

**SUMATRAN ELEPHANT'S DIETARY ECOLOGY, MOVEMENT
AND HABITAT USE: USING ECOLOGICAL APPROACH TO
SAVE ENDANGERED ASIAN ELEPHANT AND THEIR
HABITAT IN INDONESIA**

**Interim Report:
September 17, 2007**

**A REPORT TO
THE INTERNATIONAL ELEPHANT FOUNDATION**



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INTRODUCTION

Asian elephant (*Elephas maximus*) populations continue to decline due to habitat loss, poaching and conflict with humans (Santiapillai & Jackson 1990; Sukumar 1992; Blake & Hedges 2004). In Sumatra, elephant populations are fragmented into small isolated population and cause conflict with humans (Santiapillai & Jackson 1990). Rapid land conversion into plantations cause extensive loss of elephant habitat. Furthermore, land conversion into plantation (i.e palm oil, rubber) is now a main priority of the development programs of most local governments in Sumatra. Developing a conservation strategy then becomes more complicated because limited ecological information exists about Asian Elephants in Sumatra. Clearly, to identify priority areas for elephant conservation we need more information on current population distribution and more importantly scientific information on elephant ecology. Ironically, until now, studies on dietary ecology of Sumatran elephant have never been conducted. Furthermore, there are no studies, which have attempted to link dietary ecology to the habitat quality across remaining elephant habitat and human elephant conflict. Understanding elephant dietary ecology will help us determine suitable areas for elephants, mitigating human elephant conflict and restoring elephant habitat.

In Sumatra, elephant range is mainly found as a cluster of fragmented elephant habitat with large and small elephant populations (Leimgruber et al. 2003). Conservation efforts for most elephant habitat in Sumatra therefore has focused on increasing the effectiveness of existing protected areas; identifying corridors linking protected elephant range, and better land use planning (Santiapillai & Jackson 1990; Leimgruber et al. 2003). To date, none of these recommendations have been adequately implemented, because of the lack of information on elephant habitat use, seasonal movement and home range area. Connecting isolated elephant populations by developing corridors to the larger elephant populations had been suggested to increase the long-term survival of the species. For example, in Bengkulu province, the corridor connecting SECC to KSNP had been proposed by Bengkulu Natural Resource and Conservation Agency (BKSDA Bengkulu) to the Directorate General Forest Protection and Nature Conservation, in the Indonesian Ministry of Forestry (PHKA). This proposal is very important, and scientific information to support this proposal is clearly needed. In this study we will investigate how intensively elephants use the corridor connecting SECC and KSNP as habitat, and how this corridor facilitates wild elephant movement as a part of landscape permeability concept. We believe if we can scientifically determine the importance of the proposed corridor for elephants, we have a better chance to establish the corridor as a protected area, and save one of the last remaining elephant population from extinction in Sumatra.

Project Goals and Objectives

The goals of this project are to determine elephant dietary ecology and to assess elephant movement, home range and habitat use in SECC and surrounding area. The specific objectives of this project are;

1. To determine elephant dietary ecology in the tropical lowland forest in Sumatra
2. To assess elephant movement, home range, and habitat use, in SECC and corridor area connecting SECC to KSNP.
3. To determine if crop raiding frequency can be predicted from the phenological cycle in food quality in and adjacent to SECC.
4. To build a predictive model of crop raiding by elephants.

PROGRESS REPORT

General / Administration

The project had been delayed for several months due to the problems encountered on transfer of funding from IEF to the Principal Investigator. The project started in late March 2007 and currently is well progressing. Some necessary equipment had been purchased (GPS, compasses, rain gauge, binocular, etc). Recent satellite imagery for Seblat Elephant Conservation Center (SECC) and surrounding area has also been purchased. One house in SECC has been renovated and used as base camp for the project.

Four mahouts from SECC have been hired to form a permanent core elephant dietary ecology team. A BKSDA staff member has been hired as a project counterpart, with special responsibility for coordinating the activity in SECC. One cook is also hired for the project.

Sumatran elephant dietary ecology

Effective conservation and management requires knowledge of species dietary ecology, habitat utilization and movement patterns. Unfortunately, foraging behavior of forest-dwelling wild elephant populations like Sumatran elephant are extremely difficult to observe due to the low visibility in forested area. Therefore wildlife ecologists use *lead animal technique* to understand dietary ecology of forest elephant. Lead animal technique has several advantages such as provide very precise information about food types and also selection can be investigated by sampling available foods.

During period of March 2007 – August 2007, we use six adult females' elephant (Table 1) from Seblat Elephant Conservation Center (SECC) to investigate elephant natural diet, food habits and diurnal activity budget. Elephant were released free ranging in SECC area and followed by one observer and one mahout starting around 6 am in the morning until 5 pm in the afternoon. Elephant activity such as: feeding, moving, resting, and drinking were recorded every 5-minute interval using focal observation (Altman 1974). All species eaten were sampled and collected for identification. Main elephant diet is also sampled for protein contents analysis.

