EXPEDITION REPORT

Expedition dates: 4 - 12 November 2019

Report published: October 2020

Elephant encounters:
Studying Asian elephants in the hills of northern Thailand to increase their welfare and conservation

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Kindred Spirit Elephant Sanctuary
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Authors:
Alex Johncola
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Matthias Hammer (editor)
Biosphere Expeditions

UN environment   IUCN   ecsa
European Citizen Science Association

Abstract

This study was a collaboration between Biosphere Expeditions and Kindred Spirit Elephant Sanctuary (KSES). Direct observation methods were used by citizen scientists to collect three separate data sets on five free-roaming semi-wild Asian elephants simultaneously: activity budgeting (via instantaneous sampling), foraging habits (via all-occurrence focal sampling) and social-association behaviour (via scan sampling).

Sixteen hours of activity budget data collected on each of the five elephants showed that, like wild Asian elephants, the study subjects spent the majority of their time foraging, followed by exploring. There was no significant difference between the behaviours displayed by the five elephants.

The foraging data collected during the expedition showed a high variety of plant species foraged on (17 species from seven different families). The elephants foraged almost exclusively on browse (99.4%) rather than graze species (0.6%). There was no significant difference in the plant species that they foraged on.

The elephant association data set used the proximity of the study subjects to examine social affiliation and closeness among the elephants. The elephants had varying social preferences. Four elephants regularly associated with one another, but did not consistently segregate into distinct groups. One male elephant was mostly observed on his own (87%). Close association was commonly observed amongst the youngest male and two females (42%, 45% and 27%) and less in the teenage males (17% and 13%)

Overall, the data collected are the first of their type on semi-wild free-roaming Asian elephants. There is much room for improvement in regards to management of captive elephant populations. The differences in behaviours exhibited by the elephants in this study, when compared to other captive populations, highlight this. We posit that if captive elephant populations were able to act more naturally, their behaviours and of those in this study would be more similar. Further research on the five study elephants will ensure data precision, with the intention of publication and the creation of an elephant management guide to be distributed to elephant venues in Thailand and around the world to achieve this. As a step towards this, KSES and Biosphere Expeditions have just published a research article on the foraging ecology of the study elephants in a peer-reviewed journal.

บทคัดย่อ

การวิจัยครั้งนี้เป็นความร่วมมือระหว่างไบโอสเฟียร์เอ็กซ์เพดิชั่นส์ (Biosphere Expeditions) และมูลนิธิหัวใจรักษ์ช้าง
คณะนักวิจัยได้ใช้วิธีการเฝ้าสังเกตโดยตรง เพื่อจัดเก็บข้อมูลสามชุดจากช้างสายพันธุ์เอเชียจำนวนห้าเชือก
ที่เลี้ยงแบบปล่อยอิสระในสภาพแวดล้อมกึ่งธรรมชาติ อันประกอบไปด้วย การจำแนกกิจกรรม
(จากการเฝ้าสังเกตพฤติกรรมตัวอย่าง), พฤติกรรมการหากิน (จากการเฝ้าสังเกตช้างตัวอย่างแต่ละเชือก), และพฤติกรรมทางสังคม
(จากการเฝ้าสังเกตช้างตัวอย่างแต่ละเชือก)

จากการเฝ้าติดตามเก็บข้อมูลช้างแต่ละเชือก เป็นเวลา 16 ชั่วโมง รวมจำนวน 5 เชือก ได้แสดงให้เห็นว่า
เช่นเดียวกับช้างสายพันธุ์เอเชียในธรรมชาติ ช้างกลุ่มตัวอย่างในการวิจัยจะใช้เวลาส่วนใหญ่ไปในการหาเดินอาหาร และสำรวจพื้นที่
และไม่พบว่ามีความแตกต่างอย่างมีนัยสำคัญในการแสดงออกทางพฤติกรรมของช้างทั้ง 5 เชือก

ข้อมูลเกี่ยวกับการเดินหาอาหารที่บันทึกไว้ได้ในระหว่างกรวิจัยครั้งนี้ได้ชี้ให้เห็นว่าช้างได้เลือกกินพืชอาหารที่หลากหลาย
(17ชนิดจาก 7 วงศ์ที่แตกต่างกันออกไป) ช้างจะหากินกิ่งไม้ใบไม้เป็นส่วนใหญ่ (99.4%) มากกว่าที่จะกินหญ้า (0.6%)
และไม่มีความแตกต่างอย่างมีนัยสำคัญในชนิดของพืชที่ช้างกินเป็นอาหาร

ชุดข้อมูลเกี่ยวกับปฏิสัมพันธ์ของช้าง
ได้ใช้ระยะห่างของช้างแต่ละเชือกในการประเมินความเชื่อมโยงทางสังคมและความใกล้ชิดระหว่างช้างแต่ละเชือก
ช้างมีการทิ้งระยะห่างทางสังคมที่แตกต่างกันไป ช้างสี่เชือกมีปฏิสัมพันธ์กันอยู่เป็นประจำ แต่ก็ไม่ได้จับกลุ่มกันอยู่อย่างเห็นได้ชัด
ช้างเพศผู้หนึ่งเชือกมักจะสังเกตเห็นได้ว่าแยกตัวอยู่โดยลำพังโดยชัดเจน (87%) มักจะเป็นที่พบเห็นโดยทั่วไปว่าช้างที่อายุน้อยที่สุด
ทั้งเพศผู้หนึ่งเชือก และเพศเมียสองเชือกมักจะรวมกลุ่มกันอยู่อย่างใกล้ชิดอยู่เสมอ (42%, 45% และ 27%)
และพบเห็นได้น้อยลงในช้างวัยรุ่นเพศผู้ (17% และ 13%)

