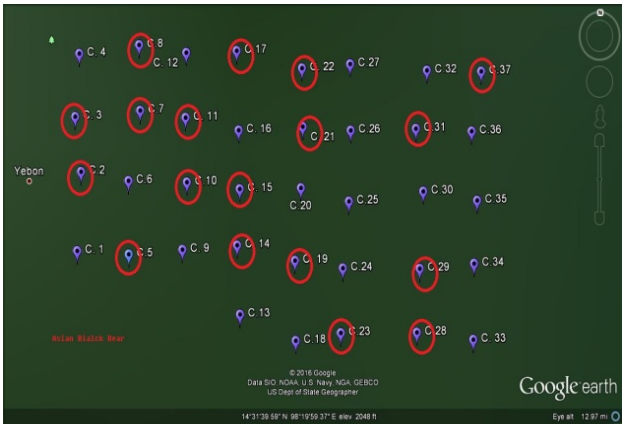
Figure 10: Showing the grid cells (yellow color) that the dungs and signs of Elephants were found.

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

(2) Asian Black Bear

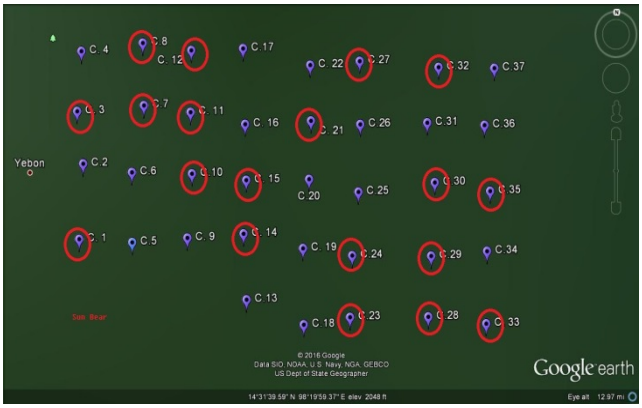
These Bears can be observed in the dense forest at everywhere. Out 36 trap cameras, 18 captured the photos of this species. It means they distributed 50% of study area (see locations of trap cameras that captured the black bear species). Capture rate per 100 camera nights was 1.68. It was the fourth highest RAI. They were presence between 250m and 909m above sea level. Both surveys resulted that they were mostly found in closed evergreen (EFC) and open evergreen (EFO) forests. They were mostly active during day time (6:00-18:00 hrs) (93%).

Photo 5: Photo of Asian Black Bear, and Figure 11: locations of trap cameras that captured pictures of Black Bear.



(3) Sun bear

Photo 5: Photo of Sun Bear: Figure 11: locations of trap cameras that captured pictures of Sun Bear.



Sun bear was found in all forest types (EFC, EFO, SEF and Bamboo) like black bear. A total of 19 trap cameras captured the photos of this species. The capture rate was 1.38 per 100 camera nights. The locations of those trap cameras indicated that sun bear distributed between 250m and 932m asl elevation. It means both bear species occupied the same ASL elevation. Activity analysis resulted that they were mostly very active in day time (Sun bear 67%, Black bear 93%) (see table 9).

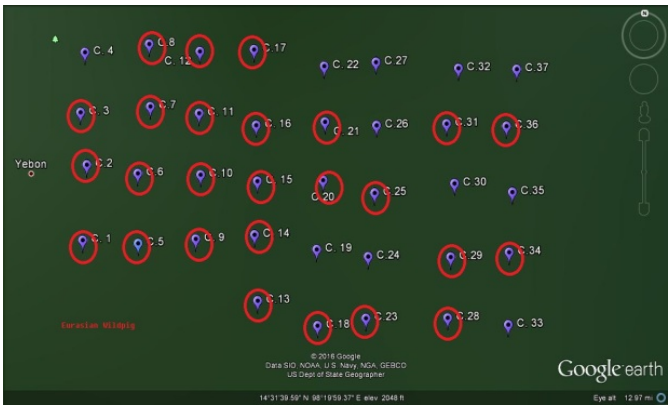
Figure 12: Showing the grid cells that signs of black bear species were found in.

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

Tracks and scats of both bear species were observed frequently in the study area. According to track and sign surveys, bears are one of the most relatively abundant species in the whole study area. Interview survey also suggested that both Asiatic Black and Sun bear species are well present.

(4) **Wild boar**

Photo 6: Photo of Wild Boars; **Figure 13:** locations of trap cameras that captured pictures of wild boar



Wild boars were found in all forest types. A total of 26 trap cameras captured the photos of this species. The capture rate per 100 camera nights was 6.8. The track and sign survey also showed that 20 grid cells were presence by wild boar and encounter rate was 0.89 per km. They were observed between 250 m and 960m asl. This species is mostly active in day time (83%), however, they also move at night time (17%). If combined both data from trap camera and track/sign surveys, it assumed that wild boar are present in all 25 study grids.

