Kingdom of Cambodia
Nation Religion King

SAMLOUT BIODIVERSITY REPORT, CAMBODIA 2023

MJP
MADDOX JOLIE-PITT FOUNDATION

Fauna & Flora
Saving Nature Together

SAMLOUT BIODIVERSITY REPORT, CAMBODIA 2023

Citation: Sinovas, P., Furey, N., Yim, R., Roberts, O., Maquart, P.O., Chantha, N., Song, D., Duong, N., Neab, S.N., Holden, J. 2023.: Samlout Biodiversity Report, Cambodia 2023. Technical report prepared by Fauna & Flora for the Maddox Jolie-Pitt Foundation in collaboration with the Ministry of Environment of Cambodia. Phnom Penh, Cambodia.

Text and images © Fauna & Flora, 2023
Additional images © Jeremy Holden
Design and layout by Jeremy Holden

Cover images: *Trimeresurus cardamomensis* (main); *Glaucidium cuculoides*; *Dendrobium farmeri; Cuon alpinus*; *Hipposideros larvatus.*

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

For their invaluable support during the survey, the authors wish to thank the staff of the Maddox Jolie-Pitt Foundation, Mr. Kung Munichan, Mr. Ray Sano, Mr. Long Laen, Mr Chan Hul. Special thanks to Ministry of Environment technical staff from the General Directorate of Natural Protected Areas (GDNPA): Mr. Neab Samneang, Mr. In Visatta, Mr. Phat Sokunvath, Mr. Ob Narith, Mr. Than Buntheth, Mr. Chea Puthea; and to Border and Military Police, including Mr. Me Ratha, Mr. Nhem Phea, Mr. Sok Kheng and Mr. Heng Chet.

We are also grateful to Provincial Department of Environment rangers who assisted the field work, including: from the Battambang PDoE, Mr. Chhim Sophy, Mr. Mao Sopheak, Mr. Em Vuthy, Mr. Siek Chhoeurn, Mr. Sen Kay Ranger , Mr. Keo Heng; and from the Pailin PDoE, PA Director Mr. Iev Ra, Mr. Men Sokeourn, Mr. Sok Toeurt, Mr. Sorn Vannat, Mr. Yoeurng Pov, Mr. Phon Soken. Thanks also to Mr. Khav Bora from the Salakrav District Pailin Army, and Mr. Me Be and Mr. Pov Vuth from the local community in Pailin.

The survey was conducted with financial support from Maddox Jolie-Pitt Foundation and Fauna & Flora International (the latter from the Halcyon Fund).

INTRODUCTION

Samlout Multiple Use area is a 60,000-hectare protected area declared in 1993 by King Norodom Sihanouk and straddling the Pailin and Battambang Provinces of Cambodia. It represents one of the last remnants of forest in north-western Cambodia. Being adjacent to protected areas in the Cardamom Mountains (in particular Phnom Samkos Wildlife Sanctuary) and over the border with Thailand (Khlong Kruewai Chalearm Phrakiat Wildlife Sanctuary and Namtok Klong Kaeo National Park), it plays a role in maintaining connectivity for wildlife.

The Maddox Jolie-Pitt Foundation (MJP) initiated in 2003 a conservation and community development programme in Samlout, working with local communities and the Ministry of Environment to help conserve the area's ecosystem.

Zonation and management of protected areas is a key step towards effective management in Cambodia. Establishing a baseline of the biodiversity within the Samlout Multiple Use Area will be a key step towards informing these processes so the most important conservation values can be prioritised and sustainably managed into the future.

This report presents the results of a rapid biophysical survey of Samlout Multiple Use area as a step to secure the valuable forests and wildlife of this protected area. Field surveys were undertaken during 2021–2022. Details on methodologies and findings are provided under each chapter.

EXECUTIVE SUMMARY

This document is a compilation of biological field survey reports undertaken in the Samlout Multiple Use Area (MUA) of Battambang and Pailin provinces of western Cambodia. The surveys focused on five taxonomic groups and one general camera trapping programme, and were carried out between October 2021 and June 2022. The work was commissioned by the Maddox Jolie-Pitt Foundation (MJP) to determine the biological significance of the area they manage.

Experts in their various fields were employed by Fauna & Flora International's Cambodia Programme to conduct the surveys, with logistical support from MJP staff and rangers from the Ministry of Environment. The survey targets included bats, invertebrates, reptiles and amphibians, orchids and notable plant species, birds, and a general camera trap survey aimed at mammals and terrestrial bird species that are harder to detect. Each survey produced a standalone report, detailing findings and concluding with suggested recommendations.

In most cases, with the exception of the camera trapping programme, the surveys could be considered provisional, with more survey work needed. Many of the higher elevation and remoter areas of the MUA, where more interesting records would likely be made, were not possible to visit due to security concerns. As such, the surveys revealed a general picture of the more accessible areas of the MUA. Seasonality was also a factor: surveys conducted for bats, and for amphibians and reptiles, only took place during the dry season, meaning that species inventories were unlikely to be complete. The most significant findings were made through the camera trap programme with the presence of Endangered and Critically Endangered species such as Asian elephant, dhole and Sunda pangolin confirmed from the core of the MUA.

Undoubtedly, there remains much more to discover in the Samlout MUA, but the findings reported here show that it remains an important part of Cambodia's protected area system.

BAT SURVEY

Neil M. Furey & Yim Raksmey

SUMMARY

This report details the results of a bat survey undertaken during the 2021–2022 dry season in the Samlout Multiple Use Area (MUA) of the Battambang and Pailin provinces of west Cambodia. The purpose of the survey was to generate a species list for bats in the MUA and evaluate its likely significance for Cambodian bat conservation.

The assessment comprised a literature and collections review and passive and active sampling for bats within Samlout MUA. Field methods included live-sampling with harp traps and mist nets and acoustic sampling with ultrasound detectors, all of which were undertaken between 149–320 m a.s.l. within or adjacent to the MUA from 22–30 November 2021. Aside from two nights around the MJP field headquarters, all bat sampling was undertaken in variably disturbed forest formations within the O'Slev (one night) and Phnom Pech (four nights) areas.

Review revealed that although 27 bat species have been previously documented in Battambang Province, no records apparently exist for Pailin Province. Fifteen discrete locations were sampled during the field survey. This resulted in the live-capture of 104 bats representing 14 species, whereas acoustic sampling detected 11 phonically-distinct taxa. Seven of the latter were not captured in live-traps, increasing the total number of bat species recorded during the survey to 21 taxa. All of these species are currently regarded at Least Concern by the IUCN.

This figure represents 26% of the known bat fauna of Cambodia (80/21 species) but undoubtedly falls short of the true site total for several reasons including the A) limited representation of diverse genera and absence of commonplace taxa on the current species list, B) occurrence of at least 14 additional species in Battambang Province, many of which may also occur within the MUA, and C) low survey effort and marginal sampling coverage thus far achieved at the site.

As a consequence, the bat species richness of Samlout MUA is undoubtedly greater than presently known, although there is no reason to suppose that any of the species present might be endemic to the MUA or Cambodia. Notwithstanding this, the MUA has

good prospects for supporting bat species that occur in eastern Thailand which have yet to be recorded nationally, as well as several threatened and/or seemingly rare taxa only recently documented in Cambodia.

The present work indicates further surveys will reveal additional bat species at Samlout MUA. Future surveys should ideally aim to encompass both seasons and employ multiple detection methods e.g., live-trapping and acoustic sampling. In this context, 5–6 individuals (= two surveyors, two assistants and 1–2 camp guards/cooks) should also be regarded as preferable for survey purposes, in maximising site access (by minimising the quantity of materials and supplies that require transport) and greatly reducing financial costs.

CONTEXT

Bat Biodiversity in SE Asia & Cambodia

Bats are divided into two suborders: the Yinpterochiroptera (Rhinolophoid bats and Old-World fruit bats) and Yangochiroptera (all other bats), whose ability to perceive their surroundings using echolocation, together with powered flight, has allowed them to master the night skies and exploit a wide range of niches worldwide (Schnitzler et al. 2001, Jones & Teeling 2006). Over 1,430 bat species are currently recognized (Simmons & Cirranello 2021), and this figure continues to grow each year with the discovery of new species, particularly in SE Asia (Tsang et al. (2016).

Bats form a critical component of the SE Asia's mammal fauna, as the group constitutes ca. 30% of the region's mammal species and can comprise as many as half of all mammal species in tropical rainforests (Kingston et al. 2006). Southeast Asia is also pivotal area for global bat conservation as it supports over 25% of the world's bat fauna and as >197 of 342 species known from the region are endemic to it (Kingston 2010).

Despite the economic and conservation importance of bats (Kunz et al. 2011), the natural history of the Cambodian bats is relatively poorly known. With ≥80 species now recorded (Furey et al. 2021) however, knowledge regarding species composition has increased dramatically in recent years. As elsewhere in SE Asia, the group is threatened by habitat loss, hunting - particularly of flying foxes and cave-dwelling bats - and other human disturbance (Furey et al. 2012, 2016; Ravon et al. 2014; Hoem et al. 2017; Lim et al. 2018).

Of the ≥80 species known in Cambodia, 12 are fruit bats within the Pteropodidae, whereas the remainder are mostly insectivores in seven families. Though discovery of additional species is likely, particularly in understudied border areas (Furey et al. 2021)[1], only ten bat species known for the country are currently listed in categories other than Least Concern by IUCN (2021) , whereas three are listed in CITES Appendix II[2]. One is also listed in Cambodian legislation as nationally rare (*P. hypomelanus*: MAFF 2007), although the species annexes associated with this Prakas are currently being revised.

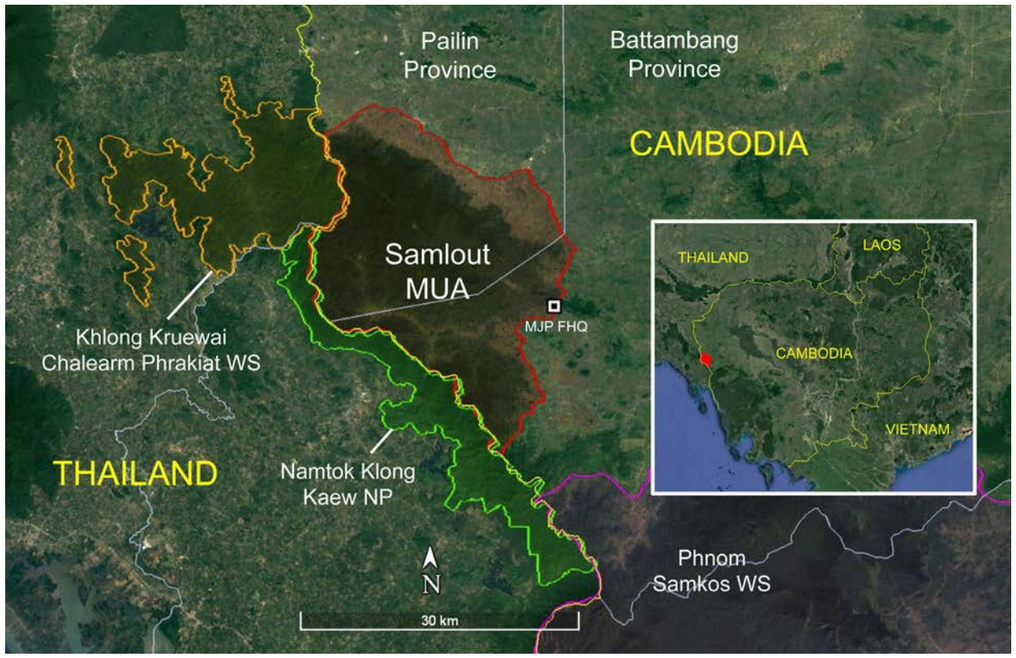
Project & Survey Objectives

Samlout Multiple Use Area (MUA) is located in the Battambang and Pailin provinces of west Cambodia, adjacent to the international border between Cambodia and Thailand (Fig. 1). Designated in 1993, the MUA occupies 60,000 ha, of which an estimated 48,193 ha were covered in evergreen forest in 2015 (Bognar, 2015).

The primary aim of the study in Samlout MUA was to undertake an inventory survey to generate a species list for bats at the MUA and evaluate its likely significance for Cambodian bat conservation. The field survey was undertaken during the 2021–2022 dry season from 22–30 November 2021 (Table 1).

[1] Although it should be noted that the IUCN Red List categories are currently being revised for many species.
[2] Convention on International Trade in Endangered Species of Wildlife Fauna and Flora, Annex II: *Pteropus hypomelanus, P. lylei* & *P. vampyrus*

Fig. 1: Location and protected area context of Samlout MUA in western Cambodia



SURVEY METHODS

Alongside literature review, the field survey focused on passive and active sampling for bats within Samlout MUA (Fig. 1). Sampling methods comprised live-trapping using mist nets and harp traps and acoustic surveys using passive and active ultrasound detectors.

Data Collection

Literature Review

A desk review of previous records of bats from the Battambang and Pailin Provinces was undertaken. This included review of specimens from these provinces in the zoological collection of the Centre for Biodiversity Conservation (CBC), Royal University of Phnom Penh.

Live Sampling

Outside of cave roosts, the success of live-sampling efforts in any bat survey are largely determined by the extent to which the habitat and terrain concentrate commuting bats into discreet flyways. Selection of sampling locations consequently focused on putative flyways within the widest range of vegetation types in-situ, including ecotones and the interior (e.g., trails, watercourses and natural linear breaks) and edge of each (plus any standing water features). Geo-coordinates, basic habitat data and photo-documentation were recorded at all sites.

Because bat species vary in their relative susceptibility to capture with mist nets and harp traps (Francis 1989, Berry et al. 2004) and the aim was to maximize inventory completeness, both capture devices were employed. A variety of mist nets were used depending on topography (e.g., 7x3m, 10x3m & 12x3m), all of which were 70 denier nets (Fig. 2). One four-bank harp trap was employed, with a capture surface of 2.9 m2 (Fig. 2). To standardize sampling effort between these, effort for mist nets was calculated as m2 of net multiplied by the hours of use (m2mnh), whereas harp trap effort was similarly calculated as m2 multiplied by the hours of use (m2hth).

Mist nets were employed from ≈1730–2130 hrs each night, whereas the harp trap was employed from ≈1730–0630 hrs, except where rain prohibited live trapping. These were checked for captures every 10–30 minutes between 1730–2130 hrs and again the following morning. Sampling was avoided on consecutive nights at the same location to avoid trap familiarity.

All bats captured during live-sampling were measured, photographed and identified in the field using the appropriate field guides/monographs e.g., Kruskop (2013) & Francis (2019), and released at their capture site the same night. Reference echolocation calls were recorded from each released individual using the appropriate species-specific methods to facilitate identification of unseen bats registered in the acoustic sampling (see below). A M500-384 USB ultrasound microphone (Pettersson Electronik AB, Sweden), connected to an Android smartphone (Samsung Galaxy S6) running the Bat Recorder app (vers. 1.0R156) was employed to this end.

Fig. 2: Mist net (left) and harp trap (right) in Samlout MUA, November 2021

Where required to verify species identifications, non-reproductively active adult bats were retained as specimens in 80% ethanol (in practice, this usually means 1–2 specimens for species which are taxonomically complex). These voucher specimens were subsequently deposited in the zoological collection of the Centre for Biodiversity Conservation.

Acoustic Sampling

Acoustic sampling with ultrasound (bat) detectors is extensively used in temperate regions and is recognized as an important complement to conventional capture methods (e.g., mist nets and harp traps) for bat species inventories in the tropics (MacSwiney et al. 2008, Furey et al. 2009). This is particularly true for insectivorous species that habitually fly in open areas and at higher altitudes outside the range of ground-based live-traps (Fenton 1990, Furey et al. 2009).

Fixed-point recordings were made in different locations each sampling night. Two Anabat Swift bat detectors (Anabat, Australia; Fig. 3) were employed to this end. These were set to record from 30 minutes before sunset until 30 minutes after sunrise each night. Local sunset and sun rise times during the survey period were ≈1738 and ≈0610 hrs, respectively.

Because bat detectors cannot distinguish between different individuals of the same species (and so a single bat repeatedly circling a site can be acoustically equivalent to many bats passing through the site just once), a relative index of activity was employed for analysis based on the number of bat passes. Following international standards, a bat pass was defined as a sequence of >2 echolocation calls, with each sequence, or pass, separated by >1 second (Kunz et al. 2007).

SCAN'R software (Binary Acoustic Technology, USA) was used to remove recordings solely comprising non-bat sounds. Phonically distinct bat species were identified through inspection of the remaining recordings (via call frequency and structure) in Adobe Audition (Adobe Systems, USA) and Batsound (Pettersson Elecktronic AB, Sweden), and 19 parameters were measured per call for each taxon. Identifications were made to the lowest possible taxonomic level possible based on discriminant function analysis employing A) reference call data generated by the survey for identified species, and B) datasets of verified recordings for known bat species from Cambodia (e.g., Phauk et al. 2013, NF unpublished data) and neighbouring countries held by the consultants (e.g., Furey et al. 2009, Furey & Douangboubpha 2015, 2017, 2021).

Fig. 3: Full spectrum bat detector in Samlout MUA, November 2021

These reference data were then used to determine the presence/absence of each phonic species in each sampling location using a filtering pipeline in SZAPP software (Armstrong & Aplin 2014, Armstrong et al. 2016). Temporal variations in bat activity were quantified using proprietary code which was run in the R software environment (R Core Team, Austria).

Analysis

Conservation Significance

The conservation significance of all bat species recorded was evaluated using IUCN (2021) and refined where necessary with reference to existing literature and unpublished data held by the consultants for Cambodia and mainland SE Asia. Taxonomy and nomenclature follow Simmons & Cirranello (2021).

Ecological traits

Ecological trait data for each bat species were obtained from Francis (2019), Kruskop (2013), Furey et al. (2010, 2011), Furey & Racey (2016), IUCN (2021) and data held by the author.

All bat species were assigned to one or more of three categories regarding their roosting preferences. These categories comprised: 1) Caves, defined here as including other subterranean sites such as mines and rock voids, 2) Foliage, inclusive here of tree hollows, and 3) Artificial roosts, recognized here as including all human-made structures above ground. As the roosting preferences of some poorly-studied species are currently unknown, these were necessarily inferred from the preferences of related taxa and land cover of known localities for each species.

The wing morphology of bats determines their mobility and directly influences their foraging preferences, home range areas and dispersal abilities, including capacity for migration (Norberg & Rayner 1987). Because the classification of McKenzie et al. (1995) reflects the differential foraging strategies and propensities for migration of bat species, all species registered were categorized using Furey & Racey (2016) and associated publications as follows:

Strategy I: Insectivorous species that forage in the highly cluttered airspace within the forest interior (or forest interior specialists);

Strategy II: Insectivorous species that forage in partially cluttered spaces such as clearings, streams or other tunnels within the forest or just above the canopy (edge and gap foragers);

Strategy III: Insectivorous bats that forage in unobstructed airspaces found in large clearings or high above the forest canopy (open-space foragers);

Strategy IV: Fruit and nectar-eating bats that fly into the partially cluttered air-spaces between tree canopies, roost in small numbers and forage locally;

Strategy V: Fruit and nectar-eating bats that fly in unobstructed airspaces, roost in large colonies and forage over large areas.

RESULTS

Literature Review

Although no records were traced for Pailin Province, review of literature and specimen collections indicates that at least 27 bat species have been recorded in Battambang Province (Table 1). Four of these species are currently listed in categories other than Least Concern by the IUCN (2021): *Pteropus lylei* (Vulnerable), *Rousettus leschenaultii* (Near-threatened), *Hipposideros halophyllus* (Vulnerable) and *Hipposideros lekaguli* (Near-threatened).