โดยภาพรวมแล้ว
ข้อมูลที่ได้มาถือว่าเป็นครั้งแรกที่มีการบันทึกข้อมูลช้างสายพันธุ์เอเชียในลักษณะที่มีการปล่อยอิสระในสภาพแวดล้อมกึ่งธรรมชาติ
และยังควรได้รับการปรับปรุงอีกมากในส่วนของการบริหารจัดการประชากรช้างในที่เลี้ยง ประเด็นที่สำคัญก็คือ
ความแตกต่างด้านพฤติกรรมที่ช้างได้แสดงให้เห็นในการวิจัยครั้งนี้ เมื่อเปรียบเทียบกับประชากรช้างในที่เลี้ยงกลุ่มอื่นๆ
เราสรุปได้ว่า หากประชากรช้างในที่เลี้ยงได้รับโอกาสให้แสดงออกพฤติกรรมตามธรรมชาติมากยิ่งขึ้น
พฤติกรรมการแสดงออกของช้างเหล่านี้และช้างกลุ่มตัวอย่างในการวิจัยก็คงจะมีความคล้ายคลึงกันมากยิ่งขึ้น
การวิจัยอย่างต่อเนื่องกับช้างกลุ่มตัวอย่างทั้ง 5 เชือกจะช่วยยืนยันความถูกต้องแม่นยำของข้อมูล
โดยมีจุดมุ่งหมายที่จะตีพิมพ์และสร้างแนวทางสำหรับการบริหารจัดการช้าง
เพื่อเผยแพร่ไปยังสถานที่เลี้ยงช้างทั้งในประเทศไทยและทั่วโลกให้สามารถบรรลุเป้าหมายเดียวกันนี้
และปัจจุบันนี้มูลนิธิหัวใจรักษ์ช้างกำลังดำเนินการให้มีการตรวจสอบเอกสารการวิเคราะห์ข้อมูลเกี่ยวกับพฤติกรรมการหากินของช้า
งกลุ่มตัวอย่างอีกครั้ง

UN environment IUCN ecsa European Citizen Science Association

Contents

1. Expedition Review

Matthias Hammer (editor)
Biosphere Expeditions

1.1. Background

Background information, location conditions and the research area are as per [Gale & Hammer (2019)](). This expedition conducted close-encounter studies on a herd of five Asian elephants at Kindred Spirit Elephant Sanctuary (KSES) in the hills of Northern Thailand. KSES rescues elephants from the tourism industry and returns them to their forest homes. The elephants at KSES live in semi-wild conditions, providing an opportunity to study individual and herd behaviours, as well as dietary preferences. KSES is amongst only a handful of projects in Thailand that allow rescued elephants to return to a near natural life in the forest. Because of the scarcity of such projects and because of the difficulties of studying elephant behaviour in dense forest habitat, few studies exist. The goal of these studies is therefore to expand on the limited knowledge of natural behaviours and dietary preferences of Asian elephants so that more elephants can be brought back into the wild in the future, effectively and maximising animal welfare. During the expedition, citizen scientist researchers focused on three studies: elephant behaviour, herd association and foraging. All studies were solely observational with no interaction between the elephants and researchers. The study site is based in a Karen hilltribe village situated in the mountains, with an elevation between 650 m and 1,100 m. The elephants have around 14 square kilometres to roam.

1.2. Dates & team

The project ran from 4 to 12 November 2019 and the expedition team comprised national and international citizen scientists, a professional scientist and an expedition leader. The study period was chosen to coincide with the mildest climate in terms of temperature extremes. It is also a good time of the year to collect data as the forest food for the elephants, as well as forest biodiversity, is still thriving after the rainy season.

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of ages, nationalities and backgrounds. They were (in alphabetical order and with country of residence): Anneke Berendts (Netherlands), Anna Blümel (Germany), Bianca Caranua* (Australia), Anthony Lyons** (Spain), Nick Rice* (UK), Gesa Scharpff (Germany), Henning Scharpff (Germany). *Journalist/blogger (see [coverage]()). ** Biosphere Expeditions support staff.

Malika Fettak, the expedition leader, is half Algerian, but was born and educated in Germany. She majored in Marketing & Communications and worked for more than a decade in both the creative department, and also in PR & marketing of a publishing company. Her love of nature, travelling and the outdoors (and taking part in a couple of Biosphere expeditions) showed her that a change of direction was in order. Joining Biosphere Expeditions in 2008, she runs the German-speaking operations and the German office and leads expeditions all over the world whenever she can. She has travelled extensively, is multilingual, a qualified off-road driver, diver, outdoor first aider, and a keen sportswoman.

Alexandra Johncola was the incoming expedition scientist for the 2019 expedition. Alexandra studied Integrative Animal Biology and Psychology at the University of South Florida. After studying elephants in South Africa, she came to Thailand in 2018 to study Asian elephants and has remained in Thailand since. Alexandra has been on the KSES team for over two years, implementing and continuing studies on the elephant herd in order to gain insight on natural Asian elephant behaviours.

Talia Gale, the outgoing expedition scientist, studied Zoology at the University of British Columbia. Talia first came to Thailand in 2011 to study Asian elephant foraging behaviour. After working in Canada for 2 years in the field of veterinary science, she returned to Thailand again to work with and study Asian elephants on a project near Chiang Mai. Talia has been working in Thailand for over 4 years, both in the north studying elephants and in the south studying sea turtles and general biodiversity. In May 2016 Talia began working with KSES where her main focus has been designing and carrying out studies on their elephants' social structure and behaviours.

Kerri McCrea was born in Co. Tyrone, Northern Ireland and studied Zoology at Queen's University Belfast. Having already worked on conservation projects in Australia and Sri Lanka, Kerri first came to Thailand in 2013 to help an elephant project with their community and research efforts. In May 2016, Kerri and her local partner Sombat founded KSES and brought home the first 4 elephants to live in the surrounding forests, and later added a fifth elephant. Kerri's main focus is to oversee all projects, including but not limited to, research, community, teaching, administration, project expansion and maintenance.

A medical umbrella, safety and evacuation procedures were in place, but did not have to be invoked, because there were no significant medical or other incidences (there was a sprained ankle, which was treated on site).

1.3. Partners

On this expedition Biosphere Expeditions' main partner was Kindred Spirit Elephant Sanctuary (KSES). Their mission is to bring as many elephants as possible back to their natural environment to live in semi-wild conditions and provide an alternative and sustainable livelihood for the human communities with which they share a living space. One of KSES's ultimate goals is to stop and eventually reverse the effects of the illegal elephant trade, as well as provide some much-needed research to give insights into natural elephant behaviour.