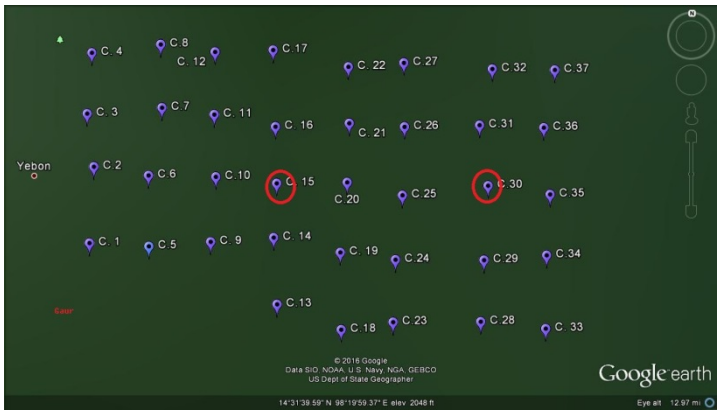
Figure 14: Showing the grid cells that the signs of wild boar were found

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

(5) Gaur

Gaurs were found in EFO and bamboo forests. Only two cameras captured the photos and the capture rate per 100 camera nights was 0.1. This was the lowest RAI among the analyzed species. They were found between 502m and 680m asl.

Photo 7: Photo of Gaur; **Figure 15:** locations of trap cameras that captured pictures of Gaur



The track and sign survey showed that they were occurred in 3 grid cells and the encounter rate was 0.02 per km. This species are diurnal, and mostly active in the morning and late evening. Gaur inhabits the forested hills with open grassland. Tracks and dungs of gaurs have been observed at saltlicks. It indicated that they also occupy at the place where the elevation varies between 150 m ASL to 400 m ASL.

Figure 16: Showing the grid cells that have been found the signs of Gaur

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

(6) Sambar

Photo 8: Photo of Sambar; **Figure 17:** locations of trap cameras that captured pictures of Sambar

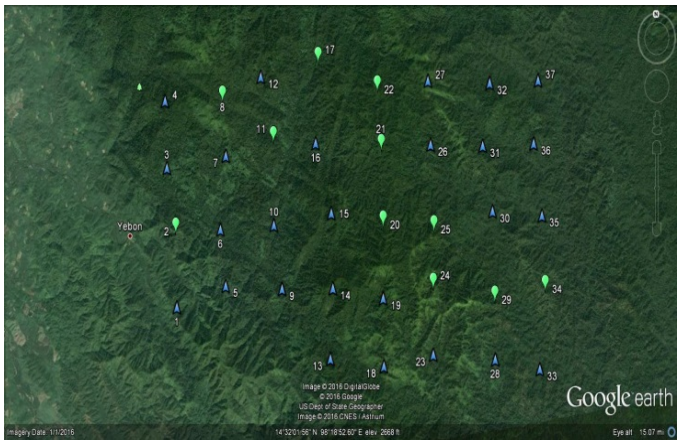
The photos of Sambar were captured by 3 trap cameras located near reserved boundary. The rate per 100 camera nights was 1.1. They also survive at the place where the elevation varies between 189 m ASL to 378 m ASL. Signs of Sambar were found at 6 grid cells crossed the study area. The encounter rate resulted as 0.15 per km. This species inhabited in all forest types (EFC, EFO, SEF and bamboo forests). Sambars are very active in day time (60%), and also active in late evening (18:00-24:00hrs) (40%) (Table 9).

Figure 18: Showing the number of the grid cells that the signs and tracks of Sambar were found.

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

(7) Clouded Leopard

Photo 9: Photo of Clouded leopard; **Figure 19:** locations of trap cameras that got phots

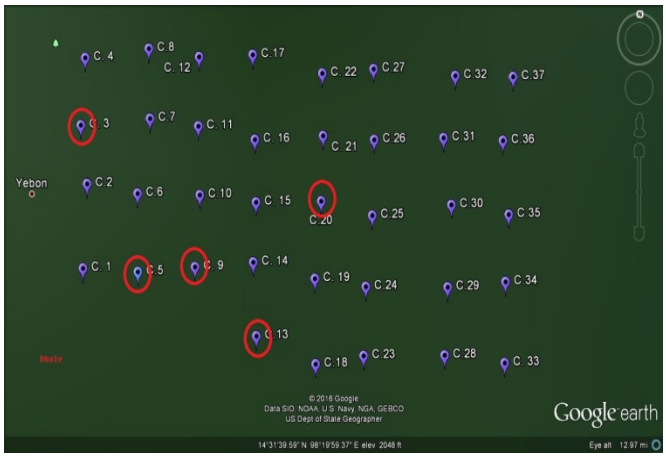


A total of 11 cameras captured the photos of this species (30% of total trap cameras). The photos capture rate was 0.9 per 100 camera nights. Clouded leopard were present between 373 m and 960 m asl. They were occurred in all forest types. They are active at night. However, they mostly very active in early morning (43%) during 0:00 – 06:00 and morning (23%) during 6:00 – 9:00 hrs (Table 9). They were rest and limited active during 9:00-12:00 hrs.