Name	Sex	Shoulder height (cm)	Approximate weight (kg)	Approximate Age (years)
Anggreni	AF	204	1454	21
Fatma	AF	206	2150	20
Darmi	AF	220	2267	23
Tria	AF	224	2344	31
Natalia	AF	220	2190	35
Yanti	AF	205	1735	23

Table 1. ECC elephants used for dietary ecology study period March 2007 – August 2007

A. Activity budget

Total 1334 hours of observation on daily activity were recorded during period of March 2007 to August 2007 on six adult female elephants (Table 1). Four main activities (moving, feeding, resting and drinking) were recorded daily and average time budget and standard deviation is calculated for each individual elephants. The result of this study indicates that Sumatran elephant may spend about 66 % to 88 % of their time in feeding during the day (Figure1; Table 2). Other studies in Africa shows time-activity budgets of elephants on feeding varies from 40% to 75% (Guy 1976; Lindsay 1994). Studies in Sri Lanka reported that male elephant might spend up to 94% of their time-activity budget on feeding (Mckay 1973; Vancuylenberg 1977).

Elephants/Sex	Moving/ (SD)	Feeding / (SD)	Resting/ (SD)	Drinking / (SD)	Total Hours
Anggreni/AF	27.79 (14.24)	66.36 (13.48)	3.94 (2.97)	1.91 (1.25)	114.58
Fatma/AF	7.91 (4.30)	88.10 (4.14)	1.53 (2.13)	2.46 (1.94)	326.33
Darmi/AF	10.57 (5.22)	82.99 (6.99)	4.56 (5.52)	1.89 (1.80)	314.42
Tria/AF	6.25 (3.68)	86.21 (6.00)	5.98 (4.04)	1.56 (0.95)	243.50
Natalia/AF	13.00 (7.17)	77.43 (7.33)	8.47 (3.78)	1.10 (1.25)	143.83
Yanti/AF	19.30 (8.36)	75.84 (8.94)	4.33 (2.52)	0.53 (0.81)	191.33

Table 2. Average time budget and standard deviation of six adult female elephants in Seblat Elephant Conservation Center (SECC) Sumatra.

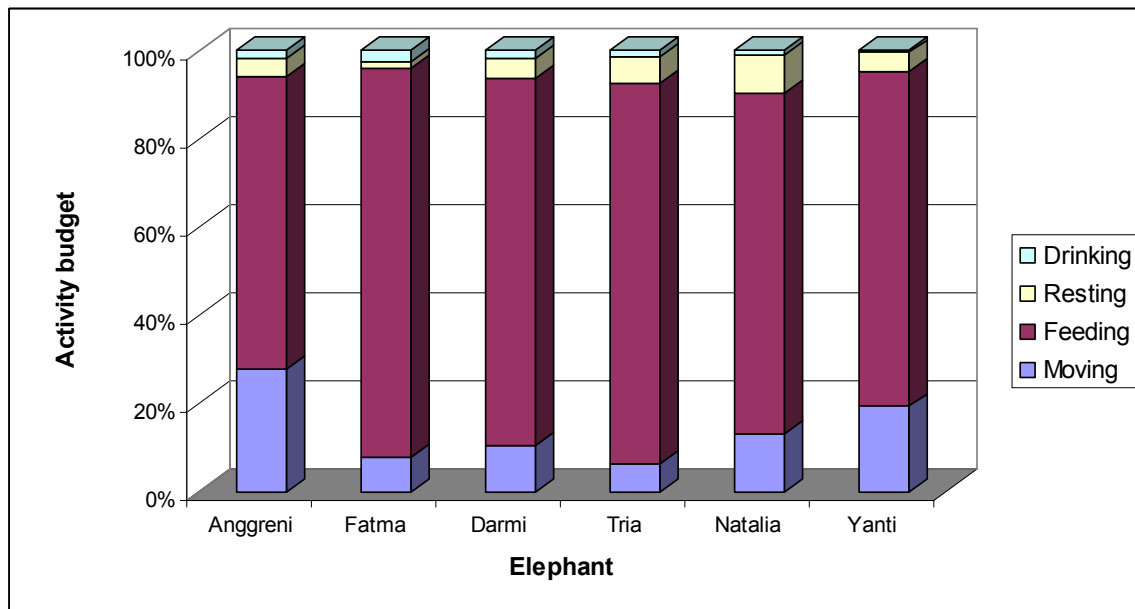


Figure 1. Time-activity budget on six adult elephants in Seblat Elephant Conservation Center (SECC)

I performed one-way ANOVA to investigate the differences on the individual elephant activity budget. The results shows that average time spent for each activity were significant different among individual (Figure 2, 3, 4 and 5).