1.4. Acknowledgements

The expedition provided labour and funding, and permitted data collection to occur throughout the day, allowing for full data sets on KSES's elephants to be collected. We are grateful to the citizen scientist volunteers, who not only dedicated their spare time to helping but also, through their expedition contributions, funded the research. A big thank you to all the members of the local community, especially those who welcomed expedition participants into their homes with open arms, who guided us through the forest, who helped with transportation and who cooked amazing meals. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors for their support.

1.5. Further information & enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org. Enquires should be addressed to Biosphere Expeditions at the address given on the website.

1.6. Expedition budget

Each team member paid a contribution of €1,890 per person per nine-day slot towards expedition costs. The contribution covered accommodation and meals, supervision and induction, special research equipment and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., or visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	€
Expedition contributions	9,150

Expenditure	
Staff includes local and Biosphere Expeditions staff salaries and travel expenses	7,249
Research includes equipment and other research expenses	81
Transport includes fuel, taxis and other local transport	407
Expedition base includes board & lodging and base hut upgrade	1,340
Administration includes miscellaneous fees & sundries	54
Team recruitment Thailand as estimated % of annual PR costs for Biosphere Expeditions	8,676
Income – Expenditure	**-8,657**

Total percentage spent directly on project	**195%***

*This means that in 2019, the expedition ran at a loss and was supported over and above the income from the expedition contributions by Biosphere Expeditions.

2. Activity budgeting, foraging and social behaviour of free-roaming semi-wild Asian elephants

Alexandra Johncola & Talia Gale
Kindred Spirit Elephant Sanctuary

2.1 Introduction

Activity budget data

Activity budgets are a tool used to measure the amount of time an animal spends performing different behaviours. Activity budgets utilize an ethogram, which is a table outlining the behaviours or activities observed in the animal. Utilizing activity budgets provides an opportunity to compare wild and captive populations and identify differences in their behaviour in order to improve captive elephant welfare (Ahamed 2015). Activity budgets of captive elephants often differ from that of wild populations (Mackey 2014, Lukacs et al. 2016). This study investigates the activity budgets of a semi-wild herd of Asian elephants at Kindred Spirit Elephant Sanctuary (KSES). It is hypothesised that the activity budget of this semi-wild herd will mimic that of wild Asian elephants.

Elephant foraging data

Elephants are mega-herbivores, consuming up to 10% of their body mass a day in diverse fodder (Sukumar 1989, Sukumar 2006). Studies on wild Asian elephant foraging habits in different countries show elephants consume a variety of diverse plant species with a selective feeding strategy (Joshi and Singh 2008, Roy and Chowdhury 2014, Koirala et al. 2016). Elephants in captive facilities are often fed only a few species, comprised mostly of grasses and high sugar supplements. More information on the natural foraging preferences of Asian elephants in Thailand is needed to improve welfare standards for captive elephants. This study examines the foraging habits of five free-roaming elephants, which are free to forage as they please. Mahouts are present while the elephants are roaming to ensure that the animals do not enter areas such as villages and agricultural fields, thereby creating conflict. This study helps to fill the deficit of information on the diet of Asian elephants in their natural environment.

Elephant association data

Surprisingly little is known about Asian elephant social structures when compared to their African relatives. It has been established that African savannah elephants live in multilevel, hierarchal societies while the social units of Asian elephants are not well understood (de Silva and Wittemyer 2012). Studies suggest that African forest elephants live in smaller, simpler herds compared to African savannah elephants (Sukumar 2003). It is difficult to study the social structure of Asian elephants in Thailand due to the low visibility of their dense forest habitat and low numbers of wild populations. While the five elephants of KSES are semi-wild, they have the freedom to choose who they associate with and separate themselves into social units. This study aims to provide a glimpse into social interactions among Asian elephants.

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2.2 Materials and methods

The study site and animals are as per Gale & Hammer (2019). In summary, KSES is home to five elephants. All of these elephants were previously working elephants in the logging industry or in tourist camps. Too Meh is a female and the oldest elephant in the herd at 58 years old. Mae Doom is the daughter of Too Meh and the aunt of Dodo and Gen Thong. She is in her mid-twenties. Gen Thong is a male and the youngest elephant in the herd at eight years old. Boon Rott is a 14-year-old male elephant and the only unrelated elephant in the herd. These four elephants joined KSES when the organisation opened in 2016. Dodo, a 14-year-old male elephant, joined the herd in September 2018. Dodo and Gen Thong are brothers.

During the day, the elephants are free to roam the forest surrounding the base location of Ban Naklang village in the Mae Chaem district, Chiang Mai province, Thailand. There is approximately 40km^2 of forest in the surrounding area. Each elephant is accompanied by a mahout (caretaker). The mahouts stay with the elephants during the day while they are roaming to ensure they stay in the forest and do not wander into any agricultural fields or villages. The elephants have restricted movement at night for safety purposes. Each morning, the mahouts join the elephants, only instructing them on where to go if they head towards villages, fields or need to go to an area with more food and/or water available.

KSES does not purchase elephants, but instead provides a monthly compensation to the local elephant owners. This helps the local community provide for their families and also prevents illegal elephant trafficking and capture from the wild. KSES currently only has the funding to support five elephants, but hopes to bring more home to the forest in the future.

Data collection started at 08:00 and concluded at 16:00. Data was collected in one-hour periods, with the aim of collecting data on activity budget, elephant foraging and elephant association simultaneously. All data collected were solely observational with no interaction between the elephants and researchers.

Activity budget

During the expedition, two full data sets (08:00-16:00) were collected for each elephant. Data were collected via instantaneous sampling at five-minute intervals. At each interval, the observer recorded the behaviour exhibited by the individual elephant using a behavioural ethogram (Table 2.2a). Cloud cover (0, 25, 50, 100%) and ambient temperature were also recorded at each five-minute interval.

Elephant foraging

Data were collected via all occurrence focal sampling. The GPS coordinates and the elevation were recorded at the start of the observation. As the elephant selected plants to forage, the observer recorded the start and end time of the foraging incident, the name of the plant (local name provided by the mahout) and the part eaten by the elephant (bark, fruit, leaf, root, twig, stem). If the plant could not be identified, a description of the plant and detailed photos of it were taken.

Elephant association

Data were collected via scan sampling at five-minute intervals. At each interval the identity of an elephant's nearest neighbour and next nearest neighbour, and the approximate distance between them, were recorded. The distance between two elephants was split into four categories: (1) touching, (2) two trunks reach apart – approximately 3m, (3) one elephant length apart – approximately 6m, or (4) over 6 m apart.