Table 1: Bat species previously recorded in Battambang Province, Cambodia
[DD = Data deficient, LC = Least concern, NT = Near-threatened, VU = Vulnerable]

No.	Family / Species	UCN Status[1]	Source
I	**Pteropodidae**		
1	*Pteropus lylei*	VU	Ravon et al. 2013
2	*Cynopterus sphinx*	LC	Furey, unpubl. data
3	*Megaerops niphanae*	LC	CBC
4	*Eonycteris spelaea*	LC	Furey, unpubl. data; CBC
5	*Rousettus leschenaultii*	NT	Furey, unpubl. data
II	**Emballonuridae**		
6	*Taphozous longimanus*	LC	Furey, unpubl. data; CBC
7	*Taphozous melanopogon*	LC	Furey, unpubl. data; CBC
III	**Megadermatidae**		
8	*Lyroderma lyra*	LC	Furey, unpubl. data
9	*Megaderma spasma*	LC	Furey, unpubl. data
IV	**Hipposideridae**		
10	*Hipposideros armiger*	LC	Furey, unpubl. data; CBC
11	*Hipposideros cineraceus*	LC	Furey, unpubl. data
12	*Hipposideros galeritus*	LC	Furey, unpubl. data
13	*Hipposideros gentilis*	LC	Furey, unpubl. data; CBC
14	*Hipposideros halophyllus*	VU	Furey et al. 2021
15	Hipposideros cf. larvatus	LC	Furey, unpubl. data
16	*Hipposideros lekaguli*	NT	Furey et al. 2021
V	**Rhinolophidae**		
17	*Rhinolophus malayanus*	LC	Furey, unpubl. data
18	*Rhinolophus marshalli*	LC	Furey et al. 2021
19	*Rhinolophus microglobosus*	LC	Furey, unpubl. data
20	*Rhinolophus pearsonii*	LC	Furey, unpubl. data
21	*Rhinolophus shameli*	LC	Furey, unpubl. data; CBC
22	*Rhinolophus siamensis*	LC	Furey et al. 2021
23	*Rhinolophus pusillus*	LC	Furey, unpubl. data
VI	**Vespertilionidae**		
24	*Scotophilus heathii*	LC	Furey, unpubl. data
25	*Scotophilus kuhlii*	LC	Furey, unpubl. data; CBC
26	Myotis cf. *alticraniatus*[2]	–	Furey, unpubl. data
VII	**Molossidae**		
27	*Mops plicatus*	LC	Furey et al. 2018; CBC

[1] As of 28 December 2021. [2] A specimen was collected in Rotonak Mondol District in 2018 which was referred to *M.* cf. *alticraniatus* pending further comparative studies, although genetic data suggests it does not represent any taxon currently recognised.

Sampling Effort & Weather Conditions

Over the course of the survey (seven sampling nights), 2,380 m2 mist-net-hours, 103.8 m2 harp-trap-hours and 168 hrs of acoustic sampling (=14 detector nights) were achieved at 15 discrete locations between 149–320 m a.s.l. (above sea level) within or adjacent to Samlout MUA (Table 2, Fig. 4).

Aside from the second and last nights of the survey (24 and 29 November) when sampling occurred in the gardens of the MJP field headquarters, all bat sampling was undertaken in variably disturbed forest formations (Table 3). Indicative images of habitats at each sampling location are provided in Fig. 5. Rain only fell once during live-trapping sessions (≈1730–2130 hrs) on 23 November, although sustained rainfall occurred during the morning and afternoon of 29 November.

Table 2: Survey locations and effort in Samlout MUA, November 2021

Survey Date	Site Code	Lat/Long	Elevation (m asl)	Mist net (m2 mmh)	Harp trap (m2 hth)	Acoustic (hrs)	Habitat
23/11	S-01	12.69745 102.71507	182	468		24	Degraded forest/Scrub mosaic
24/11	S-02	12.68150 102.74564	155	288		12	Relict forest stands in agriculture
	S-03	12.68607 102.74766	149	348		12	Relict forest stands in agriculture
25/11	S-04	12.68439 102.64963	269	120		12	Degraded forest/Scrub mosaic
	S-05	12.68555 102.64867	287	204		12	Degraded forest/Scrub mosaic
	S-06	12.68471 102.64925	265		34.6		Degraded forest
26/11	S-07	12.68706 102.64883	280	120		12	Degraded riverine forest
	S-08	12.68812 102.64924	285	144		12	Degraded riverine forest
	S-09	12.68903 102.64935	290		34.6		Degraded forest
27/11	S-10	12.68983 102.64927	308	120		12	Degraded forest
	S-11	12.69164 102.64990	320	164		12	Degraded riverine forest
	S-12	12.68040 102.63525	273	284	34.6	12	Degraded forest
28/11	S-13	12.68068 102.65128	287	120		12	Degraded forest
	S-14	12.68046 102.74497	≈155			12	Riparian scrub
29/11	S-15	12.67805 102.74562	≈165			12	Relict forest stands in agriculture
				2,380	**103.8**	**168**	

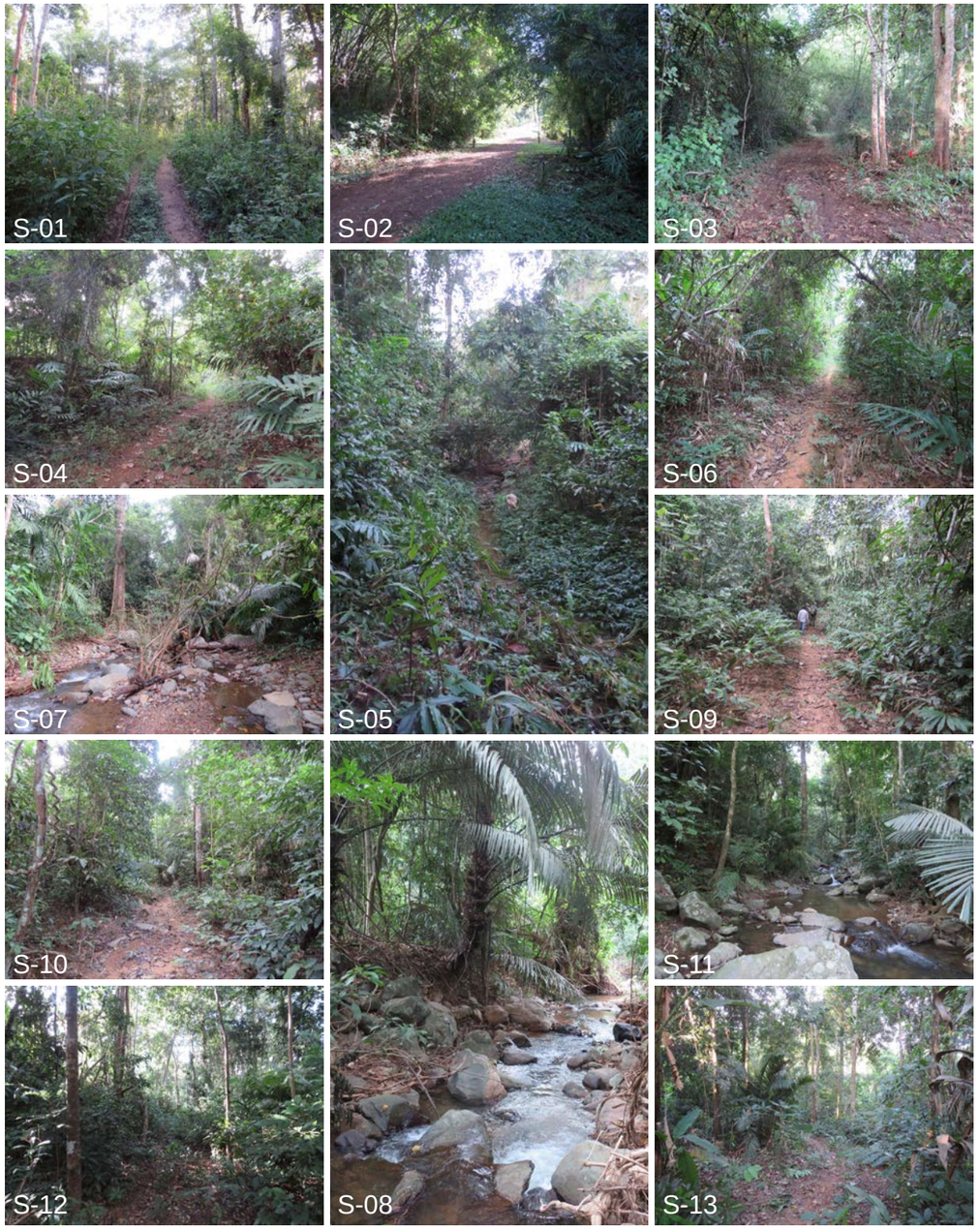


Fig. 4: Indicative images of habitats sampled in Samlout MUA, November 2021

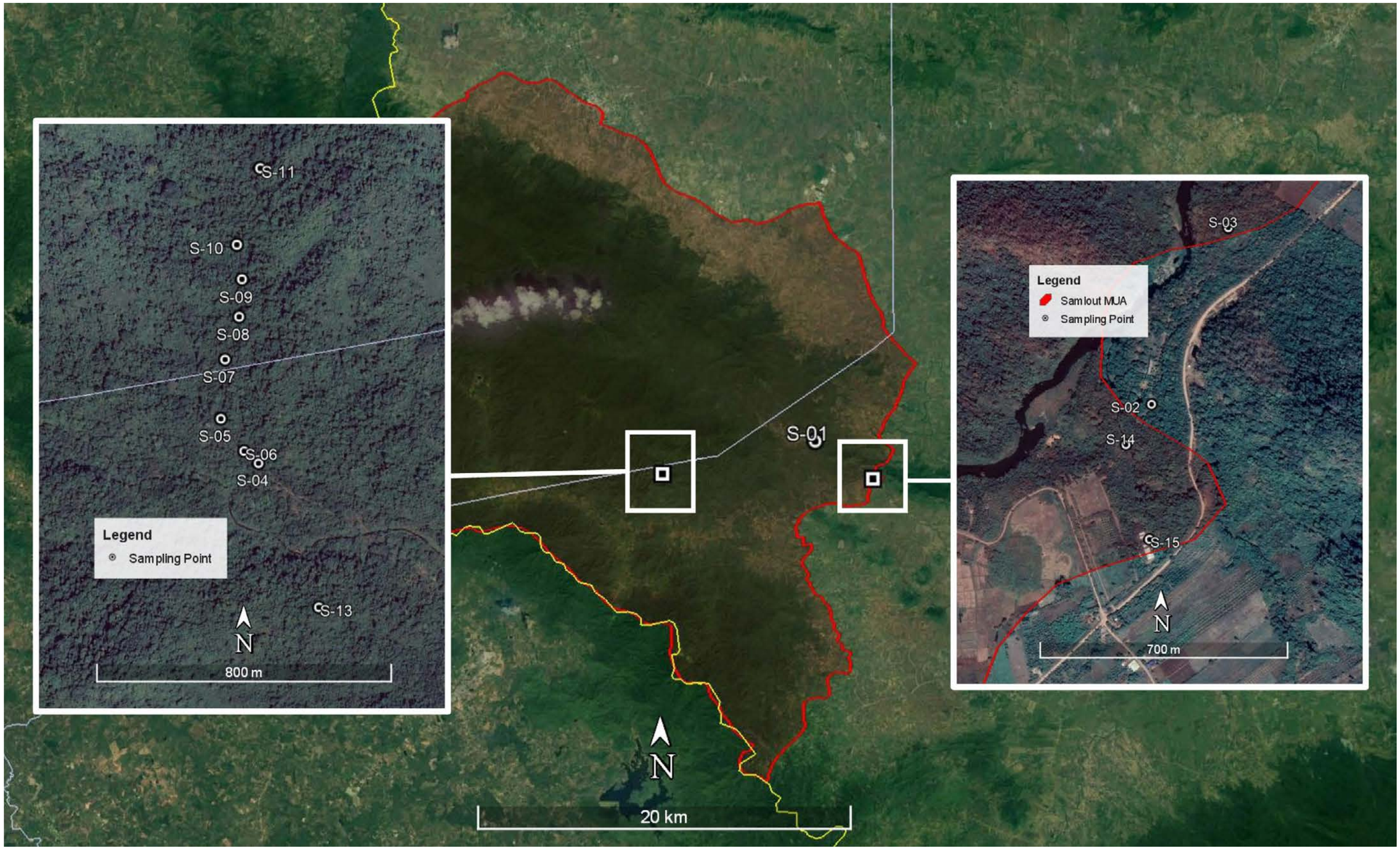


Fig. 5: Bat survey locations in Samlout MUA, November 2021

Bat Species Composition

During the field survey, 104 bats representing 14 species arranged in five families were recorded in live traps (Table 4, Figs 6). Horseshoe bats (Rhinolophidae) accounted for most captures (49%, 51 bats) with four species, followed by evening bats (Vespertilionidae, 21%, 22 bats) also with four species, frugivorous bats (Pteropodidae, 20%, 21 bats) with three species and false vampire bats (Megadermatidae, 9%, 9 bats) with two species. The remainder comprised a single capture of a leaf-nosed bat (Hipposideridae).

Based on live-trapping, the most common species were least horseshoe bat *Rhinolophus pusillus* (46 of 104 bats), common short-nosed fruit bat *Cynopterus sphinx* (17) and Woolly bat *Kerivoula hardwickii* (15). All three species are variably common within their widespread distributions in mainland SE Asia.

Eleven phonically distinct bat taxa were detected in the acoustic sampling, including seven species not captured in live traps. Presence/absence data for these are provided in Table 4 and exemplar calls are shown in Fig. 7. Reference data from Cambodia and neighbouring countries permitted specific assignment of the seven species not captured during the survey: *Mops plicatus* (mean characteristic frequency = 22.2 kHz), *Hesperoptenus tickelli* (25.3 kHz), *Taphozous* sp. (25–26 kHz), *Scotophilus heathii* (35.6 kHz), *S. kuhlii* (40.4 kHz), *M. muricola* (58.4 kHz) and *R. microglobosus* (99.5 kHz).

While these acoustic identifications are necessarily provisional due to geographical variation in call frequencies and paucity of data on the echolocation calls of bat species in west Cambodia, the signals emitted by these taxa differ greatly from all other species captured during the survey and therefore unequivocally increase the number of species recorded to 21 taxa. All bat species registered during the survey are currently regarded as Least Concern by the IUCN (2021).

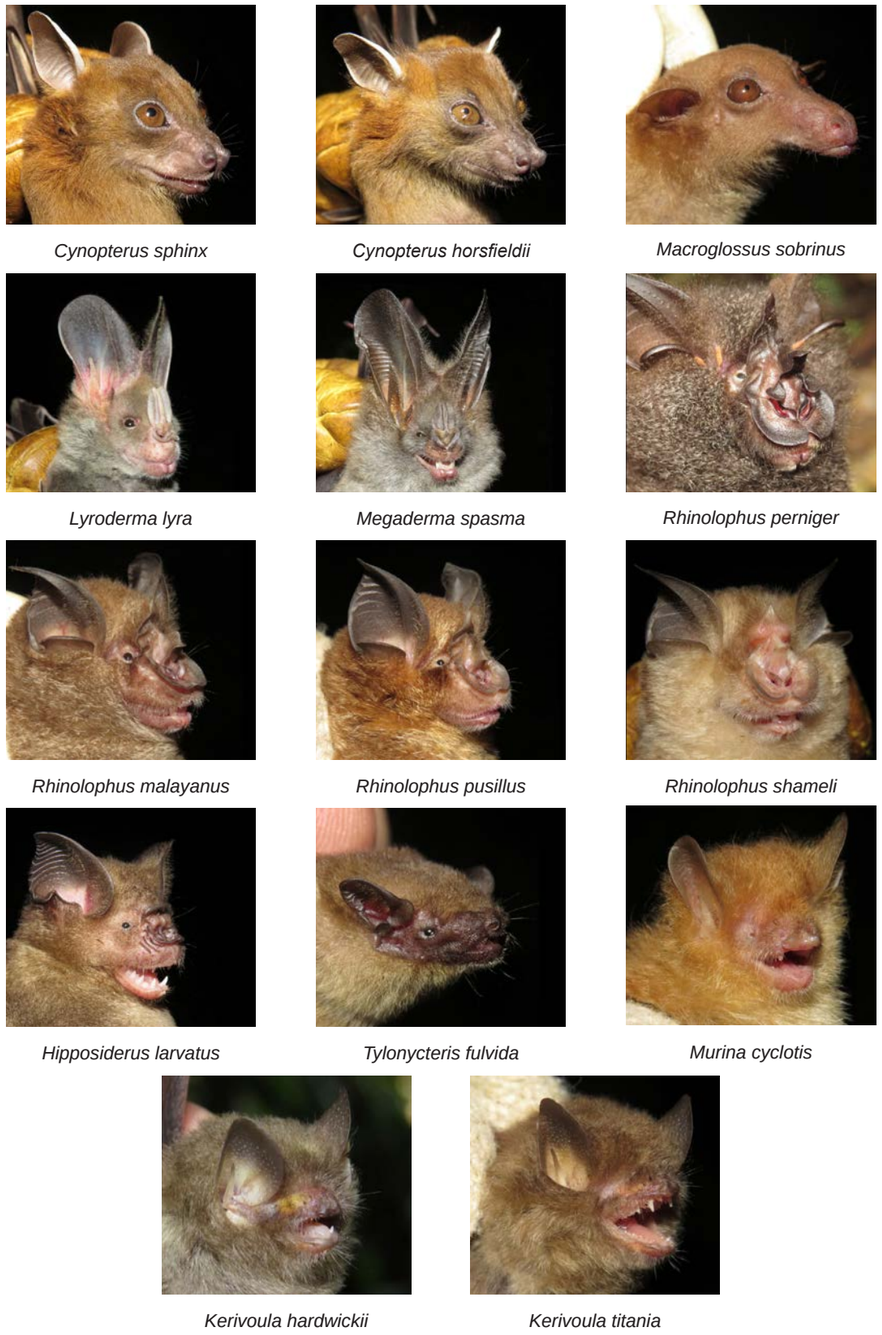


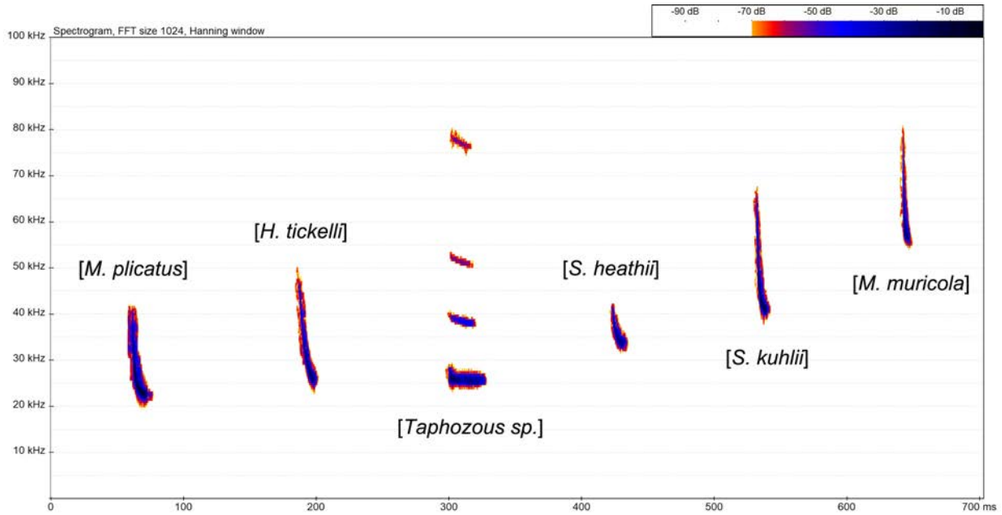
Fig. 6: Bat species captured in Samlout MUA, November 2021 (Not to scale)