(8) Wild dog

Dholes are diurnal species and mostly very active in the morning 6:00-9:00 hrs (50%). The capture rate per 100 camera nights was 0.4. They were occurred in all forest types and between 319m and 960 m asl. The result indicated that they occupied the areas where wild boars and muntjac were abundant. The elevations of those species found were almost the same (300m - 960m asl).

Photo 10: Photo of Dhole; **Figure 20:** locations of trap cameras that received the phots of Dhole



(9) **Tapir**

We did not get any pictures of Tapir during trap camera survey. However, the track and sign survey indicated that very low encounter rate (0.007 per km). The signs of Tapir were seen in grid number 171 from lowland to upland areas with altitude ranging from 223 m ASL to 335 m ASL in Yebone area.

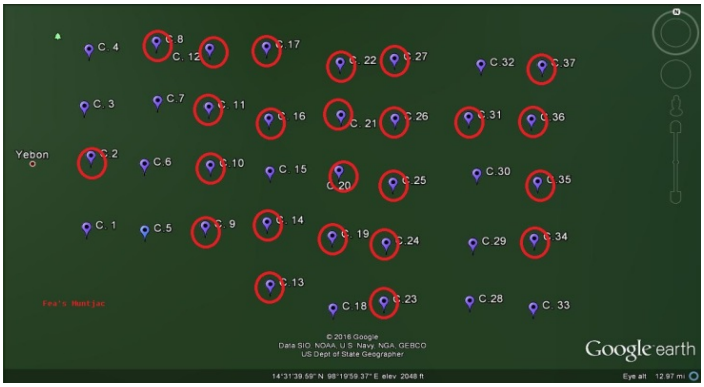
Figure 21: Showing the number of the grid cells that have been found the Tapair's sign.

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

(10) Fea's munjac

This species was occurred in EFC, EFO and SEF. Survey indicated that Fea's muntjac was one of most abundance species. Its photos were captured by 24 trap cameras which were cross the study area. The capture rate (RAI) was 3.7 per 100 camera nights. They occupied between 250 m and 960 m asl. They are diurnal especially very active during 12:00-18:00 hrs (48%). This species is solitary like red muntjac.

Photo 11: Photo of Fea's muntjac; **Figure 21:** locations of trap cameras that received the photos



(11)**Red Muntjac**

Photo 12: Photo of Fea's muntjac; **Figure 22:** locations of trap cameras that received the photos

Red Muntjac was different in activity pattern. They were also active in late evening (12:00-18:00hrs) (27%) and early night time (18:00-24:00hrs) (35%). They occupied between 366 m and 785 m asl in all forest types. It looks near the same like Fea's muntjac. A total of 6 trap cameras received the photos, and RIA was (4.1).

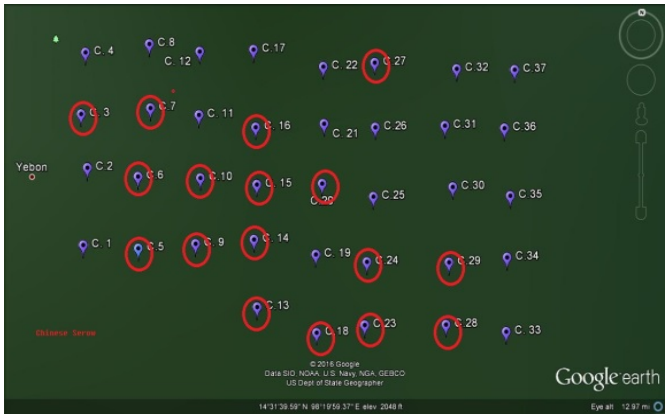
Figure 23: Showing the number of the grid cells that signs of Muntjac species were found.

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

Signs of both Muntjac species were found in 4 grid cells (No. 158, 168, 171 and 186). Most of signs were occurred in EFO and SEF. The encounter rate was 0.04 per km.

(12) Chinese serow

Photo 13: Photo of Serow; **Figure 24:** locations of trap cameras that received the photos



Serow pictures were captured by 17 trap-cameras (47% of total camera traps). The RAI was 2.34 per 100 camera nights and it was one of the highest rates (RAI). This species occupied between 189 m and 960 m als where are EFC, EFO and SEF types. They were active in day (49%) and night (51%) times nearly equal, more active during 18:00-24:00hrs (31%).

Figure 25: Showing the locations of the grid cells that the signs of Serow were found.

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

Tracks were found at altitude between 225-500 m ASL where steep forested areas existed. Very little signs (n=9) was observed in the study area and encounter rate per km was 0.07. Catchments areas of Yebone Stream would appear highly suitable for the survival of serow.

(13) Golden cat

Golden cat occupied between 366m and 558 m asl. It inhabited in all forest types. Very interestingly, all the captured photographs of golden cats were at night time. the photos of this species received by 4 trap cameras. The capture rate was 0.4 per 100 camera nights.