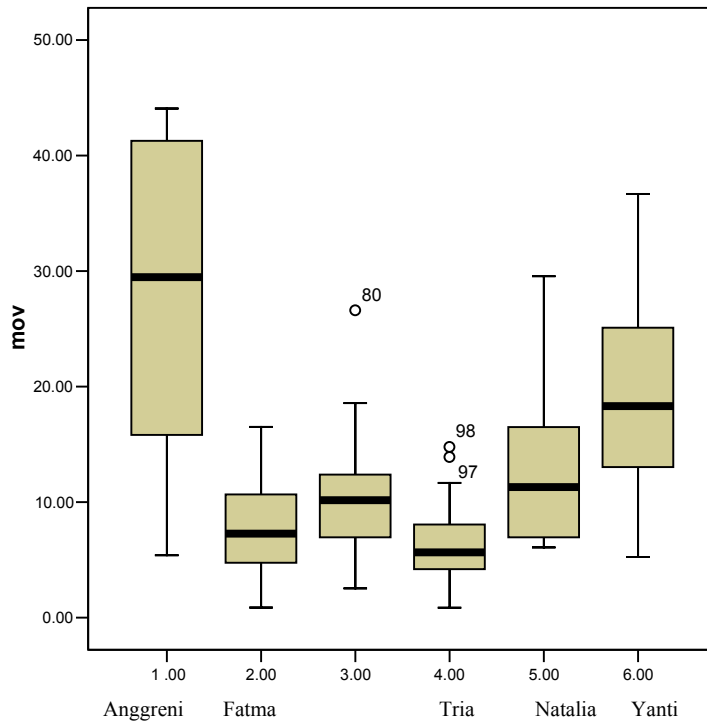


Figure 2. Comparison on “moving” activity among six individual elephants in Seblat Elephant Conservation Center, Sumatra

$F=24.39, P<0.01, df=5$

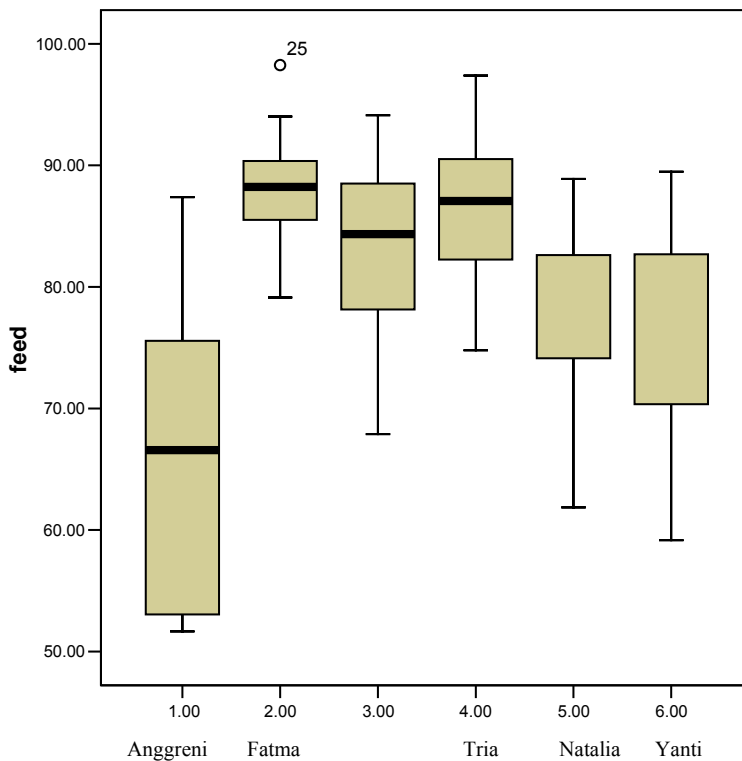


Figure 3. Comparison on “feeding” activity among six individual elephants in Seblat Elephant Conservation Center, Sumatra

$F=21.29, P<0.01, df=5$

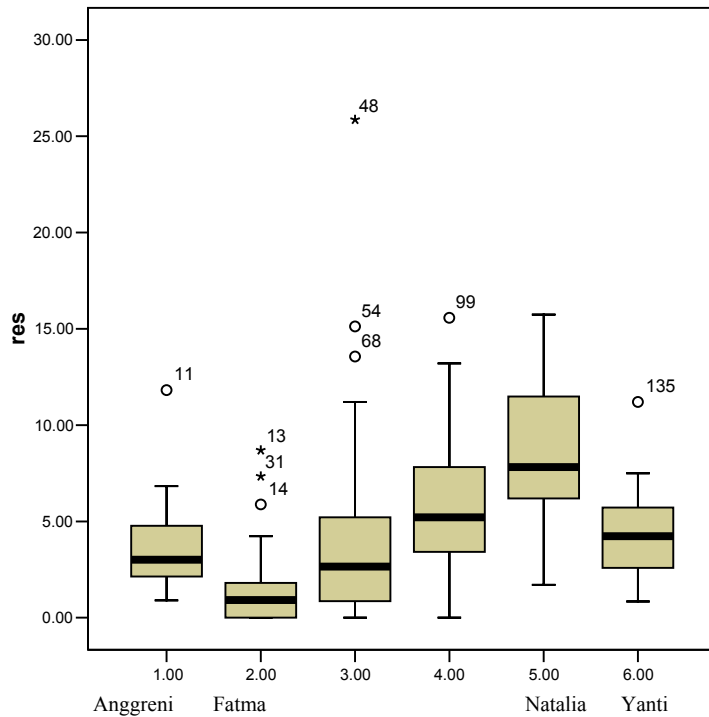


Figure 4. Comparison on “resting” activity among six individual elephants in Seblat Elephant Conservation Center, Sumatra