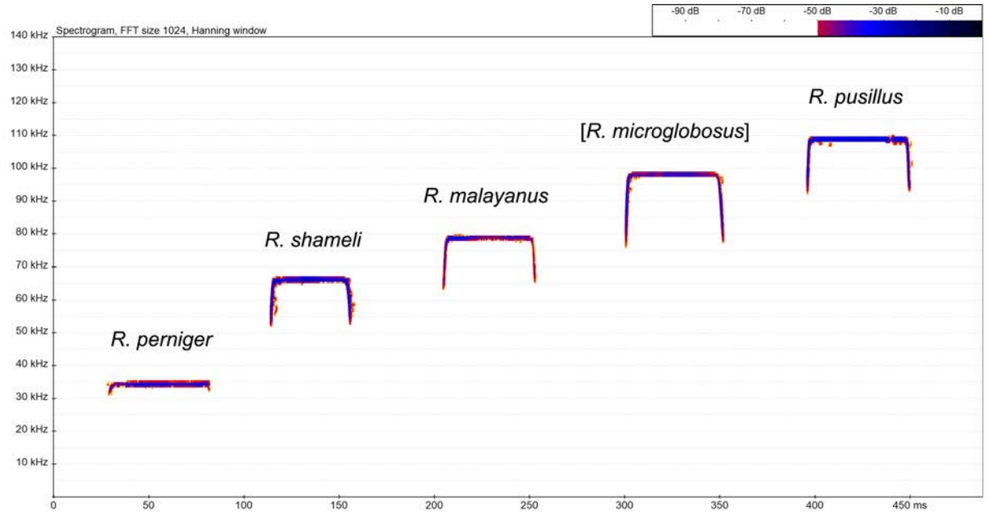
Table 3: Bat species recorded in Samlout MUA, November 2021

No.	Date	23	24		25			26			27			28		29	
	Site Code	S-01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
I	**Pteropodidae**															
1	*Cynopterus sphinx*	1			12	2		1						1		
2	*Cynopterus horsfieldii*				2											
3	*Macroglossus sobrinus*		1										1			
II	Megadermatidae															
4	*Lyroderma lyra*		3	4												
5	*Megaderma spasma*		1										1			
III	**Emballonuridae**															
6	[*Taphozous* sp.]														A	A
IV	**Rhinolophidae**															
7	*Rhinolophus malayanus*		A			1A	1	A	A		A	A	A	A		
8	[*Rhinolophus microglobosus*]		A	A					A		A					
9	*Rhinolophus perniger*								A		A	A	1A	A		
10	*Rhinolophus pusillus*				1	5A	10	A	A	21	5A	1A	3A	A		
11	*Rhinolophus shameli*	A	1A	1A	A	A			A		A			A	A	
V	**Hipposideridae**															
12	Hipposideros cf. *larvatus*			1												
VI	**Vespertilionidae**															
13	[*Myotis muricola*]	A	A	A	A	A		A	A		A	A	A	A	A	A
14	[*Hesperoptenus tickelli*]	A	A	A	A	A		A	A		A	A	A		A	A
15	[*Scotophilus heathii*]		A	A	A										A	A
16	[*Scotophilus kuhlii*]	A	A	A		A					A	A			A	A
17	*Tylonycteris fulvida*			1		3										
18	*Kerivoula hardwickii*						2			13						
19	*Kerivoula titania*									2						
20	*Murina cyclotis*									1						
VII	**Molossidae**															
21	[*Mops plicatus*]	A	A	A	A						A		A	A	A	A
	Bats captured	**1**	**6**	**7**	**15**	**11**	**13**	**1**	**0**	**37**	**5**	**1**	**6**	**1**	**-**	**-**
	Species captured	**1**	**4**	**4**	**3**	**4**	**3**	**1**	**0**	**4**	**1**	**1**	**4**	**1**	**-**	**-**
	Combined species total	**6**	**11**	**10**	**8**	**8**	**3**	**5**	**7**	**4**	**9**	**6**	**8**	**7**	**7**	**6**

A = Acoustic detection. Square brackets indicate taxa solely recorded in acoustic sampling.

Fig. 7: Echolocation calls of bats registered in Samlout MUA, November 2021
[Square brackets indicate taxa solely recorded in acoustic sampling]





Insectivorous Bat Activity

Over the course of the survey, 183.5 GB of recordings were registered in the acoustic sampling. Following removal of all recordings with <3 bat signals, these represented 55.4 GB of insectivorous bat activity comprising 8,499 discrete bat passes.

Nightly bat activity varied significantly between sampling sites and is depicted in Fig. 8. Mean nightly activity was 607.1 bat passes (SD ± 591.6), with a maximum of 1,987 passes at S-08 and a minimum of 51 passes at S-14. Although nightly variation was significant, insectivorous bat activity was greatest between 1800–2200 hrs (with 54% of mean hourly activity registered at this period) and declined markedly thereafter (Fig. 9).

Fig. 8: Bat activity across sampling sites & nights in Samlout MUA, November 2021
[* = mean number of recordings from two detectors]

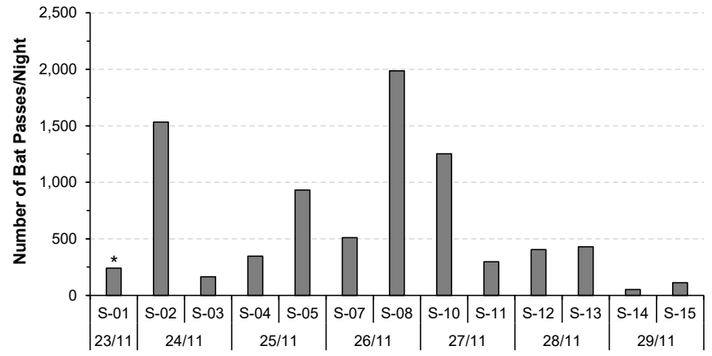
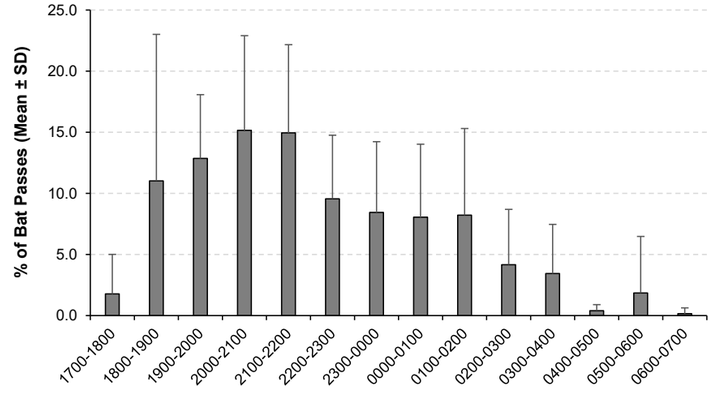


Fig. 9: Hourly variation in bat activity in Samlout MUA, November 2021rs



INTERPRETATION

Conservation Significance & Future Prospects

On current data, at least 21 bat species occur in Samlout MUA, all of which are currently regarded as Least Concern by the IUCN (2021) (Table 4). This figure represents 26% of the known bat fauna of Cambodia (80/21 species), but undoubtedly falls short of the true total for several reasons including:

- The limited representation of diverse genera (e.g., *Hipposideros, Myotis, Pipistrellus*) and absence of commonplace taxa on the current bat species list for the MUA;
- The documented occurrence of at least 14 additional species in Battambang Province (Table 5), many of which may also occur within the MUA; and,
- The low survey effort and marginal sampling coverage achieved at the site to date, coupled with the reality that detection of many bat species requires sustained sampling effort.

As a consequence, further sampling in the MUA will undoubtedly reveal additional bat species. Additionally, Samlout MUA has good prospects for supporting bat species which occur in eastern Thailand but have yet to be encountered in Cambodia (e.g., the Near-threatened *R. trifoliatus*), as well as globally threatened or seemingly rare taxa only recently documented nationally (e.g., *R. marshalli, H. halophyllus* & *M.* cf. *alticraniatus*) (Furey et al. 2021). As such, the bat species richness of the site is undoubtedly greater than presently documented, although there is no reason to suppose that any of the taxa present might be locally or nationally endemic.

Table 4: Ecological traits & status of bat species recorded in Samlout MUA (S) and Battambang Province (B)

No.	Family / Species	Current Records	Typical Roosts	Foraging Strategy	IUCN Status
I	**Pteropodidae**				
1	*Pteropus lylei*	B	F	V	VU
2	*Cynopterus sphinx*	S / B	F	IV	LC
3	*Cynopterus horsfieldii*	S	F	IV	LC
4	*Macroglossus sobrinus*	S	F	IV	LC
5	*Megaerops niphanae*	B	F	IV	LC
6	*Eonycteris spelaea*	B	C	V	LC
7	*Rousettus leschenaultii*	B	C	V	NT
II	**Emballonuridae**				
8	*Taphozous longimanus*	[S] / B	A, C, F	III	LC
9	*Taphozous melanopogon*	[S] / B	A, C	III	LC
III	**Megadermatidae**				
10	*Lyroderma lyra*	S / B	A, C	I–II	LC
11	*Megaderma spasma*	S / B	A, C, F	I–II	LC
IV	**Rhinolophidae**				
12	*Rhinolophus malayanus*	S / B	C	I	LC
13	*Rhinolophus marshalli*	B	C, F	I	LC
14	*Rhinolophus microglobosus*	[S] / B	C, F	I	LC
15	*Rhinolophus pearsonii*	B	C	II	LC
16	*Rhinolophus perniger*	S	C, F	II	LC
17	*Rhinolophus pusillus*	S / B	A, C, F	I	LC
18	*Rhinolophus shameli*	S / B	C	I	LC
19	*Rhinolophus siamensis*	B	C	I	LC

Typical Roosts: **A =** Artificial (anthropogenic) roosts, **C** = Caves, **F** = Foliage.
Foraging Strategy: See section 2.2.2.

IUCN (2021): **LC** = Least Concern, **NT** = Near-Threatened, **VU** = Vulnerable.
Square brackets indicate taxa solely recorded in acoustic sampling.

No.	Family / Species	Current Records	Typical Roosts	Foraging Strategy	IUCN Status
V	**Hipposideridae**				
20	*Hipposideros armiger*	B	C, F	II	LC
21	*Hipposideros cineraceus*	B	A, C	I	LC
22	*Hipposideros galeritus*	B	C	I	LC
23	*Hipposideros gentilis*	B	C, F	I	LC
24	*Hipposideros halophyllus*	B	C	I	VU
25	*Hipposideros* cf. *larvatus*	S / B	A, C	II	LC
26	*Hipposideros lekaguli*	B	C	II	NT
VI	**Vespertilionidae**				
27	[*Myotis muricola*]	[S]	F	II–III	LC
28	*Myotis* cf. *alticraniatus*	B	–	–	–
29	[*Hesperoptenus tickelli*]	[S]	F	II–III	LC
30	*Scotophilus heathii*	[S] / B	F	III	LC
31	*Scotophilus kuhlii*	[S] / B	F	III	LC
32	*Tylonycteris fulvida*	S	F	I	LC
33	*Kerivoula hardwickii*	S	F	I	LC
34	*Kerivoula titania*	S	F	I	LC
35	*Murina cyclotis*	S	F	I	LC
VII	**Molossidae**				
36	*Mops plicatus*	[S] / B	A, C	III	LC

Typical Roosts: **A =** Artificial (anthropogenic) roosts, **C** = Caves, **F** = Foliage.
Foraging Strategy: See section 2.2.2.

IUCN (2021): **LC** = Least Concern, **NT** = Near-Threatened, **VU** = Vulnerable.
Square brackets indicate taxa solely recorded in acoustic sampling.

Discussions with local authorities during the survey suggested that limestone karst outcrops and significant cave bat roosts (>100 individuals) are unlikely to exist within Samlout MUA. If this is the case, roosts employed by local bat populations will largely be confined to forest areas. Because forest roosts typically support small colonies and are rarely limited in abundance (Kunz & Lumsden 2003, Fletcher 2006), these will occur throughout the forests of the MUA.

In this context, studies in Vietnam and Thailand have demonstrated dramatic declines in bat abundance between areas with natural and mature forest cover compared to areas with disturbed formations or plantations (Furey et al. 2010, Phommexay et al. 2011). As such, priority should be given to maintaining forest condition and cover within the MUA, since the loss of older, larger trees (which typically provide more cavities, hollows and crevices) particularly threatens foliage-roosting species, whereas fragmentation of mature forest stands erodes the foraging effectiveness of forest-interior specialists (=strategy I taxa: Table 5).

The present work indicates further surveys will reveal additional bat species at Samlout MUA. As multi-year sampling in Indochina indicates that sampling during the dry and wet seasons is critical to inventory completeness (Furey et al. 2010), such work should ideally encompass both seasons and employ multiple detection methods e.g., live-trapping and acoustic sampling. In this context, 5–6 individuals (=two surveyors, two assistants and 1–2 camp guards/cooks) should be regarded as preferable for survey purposes, in maximising site access (by minimising the quantity of materials and supplies that require transport) and greatly reducing financial costs.

REFERENCES

Armstrong, K.N., Aplin, K.P. (2014) Identifying bats in an unknown acoustic realm using a semi-automated approach to the analysis of large full spectrum datasets. Oral presentation at the 16th Australasian Bat Society Conference 22-25 April 2014, Townsville, Queensland. The Australasian Bat Society Newsletter 42: 35–36.

Armstrong, K.N. et al. (2016) A pipeline and app for massive filtering and assisted inspection of enormous acoustic datasets. Poster presentation at the 17th Australasian Bat Society Conference, Hobart, Tasmania, Australia 29 March–1 April 2016. The Australasian Bat Society Newsletter 46: 51.

Berry, N. et al. (2004) Detection and avoidance of harp traps by echolocating bats. Acta Chiropterologica 6: 335–346.

Bognar, S. (2015) Samlout protected area park profile, Cambodia's forgotten eco-hotspot. Report submitted to the Maddox Jolie-Pitt Foundation, Cambodia.

Fenton, M. (1990) The foraging behaviour and ecology of animal eating bats. Canadian Journal of Zoology 68: 411–422.

Fletcher, C.D. (2006) Roosting ecology of insectivorous bats in Krau Wildlife Reserve, Pahang, Peninsular Malaysia. PhD dissertation, Universiti Kebangsaan Malaysia, Bangi.

Francis, C.M. (1989) A comparison of mist nets and two types of harp traps for capturing bats. Journal of Mammology 70: 865–870.

Francis, C.M. (2019) A guide to the mammals of Southeast Asia. Bloomsbury, USA.

Furey, N.M. et al. (2009) The role of ultrasonic bat detectors in improving inventory and monitoring surveys in Vietnamese karst bat assemblages. Current Zoology 55: 327–341.

Furey, N.M. et al. (2010) Bat diversity in Vietnamese limestone karst areas and the implications of forest degradation. Biodiversity and Conservation 19: 1821–1838.

Furey, N.M. et al. (2011) Reproductive phenology of bat assemblages in Vietnamese karst and its conservation implications. Acta Chiropterologica 13: 341–354.

Furey, N.M. et al. (2012) New country records for five bat species (Chiroptera) from Cambodia. Cambodian Journal of Natural History 2012(2): 141–149.

Furey, N.M., Douangboubpha, B. (2015) Sepon sustain project: dry-season bat survey, Sepon Mine Lao PDR. Hatfield Mekong Consultants and MMG Limited, Lane Xang Minerals Limited, Australia.

Furey, N.M., Racey, P.A. (2016) Can wing morphology inform conservation priorities for Southeast Asian cave bats? Biotropica 48: 545–556.

Furey, N.M. et al. (2016) The conservation status of Cambodian cave bats. In: Laumanns, M. (ed.) International speleological project to Cambodia 2016 (Provinces of Stoeng Treng, Kampong Speu, Banteay Meanchey and Battambang), pp. 82–95. Berliner Höhlenkundliche Berichte, 64, Germany.

Furey, N.M., Douangboubpha, B. (2017) Final report on the bat fauna of Hin Nam No National Protected Area. Integrated Nature Conservation and Sustainable Resource Management in Hin Nam No Region, Lao P.D.R., Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany.

Furey, N.M. et al. (2018) Reproductive ecology of *Chaerephon plicatus* (Buchannan, 1800) in relation to guano production in Cambodia. Diversity 10: 91. DOI: 10.3390/d10030091.

Furey, N.M., Douangboubpha, B. (2021) Baseline bat assessment —2021 dry and wet seasons— for the 600 MW Monsoon Wind Power Station, Xekong & Attapu Provinces, Lao PDR. Impact Energy Asia Development Ltd, Lao PDR.

Furey, N.M. et al. (2021) First records of seemingly rare bats (Mammalia: Chiroptera) in Cambodia, with a revised checklist of species for the country. Acta Chiropterologica 23: 345–369.

Hoem, T. et al. (2017) The diet of the cave nectar bat (*Eonycteris spelaea* Dobson) suggests it pollinates economically and ecologically significant plants in southern Cambodia. Zoological Studies 56: 17. IUCN (2021) The IUCN Red List of Threatened Species. Version 2017-3. Http://www.iucnredlist.org [Accessed 28 December 2021].

Jones, G., Teeling, E.C. (2006) The evolution of echolocation in bats. Trends in Ecology and Evolution 21: 149–156.

Kingston, T. et al. (2006) Bats of Krau Wildlife Reserve. Penerbit Universiti Kabangsaan Malaysia Bangi, Malaysia.

Kingston, T. (2010) Research priorities for bat conservation in Southeast Asia: a consensus approach. Biodiversity Conservation 19: 471–484.

Kruskop, S.V. (2013) Bats of Vietnam, checklist and an identification manual. Joint Russian Vietnamese Science and Technological Tropical Centre, Hanoi, Vietnam.

Kunz, T.H., Lumsden, L.F. (2003) Ecology of cavity and foliage roosting bats. In T. H.

Kunz, and M. B. Fenton (Eds.). Bat ecology, pp. 3–89. University of Chicago Press, Chicago and London, USA.

Kunz, T.H. et al. (2007) Assessing impacts of wind-energy development on nocturnally active birds and bats: a guidance document. Journal of Wildlife Management 71: 2449–2486.

Kunz, T.H. et al. (2011) Ecosystem services provided by bats. Annals of the New York Academy of Sciences. DOI: 10.1111/j.1749-6632.2011.06004.x

Lim, T. et al. (2018) Insectivorous bat reproduction and human cave visitation in Cambodia: A perfect conservation storm? PLOS One. DOI: 10.1371/journal. pone.0196554.

MacSwiney, M.C.G. et al. (2008) What you see is not what you get: the role of ultrasonic detectors in increasing inventory completeness in Neotropical bat assemblages. Journal

of Applied Ecology 45: 1364–1371. MAFF (2007) Prakas on Classification and List of Wildlife Species. Ministry of Agriculture, Forestry and Fisheries, No. 020 PR. MAFF, 25 January 2007.

McKenzie, N.L. et al. (1995) Correspondence between flight morphology and foraging ecology in some palaeotropical bats. Australian Journal of Zoology 43: 241–457.