Statistical analysis

Activity budget: At each interval, if a single behaviour was observed, it was given a value of 1; if two behaviours were observed simultaneously, they were each given a value of 0.5. Incidences recorded as 'cannot see' were omitted from analysis. Social bathing and social foraging were added to the 'socialising' category and drinking, rolling and digging were added to the 'other' category. A one-way ANOVA ($\alpha = 0.05$, $n = 5$) was performed across the behaviours for the elephants.

Foraging: A one-way ANOVA ($\alpha = 0.05$, $n = 5$) was performed (Microsoft Excel) comparing foraging encounters of each elephant.

Table 2.2a. Behavioural ethogram used in the field.

Behaviour	Description
Bathing	Standing/laying in water or mud; spraying water or mud over body with trunk
Digging	Digging in soil using the foot (but not as part of a dusting behaviour)
Drinking	Collecting water in the trunk and spraying it into the mouth
Dusting	Collecting soil and throwing it over the body/rubbing it into the skin (while standing still or walking), including digging in soil for this purpose
Exploring	Exploring any area of the environment; includes raising trunk to smell environment, using trunk on ground to explore substrate or other objects; does not include exploring forage
Foraging	Collecting solid food with the trunk and placing it in the mouth while standing or walking; includes tearing down tree and branches and exploring forage
Mahout interaction	Any interaction with a mahout
Rolling	Rolling in soil or mud (but not as part of playing with another individual)
Scratching	Scratching or rubbing any body part with another part of the body, or with an inanimate object
Socializing	Interacting with other individuals via touch of any body part (not as part of courtship)
Social Bathing	Interacting with other individuals via touch of any body part while bathing
Social Foraging	Interacting with other individuals via touch of any body part while foraging
Sex	Courting or being courted or mounting another elephant or being mounted by another elephant of either sex
Standing	Standing motionless
Walking	Walking (except while feeding)
Other	Any other behaviour
Cannot see	Elephant behaviour is not visible or not distinguishable

Figure 2.2a. Citizen scientists following the elephants through the forest (top) and observing the elephants in a field.

Training of expedition participants

For this study, data were collected by volunteer citizen scientists with little or no previous knowledge of wildlife research and conservation, elephant research or elephant behaviour. One participant, a citizen scientist from the 2018 expedition, returned for the 2019 expedition. Training included an introduction to differentiating individual elephants and elephant behaviours. Expedition members were required to pass an elephant identification and behaviour test prior to collecting data to ensure accurate data collection and quality.

A training hike and training data collection period were conducted in the field to familiarise participants with the conditions and expectations of collecting field data (e.g. walking on steep hillsides while recording elephant behaviour) prior to recorded data collection periods.

2.3 Results

Activity budget

192 incidents of behaviours were recorded for each elephant, for a total of 960. For 48 incidences, the elephants were out of sight (recorded as 'cannot see'). Out of 16 behaviours listed on the ethogram (Table 2.2a), the elephants displayed 15 behaviours. Sex was the only behaviour not observed. Foraging was the most prominent behaviour observed, with an average of 52% of the study time spent foraging. This was followed by exploring at 12%, socialising at 10%, walking at 8%, standing at 6%, dusting and scratching both at 3% and bathing, mahout interaction, and other all at 2% (Figure 2.3a). Mean temperature for each hour interval of data collection ranged from 20°C to 35°C. There was no significant difference in the behaviours observed for the five individual elephants ($F=0.005$, $p=0.999$).

Elephant foraging

877 minutes of foraging data were recorded, with 17 different species consumed, 10 of which were identified to the genus level, four to family and three to local names. The plants consumed and identified come from seven different families: Fabaceae (five species), Poaceae (four species), as well as one species each for Rubiaceae, Tiliaceae, Clusiaceae, Cucurbitaceae, Fagaceae.

The elephants consumed 99.4% browse species (bamboo, climbers, trees, shrubs, and herbs) and only 0.6% grasses. The most consumed plant was a new unidentified species added on this expedition (71.0%), followed by two species of bamboo (15.4%) (Table 2.3a). There was no significant difference between plants consumed by each elephant ($F=5.150 \times 10^{-4}$, $p=1.000$).
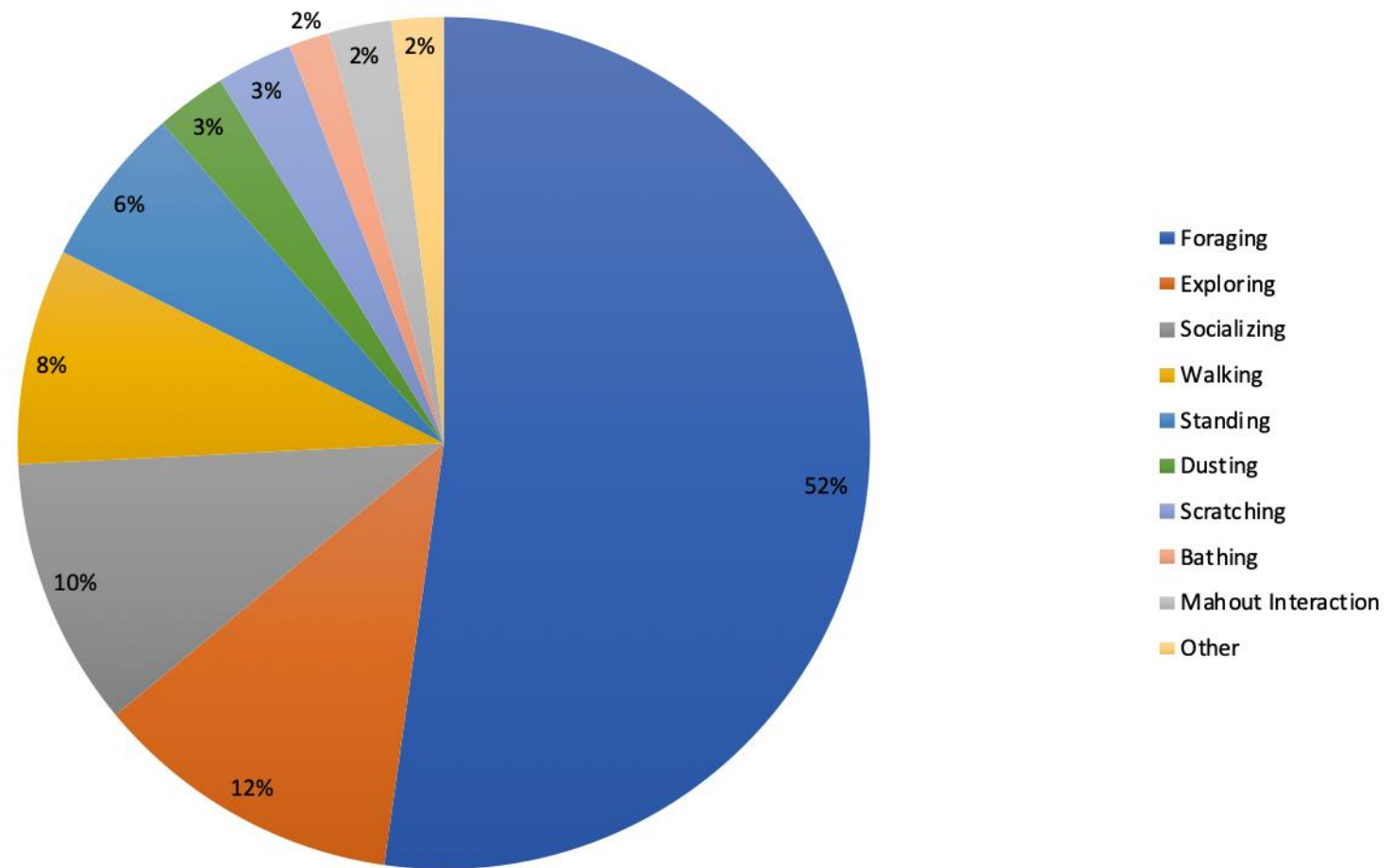
Figure 2.3a. Pooled percentage of time the elephants spent performing behaviours