Photos 14: photos of Golden cat

(14) Tiger and (15) Leopard

All 36 cameras did not capture any photos of tiger and leopard in our study area. Although we got one photo look like tiger from camera no. 35, we had analyzed it as Clouded leopard according to identification by experts. The picture was received from the unsurvey area closed to insurgent boundary (see the photo and location of camera trap).

Unfortunately, survey team did not find any sign of tiger and leopard such as pugmarks along the transect lines in 25 grid cells. It was very difficult to detect signs even when the species was present due to its rarity, dense vegetation, and avoidance of humans. No villagers from Yebone and others mentioned about livestock depredation incidents by leopard/tigers in recent past. Therefore, it was very difficult to say the presence of tiger in study area. Our conclusion was that it may be a small, or non-viable population of tiger in Yebone area. However, three factors suggest that TNR is suitable for tigers. Firstly, there is a large area of contiguous habitat. Secondly, prey resources would appear sufficient to support tigers. Thirdly, there is uniform access to water in the study area. Therefore, tiger is presumed to persist in the area and future surveys should focus to detect its presence.

6 Discussion, Conclusion and Recommendation

Taninthayi Nature Reserve (TNR) is well known for its biodiversity and has the potential to serve as a national model for wildlife conservation. Getting information on terrestrial large mammals is particularly difficult in tropical rainforests, since the traditionally used method (line-transect census) presents low efficiency in dense vegetation. Therefore, we combined two methods (line transect and trap camera) in this survey.

Our results highlight the value for conservation in TNR for terrestrial mammals. This survey demonstrated the efficiency of camera trapping and line transect for large and medium-sized terrestrial mammal inventories. Eleven globally IUCN endangered or vulnerable species were recorded which suggests this mammal community still retains a good amount of species richness. The populations of Asian elephant, and other medium sized mammals may be seen as particularly significant due to extensive regional declines.

Species numbers

Our survey built on previous wildlife monitoring in TNR by including some parts of formerly under-surveyed area close to the insurgent zone (Kamaungthwe chaung). Camera-trapping and track/sign transect are two monitoring-tools available to park authorities for evaluating the occurrence of some medium-large mammals, and to estimate relative abundance patterns across LOUs for species that are highly detectable by camera traps.

Twenty Eight out of the 67 mammal species previously informed for TNR were also detected by our camera traps. We did not photograph leopard, tiger or small Indian civet. A previous monitoring program also did not detect tiger species by trap cameras.

Distribution patterns detected in our study indicated that wildlife relative abundance in Yebone is significantly higher in central grid cells than in marginal areas near park boundaries. Most carnivore species were widely dispersed across sampling grids. Survey team also detected two felid species (leopard cat and golden cat) with the same camera No. 8, and another two species (leopard cat and marbled cat) with the same camera No. 21. Elevations of both cameras (No. 8 and 21) were not much different in ASL (750-925 m). The high elevation of the area may be less accessed by people, reducing human impacts. These observations are of management interest because the presence of three wild felids may indicate sufficient prey resources for all species, and natural protection from humans that benefits all species along the ridge of grids.

Some limitations of trap-camera deployment

Camera traps are a reliable method to evaluate biodiversity and used by wildlife managers and

policy makers who can use camera trapping datasets to make decisions regarding conservation and management of mammal populations. Although camera trapping is seen as more expensive in terms of initial investment, considering the incurring costs for loss of cameras, there are tradeoffs to consider for considering future monitoring goals within the TNR.

During this study, there were limitations for efficiently using the camera traps, including placement in areas with high amounts of vegetation which trigger the cameras unnecessarily, loss of camera from dense forest area, and loss of data card which reduced the number of camera trap days. Being aware of these limitations, the TNR can work towards further standardization of their camera trap efficiency to detect species within the reserve using occupancy methods, and work towards improving technique since the TNR staff have been improving a lot in deploying camera traps independently.

The relative abundance

Overall mammal abundance seems different in Yebone LOU and perhaps has declined within eight years. Survey data showed significantly lower RAIs and zero-detection for some species such as elephant, tiger, leopard, gaur, etc. in Yebone LOU. To evaluate our reported RAIs, it is helpful to consider that similar study should be done in Yebone and other LOUs at least 3 years interval. This suggests that the relative abundances of mammalian predators and their prey in Yebone area were suppressed, and this may be related to increased human activity (See Figure 26). Elevation was the most important variable impacting wildlife presence and wildlife detections increased as elevation increased. It was the same like distance to edge/boundary. This may be because higher elevations of the Park are less accessible to poachers.

Previous studies (Win Maung 2002, Ye Htut et al. 2008, Myint Maung 2011, Hla Myo Aung 2011, Nay Myo Shwe 2008) have demonstrated the importance of TNR areas for the national and regional conservation of forest mammals. Although TNR's forest mammals are relatively well studied 5 times, there is little comparative data available from studies of mid and large bodied mammals in TNR because of different objectives, study areas and survey designs. Although it is not possible to make direct comparisons with previous studies, our predicted species richness shows the importance of Yebone LOU area for the conservation of TNR and Taninthati region's fauna.