Norberg, U.M., Rayner, J.M.V. (1987) Ecological morphology and flight in bats (Mammalia: Chiroptera): Wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society London B 316: 355–427.

Phauk, S. et al. (2013) Cambodian bat echolocation: A first description of assemblage call parameters and assessment of their utility for species identification. Cambodian Journal of Natural History 2013(1): 16–26.

Phommexay, P. et al. (2011) The impact of rubber plantations on the diversity and activity of understorey insectivorous bats in southern Thailand. Biodiversity Conservation 20: 1441–1456.

Ravon, S. et al. (2014) A rapid assessment of flying fox (Pteropus spp.) colonies in Cambodia. Cambodian Journal of Natural History 2014(1): 14–18.

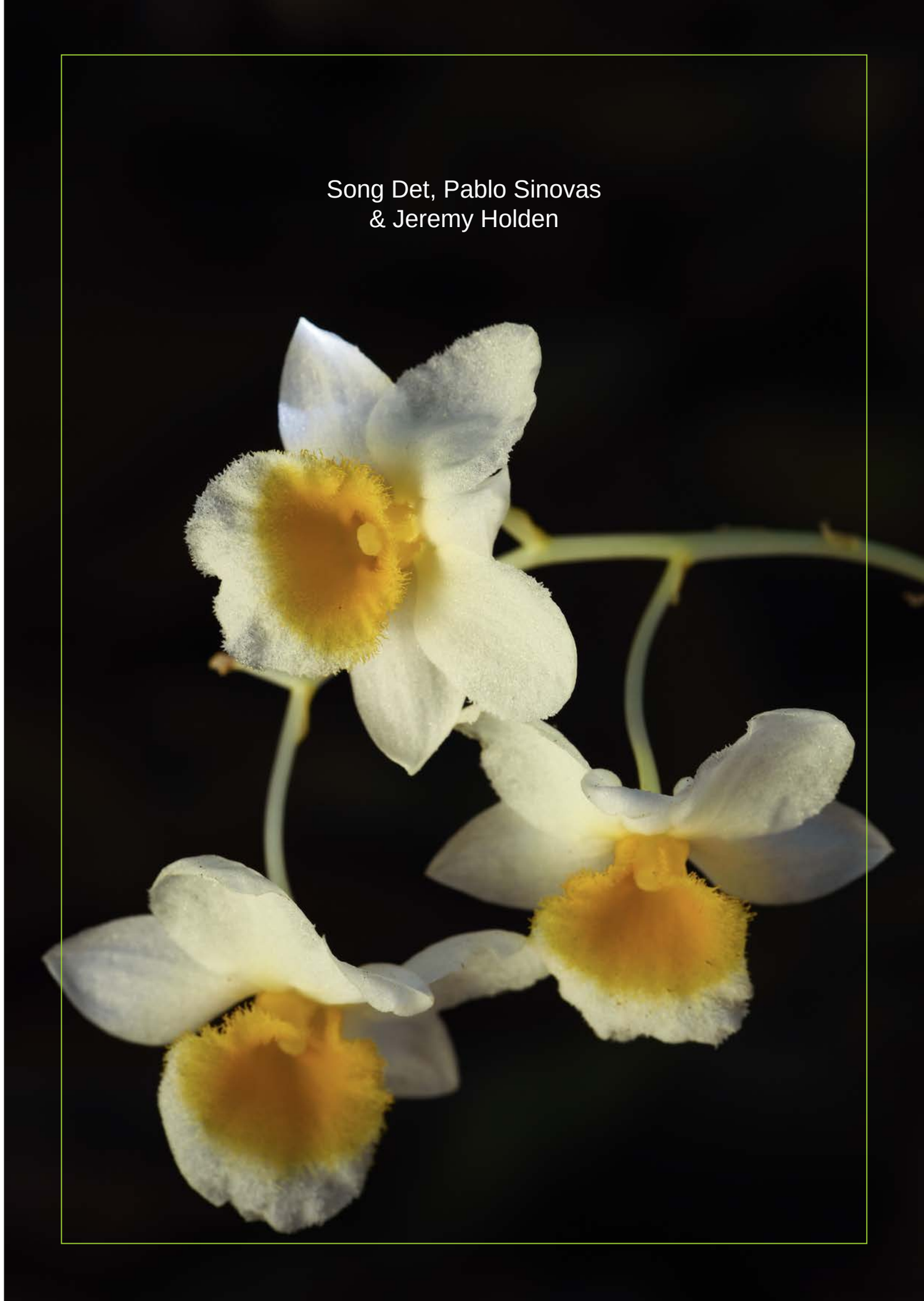
Schnitzler, H-U. et al. (2001) Evolution of echolocation and foraging behaviour in bats. In: Thomas, J.A., Moss, C.F., Vater, M. (eds). Echolocation in bats and dolphins. The University of Chicago Press, Chicago and London, p. 330–338.

Simmons, N.B., Cirranello, A.L. (2021) Bat species of the world: a taxonomic and geographic database. Https://batnames.org/ [Accessed 30 December 2021].

Tsang, S. et al. (2016) The roles of taxonomy and systematics in bat conservation. In: Voigt, C.C., Kingston, T. (Eds.), Bats in the Anthropocene: conservation of bats in a changing world. Springer, Heidelberg, Germany, p. 503–538.

ORCHID SURVEY

Song Det, Pablo Sinovas
& Jeremy Holden



INTRODUCTION

The term “orchid” refers to a flowering plant of the family Orchidaceae, of which species can be found in almost every habitat and elevation. There are more than 25,000 species of orchid globally, and many new species are described as new to science every year (Fardhani & Kisanuki 2016).

Orchid diversity in Cambodia is rarely discussed in the field of conservation. It is thought that there is likely to be upwards of 500 species in this tropical country, however to date only around 300 species of orchid have been discovered in Cambodia. These species are found in many different forest types and habitats, so diversity is high.

Orchid poaching is a major threat to certain rare and iconic orchid species’ survival in the wild (Fardhani & Kisanuki 2016). Some orchid genera in Cambodia, such as *Rhynchostylis*, *Cymbidium* and *Aerides*, have suffered from unsustainable collection. Deforestation is already a significant threat to many terrestrial and epiphytic orchid species across Cambodia, and it is possible some species have already become extinct or extirpated before they have be described or recorded.

The aim of this orchid survey is to provide basic diversity information on the orchid diversity found within the Samlout MUA. Along with orchid records, we also include other opportunistically observed plants of interest from families such as Areaceae, Begoniaceae, Melastomataceae and Zingziberaceae.

SURVEY METHOD

The orchid survey was conducted in Samlout MUA from 26 October - 03 November 2021, at the end of the rainy season. Both random searches and targeted searches were utilized to detect orchid species. Some additional orchid and other botanical species of interest were made on further non-specific surveys in 2021 and 2022.

Whenever possible, photographic records were taken for all orchid species encountered, regardless of whether they were flowering or not. Specimens were also collected under

license in the cases where they were deemed to be particularly noteworthy, such as potential new species or country records. Collected specimens were persevered in 75-90% ethanol solution and then pressed and dried using an herbarium press.

Identifications were then compared with known and existing orchid species of Cambodia using the guidebook Wild Orchids of Cambodia (2021), in addition to online sources (OrchidCambodia and Cambodian Orchid Conservation Project). Photographs of specimens that could not be readily identified from these sources, or were particularly notable, were then shared and discussed with various experts, both nationally and internationally.

RESULTS

Most areas surveyed were secondary forest, whose understory was composed of covered dense undergrowth, Survey areas rarely had a closed canopy, but were composed of scattered emergent trees. These larger trees, both standing and fallen, provided good hosts for sunlight-preferring epiphytic orchids, which were the most regularly encountered species. As many of the recorded specimens were not in flower, identifying plants to species level was not always possible. Where species determination could not be definitely established, tentative identifications have been included in the species list (Table 1).

In total, 50 species of orchid from 29 genera were recorded across Samlout MUA during the original orchid survey in November 2021, with one additional species added from a subsequent survey in June 2022. It is fully expected that there are many more species of orchid in the MUA than were recorded during our survey, particularly in drier areas that were not as thoroughly explored. Due to the survey period covering only one month of the year, there is undoubtedly many species that were missed because they were not flowering. This would certainly be the case with some of the terrestrial orchids likely occurring in the deciduous forest areas.

Dendrobium (*anosmum*) | *Dendrobium* (*heterocarpum*) | *Dendrobium* (*secundum*)

Dendrobium (*delacourii*) | *Dendrobium* (*hecoglossum*) | *Dendrobium* (*crumenatum*)

Dendrobium (*heterocarpum*) | *Dendrobium* (*plicatile*) | *Dendrobium* (*crumenatum*)

Fig. 1: *Dendrobium* orchids occurring in the Samlout Multiple Use Area

Table 1: Species list of Orchidaceae recorded in Samlout MUA. Probable identifications are noted with cf. (confer).

No.	Species	Categ.[1]	Growth[2]	Altitude	Micro Habitat
1	*Aerides* cf. *houletiana*	Epi	Mono	148	Standing tree
2	*Aerides* cf. *multiflora*	Epi	Mono	266	Standing tree
3	*Agrostophyllum* sp.	Epi	Sym	358	Fallen tree
4	*Anoectochilus lylei*	Ter	Mono	N/A	Forest trail
5	*Brachycorythis* sp.	Ter	?	N/A	Forest trail
6	*Bulbophyllum parviflorum*	Epi	Sym	632	Fallen tree
7	*Bulbophyllum* cf. *cambodianum*	Epi	Sym	499	Fallen tree
8	*Bulbophyllum* sp. 2	Epi	Sym	632	Fallen tree
9	*Cleisostoma* cf. *lanatum*	Epi	Mono	360	Fallen tree
10	*Cleisostoma* sp. 2	Epi	Mono	266	Standing tree
11	Coelogyne cf. brachyptera	Epi	Sym	N/A	MJP Station
12	*Coelogyne* cf. *pallens*	Epi	Sym	358	Fallen tree
13	*Coelogyne* sp. 2	Epi	Sym	498	Fallen tree
14	*Crepedium* sp. 1	Lith	Sym	146	Vertical rock
15	*Crepedium* sp. 2	Ter	Sym	N/A	Grassland
16	*Crepedium* sp. 3	Ter	Sym	N/A	Grassland
17	*Cymbidium* sp.	Epi	Sym	N/A	Forest trail
18	*Dendrobium crumenatum*	Epi	Sym	N/A	Forest trail
19	*Dendrobium* cf. *aggregatum*	Epi	Sym	N/A	Village
20	*Dendrobium* cf. *aloifolium*	Epi	Sym	358	Fallen tree
21	*Dendrobium* cf. *delacourii*	Epi	Mono	N/A	Forest trail
22	*Dendrobium* cf. *farmeri*	Epi	Sym	505	Fallen tree
23	*Dendrobium* cf. *hecoglossum*	Epi	Sym	N/A	Village
24	*Dendrobium* cf. *heterocarpum*	Epi	Sym	508	Standing tree
25	*Dendrobium* cf. *plicatile*	Epi	Sym	360	Fallen tree
26	*Dendrobium* cf. *secundum*	Epi	Sym	360	Fallen tree
27	*Dendrobium* cf. *anosmum*	Epi	Sym	N/A	Forest trail
28	*Dendrolirium* cf. *lasiopetalum*	Epi	Sym	360	Fallen tree
29	*Diplophora* cf. *championii*	Epi	Mono	511	Unrooted
30	*Eulophia* sp.	Ter	Sym	N/A	Roadside
31	*Gastochilus* sp.	Epi	Mono	N/A	Low hill
32	*Hataeria* sp.	Ter	Mono	N/A	Rocky hillside
33	*Micropera* cf. *thailandica*	Epi	Mono	498	Fallen tree
34	*Nephelaphyllum* sp.	Ter	Sym	N/A	Fallen tree
35	*Nervilia* cf. *plicata*	Ter	Sym	N/A	Low hill
36	*Peristylis* cf. *parishi*	Ter	Sym	152	Bamboo forest
37	*Phalaenopsis* cf. *conu-cervi*	Epi	Sym	360	Fallen tree
38	*Phalaenopsis* cf. *difformis*	Epi	Mono	N/A	Full shade
39	*Pholidota* cf. *imbricata*	Epi	Sym	401	Standing tree
40	*Pholidota* cf. *recurva*	Epi	Sym	358	Fallen tree
41	*Pinalia xanthocheila*	Epi	Sym	498	Fallen tree
42	*Porpax* sp.	Epi	Sym	529	Standing tree
43	*Porpax* cf. *muscicola*	Epi	Sym	508	Standing tree
44	*Renanthera* sp.	Epi	Mono	505	Fallen tree
45	*Thelasis perpusila*	Epi	Sym	360	Fallen tree
46	*Trichotosia* cf. *dasyphylla*	Epi	Mono	360	Fallen tree
47	*Trichotosia* cf. *pulvinata*	Epi	Mono	632	Fallen tree
48	*Tropidia angulosa*	Ter	Mono	N/A	Bamboo forest
49	*Vanda* sp.	Epi	Mono	N/A	Village
50	*Zeuxine* sp.	Ter	Mono	N/A	Grassland

[1] Category: Orchid species are epiphytic (Epi), terrestrial (Ter) or lithophyte (Lith).
[2] Growth: Orchid species grow in one of two patterns: monopodial (Mono) or sympodial (Sym). Cases where growth pattern was unknown are shown as "?".

Fig. 2: Top: Inflorescence of *Bulbophylum parviflorum.* Bottom left: leaves of *Anoectochilus lylei,* and bottom right: flowers of *Pinalia xanthocheila*.

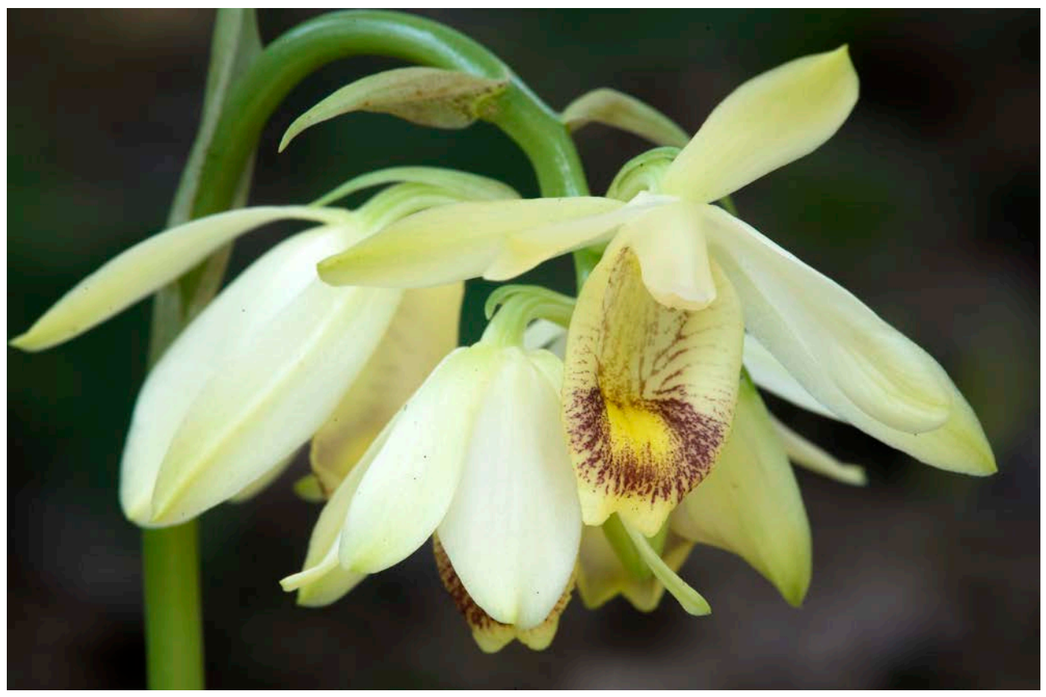


Fig. 3: Orchid species occurring in the Samlout Multiple Use Area. Top left *Dendrobium cruentatum;* top right, *Pholidota recurva*, and bottom *Geodorum* cf. *terrestre.*

In addition to orchids, 7 additional plant species of note from 5 other families were recorded during the survey.

Two species of *Begonia* were discovered during the survey, which were subsequently identified by experts as *Begonia afromigrata* (de Wilde et al. 2011) and *Begonia longifolia* (Tebbitt et al. 2003), both new species records for Cambodia (Fig. 4).

Two noteworthy Apocynacaea findings were *Pentasachme caudatum* - an expected new species for Cambodia that requires further research (Kidyoo 2016), and an unidentified *Hoya* species, which has unusually large leaves and may possibly constitute a new species.

Additional notable discoveries during the orchid survey in the Samlout MUA were a king fern, *Angiopteris* sp. from the Marattiaceae family; an *Elatostema* sp. from the Urticaceae family; and a *Sonerila* sp. (*maculata*) from the Melastomataceae family. The king ferns are little studied in Cambodia, and both latter species are likely new species records for Cambodia.

Table 2: Summary of notable species from other families

No.	Family	Species	Note
1	Areaceae	*Amorphophallus tenuistylis*	Notable finding
2	Areaceae	*Pycnospatha arietina*	Notable finding
3	Apocynacaea	*Pentasachme caudatum*	Expected new record
4	Apocynacaea	*Hoya* sp.	Possible new species
5	Begoniacaea	*Begonia afromigrata*	New record for Cambodia
6	Begoniacaea	*Begonia longifolia*	New record for Cambodia
7	Marattiaceae	*Angiopteris* sp.	Notable finding
8	Melasomataceae	*Sonerila* sp. (*maculata*)	Expected new record
9	Urticaceae	*Elatostema* sp.	Expected new record

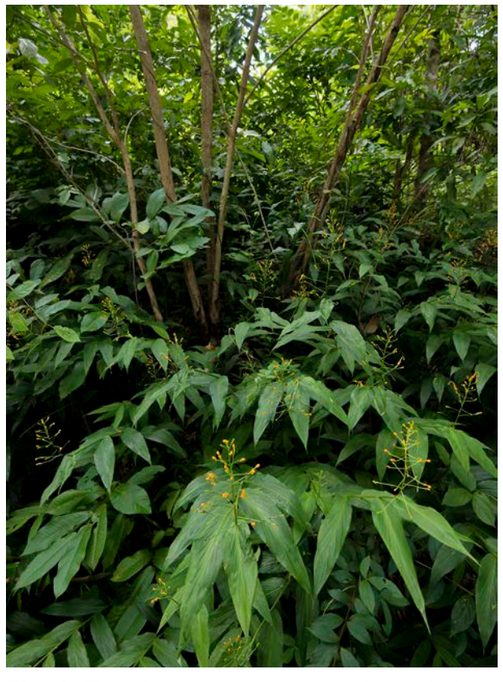
Fig. 4: Top left *Begonia longifolia;* top middle: *Begonia afromigrata*; Top right: *Pentasachme caudatum*; Bottom: *Sonerila* sp. (*maculata*).