$F=8.33, P<0.01, df=5$

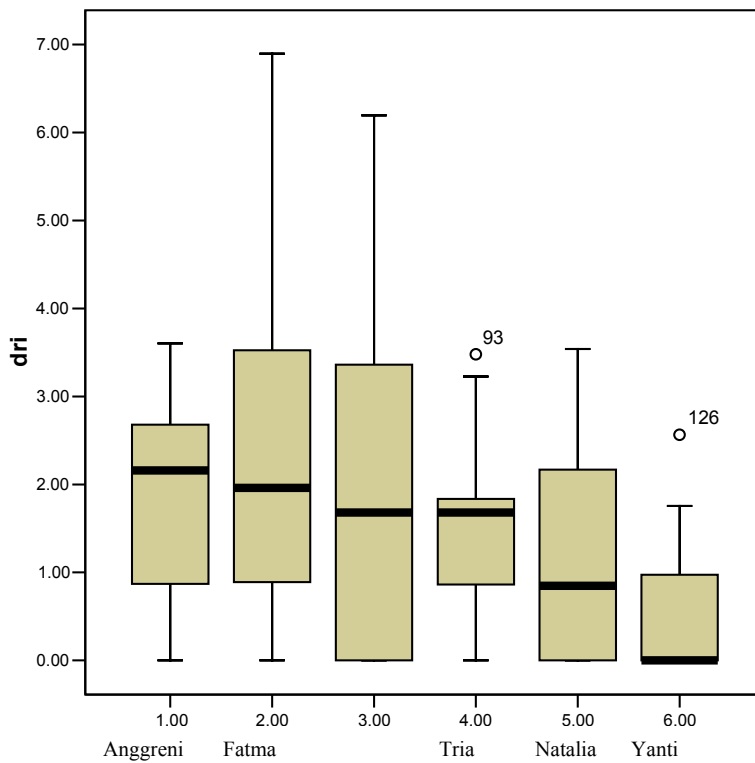


Figure 5. Comparison on “drinking” activity among six individual elephants in Seblat Elephant Conservation Center, Sumatra

$F=4.86, P<0.01, df=5$

To identify which individual elephant had different time-activity budget compared to other individual elephant, therefore I conduct post hoc TUKEY- HSD statistical test. The results show that Aggreni has significant different time-activity budget on feeding and moving compared to other individual elephant (Table 3). We have limited data at this stage of study period to determine why these phenomena occur. Further observation to investigate this phenomenon will be conducted in the next six-month period of this study.

	Angreni	Fatma	Darmi	Tria	Natalia	Yanti
<i>Moving</i>						
Angreni		**	**	**	**	*
Fatma			ns	ns	ns	**
Darmi				ns	ns	**
Tria					*	**
Natalia						ns
Yanti						
<i>Feeding</i>						
Angreni		**	**	**	*	*
Fatma			ns	ns	**	**
Darmi				ns	ns	*
Tria					**	**
Natalia						ns
Yanti						
<i>Resting</i>						
Angreni		ns	ns	ns	*	ns
Fatma			*	**	**	ns
Darmi				ns	*	ns
Tria					ns	ns
Natalia						*
Yanti						
<i>Drinking</i>						
Angreni		ns	ns	ns	ns	ns
Fatma			ns	ns	**	**
Darmi				ns	ns	**
Tria					ns	ns
Natalia						ns
Yanti						

Table 3. Statistical comparisons among individual elephant on their four main activity budget

Note: (**): Significant level $P < 0.01$ (*): Significant level $P < 0.05$, (ns): Not Significant

B. Feeding rate

During this period I observed elephant feeding rate while elephants grassing. Average elephant feeding rate on grass in Seblat ECC is **0.86** trunkful per minute ($sd=0.33$; $N= 39$). This finding is

similar with the result found by Sukumar in Biligirirangans, India. This result shows that elephant's physical and physiological character is probably more important parameter to determine elephant feeding rate rather than environmental characteristic. Compared to other studies, Asian elephant also shows less variation in their feeding rate and feed relatively less rapid compare to African elephant (Table 4). Sukumar (2003) argue, because of the quantity grass per trunkful is substantially higher in Asian elephant compare to African thus daily intake that expressed, as a percentage body weight is relatively similar. We will collect more data in this study in the next six-months period to investigate this type of behavior. We will also investigate elephant feeding rate on browsing.