However, we compared our data with 2008 survey that was conducted in Yebone stream because those were used the same season and the same method "track and sign". As overall result, encounter rates per km for most mammal species were decreasing and it means that populations of some mammal species were going down within 8 years (Table 10). Only one assumption was that 2008 survey was conducted along the stream trails, and our survey included forested trails.

Table 10: Comparing on distance encounter rates of some mammal species between 2008 and 2015-16 track/sign surveys.

Period	Location	Total Distance (km)	Otter spp.	Bear spp.	Civet spp.	Wild boar	Black Giant squirrel	Wild Elephant	Sambhur Deer	Barking Deer	Porcupine spp	Macaque spp.	Serow
Feb-08	Yebone stream	22.4	7	17	24	29	3	2	17	6	2	10	4
Encounter rate/km			**0.31**	**0.76**	**1.07**	**1.3**	**0.13**	**0.09**	**0.76**	**0.27**	**0.09**	**0.45**	**0.2**
Dec 15 to Apr 16	Yebone LOU	130	30	99	31	116	3	36	20	5	17	20	9
Encounter rate/km			**0.23**	**0.76**	**0.24**	**0.89**	**0.02**	**0.27**	**0.15**	**0.13**	**0.13**	**0.15**	**0.1**

Combined with the distribution, abundance and diversity of some species recorded we believe this group of mammals must be considered a management priority within this protected area. Our results provide a baseline upon which management activities can be measured and evaluated. However, future studies focusing on species ecology, habitat preferences and population densities are required to inform management activities. For example further studies are required to enable the best zonation, the best study design, conducting it at same season and period, etc.

Human disturbances

The areas along the western boundary are closed to human settlement. The people from those, mostly practiced shifting cultivation. After a couple of yields, they abandon the land and seeking new area. Of this reason, western boundary and outer areas are subjected to human disturbances like illegal logging, collection of natural recourses, and series of land conversion activities such as rubber, oil palm, and cashew nuts, betel nuts plantation and so on. Illegal hunting and illegal collection of natural resources are also added effect upon T.N.R and diverse of animal species which live in. Regarding about the natural forest resources utilizing in T.N.R, local people practiced the ways of unsustainable since then before the

area is notified as a nature reserve. According to TNR's survey records, there are two kinds of hunting in the TNR, subsistence and for commercial hunting. Wild boar, Muntjac and Sambar were mostly hunted for subsistence and Tigers, Elephant were hunted for trade.

Camera traps provided direct evidence of poaching including photos of individuals carrying forest products, and/or carrying guns/knives. The capture rate of hunters per 100 camera nights was 0.6. One camera trap (No. 4) was stolen by intruders. One clouded leopard had an injury on the back and it may be caused by the gun.

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 any primate species within grids where we heard gun sound except in grid no. 156. However, the best thing was that the survey team did not find snare-traps in the studied grids during survey period.

Figure 26: the grid cells that human disturbance were found

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, Grey grids: that old-logging signs were found

Conclusions

This survey accomplished an important step in making an intensive study in the best area of TNR for species information, and engaging local staff in deploying and demonstrating camera trap methods and analysis. The sampling saturation was high, and obtained records of 17 medium to large sized terrestrial mammals, including several species of conservation concern. The use of camera trapping also allowed us to detect elusive rainforest mammals, which otherwise would have been difficult to detect via tracking or trapping. Of particular interest were the carnivores, which represented by 7 species, including Asiatic black bear, Sun bear and clouded leopard, the nature reserves top predators.

The information from the survey can be useful for developing conservation management programs into the future, and also decide which species may possibly be for monitored over the long term. To maintain viable populations of mammal species within the nature reserve, and encourage the recovery of populations of keystone species such as tiger, leopard and clouded leopard, effective management is necessary. Standardizing future camera trapping data management and operating procedures is essential to further inform us the species currently within and outside the reserve so as to meet various conservation challenges.

Although there are many threats and a decrease or near extirpation of tigers and leopards, TNR supports a diversity of carnivore species of conservation concern including dhole, clouded leopards and small felids. Great efforts to monitor wildlife using simple tools such as line transect, camera traps will be essential to TNR's mission. Continued monitoring will provide critical information on the occurrence of native species, threats, indication of the effectiveness of patrolling, other management and conservation interventions.

Recommendations

- Continuation and comprehensive studies on large mammal species not only in Ye-bone, but also Kyauk-Shat, Michaunglaung, Zinnba LOUs are strongly recommended. This survey was not standardized for a systematic occupancy analysis due to many reasons including logistical considerations. In the future, a more systematic sampling for specific species can be designed and implemented based on these initial results and trials.