One significant botanical find in Takut Beng, made during the herpetological survey in June, was a small colony of the rare aroid *Pycnospatha arietina* (Fig. 6). This plant is endemic to Indochina and known in Cambodia from a few records made in Siem Reap Province. Only three plants were seen, all in flower, along the logging track between the Takut Beng ranger station and the study site (no UTM was obtained at the location, but the position was noted by rangers Mr Men Veasna, Sok Toeurt and Keo Heng). As advised to MJP, the intervention of moving these three rare plants to the safer forest complex at the MJP Station in Samlout should be considered. It was clear that from comparisons made during my two visits to Takut Beng in February and June that rapid forest clearance for agriculture is happening in this area. It seems likely that this location for *Pycnospatha arietina* may soon be converted, and another location for this rare species will be lost. The dry forest habitat at the MJP station is a good match for the locality in which the plants were seen, so careful removal and replanting should be possible. In regard to the rarity of this species, even within Takut Beng, it was noted that one of the rangers, Sok Toeurt, was very familiar with the local flora and knew many medicinal and culinary applications for species we saw. However, he was unfamiliar with the species. Given that this is a relatively large plant, and an unusual one, it suggests that even in Takut Beng *Pycnospatha* is scarce.

In the same general area as the *Pycnospatha* a second notable aroid was seen - *Amorphophallus tenuistylis* (Fig 5). This is known from a few other locations in deciduous forest throughout Cambodia, and has been recorded from Pursat and Kratie provinces. The plants at Takut Beng were in flower in June, and around 12 inflorescences were noted, plus some infructescences from earlier flowerings. This species was recognised by Sok Toeurt, who claimed it was used medicinally.

Another medicinal plant pointed out by Toeurt was the small ginger *Kaempferia koratensis* (Fig.6).

Fig. 5: *Pycnospatha arietina* seen in Takut beng area of the Samlout MUA



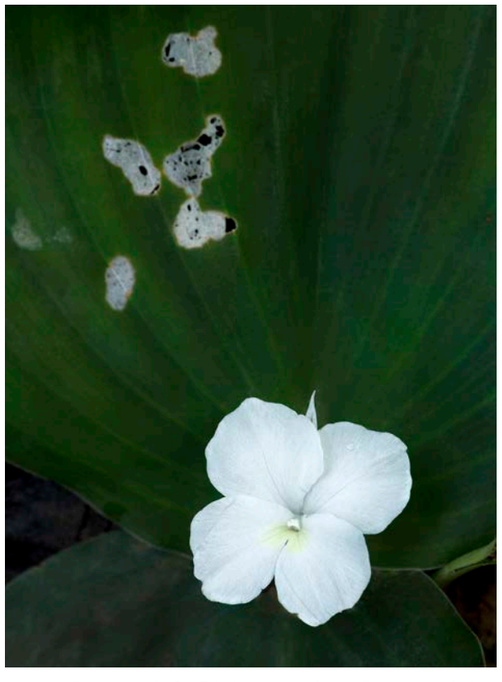


Fig. 6: Top: *Amorphophallus tenuistylis* inflorescence; Bottom left *Globa* species; Bottom right: *Kaempferia koratensis,* a medicinal ginger seen in Takut Beng.

THREATS

Orchid Poaching

Some species recorded during the survey are under significant threat from collection and are considered rare in the wild. *Dendrobium* sp. are the most common species in the South East Asian orchid trade, along with *Aerides* sp. and *Cymbidium* sp. - dependent upon how aesthetic their flowers are thought to be (Phelps & Webb 2015).

The Samlout MUA contained a number of these heavily traded orchids. Ten *Dendrobium* species were found, including *Dendrobium* cf. *anosmum* and *Dendrobium* cf. *delacourii*, both found in semi-evergreen and mixed dipterocarp forest. *Dendrobium* cf. *heterocarpum*, *Dendrobium* cf. *secundum* and *Dendrobium* cf. *hecoglossum* were found in secondary forest. Two species of *Aerides* were recorded: *Aerides* cf. *houletiana* and *Aerides* cf. *multiflora*, along with one *Cymbidium* species. Two species of jewel orchid found in the survey are also both likely to be targeted by poachers or collectors: *Anoectochilus lylei* and *Nephelaphyllum* sp.

In recent years, there has been an increase in awareness of orchids among Cambodians. This has led to a subsequent rise in orchid poaching as their value becomes more widely known. Unsustainable collection and proffering orchids for sale, frequently through the Internet, is a growing threat.

During the survey, three species were only recorded from local houses, where they had been collected and used for decoration: *Dendrobium* cf. aggregatum, *Vanda* sp. and *Coelogyne* cf. *brachyptera*.

Habitat Destruction

Habitat loss and forest degradation is a concern for many plant species in Samlout MUA, especially species that are alongside newly developed roads, such as the border road belt. Many plant species in addition to orchids are being negatively impacted here, such as king ferns (*Angiopteris* sp.) and other tree ferns. The survey noted many orchid species impacted by forest clearance: *Dendrobium* sp., *Bulbophylum* sp., *Renanthera* sp., *Pinalia* sp., *Phalaenopsis* sp., and *Micropera* sp.

Forest encroachment for agricultural use was another observed threat to local plant and wildlife, including orchid species. Orchid species reliant on undisturbed forest are most at risk from forest loss and degradation, such as terrestrial orchids that require shade, and epiphytic orchids reliant on large trees.

Fig. 7: Several orchid species on branches of trees felled for road construction.

RECOMMENDATIONS

Further and wider botanical surveys should be carried out in Samlout MUA and will likely find several new records for the area and for Cambodia as a whole.

Ex-situ plant conservation of key species should also be considered, especially for plants in areas under high risk of deforestation or development. Plant confiscations from collectors or poachers should also be considered for ex-situ conservation. The MJP Station in Samlout MUA offers suitable environment, an ideal location for a plant-based ex-situ conservation and research centre.

REFERENCES

de Wilde, J. J. F. E., Hughes, M., Rodda, M., & Thomas, D. C. (2011). Pliocene intercontinental dispersal from Africa to Southeast Asia highlighted by the new species begonia afromigrata (Begoniaceae). Taxon, 60(6), 1685–1692. http://doi.org/10.1002/tax.606013

Fardhani, I., & Kisanuki, H. (2016). Diversity of Orchid Species in Mount Sanggarah , West Bandung Diversity of Orchid Species in Mount Sanggarah , West Bandung. TRI-University International Joint Seminar and Symposium, October.

Houttekiet, J. (2020). Cambodian Orchid Conservation Project. http://www.cambodianorchid.com/

INVERTEBRATE SURVEY

Pablo Sinovas, Pierre-Olivier Maquart
& Jeremy Holden

INTRODUCTION

Invertebrates make up the vast bulk of non-botanical diversity in tropical environments and are therefore an important constituent of any biodiversity survey, However, with the focus on other taxa during this survey work, invertebrates were noted on a primarily opportunistic and ad-hoc basis, with records being made when and where they occurred during the course of fieldwork.

A series of records were made the camera trapping deployment, between 26 October and 07 November 2021, and further records were added during the two herpetological surveys in February and June 2022. As such, they were collected from the same areas where the camera trapping and herpetological work was undertaken: the Cambodia-Thailand Border Gate 400, the Cambodia-Thailand Border in Pailin, Prek Bey, Phnom Pich, the MJP station, Anlung Kav, O'Slav, Phnom Sar Ruom, Phnom Pich and Takut Beng.

SURVEY METHOD

Invertebrate specimens, when found, were collected when possible during the October-November 2021 period, and photographed where possible during the February-June 2022 period. Collected specimens were euthanized and preserved in sealed tubes of ethanol solution for later identification by relevant experts.

RESULTS

Specimens were identified as closely as possible to species level; however many could only be confidently identified to Family or Order. Specimens collected during the camera trapping work are listed in Table 1. The following photographic records were made during the herpetological survey work, where the many hours spent exploring the forest at night meant invertebrates were regularly encountered.

Table 1: Species list of invertebrates opportunistically recorded in October-November 2021 during the course of camera trapping work

No.	Class	Order	Family	Sub-family	Genus	Species
1	Arachnida	Scorpiones	Scorpion	Hormuridae	*Liocheles*	*australasiae*
2	Arachnida	Araneae	Araneidae		*Gasteracantha*	*geminata*
3	Arachnida	Ampblypygi	Phrynichidae	Phrynichina	*Phrynichus*	*orientalis*
4	Arachnida	Uropygi	Thelyphonidae	Hypoctoninae	Hypoctonus	sp.
5	Diplopoda	Polydesmida	Polydesmidea			
6	Insecta	Blattodea				
7	Insecta	Coleoptera	Coleoptera	Pythidae	*Phyto*	sp.
8	Insecta	Coleoptera	Coleoptera	Dynastinae	*Xylotrupes*	*gideon*
9	Insecta	Coleoptera	Scarabaeidae	Dynastinae	Xylotrupes	gideon
10	Insecta	Coleoptera	Lycidae	Lyropaeinae	*Platerodriulus*	sp.
11	Insecta	Coleoptera	Carabidae	Brachininae	*Pheropsophus*	*javanus*
12	Insecta	Coleoptera	Scarabaeidae	Cetoniinae	*Euchloropus*	*laetus*
13	Insecta	Coleoptera	Brenthidae	Cyladinae	*Cylas*	*formicarius*
14	Insecta	Coleoptera	Staphilinidae			
15	Insecta	Coleoptera	Carabidae	Lebiinae	*Allocota*	*caerulea*
16	Insecta	Coleoptera	Coccinelidae			
17	Insecta	Coleoptera	Chrysomelidae	Galurinae		
18	Insecta	Coleoptera	Passalidae	Passalinae	*Leptaulax*	*dentatus*
19	Insecta	Coleoptera	Passalidae	Passalinae	*Aceraius*	*helferi*
20	Insecta	Coleoptera	Tenebrionidae			
21	Insecta	Coleoptera	Scarabaeidae	Rutelidae	*Popilia*	sp.
22	Insecta	Coleoptera	Lucanidae			
23	Insecta	Coleoptera	Cerambycidae			
24	Insecta	Fulgoridae	Fulgora	Aphaeninae	*Penthicodes*	*pulchella*
25	Insecta	Hemiptera	Nepidae	Ranatrinae	*Ranatra*	sp.
26	Insecta	Hemiptera	Scutelleridae		*Chrysocoris*	*stollii*
27	Insecta	Hemiptera	Pentatomidae			
28	Insecta	Hemiptera	Reduvidae		*Dysdercus*	*cingulatus*
29	Insecta	Heteroptera	Reduvidae	Harpactorinae		
30	Insecta	Hymenoptera	Vespidae	Polistes	*Polistella*	*nigritarsis*
31	Insecta	Orthoptera	Caelifera			
32	Insecta	Orthoptera	Ensifera			

Fig. 1: A Thelyphonida species from Phnom Pich (above) and Takut Beng (below)

Fig. 2: Amblypygi - probably *Phrynichus orientalis*. The adult above was seen in Phnom Pich; the smaller specimen below in Takut Beng

Fig. 3: Wood scorpion *Heterometrus spinifer* with young in Takut Beng.

Fig. 4: *Pandercetes* species of huntsman spider seen in Takut Beng.

Fig. 5: Four different species of Phasmid stick insect seen in Takut Beng

Fig. 6: The cryptic stick insect *Orestes mouhoti* seen at Phnom Pich

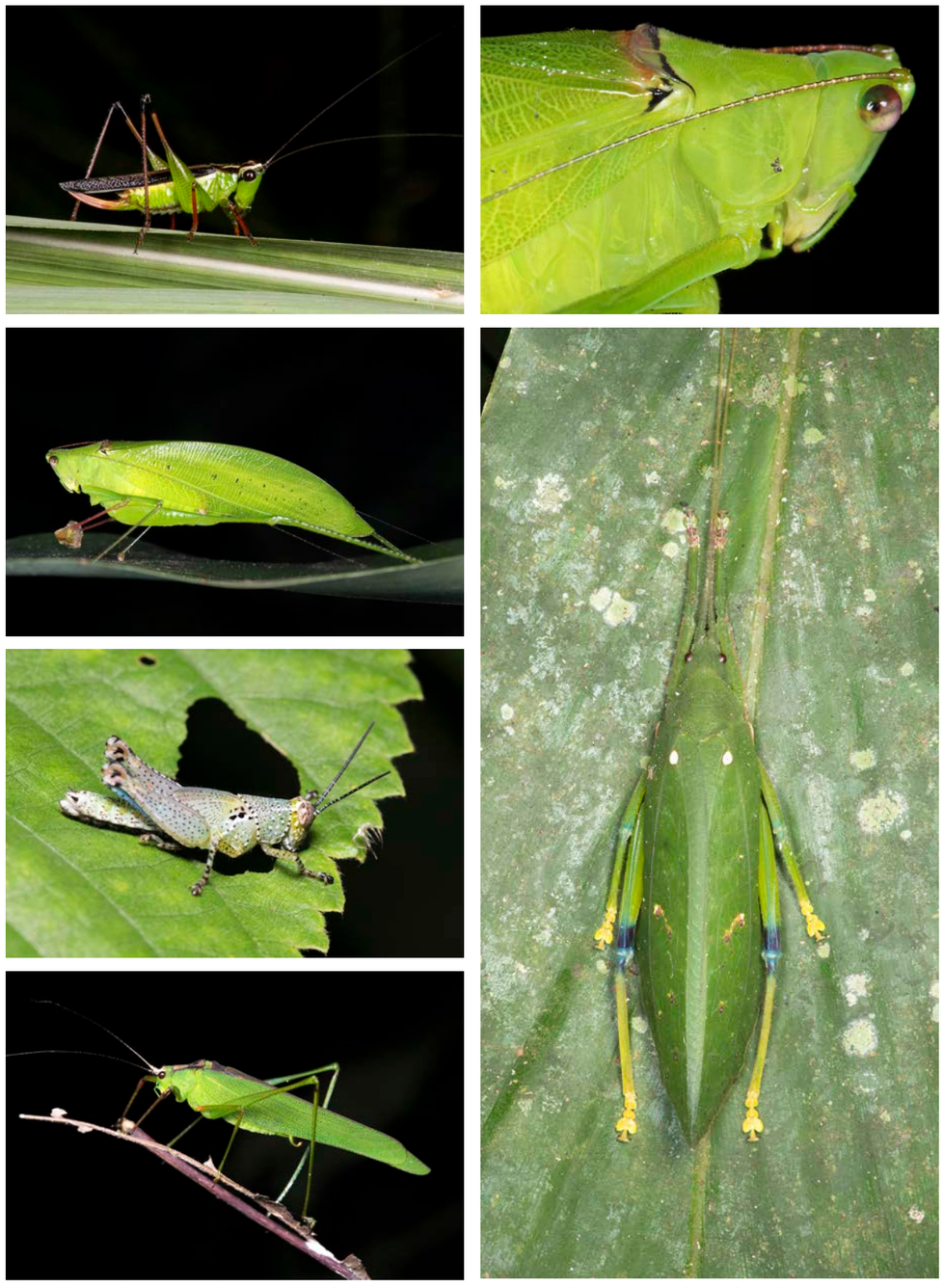


Fig. 7: In June, at the onset of the wet season, the forest was full of various species of Orthoptera. The above species were seen during night surveys in Takut Beng

Fig. 8: Fulgorid bugs. Left *Penthicodes variegata;* Right *Pyrops condorinus*

Fig. 9: Mango borer beetle *Batocera* cf. *rubus* at Phnom Pich in June

Fig. 10: Above caterpillars of *Eudocima* sp (left) and *Papilio polytes romulus* (right) Below Uraniid moth in the genus Micronia. All seen at Takut Beng in June

CONCLUSION & RECOMMENDATIONS

Almost any area of tropical rain forest is likely to hold many invertebrate species unknown to science, and the Samlout MUA would not be an exception. The diversity we discovered as a side study to other work shows the rich scope for further research. As with the other taxa documented here, further surveys in higher altitude and more pristine habitat within the MUA would certainly lead to potentially interesting species. MJP rangers should also be encouraged to photograph or otherwise record interesting invertebrates they might come across, either during survey work or when species arrive at lights at night. Building a database of records can be extremely helpful for future researchers.

Areas where further research could fit with ongoing studies within Cambodia are the Lepidoptera (butterflies and moths) and the Odonata (dragonflies and damselflies).

HERPETOLOGICAL SURVEY

Jeremy Holden, Ollie Roberts
& Pablo Sinovas

INTRODUCTION

The Samlout Multiple Use Area covers 60 km² of mixed habitat in Battambang and Pailin provinces in Cambodia. It lies within the Greater Cardamom Mountain range, which stretches approximately 300 km from the Elephant Mountains in Kampot Province, through to the Khao Soi Dao Mountains in eastern Thailand.

This area of Cambodia is interesting from a herpetological perspective for a number of reasons. The first of these is that no serious herpetological survey has been carried out in the area. This is a noteworthy omission, as the Cardamom Mountains form one of the most important biogeographic areas in Cambodia, hosting a large percentage of the country's endemic species. Secondly, the amount of survey work conducted, not only throughout the greater Cardamoms, but in Cambodia as a whole, remains negligible compared to the effort expended in neighbouring Thailand and Vietnam.

Judging by the continued discovery of new species and new country records made in Cambodia, it is clear that a complete understanding of Cambodia's herpetofauna remains elusive.

Current figures put the total number of reptiles and amphibians recorded from Cambodia at 259 species. This breaks down to 99 Serpentes, with 3 endemics; 68 Sauria with 12 endemics; 2 Crocodylia; and 18 Testudines (Poyarkov in litt). The official figure for amphibians is 72 (Poyarkov et al. 2021) but some species discovered in country remain to be described.

In the case of both reptiles and amphibians, many more species are anticipated to occur in Cambodia. The majority of these are species that are known to occur in either Vietnam or Thailand. For this reason, the Samlout Multiple Use Area, with its western border with Thailand, is of particular interest.

This report details the findings made during two field surveys in the Samlout Multiple Use Area in Battambang and Pailin provinces of western Cambodia, conducted by Fauna & Flora Cambodia Programme and the Ministry of Environment in 2022.

STUDY AREAS

The survey focused on three areas situated within the MUA: The MJP base station and surrounds at Samlout; Takut Beng; and the base of Phnom Pich (Fig.1) None of these areas represented undisturbed, primary habitats, or gave access to habitat at elevations above 300 m.a.s.l. Both of these omissions significantly decreased the chances of finding scarce or endemic species.

The MJP Base Station and surrounding area (12.68180 102.74480) at an altitude of around 150 m.a.s.l. provided a mosaic of lowland disturbed habitats, plus small areas of evergreen gallery forest, bamboo groves and dry evergreen forest. Water could be found in a large artificial tank dug within the grounds of the station, a small pond and stream near the base camp, a small waterfall and pool behind the station, and various small features in the agricultural landscape around the station that still contained water.

The Takut Beng camp (12.729559 102.664841) was situated beside the O'Slev River in heavily disturbed evergreen forest at around 200 metres elevation. Situated approximately 10 km from the MJP base camp, this area was reached via unpaved tracks through a variety of plantations and agricultural features before traversing 3 km of patchy dry evergreen forest. The mid-sized O'Slev notwithstanding, water here was scarce. None of the wet season forest streams were flowing, and no standing water had accumulated into temporary pools or puddles during either visit.

The Phnom Pich camp (12.680531 102.654816) was situated 10 km from MJP base station in an old logging base close to the Phnom Pich River at around 230 masl. This camp gave access to riparian habitat along the river and some lightly logged evergreen hill forest. Away from the river, water features were completely absent during the surveys. The only still water encountered was in stagnant overflow pools bordering the river. Access was made via a track through disturbed forest and grassland that followed the course of the river. Our departure point was the MoE ranger station at Phnom Pich (12.661632 102.69143).