Table 2.3a. Plant species consumed by the elephants during the 2019 expedition.

Plant	Type	Part(s) consumed	% of foraging encounters
Unidentified (Hoh duh doh)	Herb	Whole Plant	71.0%
Bamboo (Vami) Poaceae family	Bamboo	Whole plant	14.8%
Golden Gardenia *Gardenia sootepensis*	Tree	Leaves, bark	3.8%
Unidentified (Dah sway) Tiliaceae family	Tree	Leaves	2.3%
African dream herb *Entada rheedii*	Climber	Stem	2.0%
Giant sensitive tree *Mimosa pigra*	Shrub	Leaves	1.2%
Mampat *Cratoxylum formosum*	Tree	Bark, leaves	1.1%
Pumpkin *Cucurbita maxima*	Climber	Stem, leaves, fruit	0.8%
Bamboo (Vasu) Poaceae family	Bamboo	Whole plant	0.6%
Ring-cupped oak *Quercus kerrii Craib*	Tree	Twigs, leaves	0.6%
Unidentified (Noh) Poaceae family	Grass	Whole plant	0.5%
Unidentified (Say gloh boh)	Shrub	Leaves	0.5%
Akar malam *Spatholobus* sp*.*	Climber	Leaves, bark, stem	0.3%
Jicama 'yam bean' *Pachryrhizus* sp*.*	Climber	Leaves, bark, stem	0.2%
Corn *Zea mays*	Grass	Stem, fruit	0.2%
Dalbergia sp*.*	Tree	Bark, stem	0.2%
Unidentified (Koh)	Tree	Bark, twigs	0.2%

Elephant association

All five elephants showed varied social preferences. Dodo was commonly observed on his own, while the other four elephants did not consistently segregate into distinctive groups.

For the young male Gen Thong, 167 data points were collected where association to at least one other individual could be determined. Gen Thong was touching another elephant for 15% of recorded observations, within reach of another elephant for 27% of recorded observations, and at a distance of 6 m or greater for 58% of recorded observations (Figure 2.3b). When comparing Gen Thong's association to each elephant, he was observed touching Mae Doom and Boon Rott the most, but this only accounts for 5% of observations relating to him. He was more commonly within a trunk's reach of Mae Doom (19%) followed by Too Meh (10%). The majority of his time was spent greater than 6 m to Boon Rott (33%), followed by Too Meh and Dodo (21%).

The adult female Mae Doom had 173 data points collected where association to at least one other individual could be determined. Mae Doom was touching another elephant for 10% of observations, within reach of another elephant for 35% of recorded observations, and a distance of 6 m or greater 55% of the time (Figure 2.3b). When touching another elephant, it was most commonly Gen Thong (7%), followed by Dodo (5%) and Boon Rott (3%). Mae Doom was observed within a trunk's reach of Gen Thong (16%) and Too Meh (13%). Mae Doom was observed with Boon Rott at a distance greater than 6 m (30%), followed by Too Meh (25%).

For the old female Too Meh, 147 data points were collected where association to at least one other individual could be determined. Too Meh was recorded touching another elephant 3% of the time, within reach of another elephant 24% of the time, and at a distance of 6 m or greater for 73% of observation time (Figure 2.3b). No association could be determined for 22% of total observation time. Too Meh was rarely observed touching another elephant (Gen Thong 2%), but was observed within a trunk's reach of Mae Doom (12%) and Gen Thong (7%). The majority of her observations were greater than 6 m from Gen Thong and Mae Doom (17%).

Looking at Boon Rott, the unrelated male, 147 data points were collected where association to at least one other individual could be determined. Boon Rott was recorded touching another elephant 9% of the time, within reach of another elephant 8% of observation time, and at a distance of 6 m or greater 83% of the time (Figure 2.3b). No association could be determined for 23% of total observation time. The majority of Boon Rott's observations were greater than 6 m from Dodo (35%). When closely associating with the other elephants (distance of touching or a trunk's reach), he was interacting with Gen Thong (8%) or Mae Doom (5%).