- Camera-trapping at TNR should be carried out every year in the dry season in selected grid cells of selected LOUs (such as Kyauk-shat, Michaunglaung, Yebone) for 50 days (2 months survey) in dry season during SMART patrols if possible. Unlike other many protected areas in Myanmar that have very limited budgets and resources available for management, TNR has well trained staff, and the largest annual budgets available to commit to park management. We encourage the adoption of a system of regular monitoring using a range of methods by dedicated teams of rangers, together with important SMART patrol efforts. To recover tigers will require a long-

term plan to protect the vulnerable LOUs. Additionally, with loss of tigers, the dhole, an endangered species that has historically not conservation action by park authorities needs high level of protection.

- Patrolling is one of the most important interventions for conserving wildlife in the TNR. Although it is not possible to be zero-poaching/hunting, TNR should try some LOU areas such as Yebone, Kyauk-shuk, as "**hunting free zone**" through people participation and joint patrolling.
- Many of TNR staff have well experiences in applying some field techniques such as line transect, camera trapping, and collecting/maintaining the field data. Only they need to do data analysis and statistics. Therefore, we suggest that TNR should arrange the trainings on field data analysis.
- We propose the grid cells (highlighted by green color) in Yebone area for long-term study & monitoring on the population trend of some medium-large mammal species using camera trap method and line transect techniques.

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**

- It is not possible zero-hunting, but Wildlife trade in townships and villages should be investigated and necessary action must be taken against offenders. To be prepared necessary agreement with KNU through higher authorities level communication for effectiveness in protecting threatened and endangered mammal species in TNR areas.
- Local people who are educated and interested in the conservation of wildlife should be recruited to assist with TNR project activities.

- Efforts to effect trans-boundary conservation in the border area should be encouraged by making contact with the respective authorities from Thailand and also close connection with the Association of South-East Asia Nation Wildlife Enforcement Networks (ASEAN-WEN).
- FD should allow the university students to involve in mammal 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.

Finally we would like to mention that as the National Consultant for Large Mammal Survey, FOW was able to accomplish the following tasks:

1. Conducted a comprehensive interview survey with local communities to understand known distribution of medium-Large Mammal populations, and then prioritize area was selected for survey.
2. Conducted the track and sign survey along trails and streams in Yebone LOU area, based on information from local informants
3. Deployed the trap cameras across the study area of Yebone LOU using grid cells designed by WCS.
4. We had analyzed the data of trap camera and track/sign survey to understand the relative abundance, habitat use, activity patterns of some medium-large mammal species.
5. We were able to record the use of grids to understand and mapping on distribution of some medium-large mammal species across the Yebone LOU.
6. Through interview survey, the document for all local uses of mammal species and their parts was recorded.
7. We were also able to make recommendations for future survey design and methods to monitor the population abundant and efforts of management activities for mammal species.

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

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Appendix 1: List of medium-large mammal species recorded by 2015-2016 survey

No.	English Name	Scientific Name	IUCN Red List	Remark
1.	Sambar	*Cervus unicolor*	VU	Camera trap
2.	Sun bear	*Helarctos malayanus*	VU	Camera trap
3.	Asiatic Black Bear	*Ursus thibetanus*	VU	Camera trap
4.	Chinese Serow	*Capricornis milneedwardsi*	NT	Camera trap
5.	Clouded Leopard	*Neofelis nebulosa*	VU	Camera trap
6.	Banded Linsang	*Prionodon linsang*	LC	Camera trap
7.	Leopard Cat	*Prionailurus bengalensis*	LC	Camera trap
8.	Sunda Pangolin	*Manis Javanica*	CR	Camera trap
9.	Dhole	*Cuon alpinus*	EN	Camera trap
10.	Marbled Cat	*Pardofelis marmorata*	VU	Camera trap
11.	Gaur	*Bos frontalis*	VU	Camera trap
12.	Asian Golden Cat	*Catopuma temmimckii*	NT	Camera trap
13.	Eurasian Wild Pig	*Sus scrofa*	LC	Camera trap
14.	Binturong	*Arctictis binturong*	VU	Camera trap
15.	Fea's Muntjac	*Muntiacus feae*	Data Deficient	Camera trap
16.	Common Palm Civet	*Paradoxurus hermaphroditus*	LC	Camera trap
17.	Masked Palm Civet	*Paguma larvata*	LC	Camera trap
18.	Large Indian Civet	*Viverra zibetha*	NT	Camera trap
19.	Yellow Throated Martin	*Martes flavigula*	LC	Camera trap
20.	Crab Eating Mongoose	*Herpestes urva*	LC	Camera trap
21.	Malayan Porcupine	*Hystirx brachyuran*	LC	Camera trap
22.	Brush-tailed Porcupine	*Atherurus macrourus*	LC	Camera trap
23.	Red Muntjac	*Muntiacus muntjak*	LC	Camera trap
24.	Northern Pig-tailed Macaque	*Macaca leonine*	VU	Camera trap
25.	Stump-tailed Macaque	*Macaca arctoides*	VU	Camera trap
26.	Greater Mousedeer	*Tragulus napu*	LC	Camera trap
27.	Lesser Mousedeer	*Tragulus kanchil*	LC	Camera trap
28.	Small-toothed Palm Civet	*Arcotogalidia trivirgata*	LC	Camera trap
29.	Asian Elephant	*Elepha miximun*	EN	Track and Sign
30.	Asian Tapir	*Tapirus indicus*	VU	Track and Sign