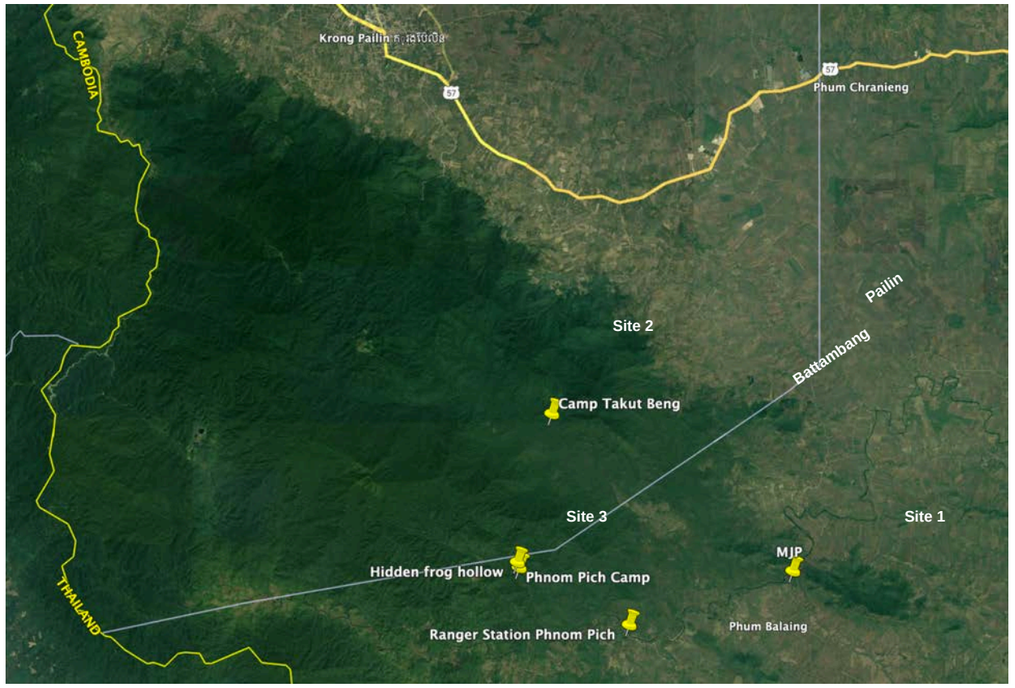


Fig. 1: Study sites within the Samlout Multiple Use Area

All three areas were visited twice within the survey period: firstly, during the dry season in February, and again during what should have been the wet season in June. Uncharacteristically, the February trip proved to be much wetter than the June trip. Short rain showers occurred twice in February; while the June trip saw no rainfall at all. Due to current tensions, I was not able to visit the higher altitude and less disturbed forest closer to the Thai border area.

These three areas should all be counted as lowland disturbed habitat with varying degrees of forest cover. One small section of the Phnom Pich site maintained habitat that approximated the kind of forest that once would have covered the landscape in this area.

Both sites outside of the MJP Station were accessed by motorbike and hand tractor.

SURVEY METHODS

Searches for amphibians and reptiles were conducted at all hours of the day and night. The majority of species show a nocturnal activity pattern, which meant that search periods of 4-5 hours were conducted every night of the survey period. Most mornings were spent photographing and recording specimens. Daylight searches were conducted to find leaf litter skinks, diurnal snakes, and to examine places where nocturnal species might be concealed. The study sites were also surveyed during the day to find potentially interesting areas to survey once darkness fell.

No specialized techniques, such as pit fall traps or glue strips were used. Searches were conducted visually or aurally using powerful but compact flashlights.

Searching concentrated on areas were water was available, with particular focus on small water bodies or streams in forested habitat. To locate concealed species, logs were examined, discarded cut timber turned, and loose bark and tree holes explored. Different types of water bodies, such as mid-sized rivers, small streams, ponds, animal wallows, and temporary rain pools were targeted for both frogs and snakes.

Specimens of interest were either photographed in situ or collected in bags to be photographed later. This avoided spending too much time with photography during the important nocturnal hours. Most photographs made tried to show the species in its natural habitat.

All specimens caught by the lead author were released back into the habitat in which they were found, with the exception of on *Lygosoma* skink that was accidentally crushed while turning over a fallen log (Fig. 10). A small number of specimens were collected by the second author Pablo Sinovas, which were preserved in 70% alcohol (Fig. 10).

Fig. 2: Remnant water in pig wallow at Phnom Pich ‘frog hollow’ site

RESULTS

The results of the herpetological survey were modest. In total 51 species were found: 21 amphibians, 6 agamids, 4 geckos, 5 skinks, 14 snakes and 1 turtle (Table 1). This figure represents 38.9% of the amphibian and reptile species reported to occur in the Cardamom Mountains (Grismer 2007). However, due to recent discoveries, and the splitting of some known forms following genetic evaluations, this number has now increased from the published 2007 figure of 131 species.

All but two of these species were specifically identified. One frog, a *Chirixalus* species, was heard calling but could not be located due to the intermittent calls. This was almost certainly *C. nongkhorensis*, but records of *C. doriae* from the Cardamom region gave potential for doubt. The second unidentified species was possibly a litter skink of the genus *Tytthoscincus* (Fig. 10).

Table 1: Full herpetological species list compiled from records made in February and June 2022 from the Samlout Multiple Use Area, Cambodia

ANURA - FROGS & TOADS

Bufonidae
Duttaphrynus melanostictus

Dicroglossidae
Fejervarya limnocharis
Hoplobatrachus rugulosus
Limnonectes gyldenstolpei
Limnonectes kohchangae
Occidozyga lima
Phrynoglossus martensii

Microhylidae
Kaloula pulchra
Glyphoglossus guttulatus
Microhyla butleri
Microhyla heymonsi
Microhyla mukhlesuri
Microhyla pulchra
Micryletta erythropoda

Ranidae
Hylarana erythraea
Papurana milleti
Sylvirana mortenseni

Rhacophoridae
Chirixalus sp.
Kurixalus bisacculus
Polypedates megacephalus
Rohanixalus hansenae

SAURIA - LIZARDS

Agamidae
Acanthosaura cardamomensis
Calotes emma
Calotes versicolor
Draco maculatus haasei
Leiolepis belliana
Physignathus cocincinus

Gekkonidae
Cyrtodactylus cf. *thylacodactylus*
Dixonius siamensis – dark and light morphs
Gekko gecko
Hemidactylus platyurus – light and dark morphs

Scincidae
Eutropis macularia
Eutropis multifasciata
Sphenomorphus maculatus
Subdoluseps bowringii
{*Tytthoscincus* sp.}[1]

SERPENTES - SNAKES

Colubridae
Boiga cyanea[2]
Dendrelaphis pictus
Fowlea flavipunctatus
Lycodon laoensis
Oligodon taeniatus
Ptyas korros
Rhabdophis chrysargos
Rhabdophis nigrocinctus

Elapidae
Bungarus fasciatus

Homalopsidae
Hypsiscopus plumbea[2]

Pythonidae
Malayopython reticulatus

Typhlopidae
Indotyphlops braminus

Viperidae
Trimeresurus cardamomensis

Xenopeltidae
Xenopeltis concolor

TESTUDINES - TURTLES

Trionychidae
Cyclemys atripons [2]

[1] Species and genus not fully determined

[2] Species was only seen on an earlier survey conducted in December 2021- January 2022

Anura - frogs and toads

A total of 21 amphibian species were recorded from 5 families. Despite observing almost no breeding activity - due to the surveys not coinciding with any heavy rain events - we managed to find most of the expected species, if only in low numbers.

The Samlout area is likely to contain at least one caecilian and possibly two species. *Ichthyophis kohtaoensis* (or a closely related species) should be present. The endemic *Ichthyophis cardmomensis*, which to date is known only from a few records in the Phnom Samkos Wildlife Sanctuary could also occur (Geissler 2015). However, no caecilian records were made during the surveys, probably because conditions were too dry.

The current amphibian list for Cambodia totals 72 species (Poyarkov et al. 2021). Forty-six of these species have been recorded from the Cardamom Mountain chain, including all six of Cambodia's endemic species. Some of these species are restricted to elevations not found within the MUA. A tentative prediction puts the expected amphibian diversity within the MUA at 38 species, or 53% or the total Cambodian fauna. There is also the possibility, given its proximity to Thailand, that addition species not yet recorded from Cambodia could occur in the MUA, or less likely, species as yet undescribed.

Bufonidae

A single common Bufonid was recorded, the ubiquitous black-spined toad *Duttaphrynus melanostictus.* This species is commensurate with human activity and is almost never seen outside of disturbed habitat. Individuals were found around the MJP camp and along the logging tracks at Takut Beng. Call choruses were heard at the Samlot Waterfall near the MJP camp in June, and along the O'Slev River in February.

Two additional Bufonids might be expected to occur in MUA: *Ingerophrynus macrotis* and *I. parvus*. The former is a dry forest species, which might be found in the dry forest areas seen near Takut Beng; while *I. parvus* is a forest species possibly occurring in wetter undisturbed forested areas deeper in the protected area. Neither species was seen during the survey.

Table 2: Amphibian records from the three study sites compared between the surveys conducted in February and June

Species	February			June		
	MJP	PP	TB	MJP	PP	TB
Bufonidae						
Duttaphrynus melanostictus	X	-	X	X	-	X
Dicroglossidae						
Fejervarya limnocharis	X	-	X	X	-	-
Hoplobatrachus rugulosus	-	-	-	-	-	X
Limnonectes gyldenstolpei	-	-	-	-	-	X
Limnonectes kohchangae	-	-	-	-	-	-
Occidozyga lima	X	-	-	-	-	-
Phrynoglossus martensii	X	-	X	X	X	X
Microhylidae						
Kaloula pulchra	-	-	-	X	-	-
Glyphoglossus guttulatus	-	X	-	X	-	-
Microhyla butleri	-	X	-	X	X	-
Microhyla heymonsi	X	X	X	X	X	-
Microhyla mukhlesuri	X	-	-	X	-	-
Microhyla pulchra	X	-	X	X	-	-
Micryletta erythropoda	X	X	-	X	-	-
Ranidae						
Hylarana erythraea	-	X	-	-	-	-
Papurana milleti	-	-	-	-	X	-
Sylvirana mortenseni	X	X	X	X	X	X
Rhacophoridae						
Chirixalus sp.	-	-	-	-	X	-
Kurixalus bisacculus	-	-	X	-	X	X
Polypedates megacephalus	X	X	X	X	X	X
Rohanixalus hansenae	-	-	-	X	X	-

Dicroglossidae

Most of the frogs in this family are not found far from water. The low encounter rate of the six species recorded demonstrates the dry nature of the sites during the survey period.

The common grass frog *Fejervarya limnocharis* is one of the most numerous frog species in Cambodia, and its presence is guaranteed on any herpetological survey that includes human-altered landscapes. This species was seen at MJP and along the forest tracks in Takut Beng.

The two floating frogs, *Occidozyga lima* and *Phrynoglossus martensii* are usually extremely common in rural areas, frequenting puddles and small water bodies. Both were found in low numbers around the MJP camp in February after some light rain produced puddles along the tracks, but in June only *Phrynoglossus* was observed. The latter species was seen in all three locations. At MJP it occurred in puddles and in the small pond within the camp grounds. At Takut beng it was found in puddles along the logging tracks; and at Phnom Pich it was found calling in anticipation of rain in the 'frog hollow' area (Fig. 1). The absence of any records for *Occidozyga* in June show how unusually dryness of this period.

The Rugose frog *Hoplobatrachus rugulosus* is also a common species in anthropogenic habitats, always found close to water in artificial ponds and roadside ditches. Its loud call makes it easy to locate when it is breeding, and it is often collected for human consumption. Only two juveniles were found, both in a remnant puddle at Takut Beng.

The two *Limnonectes* species encountered – *gyldenstolpei* and *kohchangae* – are both species that are expected in the Cardamom Mountains. Again, both were recorded in very low numbers due to the fact that the small streams and seeps in which they usually breed were not yet flowing. The one large male seen was found by chance at a dry puddle in Takut Beng. Both of these species are expected to be common in the forest streams deeper within the MUA.

No additional Dicroglossidae species to the ones seen during the surveys are anticipated to occur within the MUA.

Fejervarya limnocharis

Hoplobatrachus rugulosus

Limnonectes gyldenstolpei male

Limnonectes gyldenstolpei female

Limnonectes kohchangae

Occidozyga lima

Phrynoglossus martensii

Phrynoglossus martensii

Fig. 3: Frogs of the family Dicroglossidae

Microhylidae

Many Microhylid frogs prefer disturbed habitats. Seven of the 11 species known to occur in Cambodia were found, all within the vicinity of the MJP station.

The most interesting Microhylid discovery was *Glyphoglossus guttulatus*. This is a semi-fossorial species that is only usually seen during its explosive breeding events. Because of this it is not often recorded during surveys, but amazingly was found during an earlier survey in December 2021, and during this work in February and again in June. All three records were of lone semi-adult specimens. Two individuals were found near the MJP station - one half buried near a dry puddle, and one in forest edge at Phnom Pich. This species is rarely recorded in Cambodia. Records have been made across the country, from Pursat, Takeo, Mondulkiri and Preah Vihear, but only of single individuals. Witnessing a breeding event in Samlout would have been a first in Cambodia. In Phnom Pich it is likely that this species breeds in the ‘frog hollow’ observed at the forest edge. Around MJP it probably breeds in any number of temporary pools formed after heavy rain events. The fact that three individuals were found outside of breeding event s means the Samlout area is a notable location for this species.

The brown bull frog, *Kaloula pulchra*, is also an explosive breeder, but is far more readily found. This species was seen in the MJP station bathroom. Following heavy rain, it should be very common.

Four of the small *Microhyla* were seen: *M. butleri, M. heymonsi, M. mukhlesuri* and *M. pulchra*. All four were also seen at the MJP camp. The presence of *M*. *butleri* at MJP was a surprise as this species is generally found in primary forest at higher elevations than other *Microhyla*, which prefer more open habitat with plenty of temporary water features. Again, due to the dry conditions, these species were not frequently calling, and harder to locate than usual. Individuals of all four species were found gathered around dry puddles in anticipation of rain.

In the Phnom Pich ‘frog hollow’ a congregation of *Microhyla butleri* were seen, some sitting on vegetation up to 2 metres above the ground. There were some short choruses, which was how the hollow was discovered. The following night these frogs had dispersed,

Glyphoglossus guttulatus

Kaloula pulchra

Microhyla butleri

Microhyla heymonsi

Microhyla mukhlesuri

Microhyla pulchra

Micryletta erythropoda

Micryletta erythropoda

Fig. 4: Frogs of the family Microhylidae

as the expected rain didn't fall.

Microhyla heymonsi was recorded at Phnom Pich in the hill forest leaf litter along with *M. butleri*, but neither were seen at Takut Beng. *Microhyla pulchra* was seen at Takut Beng, but not at Phnom Pich, being a species that doesn't occur in forested habitat. It clearly was only at Takut Beng, as like the *Duttaphrynus, Fejervarya* and *Hoplobatrachus* seen there, had accessed the area by following old logging trails.

Micryletta erythropoda is another frog that is usually recorded in low numbers, if at all. Again, it is widespread across Cambodia, but is often overlooked. Examples were found around the MJP Camp, especially in the vicinity of the Samlot Waterfall, and in the hill forest leaf litter of Phnom Pich. Although not restricted to such features, this species is most commonly recorded in karst limestone habitat, so its relatively common appearance in Samlout was unexpected.

Of the four Cambodian Microhylid species we didn't find, only one of them - *Microhyla berdmore*i - is definitely expected to occur in Samlout. This is a species associated with forested habitat, and it probably occurs deeper in the protected area, and would range far from water when not breeding. The three remaining species are all fossorial and prefer areas with light sandy soil. One of these species (*Kaloula Indochinense*) is known only from a single record in Mondulkiri Province, so is unlikely to occur in Samlout. The other two species - *Glyphoglossus molossus* and *Kaloula mediolineata* – are both known from drier forest areas further north in Siem Reap Province, but could possibly occur in Samlout. However, both species only emerge from underground after periods of very heavy rain. All frogs from the genera *Kaloula* and *Glyphoglossus* are known as '*Hing'* in the Khmer language, which makes identifying frogs specifically through interviews with local people unreliable.

Ranidae

This family is known as the 'true frogs'. We found three species of Ranid in the MUA from a possible six species that are recorded from the Cardamom Mountains. Frogs in this family are associated with permanent water sources, such as larger rivers and streams, and deeper ponds.

The red-eared grass frog *Hylarana erythraea* is a species of open flooded grassland and other well vegetated permanent still water habitat. It was recorded at only one location – the MJP ranger station at Phnom Pich (12.661632 102.69143) in February. By June the water in the pool here had sunk by 50 cm and this species was no longer observed.

The Dalat frog *Papurana milleti* was also recorded at the Phnom Pich ranger station, but only in June. Individuals were heard calling during daylight hours – a repeated bird-like '*rit*'. This species was also found close to our Phnom Pich base camp in a stagnant overfill pool beside the river, and also in the 'frog hollow' feature.

Mortensen's frog *Sylvirana mortenseni* is one of the most abundant species in the Cardamom Mountains as it is found along mid-sized streams and smaller rivers in forested habitat below about 500-600 metres elevation. This species was seen at the Samlot Waterfall near the MJP station, and along the O'Slev and Phnom Pich rivers. Lone sub adult individuals were also seen along forest trails in Takut Beng during the wetter periods in February, but not once the forest had become drier in June.

Three possible Cardamom Mountain Ranid species were not seen during the surveys: *Hylarana macrodactyla, Hylarana taipehensis*, and *Sylvirana faber*. *Hylarana macrodactyla* is associated more with grassland habitat adjacent to forest, so might not occur in the SMUA. *Hylarana taipehensis* probably does occur in some open forest areas; while *Sylvirana faber* replaces *S. mortenseni* in forest above 600-700 metres elevation.

Rhacophoridae

This family encompasses the tree frogs, bush frogs and bubble- and jelly-nest frogs. It has the greatest potential for discovering either species new to science, or new Cambodian records. A number of species that are known to occur in Thailand are also anticipated to occur in Cambodia. However, these potentially missing species are strictly forest frogs, found only in less disturbed habitat than those that we were able to survey. These species are also difficult to locate if they are not breeding, as they spend most of their time either in dense vegetation or in the forest canopy.


Hylarana erythraea


Papurana milleti


Sylvirana mortenseni


Polypedates megacephalus


Polypedates megacephalus


Rohanixalus hansenae


Kurixalus bisacculus


Kurixalus bisacculus

Fig. 5: Frogs of the families Ranidae and Rhacophoridae

In total, we recorded four species of Rhacophorid. One of these was only recorded by its call, and could not be assigned beyond genus status.

The brown treefrog *Polypedates megacephalus* is another of Cambodia's most common and familiar amphibians. Examples were encountered in the accommodation buildings at the MJP Station during February, as well as in the disturbed forest of Takut Beng and Phnom Pich in June. This was one species that we did observe attempting to breed. *Polypedates* species make foam nests above temporary or standing water, often creating the hanging nests prior to an expected heavy down pour. The unusual weather during the June survey, when drops in pressure and darkening skies seemed to presage rain, prompted breeding activity in this species. At Takut Beng, an amplexus pair was observed laying their foam-encased eggs directly onto the earth of dried cart rut, anticipating that rain water would fall overnight (Fig. 6).

The frilled tree frog, *Kurixalus bisacculus* is a forest species, that can be found at temporary pools either within the forest or at the forest edge, It will also breed in puddles along forest roads. It was found in relatively large numbers in Phnom Pich and Takut Beng. In both locations, congregations of male frogs were heard calling from above depressions in the forest floor that would form ephemeral pools during the monsoon. Again, these frogs were fooled by the drops in pressure that usually precedes rain, and began to congregate and call. No females of this species were observed. At the frog hollow at Phnom Pich some tiny metamorphs were seen that clearly represented froglets developed from eggs laid earlier in the year.