Locality	Sex	Season	Time of Observation	Trunkful/minute (Grass)	Source
Sengwa (Zimbabwe)	F	Wet	Daytime	3.7	Guy (1975)
	M	Wet	Daytime	3.0	
	F	Dry	Daytime	2.0	
	M	Dry	Daytime	1.5	
Gounda-St Floris (Central African Republic)	F/M	Wet	Fulltime	5.2	Ruggiero (1992)
	F/M	Dry	Fulltime	5.0	
Amboseli (Kenya)	F	Wet	Fulltime	5.7	Lindsay (1994)
	M	Wet	Fulltime	5.4	
	F	Dry	Fulltime	3.5	
	M	Dry	Fulltime	4.4	
Gal Oya (Sri Lanka)	F/M	Wet/Dry	Daytime	1.4	McKay (1973)
Biligirirangans (India)	F/M	Wet	Daytime	0.8-1.7	Sukumar (1989a)
	F/M	Dry	Daytime	0.8-1.7	
<i>Seblat (Sumatra-Indonesia)</i>	<i>F</i>	<i>Dry</i>	<i>Daytime</i>	<i>0.86 (sd=0.33)</i>	<i>This study</i>

Table 4. Comparison of feeding rate in African and Asian elephant population from various studies and this study

C. Elephants diet

From March 2007 to August 2007 study period we found elephant in their habitat at least consume about **370 species** of plants (Figure 6). Part eaten include, short and tall grass, bark, roots, liana forbs, twigs and leaves. We have sent about 70% of the sample plants to Herbarium Bogoriensis for identification. The list of species eaten by elephant will provided after determination from Herbarium Bogoriensis completed. For comparison, Robert Olivier (1978)

listed over 400 species (+/- 78% were palms) as potential food for Asian elephant in Peninsular Malaysia in three years of his study period. We will continue to sample elephant diet in Sumatra and compare the result to Olivier's after all the plants species are determined.

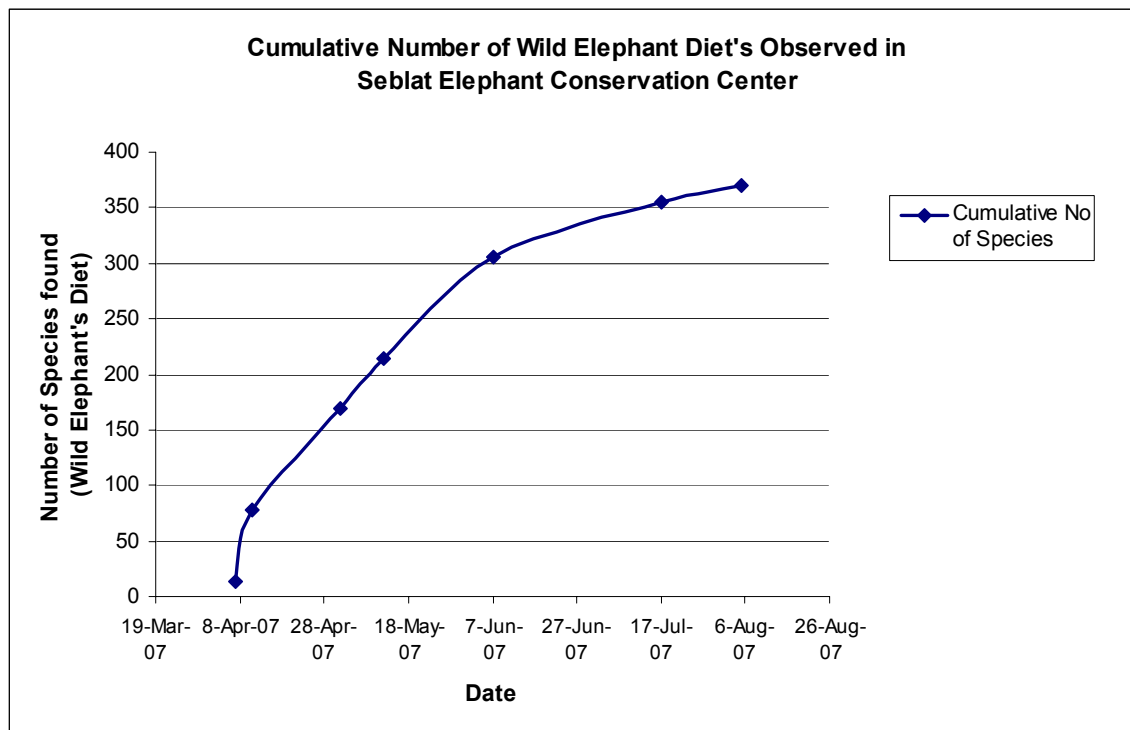


Figure 6. Cumulative number of elephants diet observed in Seblat ECC during period of March 2007 to August 2007.

D. Phenology Pattern

We completed setting up 30 phenology plots across study area during this period of study. Every five-phenology plot was located within 1 km x 1 km grid. Plot location were placed randomly at 100 meters distance between plot. We tagged all tree above 10 cm dbh and monitor the phenology pattern of individual tagged tree every month. Total trees tagged are **174 trees**. Average tree density is 5.8 per 100 m² ($SD=1.9$). Our data shows there is a strong relationship between tree diameter and tree height ($F=237.7$ $df=1$ $P<0.001$; Figure 7). Tree diameter distributions within plots shows that 84% of the tree has dbh between 10 cm -30 cm. This result suggest that large tree in the study area had been selectively logged in the past. Phenology pattern during six-month period (March to August 2007) shows only 9% are fruiting and 1% is flowering. We will continue monitor tree phenology in the next six-month. We will also quantify herbs and grass within the plots that are identified as major elephant diet and investigate their seasonal availability. We will correlate this data with the elephant movement pattern in SECC area.