Appendix 2: Distance encounter rate of some mammal species recorded by track/sign survey

Sr.No.	Date	Grid number	Distance (km)	Otter	Civet	Binturong	Bear	Elephant	Wild Pig	Serow	Muntjac	Porcupine	Macaque	Asian Tapair	Mouse deer	Gaur	Sambar	Black Giant squirrel	Langur	Pangolin	Total animal traffic
1	05-12-2015	144	4				1		1	1							1				4
2	06-12-2015	156	5	3	1	1	1														6
3	07-12-2015	156	3				1														1
4	08-12-2015	169	4				1	1													2
5	09-12-2012	170	4				1		4	1											6
6	12-12-2015	158	4				3		1	1	1										6
7	16-12-2015	159	5		1		1		3												5
8	19-12-2015	147	2				3	1	1	1											6
9	20-12-2015	148	4					2	1			1									4
10	09-01-2016	149	4				7		4	1			2				2	1			17
11	10-01-2016	160	4	2	1		2		8	1		2	2				5				23
12	11-01-2016	168	4	1					9		1						5				16
13	12-01-2016	157	4		1		2	2	12			1									18
14	13-01-2016	158	4	1													3				4
15	14-01-2016	146	4	2	4		5	6	10												27
16	15-01-2016	157	3				5														5
17	16-01-2016	145	4				3		9	1		1						1		1	16
18	18-01-2016	169	4		2		1	1	4				1								9
19	19-01-2016	158	4	2			6		1												9
20	20-01-2016	159	2		1		1	1	2				2					1			8
21	21-01-2016	160	4	7			6	1	2							1	3				20

22	22-01-2016	146	2				3		1												4
23	23-01-2016	158	4		1		5	3	2			2									13
24	24-01-2016	147	2				2	12	1												15
25	25-01-2016	148	2		1																1
26	26-01-2016	149	2				2		2										4		8
27	27-01-2016	188	2		1		6		2						1				1		11
28	27-01-2016	187	2		1				2												3
29	28-01-2016	173	3		2		3		2	1			1		1						10
30	29-01-2016	174	4	8	4		3	4					3								22
31	29-01-2016	162	2	3	3		4	1	6				1			1					19
32	30-01-2016	161	2	1																	1
33	30-01-2016	171	2				7		5		1	1		1	1	1					17
34	31-01-2016	172	2		1				2												3
35	31-01-2016	173	2		1				2												3
36	01-02-2016	186	2				1		8			1	5								15
37	01-02-2016	150	3		1		1	1					1								4
38	01-02-2016	148	2							1											1
39	01-02-2016	161	2		1																1
40	02-02-2016	149	2		1																1
41	02-02-2016	186	2				9		9		1	4	2								25
42	03-02-2016	171	4		2		3				1	4					1				11
Total			**130**	**30**	**31**	**1**	**99**	**36**	**116**	**9**	**5**	**17**	**20**	**1**	**3**	**3**	**20**	**3**	**5**	**1**	
Encounter rate/ Km				**0.23**	**0.24**	**0.01**	**0.76**	**0.28**	**0.89**	**0.07**	**0.04**	**0.13**	**0.15**	**0.01**	**0.02**	**0.02**	**0.15**	**0.02**	**0.04**	**0.01**	

Appendix 3: Summary of Trap camera survey (December 2015 - April 2016)