Only a single species of bubble nest frog was found, *Rohanixalus hansenae*. The first records of this species came from a flooded pit along the road in Samlout (12.68020 102.74680). This was discovered due to the single tick calls made by the male frogs. Investigation of the site found a small colony of *Rohanixalus* and *Polypedates megacephalus*. No breeding was taking place, but the remains of old bubble nests from earlier in the year were noted on leaves overhanging the water, and one gravid female was observed. Emerging metamorphs of *Rohanixalus* were also seen. A single female individual of this species was also found in the forest at Phnom Pich away from water, and a few males were seen in the 'frog hollow'.

Fig. 6: *Polypedates megacephalus* making foam nest at Takut Beng

Another similar species, probably from the genus *Chirixalus*, was heard calling at Phnom Pich, both from reeds along the river, and in the forest. The caller could not be located due to the infrequency of its calls. Over an hour was spent waiting for repeat calls to try and pinpoint the frog before it fell silent. This was likely *Chirixalus nongkhorensis*. However, a single individual of *Chirixalus doriae* is reported from the Cardamom Mountains (Ohler et al. 2002) so the latter species also remains a possibility.

It is possible that 13 of the 15 Rhacophorid species known from the Cardamom Mountains could occur in the MUA. The fact that Samlout is positioned in the western-most extent of Cambodia's Cardamom Mountain Range, additionally species known from Thailand but not yet recorded from Cambodia might also occur. Finding only three Rhacophorid species was very disappointing, but fit with both the weather conditions experienced and the habitat types surveyed. It is certain that many more Rhacophorid species occur in the MUA. These might be found in less disturbed or higher altitude forest, and during wetter conditions than we experienced during our surveys.

Rhacophorid species to look out for include any of the four *Theloderma* species listed for Cambodia; the huge white-lipped tree frog *Zhangixalus pachyproctus,* which is known from only a single individual found in the Cardamom Mountains; the foam-nest frog *Chirixalus doriae*, whose occurrence in Cambodia needs confirming; and the large gliding frog *Rhacophorus kio*, whose presence is anticipated from Cambodia. Additional to these, there could also be undescribed endemic forms occurring in some of the more isolated areas.

The situation in Cambodia regarding the bug-eyed frogs of the *Theloderma* genus also needs clarifying - both in terms of range and species composition. None of these were discovered during the survey, but at least two of them are expected to occur. Frogs in this genus naturally breed in water-filled tree holes, and as a consequence are most easily found during the wettest part of the year.

Sauria - Lizards

A total of 15 lizard species were recorded from 3 different families: 6 agamids; 5 skinks, and 4 geckos.

Agamidae

The Cardamom Mountain spiny lizard *Acanthosaura cardamomensis*, is endemic to the eastern part of Thailand, the Cardamom Mountain chain in Cambodia, including the offshore islands, and in southern Vietnam. This is strictly a forest species, usually in hill forest habitat. One adult individual was seen in hills above the MJP Station and Samlout, and two juveniles were found in Takut Beng.

Two *Calotes* species were recorded. *Calotes versicolor* is a species more often found in open disturbed habitat, while *Calotes emma* prefers forested habitat. Both species were found to occur in the MJP station compound, with *C. versicolor* often seen on trees around the accommodation buildings. *Calotes emma* was observed once in forested habitat in the MJP station and more often in Takut Beng. The third *Calotes* species known to occur in the Cardamom Mountains, *C. mystaceus*, was not seen during the surveys.

The gliding lizard *Draco maculatus haasei* was identified from a single individual seen in Takut Beng in June.

A single butterfly lizard *Leiolepis belliana* was observed along the sandy road into Takut Beng. This is the only species of *Leiolepis* now recognised from the Cardamoms landscape.

The Chinese water dragon, *Physignathus concincinus*, is the largest species of agamid in Cambodia, reaching lengths of almost a metre. Examples were found close to water at all three locations. Most of the individuals encountered were juveniles, found clasped to overhanging vegetation at night.

Table 3: Sauria records from the three study sites compared between the surveys conducted in February and June

Species	February			June		
	MJP	PP	TB	MJP	PP	TB
Agamidae						
Acanthosaura cardamomensis	X	-	-	-	-	X
Calotes emma	X	-	X	X	-	X
Calotes versicolor	X	-	-	X	-	-
Draco maculatus haasei	-	-	-	-	-	X
Leiolepis belliana	-	-	-	-	-	X
Physignathus cocincinus	X	-	X	X	X	X
Gekkonidae						
Cyrtodactylus cf. *thylacodactylus*	-	X	X	-	X	X
Dixonius siamensis	-	-	-	-	-	X
Gekko gecko	X	X	X	X	X	X
Hemidactylus platyurus	X	-	X	X	-	-
Scincidae						
Eutropis macularia	X	X	X	X	X	X
Eutropis multifasciata	X	X	X			
Sphenomorphus maculatus	X	X	-	-	X	-
Subdoluseps bowringii	X	X	-	X	X	-
[*Tytthoscincus*] sp.	-	-	-	-	X	-


Acanthosaura cardamomensis


Calotes emma


Calotes versicolor


Physignathus concincinus


Leiolepis belliana


Draco maculata


Subdoluceps bowringii


Eutropis macularia

Fig. 7: Lizard species seen in the Samlout MUA

Fig. 8: A juvenile *Acanthosaura cardamomensis* roosting at Takut Beng

Gekkonidae

Four gecko species were recorded all from different genera.

A single bent-toed gecko species was recorded - *Cyrtodactylus* cf. *thylacodactylus*. Previously a single *Cyrtodactylus* species – *intermedius* - was known from across the Cardamom Mountain chain, but a recent taxonomic study has now recognized 8 species within this complex (Murdoch 2019). The species encountered in Samlout fits best with *thylacodactylus*, but until it can be specifically identified we will consider this as *Cyrtodactylus* cf. *thylacodactylus*. This is strictly a forest gecko and was not seen in the MJP station area. Records were made in both Takut Beng and Phnom Pich. Adult individuals were encountered during most night surveys in Phnom Pich, usually on fallen logs. In Takut Beng and Phnom Pich juvenile geckos were found beneath rotten logs.

Siamese Leaf-toed Gecko, *Dixonius siamensis*, is another forest species that was encountered in Takut Beng hiding under sections of cut timber. Both pale and dark forms were seen.

The most regularly encounter gecko was the tokay *Gekko gecko*. The vocal nature of this species meant it was easily recorded in all of the study sites. Calls were heard at all hours of the day and night. This was a regular species in the buildings and trees in and around the MJP station, and was seen at night at the Takut Beng and Phnom Pich study sites. This species has long been the object of hunting in for use in the traditional Chinese medicine trade (Caillabet 2013) but still appears to be a common species in Samlout.

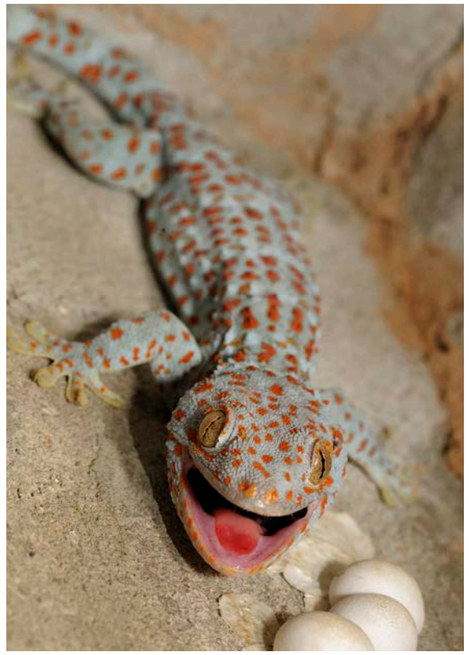
Another commonly encountered species was *Hemidactylus platyurus.* This species was regularly encountered both on buildings and trees at the MJP station. Both the well-marked and cryptic dark form, and the almost unmarked pale form were seen.

Hemidactylus platyurus

Cyrtodactylus cf. *thylacodactylus*

Cyrtodactylus cf. *thylacodactylus*

Dixonius siamensis



Gekko gecko

Fig. 9: Gecko species seen in the MUA

Scincidae

Only five species of skink were recorded during the surveys. This relatively low number certainly reflects the fact that less effort was expended looking for and trying to catch skinks. Ideally, survey methods should involve pit fall traps set in the leaf litter to maximize skink capture. Instead species were either observed during daylight hours going about their business, or discovered under fallen logs or logging waste.

By far the most commonly encountered skink was juvenile individuals of the speckled forest skink, *Eutropis macularia*. This species was easily observed at all three locations, usually scurrying across leaf litter on the forest floor. The closely related *Eutropis multifasciata* was also recorded.

The spotted forest skink, *Sphenomorphus maculatus* was observed during daylight hours in the hill forest of at Phnom Pich.

The unusually short-limbed Bowring's supple skink *Subdoluseps bowringii*, was commonly encountered under fallen timber, and occasionally disturbed at night while searching through leaf litter. One individual was accidentally killed while rolling a log, so was more comprehensively photographed.

Potentially, the most important finding of the MUA herpetological study was a semi-fossorial skink similar to *Subdoluseps frontoparietalis* or *S. herberti,* but could possibly belong to the genus *Tytthoscincus* (Grismer pers. comm.). To date this genus has not been recorded from Cambodia, but is expected to occur here, especially within the Cardamom Mountains landscape. Two individuals of this unidentified species were seen and subsequently caught in Phnom Pich. Both were found under fallen logs on the forest floor. Unfortunately, both escaped while I was attempting to make photographs, and neither were photographically recorded nor collected. One specimen of potentially the same skink was collected in December 2021 by Pablo Sinovas on a forested hill above the MJP station. Numerous individuals were seen by Sinovas, but given their ability to quickly dig into the humus, only one was caught. This specimen was collected and will be reviewed by an expert in the genus (Fig. 10).

Fig. 10: Above: Bowring's supple skink *Subdoluseps bowringii* from the MJP Station
Below: Possible *Tytthoscincus* species from hill forest near the MJP Station

Serpentes - snakes

A total of 14 different snake species were recorded from seven different families.

Colubridae
The family Colubridae is the most diverse in Cambodia, containing at least 37 species. This family also represented the most frequently encountered in the MUA, with 50% of the species we recorded being Colubrids.

A juvenile green cat snake, *Boiga cyanea*, was recorded at the MJP station in December.

The arboreal painted bronzeback, *Dendrelaphis pictus*, was recorded as a single small juvenile found alongside metamorph tree frogs in a flooded pit near the MJP station in June.

Two adult individuals of yellow-spotted keelback, *Fowlea flavipunctatus*, were also found in the presence of breeding frogs at the 'frog hollow' at the Phnom Pich study site in June.

A single adult Laotian wolfsnake, *Lycodon laoensis*, was found during day light hours in a tree hole in disturbed forest along the track to Phnom Pich in June (Fig. 11)

A single adult kukri snake,*Oligodon taeniatus*, was seen at Takut Beng in dry forest understory in June.

Two individual adult Indo-Chinese rat snake, *Ptyas korros*, were seen during daylight hours along the Phnom Pich river, one in February, the other in June.

An adult speckle-bellied keelback, *Rhabdophis chrysargos*, was encountered during daylight hours along the Phnom Pich River in June.

A single sub adult black-striped keelback, *Rhabdophis nigrocinctus*, was observed during daylight along a forest trail in Phnom Pich hill forest in June.

Fowlea flavipunctatus

Oligodon taeniatus

Trimeresurus cardamomensis

Xenopeltis concolor

Malayopython reticulatus

Rhabdophis nigrocinctus

Boiga cyanea

Rhabdophis chrysargos

Fig. 11: Snake species recorded from the MUA

Table 4: Serpentes records from the three study sites compared between the surveys conducted in February and June

Colubridae						
*Boiga cyanea**	X	-	-	-	-	-
Dendrelaphis pictus	-	-	-	X	-	-
Fowlea flavipunctatus	X	-	-	-	X	-
Lycodon laoensis	-	-	-	-	X	-
Oligodon taeniatus	-	-	-	-	-	X
Ptyas korros	-	X	-	-	X	-
Rhabdophis chrysargos				-	X	-
Rhabdophis nigrocinctus	-	-	-	-	-	X
Elapidae						
Bungarus fasciatus	-	-	-	X	-	-
Homalopsidae						
Hypsiscopus plumbea	X	-	-	-	-	-
Pythonidae						
Malayopython reticulatus	X	-	-	X	-	-
Typhlopidae						
Indotyphlops braminus	-	-	-	-	X	-
Viperidae						
Trimeresurus cardamomensis	-	-	-	-	-	X
Xenopeltidae						
Xenopeltis concolor	-	-	-	-	-	X

* Species recorded only by Pablo Sinovas in October and December 2021

Elapidae

Only a single member of the Elaphid family was seen during the surveys – a sub adult of banded krait, *Bungarus fasciatus.* This was a victim of road kill, seen near the MJP station in Samlout in June.

Homalopsidae

A plumbeous water snake, *Hypsiscopus plumbea*, was seen in the MJP station grounds in December.

Pythonidae

Two reticulated pythons, *Malayopython reticulatus*, were recorded in the MJP station area in December. During the June survey a python caught by villagers in Samlout was brought to the station and released within the grounds.

Typhlopidae

The Brahminy blind snake, *Indotyphlops braminus*, is one of the world's smallest snakes. A single individual was located beneath a rotten log at Phnom Pich in June.

Viperidae

Green pit vipers *Trimeresurus cardamomensis* are usually common snakes in the Cardamom Mountains. However, only two were seen during the June survey. Both individuals were found at Takut Beng. One adult was found close to the O'Slev River, while a very small yearling snake was collected from a cart rut at night.

Xenopeltidae

A single adult sunbeam snake, *Xenopeltis concolor*, was located under a rotten log at Phnom Pich in June.

The currently 99 species of snake species are known from Cambodia (Poyarkov in litt). A large proportion of these are found within the Cardamom Mountains landscape, so it is clear from the findings of our survey that we missed many species. The true snake diversity in the MUA is certainly far greater than what we observed.

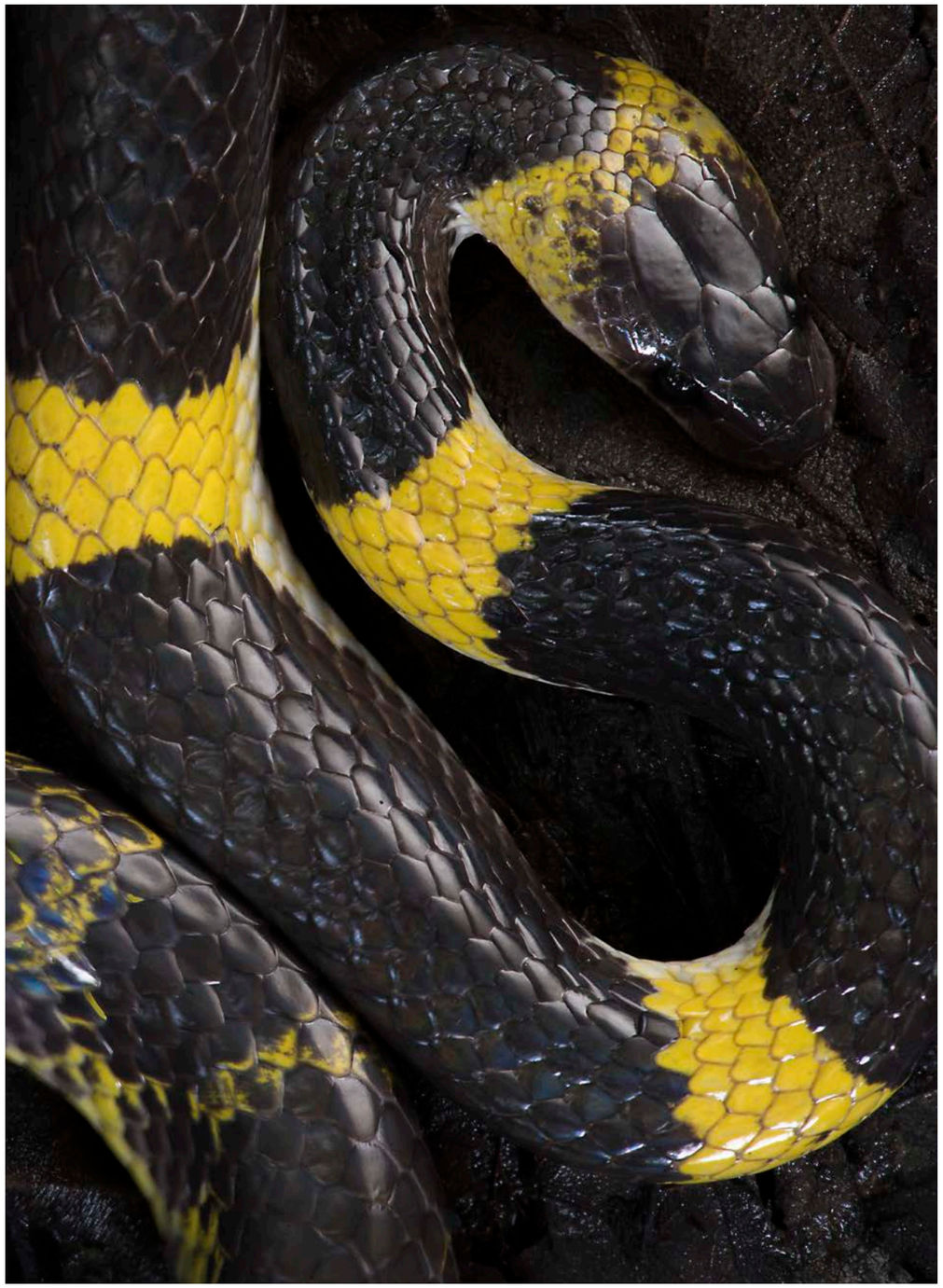


Fig. 12: Laotian wolf snake, *Lycodon laoensis*, seen in Phnom Pich

CONCLUSION & RECOMMENDATIONS

Of the 259 reptiles and amphibian species reported from Cambodia, we managed to find 51 (20%). However, many of the species that make up the species total species count do not occur in the western part of the country. For instance, only 46 of the total 72 amphibian species known from Cambodia are expected to be found in the Cardamom Mountains, and a percentage of these are found only at elevations higher than any that can be found in Samlout.

Thirty-seven species is rough estimate of the possible amphibian diversity that might occur in the MUA. This represents almost exactly half of Cambodia's known amphibians. Our total amphibian species count of 21 equals 56% of the species that might be expected to occur in the MUA, and 29% of the total Cambodian amphibian fauna. Had the survey managed to include more primary forest areas at higher altitudes, and periods of heavy rain, this number would certainly have increased.

Amphibians are in most cases much easier to locate than many reptiles, due to the fact that they make advertising calls and are found in much higher numbers at breeding sites. Nevertheless, 58% of the species count represented reptiles.

Whereas we discovered most of the frogs that might be expected to occur in anthropogenically modified habitats, there were certainly many reptile species that fall into this category that we did not find. Additionally, not surveying primary forest at higher elevations meant we missed some species. The relative dry weather, especially in June, might also have caused many reptiles to be less active.

No snake species of particular conservation interest or any degree of scarcity were seen. Likewise, most of the lizards encountered were the ones we might expect to find. A notable group missing from the survey was the monitor lizards. Two species *Varanus salvator* and *V. nebulosus* should occur in the MUA. I can only conclude that we missed both of these species.