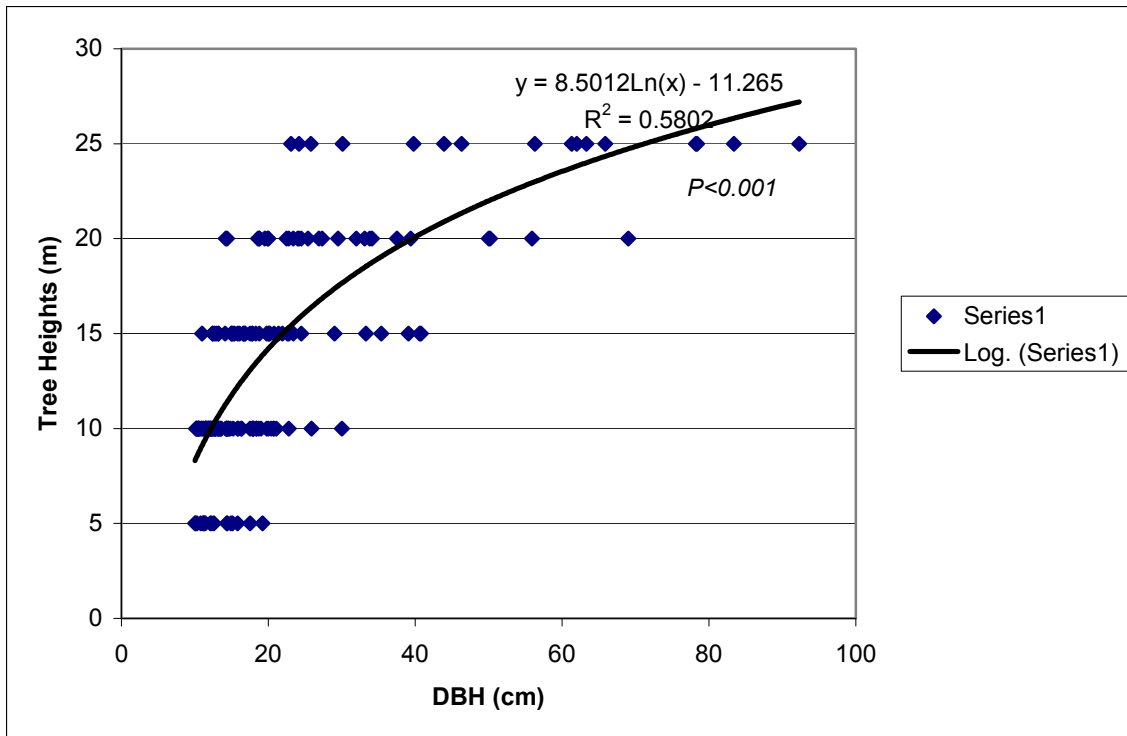


Figure 7. The relationship between tree diameter at breast height (dbh) and tree height in 30-phenology plots in SECC area

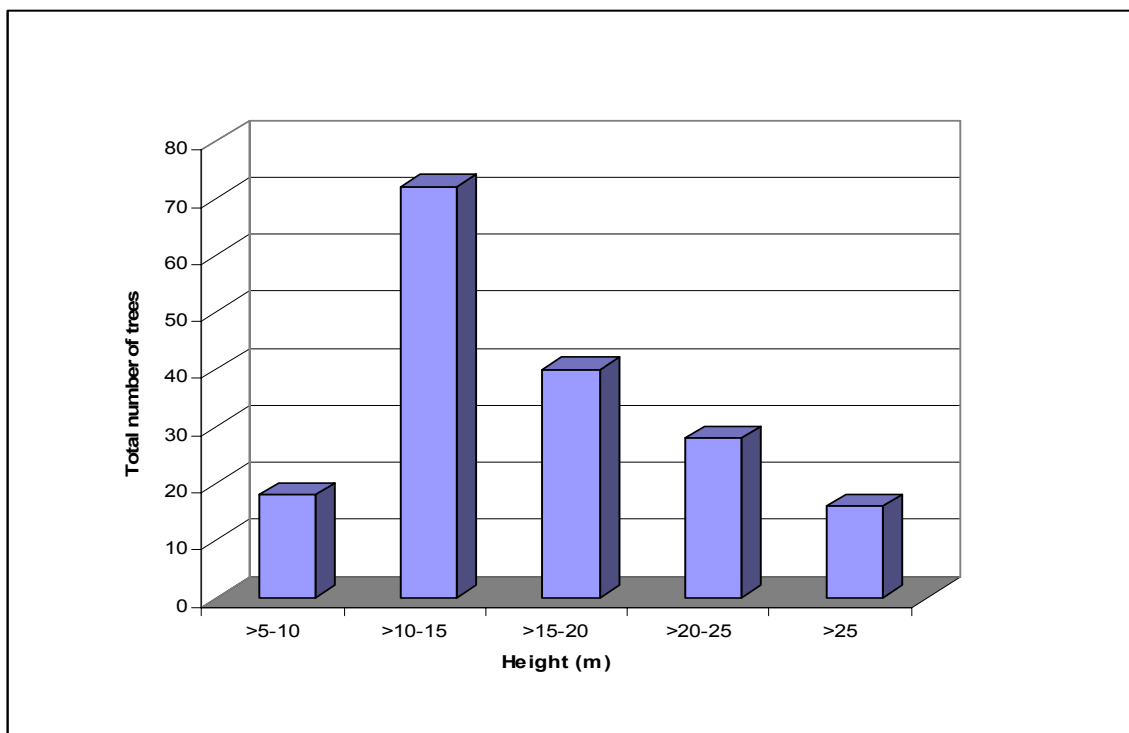


Figure 8. Tree height distribution in 30 plots (10 m x 10 m) across SECC area, all tree measured is >10 cm dbh.