Camera Number	Trap Nights	Sun Bear	Asiatic Black Bear	Chinese Serow	Clouded Leopard	Yellow Throated Martin	Banded Linsang	Leopard Cat	Mouse deer	Crab eating Mongoose	Sunda Pangolin	Dhole	Marbled Cat	Sambar	Gaur	Asian Golden Cat	Eurasian wild-pig	Stump-tailed macaque	Binturong	Fea's Muntjac	Large idian civet	Malayan Porcupine	Red muntjac	Brush tailed Porcupine	Pig-tailed Macaque	Small toothed palm civet	Masked palm Civet	Common Palm Civet	Black Giant Squirrel	Unknown	Hunter
1	84	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	1	2	5	2	0	0	0	0	0	0	0
2	120	0	2	0	2	0	0	0	0	0	0	0	0	5	0	0	16	0	0	4	0	0	110	0	0	0	0	0	0	1	0
3	121	0	3	3	0	1	0	0	4	2	0	3	0	25	0	2	39	57	0	0	0	5	11	21	3	0	0	0	0	0	0
5	118	0	2	5	0	0	0	0	0	0	0	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	1	0
6	118	0	0	5	0	0	0	0	0	0	0	0	0	5	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0
7	118	0	10	3	0	0	0	1	5	2	0	0	0	0	0	0	5	131	0	0	1	17	0	68	3	4	0	0	0	0	0
8	84	1	2	0	1	0	0	1	3	3	0	0	0	0	0	2	29	0	0	7	0	1	0	8	0	2	1	0	0	2	0
9	113	0	0	8	0	3	0	0	0	0	0	2	0	0	0	0	1	13	0	13	0	2	0	3	2	0	0	0	0	1	0
10	115	4	1	3	0	0	0	0	2	2	0	0	0	0	0	0	4	12	2	1	0	1	0	5	0	0	0	0	0	0	1
11	116	3	1	0	2	0	0	1	4	0	1	0	0	0	0	0	6	18	1	2		12	0	26	0	7	0	0	0	0	0
12	116	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	0	16	0	14	0	12	0	0	0	0	0	0	6
13	110	0	0	5	0	0	0	0	0	0	0	2	0	0	0	0	4	8	0	2	0	1	0	1	0	0	0	0	0	0	0
14	109	2	1	6	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	9	0	0	0	1	0	0	0	0	0	1	0
15	112	0	4	1	0	0	0	0	1	0	0	0	0	0	1	0	2	11	0	0	0	3	0	0	0	0	0	0	0	0	0
16	111	0	1	9	0	0	0	0	0	0	0	0	0	0	0	0	18	4	0	10	0	0	0	0	0	0	0	0	0	0	0
17	73	0	7	0	3	0	0	0	0	4	0	0	0	0	0	7	2	6	10	11	1	2	3	17	3	3	0	6	0	5	0
18	99	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	16	0	0	0	0	3	0	1	0	0	0	0	5	0
19	99	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	2	0	1	0	18	0	0	0	0	0	0	0
20	108	0	0	3	4	1	1	0	0	3	0	2	1	0	0	0	5	11	2	7	0	0	0	82	0	0	2	7	0	0	0
21	99	3	7	0	2	0	0	2	11	3	0	0	1	0	0	0	20	39	1	1	1	0	0	72	2	0	9	0	0	0	0
22	99	0	1	0	6	0	1	1	3	1	0	0	2	0	0	0	0	14	0	2	0	20	2	15	0	0	3	5	0	2	0

23	99	3	1	6	0	2	0	1	1	0	0	0	0	0	0	0	20	16	0	1	1	0	0	70	0	0	0	0	1	0	0
24	99	2	0	11	1	1	1	0	0	0	0	0	0	0	0	0	0	8	1	12	0	2	0	20	0	0	4	2	0	0	0
25	99	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	5	27	5	5	0	5	0	3	0	0	1	0	0	0	0
26	100	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	0	6	0	6	3	4	9	0	0	0	0	0	0
27	99	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
28	59	0	5	4	0	0	2	0	3	2	0	0	0	0	0	0	4	2	0	0	0	1	0	4	2	0	0	3	0	1	0
29	59	2	1	2	2	0	0	1	0	0	0	0	0	0	0	0	7	17	0	0	0	0	0	1	0	0	0	0	0	0	0
30	58	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	59	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0
32	59	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0
33	59	3	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	13	0	0	0	0	0	0
34	59	0	0	0	5	0	0	7	0	1	0	1	0	0	0	0	5	0	0	2	3	0	0	1	1	0	0	0	0	0	0
35	59	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	2	2	2	0	5	2	0	0	0	0	0	0
36	59	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	9	0	1	1	0	0	0	11	8	1	0	0	0	0	0
37	59	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Total	3327	46	55	77	30	8	5	16	62	23	1	12	4	35	2	12	226	460	23	120	10	98	137	473	49	17	20	23	1	20	7
Rate/100 camera nights		1.4	1.7	2.3	0.9	0.2	0.2	0.5	1.9	0.7	0	0.4	0.1	1.1	0.1	0.4	6.8	14	0.7	3.6	0.3	2.9	4.1	14	1.5	0.5	0.6	0.7	0	0.6	0.2

Appendix 4: Summary Data of track and sign survey in 2008*

Pe-riod	Location	Total Distance (km)	Otter spp	Pig-trailed Macaque	Bear spp	Pillars squirrel	Civet spp	Wild boar	Black Giant squirrel	Wild Elephant	Hog Badger	Big cat spp	Sambhur Deer	Barking Deer	Gibbon spp	Small cat spp	Fishing cat	Porcupine spp	Mongoose	Long-tail Macaque	Medium cat spp	White-Handed Gibbon	Serrow	Asiatic Dhole	Leopard Cat	Bush-tailed porcupine	Total Animals Traffic
Feb-08	Yebone stream trials	22.4	**7**	**4**	**17**	**3**	**24**	**29**	**3**	**2**	**6**	**3**	**17**	**6**	**3**	**7**	**4**	**2**	**1**	**6**	**4**	**3**	**4**	**3**	**1**	**1**	**160**
Encounter rate/km			0.3	0.18	0.76	0.13	1.07	1.3	0.13	0.09	0.27	0.13	0.76	0.27	0.13	0.31	0.18	0.09	0.04	0.27	0.18	0.13	0.18	0.13	0.04	0.04	7.15

*Source: Ye Htut et. a…,report 2008