For Dodo, the teenage male, 55 data points were collected where association to at least one other individual could be determined. Dodo was recorded touching another elephant for 8% of observations, within reach of another elephant for 5% of observations, and a distance of 6 m or greater 87% of the time (Figure 2.3b). No association could be determined for 71% of total observation time. Dodo was rarely observed touching an elephant (Gen Thong 1%, Mae Doom 2%). When observed, Dodo would be closest to Boon Rott at greater than 6 m (13%) followed by Too Meh (11%).
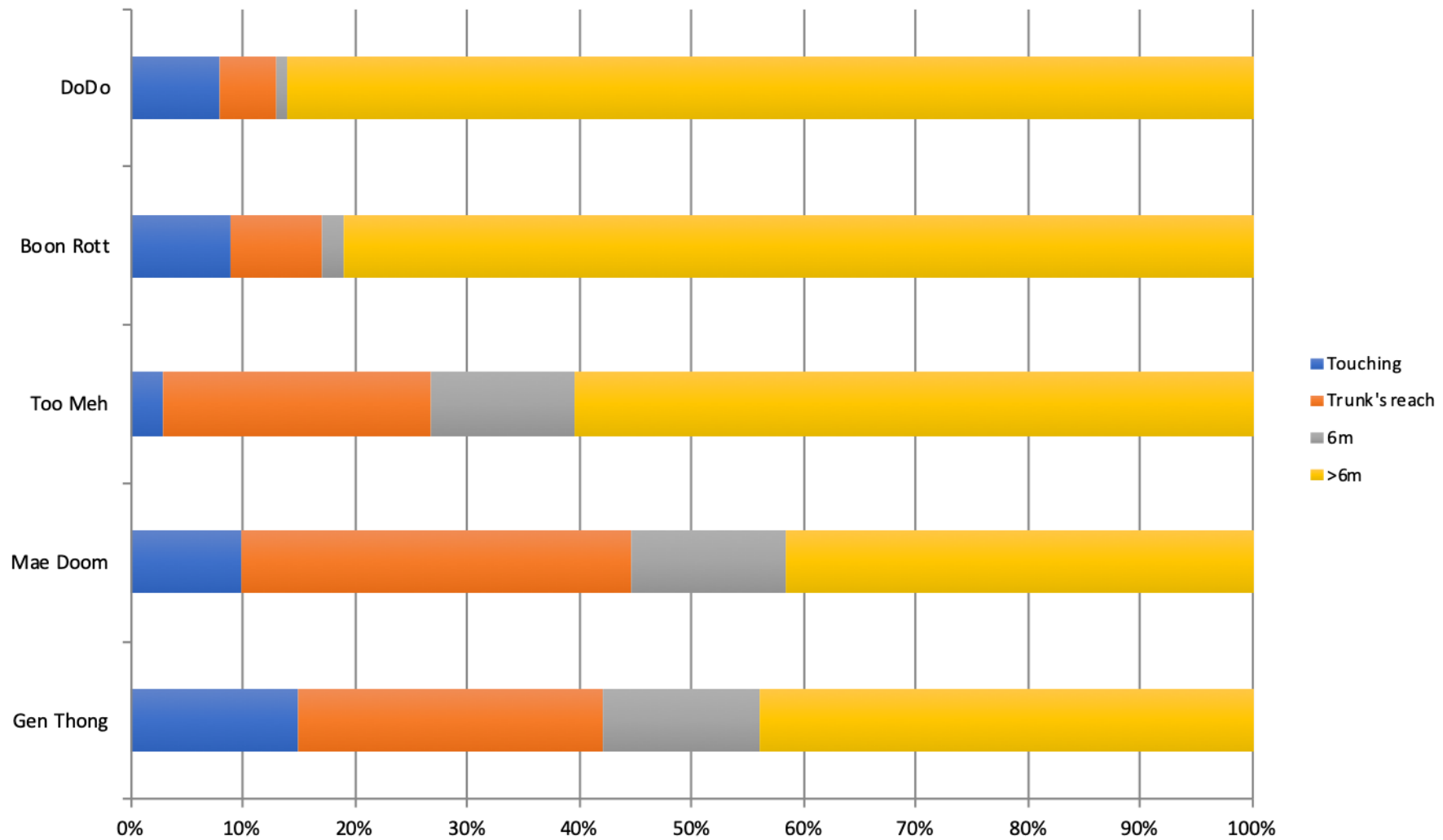
Figure 2.3b. Percentage of observed time each elephant spent within a certain distance of the other elephants.

2.4. Discussion and conclusions

Activity budgets

Foraging was the most prominent behaviour recorded for the elephants' activity budget, with the elephants foraging for 52% of the study time. Our results align with those from the 2017 and 2018 expeditions, which found foraging accounted for 59% and 63% of the elephants' activity budget, respectively (Gale and Hammer 2018, Gale and Hammer 2019), corroborating other studies that also found that wild Asian elephants spend the majority of their time foraging (45% to 75%) (Ahamed 2015, Sukumar 2003). Other than foraging, the elephants in our study were observed exploring, socialising and walking.

The behaviours of KSES's elephants vary from those in captivity, supporting our hypothesis that the behaviours of elephants at KSES mimic those of wild elephants rather than elephants in captivity. Studies on elephants in captivity have found that they spend less time foraging (ranging from 25-42%) and more time performing stereotypic behaviours (repeated movement pattern with no apparent function such as swaying and pacing) or standing motionless (Rees 2009). Another study on captive elephants in India found that foraging accounted for 29% of the activity budget (Varma 2008). A study performed on captive Asian elephants in Tampa, Florida, USA found the elephants spent the majority of their time standing (17-49%) followed by foraging (19-44%) (Lukacs et al. 2016). These variations in behaviours between captive and wild Asian elephants show that elephants in captivity are not given the opportunity to exhibit natural behaviours. To alleviate this in the interest of elephant welfare, working conditions should be adapted in such a way to ensure elephants in captivity have more time to devote to natural behaviours such as foraging, socialising, and walking.

Foraging

The study recorded 17 species eaten by the elephants in 877 minutes of foraging time. Comparing these results to the 2018 expedition (Gale and Hammer 2019), half as many plant species were recorded in 2019. While bamboo usually dominates the elephants' diet (Gale and Hammer 2018, Gale and Hammer 2019), a newly added plant species (a small herb with yellow flowers, about 30 cm tall), dominated their diet during the 2019 expedition. The addition of this new plant species may be due to changes in the location of the elephants or accessibility of plant species. The elephants are constantly foraging on new and diverse plant species, with two new species observed on this expedition (one of which was dominant). It is normal for the elephants to consume new plant species, adding one or two new species to the collection every few months. KSES has a volunteer botanist who identifies plants once ten new plants have been collected and can be sent as a batch. At the time of writing, there were three in the batch and it is expected to take another six to eight months until the required number of plants is reached and the batch can be sent off for identification.