Collaring wild elephants for telemetry studies

In August 25, we successfully collared one adult female elephants in SECC. The adult female was found with male infant about 5 years old. The collaring process was conducted in collaborative effort among CRU team (IEF, BKSDA and FFI Project), Forest Ranger from BKSDA Bengkulu, a staff from Way Kambas National Park (Nazaruddin) and a professional veterinarian (Wisnu Wardana, DVM). We use GPS collar manufactured by African Wildlife Tracking (South Africa) and service from Global Track Company for data collection. The collaring process was conducted in about 2.30 hours and is probably the fastest collaring process ever in the whole Asia. Collared elephant named **SENARA** and she was collared in northeastern part of SECC area (47 S 0801510 UTM X and 9657390 UTM Y).

We use standing sedation technique for elephant immobilization. We use 7 ml Xylazine (100 mg/ml), intra muscular, using long-range rifle tranquilizer gun. Elephant were darted in the left posterior of dorsal ilium (*gluteus maximus muscle*). We then apply 4 ml Ketamine Hydrochloride 100 mg/ml, intra muscular using local injection technique to make sure that the elephant are properly sedated and save to be fitted with GPS collar.

We apply antibiotic 50 ml Penstrep (Procaine Penicillin G 200.000 IU & Dihydrostreptomycin sulphate 200 mg), intra muscular at the area were darting applied to make sure there will not be any infection from the sedation process. Garamycin ointment was applied to both elephant eyes to avoid eyes exposed to dehydration. Medical examination during the collaring process shows the respiration is 6 pulses per minute, heartbeat is 32 pulses per minute and body temperature is 36.1 °C. Physical measurements were also conducted. Circumference of front leg (FL) is 120 cm; rear leg (RL) is 125 cm; shoulder height (SH) 217 cm; total body length (TBL) is 280 cm; and breast circumference is 350 cm. Blood sample (10 ml) was taken sent to medical laboratory for EDTA and CBC test.

We conduct monitoring on elephant movement using global track online satellite system (www.globaltrack.co.za). Data on point location are collected three times per day in eight hours interval. Data collected at 02:00 hours GMT, 10:00 hours GMT and 18:00 hours GMT. GPS login time per data collection was set up in 9 minutes period. GPS login time will be evaluated in the next three months period and will be increased if necessary. We linked the data to Google Earth (<http://earth.google.com>) for real-time visualisation and we found that within seven days after collaring process, **SENARA** moved at least 11 km from the collaring location (Figure 9).

Crop raiding pattern around SECC

We will collect data on crop raiding by elephant around SECC area in the next six-month period. Every month we will visit each village around SECC area and measure the damage from any elephant incidents reported by farmers. We will select village within 1 km from the SECC boundary and conduct crop planting to determine seasonal pattern of crop availability. This data will use to build predictive model of crop raiding around SECC. The result of this study will be provided in the final report.