Little is known about the natural foraging ecology of elephants in Thailand, mostly because of the low population levels and elusiveness of wild elephants in Thailand and a concomitant lack of studies. The continuation of this study will expand what is known about the natural foraging habits of Asian elephants in Thailand.

Comparing the results from the 2017, 2018 and 2019 expeditions, the elephants consistently consume much more browse than graze species (85%, 91% and 99% respectively) (Gale and Hammer 2018, Gale and Hammer 2019). While foraging habits will vary due to seasonal changes and food availability, browse species also comprise the majority of elephant diet in a study conducted in India (Joshi and Singh 2008). In Bengal, browse species dominated the diet of elephants in dense-mixed (89%) and open-mixed forests (57%), while graze dominated the diet of elephants in grassland habitats (76%) (Roy and Chowdhury 2014). Grasses dominated the diet of elephants studied in a tropical dry forest environment in India (54%) (Sukumar 1989). Other studies have found that elephants in captivity are fed up to five species of fodder year-round and that these species commonly consist of grasses such as napier grass and cornstalk (Norkaew et al. 2018, Vanitha et al. 2008). According to a report by the Coalition for Captive Elephant Well-Being, the Management Guidelines for the Welfare of Zoo Animals states that a lot of facilities use hay as the bulk diet with fruit and vegetable supplements. While this diet may be suitable for elephants residing in grassland habitats, browse species are critical to permit natural foraging strategies and address all dietary needs of captive elephants (Kane et al. 2005). A survey performed by Ange et al. (2001) on captive elephants suggests that most institutions do not feed Asian elephants adequate diets. There are currently no guidelines for feeding captive elephants in Thailand. A paper regarding the foraging habits of the elephants at KSES has been published in a peer-reviewed journal (Schwarz et al. 2020). From this information, this project aims to generate suggested feeding guidelines for elephants in captivity so that their diet is more akin to a natural diet.

Association

While the study elephants did not segregate into distinctive groups, they did demonstrate association patterns. Close association (touching distance) amongst the elephants was most commonly observed for the young male Gen Thong with the two adult females Mae Doom and Too Meh. This correlates with studies showing herds are often comprised of related females and offspring (de Silva and Wittemyer 2012). Being in close proximity and having the opportunity to touch is an important aspect of Asian elephant social structure (Makecha et al. 2012).

Boon Rott was observed associating with Mae Doom and Gen Thong, which differs from the 2018 expedition in which the elephants segregated into distinctive groups: the old female, adult female and young male together and solitary male bachelors (Gale and Hammer 2019). This change in behaviour may be attributed to Boon Rott maturing as a bull elephant. Since the 2018 expedition, Boon Rott has experienced his first period of musth, meaning he is now a sexually mature elephant. His interest in Mae Doom may be increasing as she is seen as a potential mate.

The association between Gen Thong and Boon Rott can often be described as play behaviour. Playing, such as wrestling trunks, pushing heads and mounting (Sukumar 2003) is common behaviour for young bulls. Older males have been found playing with peers of the same sex from other families (Sukumar 2003), which correlates with the touching behaviour of Gen Thong and Boon Rott.

Dodo was observed on his own during the majority of observations. Males often separate from family units once they reach adulthood (de Silva and Wittemyer 2012). Dodo is a relatively new addition to KSES and more research is required to examine his social patterns. Due to varying results throughout expeditions, further studies are required to establish the social patterns of the study elephants. As Dodo is still relatively new to KSES, previously living in confinement in poor conditions at an elephant camp, he may still be learning his natural and preferred behaviours. With three maturing bull elephants, the variation in social dynamics throughout the studies may be caused by the bulls maturing and changing association preferences. Future studies should examine individual changes in these bulls over the years and compare them to preferences of bulls in other studies of similar ages. This study can be then be used for the management of captive populations by elucidating how elephants should be grouped in captive facilities.

Natural behaviours and the implication for captive elephants

This expedition allowed for observations of natural behaviours displayed by semi-wild Asian elephants. The data collected showed that the behaviours and foraging habits of the elephants at KSES are more similar to those of wild Asian elephants than elephants in captivity.

The expedition highlighted areas for improvement in regards to the management of captive Asian elephant populations. For example, discrepancies in the amount of time elephants dedicate to foraging in captivity when compared to wild elephants and KSES's elephants show the importance of feeding in natural elephant behaviour. In addition, the lack of a diverse diet in captive elephant samples compared to the diversity of KSES's and wild elephants' diet needs to be addressed. Elephants in captivity should be allowed to feed for longer durations throughout the day and be provided a more diverse diet, including more browse species.

In order to improve welfare and quality of life for captive elephant populations, captive elephants should be given the opportunity to mimic the behaviours of their wild counterparts. The information from this study on natural Asian elephant behaviour can be used to improve conditions for captive elephants.

This study's contribution to elephant welfare and conservation

Understanding the diet, foraging ecology and behaviour of semi-wild Asian elephants can contribute to wild elephant conservation efforts. Knowledge of foraging habits and diet composition will help conservationists and wildlife managers implement effective strategies in order to improve management of wild populations, by ensuring the habitat provides adequate plant species to feed on, enough space to roam and maintaining social structures that minimise stress and maximise natural behaviours

This study highlights the need for long term, repetitive studies on natural Asian elephant behaviour, social preferences, and foraging ecology.

Outlook

As this was the third Biosphere Expeditions project in conjunction with KSES in Thailand, further research is needed to ensure precision of collected data. This was also only the second expedition including the fifth elephant, Dodo, as a member of the study group. As such, the study needs to be replicated in order to draw accurate conclusions in regard to this study group.