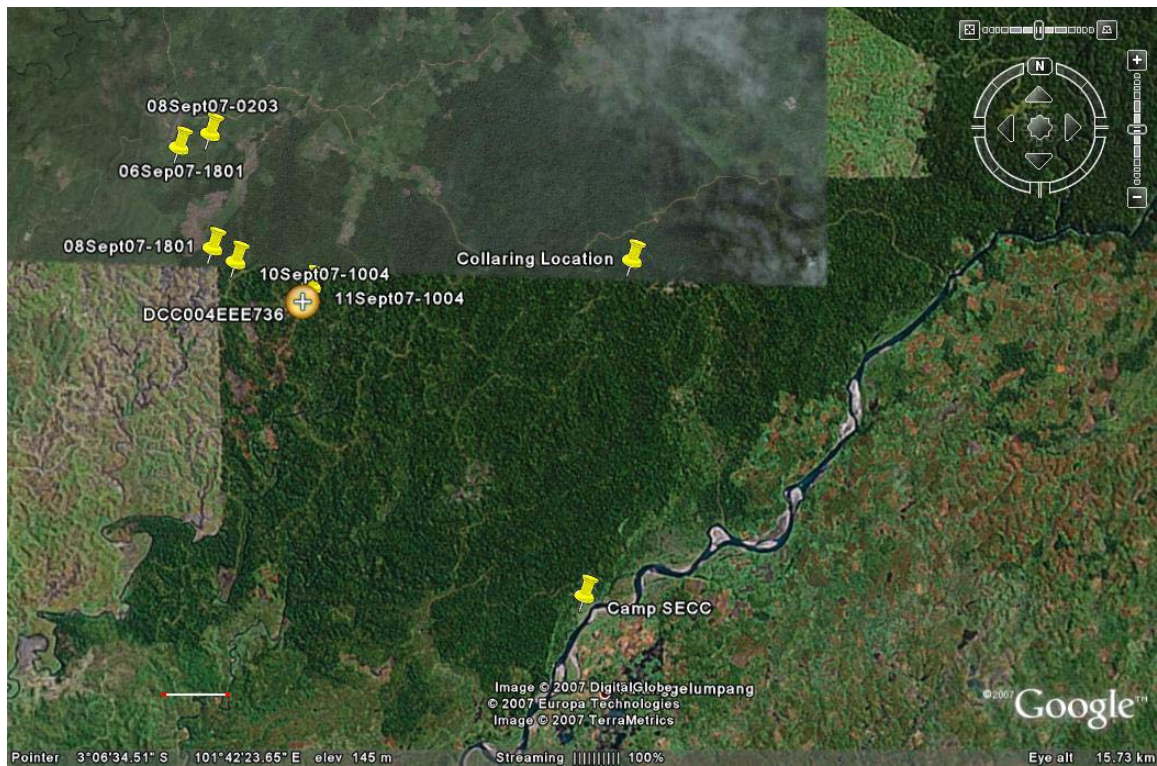


Figure 9. Some data points from August 25 to September 11 and the relative position to the collaring location and SECC camp. White line in the bottom left corner is representing 1 km distance. Date and time (GMT hh:mm)

Other activities

Project investigator (PI) has been actively involved in the discussion on elephant conservation at the national level. The PI had been appointed as a key speaker to represent elephant scientist group on the Sumatran and Kalimantan Elephant and Sumatran Tiger National Action and Strategic Plan Workshop. The workshop was held in three stages and hosted by Indonesian Government, Ministry of Forestry. The first and second workshop called Focus Group Discussion (FGD I and II). FGD I, was held in Cisarua, West Java on the 25-26 July 2007, FGD II was held in Taman Safari Cisarua, West Java on the 21-22 of August 2007, and the final workshop was held in Padang, West Sumatra on the 29-31 of August 2007. The main objectives of this workshop are to develop action and strategic plan for Elephant and Tiger Conservation in Indonesia and also to develop conflict mitigation protocol.

Problem encountered

There are some problems encountered during March 2007- August 2007 period.

1. There were few delayed on elephant feeding ecology study in the month of August due to the half of the total mahouts (15 out 30) were sent to North Sumatra Province for government staff recruitment training program in three weeks. This situation had significant impact to our observation schedule. Mahouts who stayed in camp need to handle all elephants (21 elephants) for bathing, and moved them to the feeding ground, therefore there were not any mahouts available to accompany this study.

2. Earthquake in Bengkulu province area on the 12 September 2007 damaged a few of our mahout's house. The epicenter was located in 80 miles east west of Bengkulu Province coastline. However none of the mahouts and their family was found injured. Some delay on feeding ecology study occurred because of this event.

Plans for the next six-month period of the study

1. Dietary Ecology Study

1. Continuing the observation on elephant natural diet, food habits and diurnal activity budget.
2. We will collect more data on elephant feeding rate on grassing and browsing.
3. We will compile data on all plant species sampled and determined by Herbarium Bogoriensis.
4. We will conduct crude protein contents analysis and fiber analysis on major elephant diet.

2. Telemetry studies

1. We will monitor collared elephant (SENARA) movement, habitat use and home range size.
2. We will purchase two unit GPS collars from African Wildlife Tracking and fitted to wild elephants.
3. We will purchase high-resolution aerial photograph for SECC and surrounding area for further habitat analysis.
4. We will conduct ground-truthing to determine habitat configuration in SECC and surrounding area.

3. Developing predictive model of crop raiding

1. We will monitor crop raiding by elephant in SECC and surrounding area.
2. We will conduct survey farmers planting and harvesting scheme in the villages around SECC area.
3. We will continue to monitor phenology pattern in all sample plots in SECC area.
4. We will quantify herbs and grass within the plots that are identified as major elephant diet and investigate their seasonal availability.

APPENDIX



Figure 10. Adult female (Fatma) elephant feeding palm (Salacca sp. Arecaceae)



Figure 11. Adult female (Tria) elephant feeding rattan (Calamus sp. Arecaceae)



Figure 12. Elephant (Fatma) picking up figs fruit (Ficus sp. Moraceae) on the ground



Figure 13. Project investigator observes elephant feeding rate on grass (Family Graminae) in Seblat ECC.



Figure 14. Project investigator (red shirt) fitting GPS collar on the wild elephant and assisted by professional veterinarian (Wisnu Wardana, DVM-far left) and CRU Coordinator (Aswin Bangun-far right).



Figure 15. Adult female elephant (SENARA) after fitted with GPS collar



Figure 16. The team involve in the collaring process (from left to the right below: Wisnu Wardana, DVM, Yanti DVM, Simanjuntak, Nazaruddin, Arnold Sitompul. On top of elephant from left to the right: Izal, Rassidin, Sunarko)

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