As the elephants move to different areas of the forest throughout the study site, the forest composition differs, opening up new foraging opportunities, potentially adding species to the list of foraged plants. In this expedition alone, two new plant samples were added to the species list of plants consumed by the elephants. Furthermore, in years to come, as the number of elephants under KSES's care increases, the data sets can be expanded to incorporate more individual elephants in different age/sex classes. As the data set grows, articles can be published in scientific journals to aid in conservation efforts of Asian elephants. Standards for captive elephant management can be proposed from the information obtained in this expedition.

Summary and action points for the next expedition

Key findings of this expedition:

- A continuing detailed description of the diets of elephants free-roaming in the forests of Northern Thailand; two new plant samples not previously recorded were added to the species list for a total of 165 plant species consumed by the elephants at KSES.

- A description of the behavioural patterns of five semi-wild, free-roaming elephants to show the natural behaviours of elephants displayed at KSES compared to those in captivity.

- A description of the social patterns of five semi-wild, free-roaming elephants and how these patterns change over time.

Actions for the next expedition and future research:

- Continue to record observations for the elephant association and elephant activity data sets to ensure quantity and quality of data in order to elucidate with confidence patterns in behaviours.

- Publish activity budget and association data in a peer-reviewed journal, in order to create an elephant management guide to be distributed to elephant venues in Thailand and around the world. A paper on the foraging habits of the elephants at KSES is currently in print in a peer-reviewed journal (Schwarz et al. 2020).

- Fundraise in order to implement beehive fencing and create a new data set using camera trapping to monitor the effectiveness of the fences.

2.5 Literature Cited

Ahamed, A.M.R. (2015). Activity time budget of the Asian elephant (*Elephas maximus* Linn.) in the wild. Trends in Biosciences 8(12), pp. 3024–3028.

Ange K, Crissey SD, Doyle C, Lance K, Hintz H. A survey of African (*Loxodonta africana)* and Asian (*Elephas maximus)* elephant diets and measured body dimensions compared to their estimated nutrient requirements. In 'Proceedings of the Nutrition Advisory Group 4th Conference on Zoo and Wildlife Nutrition, Lake Buena Vista' pp. 5-14. (San Diego Zoological Society: San Diego) 2001.

de Silva, S. & Wittemyer, G (2012). A comparison of social organization in Asian elephants and African savannah elephants. International Journal of Primatology, 33:1125-1141. http://dx.doi.org/10.1007/s10764-011-9564-1,

Gale T, Hammer M (2018). Elephant encounters: Studying Asian elephants in the hills of northern Thailand to increase their welfare and conservation. Expedition report available via www.biosphere-expeditions.org/reports.

Gale T, Hammer M (2019). Elephant encounters: Studying Asian elephants in the hills of northern Thailand to increase their welfare and conservation. Expedition report available via www.biosphere-expeditions.org/reports.

Joshi R, Singh R (2008). Feeding behaviour of wild Asian Elephants (*Elephas maximus*) in the Rajaji National Park. Journal of American Science. 4(2):34–48.

Kane L, Fortham D, Hancocks D. (2005). Optimal conditions for captive elephants: a report by the Coalition for Captive Elephant Well-Being.

Koirala RK, Raubenheimer D, Aryal A, Pathak ML, Ji W (2016). Feeding preferences of the Asian elephant Elephas maximus in Nepal. BMC Ecology 16: 1–9

Lukacs, D. E., Poulin, M., Besenthal, H., Fad, O. C., Miller, S. P., Atkinson, J. L., & Finegan, E. J. (2016). Diurnal and nocturnal activity time budgets of Asian elephants (*Elephas maximus*) in a zoological park. Animal Behavior and Cognition, 3(2), 63–77. doi: 10.12966/abc.01.05.2016

Mackey, Angela Dawn (2014)."Effects of Animal Management Changes on the Activity Budgets and Walking Rates of Zoo Elephants" Dissertations. 296 pages. https://aquila.usm.edu/dissertations/296

Makecha, R., Fad, O., & Kuczaj, S. A., II (2012). The role of touch in the social interactions of Asian elephants (*Elephas maximus*). International Journal of Comparative Psychology, 25, 60-82).

Norkaew, T., Brown, J. L., Bansiddhi, P., Somgird, C., Thitaram, C., Punyapornwithaya, V., Punturee, K., Vongchan, P., Somboon, N. & Khonmee, J. (2018). Body condition and adrenal glucocorticoid activity affects metabolic marker and lipid profiles in captive female elephants in Thailand. PLoS One. 2018; 13(10):e0204965. https://doi.or/10.1371/journal.pone.0204965 PMID: 30278087

Roy M, Chowdhury S (2014). Foraging ecology of the Asian elephant in Northern West Bengal. Gajah 40, 18–25.

Schwarz C, Johncola A, Hammer M (2020). Foraging Ecology of Semi-Free-Roaming Asian Elephants in Northern Thailand. Gajah 52. 4-14.

Sukumar R (1989). The Asian elephant: ecology and management. UK: Cambridge University Press, 69–85.

Sukumar R (2003). The living elephants: Evolutionary ecology, behavior, and conservation. Oxford University Press, New York, New York.

Sukumar R (2006), A brief review of the status, distribution and biology of wild Asian elephants *Elephas maximus*. International Zoo Yearbook, 40: 1-8. doi:10.1111/j.1748-1090.2006.00001.x

Vanitha, V., K. Thiyagesan & N. Baskaran (2008). Food and feeding of captive Asian elephants (*Elephas maximus*) in the three management facilities at Tamil Nadu, South India. Journal of Scientific Transactions in Environmental and Technovation 2(2): 87-97.

Varma, S., Rao, S., Ganguly, S., Bhat, H (2008). Identification of an effective and robust model of elephant keeping and keeper welfare; Insights based on the activity budget of elephants in captivity and mahout-elephant interaction in Karnataka. Compassion Unlimited Plus Action (CUPA) and Asian Nature Conservation Foundation (ANCF), Bangalore, India.

Appendix I: Expedition diary, reports and resources

Project updates, reports and publications:
https://www.researchgate.net/project/Thailand-Increasing-elephant-welfare-and-conservation-through-citizen-science

All expedition reports, including this and previous expedition reports:
https://www.biosphere-expeditions.org/reports

Expedition diary/blog:
https://blog.biosphere-expeditions.org/category/expedition-blogs/thailand-2019/

Pictures, videos, media coverage of the expedition:
https://www.biosphere-expeditions.org/thailand