The most notable herpetological discovery was a semi-fossorial skink seen in hill forest near the MJP Station in December, and again in hill forest at Phnom Pich. The Phnom Pich examples were discovered under rotten logs. These are as yet unidentified, but if not one of the less familiar Thai *Subdoluseps,* could belong to the genus *Tytthoscincus*. If so, this would represent the first record of this genus from Cambodia. If it is within the *Tytthoscincus* genus it could represent a species unknown to science, or a species known to occur in Thailand.

Due to the difficulty of photographing this species, no photographs were made of it in situ. We have only a single preserved specimen for reference – collected in December 2021 by Pablo Sinovas. Follow up work should certainly include further research into this skink species. A type series needs to be collected to facilitate a proper laboratory analysis and photographs of live individuals showing natural colouration need to made - the one preserved specimen appears to show some bleaching in colour compared to the living individuals observed.

Further survey work during proper monsoon conditions would certainly reveal many more species. Our inability to survey undisturbed forest at higher elevation than the sites visited during this work definitely impacted the finding. Access to more remote, undisturbed and higher elevation forest would dramatically increase the likelihood of finding the scarcer, endemic, or possibly new species that undoubtedly occur in the Samlout MUA. The highest recorded point within the MUA is 1,147 m.a.s.l.. The highest point we were able to survey was slightly over 300 m.a.s.l.. This accounts for the lack of any rare or new species turning up in the survey, and would have precluded finding anything endemic to the area.

REFERENCES

Caillabet O. S. (2013), The Trade in Tokay Geckos *Gekko gecko* in South-East Asia: with a case study on Novel Medicinal Claims in Peninsular Malaysia. TRAFFIC, Petaling Jaya, Selangor, Malaysia.

Geissler P., Poyarkov N. A., Grismer L., Nguyen T. Q., An H. T., Neang T., Kupfer A., Ziegler T., Böhme W., and Müller H. (2015), "New *Ichthyophis* species from Indochina (Gymnophiona, Ichthyophiidae), 1. The unstriped forms with descriptions of three new species and the redescriptions of *I. acuminatus* Taylor, 1960, *I. youngorum* Taylor, 1960 and *I. laosensis* Taylor, 1969," *Org. Divers. Evol*., 15(1), 143 – 174.

Grismer L., Neang T., Chav T., and Grismer J. (2008), Checklist of the amphibians and reptiles of the Cardamom region of southwestern Cambodia. Cambodian Journal of Natural History 2008 (1) 12-28

Grismer L. L., Neang T., Chav T., Wood P. L., Oaks J. R., Holden J., Grismer J. L., Szutz T. R., and Youmans T. M. (2008), "Additional Amphibians and Reptiles from the Phnom Samkos Wildlife Sanctuary in Northwestern Cardamom Mountains, Cambodia, with comments on their taxonomy and the discovery of three new species," Raffles Bull. Zool., 56(1), 161 – 175.

Grismer L. L., Neang T., Chav T., and Holden J. (2007), "A new species of Chiromantis Peters 1854 (Anura, Rhacophoridae)from Phnom Samkos in the northwestern Cardamom Mountains, Cambodia," *Herpetologica*, 63(3), 392 –400.

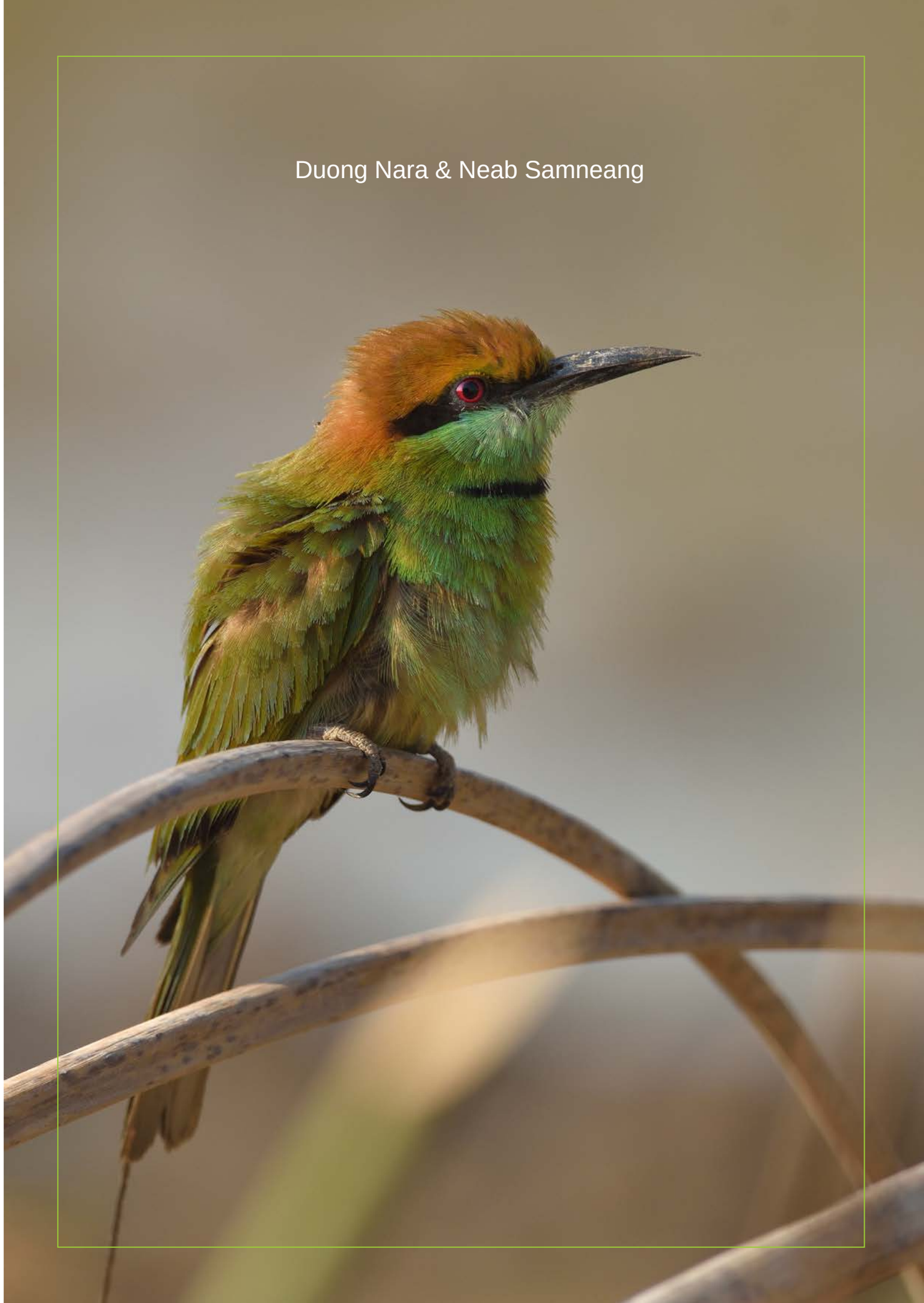
Murdoch M. L., Grismer L., Wood JR3 P. L., Neang T., Nikolay A., Poyarkov N., Ngo Van Tri, Nazarov R A., Aowophol A., Pauwels O. S. G., Nguyen N.N. Grismer J. L. (2019), Six new species of the *Cyrtodactylus intermedius* complex (Squamata: Gekkonidae) from the Cardamom Mountains and associated highlands of Southeast Asia. *Zootaxa* 2019 (1): 001–062.

Neang T., Chan S., Chhin S., Samorn V., Poyarkov, N.A., Stephens, J., Daltry, J.C. & Stuart, B.L. (2017), First records of three snake species from Cambodia. Cambodian Journal of Natural History, 2017, 142–146.

Ohler A., Swan S. R., and Daltry J. C. (2002), A recent survey of the amphibian fauna of the Cardamom Mountains, Southwest Cambodia with descriptions of three new species, The Raffles Bull. Zool., 50(2), 465 – 482.

Poyarkov N., Nguyen T., Popov E., Geissler P., Pawangkhanant P., Neang T., Suwannapoom C., and Orlov N. (2021), Recent Progress in Taxonomic Studies, Biogeographic Analysis, and Revised Checklist of Amphibians in Indochina. Russian Journal of Herpetology Vol. 28, No. 3A, 2021, pp. 1 – 110.

ORNITHOLOGICAL SURVEY



SURVEY METHODS

Two bird surveys were conducted in Samlout MUA, the first from 26 – 28 October 2021 and the second from 14 - 21 February 2022. The first survey was led by Neab Samneang of the Ministry of Environment (MoE), and the second was led by a consultant, Duong Nara, of the Cambodia Bird Guide Association (CBGA), and facilitated by an MoE ranger (Bun Teout).

The surveys consisted of opportunistic searches, wherein the surveyors walked through areas of the MUA and using binoculars and a tape recorder, recorded species through both visual identification, and from vocalizations. Species' identifications were confirmed by use of the field guide *Birds of Cambodia* (CBGA 2019).

In the first survey, two sites were surveyed: the Border Gate 400, and O'Slev. Three primary sites were selected for the second survey: O'Dong, O'Slev and Bor Lang.

Survey 1: 26-27 October 2021

The Border Gate 400 in Battambang, an area on the border with Thailand, had an average elevation of ~500 m.a.s.l. and was surveyed on 26 October in conjunction with the camera trapping survey. The area, also known as Phnom Tra Ngaol, is mountainous and accessible via a wide dirt border road flanked with thick evergreen forest on either side. The survey on followed the road due to the significant presence of landmines in the area. The survey was conducted on both motorbike and on foot along a 3.5km section of road.

O'Slev, which is primarily low land dry dipterocarp forest (DDF), has an average elevation of 205 m.a.s.l.. There are multiple trails throughout the DDF leading towards hilly areas, which allowed the surveyors to readily move around. The cleared trails and open forest also allowed clear sightlines. It was surveyed from 27-28 October, with 2 nights spent in the field. The first day, 3.3km of trails were surveyed in the western area. On the second, 1.5km was surveyed to the east along the O'Slev waterway. With both days, all surveying was conducted on foot.

Survey 2: 14-21 February 2022

The survey in O'Dong ran for 4 days, from 15-18 February. This is an area close to the Pailin area of the Cambodia-Thai border, with an average elevation of 425 m.a.s.l. There is one road in the area, which runs along the border, alongside the Pailin River. Both sides of the road have intact, dense evergreen forest with fruiting trees that attract a variety of wildlife, both birds and mammals. Most birds in this area were identified from the forest canopy, as the undergrowth along the road was thick and obstructed sightlines. The most productive times for the survey were early morning and at night, when owls and nightjars became active. There was a high likelihood of that pheasants, partridges, and other terrestrial bird species, were present, but the dense undergrowth made these species difficult to detect.

The survey in O'Slev, the same area as surveyed during the first survey in October, was a half day on 19 February, and a subsequent afternoon and night on 20 February and the morning of 21 February. At this time of year, flowering bamboo and dipterocarp trees readily attracted bird species.

The third area surveyed was Bor Lang, a riparian area with an elevation of 150 m.a.s.l.. The habitat was secondary growth DDF, bamboo forest, with some grassland areas around the river. Much like O'Slev, there were trails through the area which allowed easy access. The survey was conducted over a half day on 20 February. The initial survey site selected was Prek Bey, but due to logistical constraints, the survey was moved to Bor Lang.

RESULTS

A total of 142 bird species from 48 families were recorded. Of these, the IUCN Red List has evaluated 1 species as Vulnerable (*Rhyticeros undulatus)* and 4 species as Near Threatened (*Anhinga melanogaster*, *Psittacula roseata, Psittacula alexandri* and *Eurylaimus javanicus*). An additional subspecies of the ashy drongo was recorded, the Chinese white-faced drongo, *Dicrurus leucophaeus salangensis*. This has not been included in the total species count of 142 but has been included in the species list below.

Fig. 1: Some of the many birds occurring in the Samlout MUA © Jeremy Holden

Table 1: Full species list of birds detected during the Samlout survey

Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Galliformes Phasianidae	*Tropicoperdix chloropus*	Scaly-breasted Partridge	LC	C
	Francolinus pintadeanus	Chinese Francolin	LC	C
	Gallus gallus	Red Junglefowl	LC	C
Columbiformes Columbidae	*Columba livia*	Rock Dove	LC	C
	Streptopelia tranquebarica	Red Collared Dove	LC	C
	Streptopelia chinensis	Spotted Dove	LC	C
	Chalcophaps indica	Emerald Dove	LC	C
	Geopelia striata	Zebra Dove	LC	C
	Treron curvirostra	Thick-billed Green-pigeon	LC	C
	Ducula badia	Mountain Imperial Pigeon	LC	C
Caprimulgiformes Caprimulgidae	*Lyncornis macrotis*	Great Eared Nightjar	LC	C
	Caprimulgus macrurus	Large-tailed Nightjar	LC	C
	Caprimulgus affinis	Savanna Nightjar	LC	C
Apodiformes Hemiprocnidae	*Hemiprocne coronata*	Crested Treeswift	LC	C
Apodidae	*Hirundapus giganteus*	Brown-back Needletail	LC	C
	Aerodramus [*germani*]	[Germain's] Swiftlet	LC	C
Cuculiformes Cuculidae	*Centropus sinensis*	Greater Coucal	LC	C
	Centropus bengalensis	Lesser Coucal	LC	C
	Phaenicophaeus tristis	Green-billed Malkoha	LC	C
	Eudynamys scolopaceus	Asian Koel	LC	C
	Chrysococcyx xanthorhynchus	Violet Cuckoo	LC	C
	Cacomantis sonneratii	Banded Bay Cuckoo	LC	C
	Hierococcyx sparverioides	Large Hawk-cuckoo	LC	C

Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Gruiformes Rallidae	*Rallina fasciata*	Red-legged Crake	LC	NA
Ciconiiformes Ciconiidae	*Anastomus oscitans*	Asian Openbill	LC	C
			LC	C
Suliformes Anhingidae	*Anhinga melanogaster*	Darter	NT	C
Phalacrocoracidae	*Phalacrocorax niger*	Little Cormorant	LC	C
Pelecaniformes Ardeidae	*Ixobrychus sinensis*	Yellow Bittern	LC	C
	Ixobrychus cinnamomeus	Cinnamon Bittern	LC	C
	Ixobrychus flavicollis	Black Bittern	LC	C
	Ardea cinerea	Grey Heron	LC	C
	Ardea alba	Great Egret	LC	C
	Ardea intermedia	Intermediate Egret	LC	C
	Egretta garzetta	Little Egret	LC	C
	Bubulcus ibis	Cattle Egret	LC	C
	Ardeola bacchus	Chinese Pond-heron	LC	C
	Ardeola speciosa	Javan Pond Heron	LC	C
	Butorides striata	Little Heron	LC	C
Charadriiformes Charadriidae	*Vanellus indicus*	Red-wattle Lapwing	LC	C
Turnicidae	*Turnix suscitator*	Barred Buttonquail	LC	C
Accipitriformes Pandionidae	*Pandion haliaetus*	Osprey	LC	C
Accipitridae	*Elanus caeruleus*	Black-winged Kite	LC	C
	Pernis ptilorhynchus	Oriental Honey-buzzard	LC	C
	Aviceda leuphotes	Black Baza		
	Spilornis cheela	Crested Serpent-eagle	LC	C
	Nisaetus cirrhatus	Changeable Hawk-eagle	LC	C
	Nisaetus nipalensis	Mountain Hawk-eagle	LC	C

Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Accipitriformes				
Accipitridae	*Ictinaetus malaiensis*	Black Eagle	LC	C
	Accipiter trivirgatus	Crested Goshawk	LC	C
	Accipiter badius	Shikra	LC	C
	Butastur liventer	Rufous-winged Buzzard	LC	C
	Butastur indicus	Grey-faced Buzzard	LC	C
Strigiformes				
Tytonidae	*Phodilus badius*	Oriental Bay Owl	LC	C
Strigidae	*Ninox scutulata*	Brown Boobook	LC	C
	Glaucidium cuculoides	Asian Barred Owlet	LC	C
	Taenioptynx brodiei	Collared Owlet	LC	C
	Otus spilocephalus	Mountain Scops-owl	LC	C
	Otus lettia	Collared Scops-owl	LC	C
Trogoniformes Trogonidae	*Harpactes oreskios*	Orange-breasted Trogon	LC	C
Bucerotiformes Bucerotidae	*Anthracoceros albirostris*	Oriental Pied Hornbill	LC	C
	Rhyticeros undulatus	Wreathed Hornbill	LC	C
Upupidae	*Upupa epops*	Common Hoopoe	LC	C
Coraciiformes Meropidae	*Merops leschenaulti*	Chestnut-headed Bee-eater	LC	C
	Merops orientalis	Green Bee-eater	LC	C
	Merops philippinus	Blue-tailed Bee-eater	LC	C
Coraciidae	*Coracias affinis*		LC	C
	Eurystomus orientalis		LC	C
Alcedinidae	*Alcedo atthis*		LC	C
	Ceyx erithacus		LC	C
	Lacedo pulchella		LC	C
	Halcyon smyrnensis		LC	C

Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Alcedinidae	*Halcyon pileata*	Black-capped Kingfisher	LC	C
	Ceryle rudis	Pied Kingfisher	LC	C
Piciformes Megalaimidae	*Psilopogon haemacephalus*	Coppersmith Barbet	LC	C
	Psilopogon cyanotis	Blue-eared Barbet	LC	C
Picidae	*Psilopogon faiostrictus*	Green-eared Barbet	LC	C
	Psilopogon lineatus	Lineated Barbet	LC	C
	Psilopogon incognitus	Moustached Barbet	LC	C
	Hemicircus canente	Heart-spotted Woodpecker	LC	C
	Dendrocopos hyperythrus	Rufous-bellied Woodpecker	LC	C
	Blythipicus pyrrhotis	Bay Woodpecker	LC	C
	Micropternus brachyurus	Rufous Woodpecker	LC	C
	Meiglyptes jugularis	Black-and-buff woodpcker	LC	C
	Chrysocolaptes guttacristatus	Greater Flameback	LC	C
	Dinopium javanense	Common Flameback	LC	C
	Picus chlorolophus	Lesser Yellownape	LC	C
	Picus xanthopygaeus	Streak-throated Woodpecker	LC	C
	Picus vittatus	Laced Woodpecker	LC	C
	Picus canus	Grey-headed woodpecker	LC	C
	Picus erythropygius	Black-headed Woodpecker	LC	C
	Chrysophlegma flavinucha	Greater Yellownape	LC	C
Psittaciformes Psittaculidae	*Psittacula roseata*	Blossom-headed Parakeet	NT	C
	Psittacula alexandri	Red-breasted Parakeet	NT	C
	Loriculus vernalis	Vernal Hanging-parrot	LC	C
Passeriformes Eurylaimidae	*Eurylaimus javanicus*	Banded Broadbill	LC	C
	Lalage melaschistos	Black-winged Cuckooshrike	LC	C
	Lalage polioptera	Indochinese Cuckooshrike	LC	C

Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Passeriformes				
Eurylaimidae	*Pericrocotus divaricatus*	Ashy Minivet	LC	C
	Pericrocotus speciosus	Scarlet Minivet	LC	C
Oriolidae	*Oriolus chinensis*	Black-naped Oriole	LC	C
Artamidae	*Artamus fuscus*	Ashy Woodswallow	LC	C
Vangidae	*Hemipus picatus*	Bar-winged Flycatcher-shrike	LC	C
Aegithinidae	*Aegithina tiphia*	Common Iora	LC	C
	Aegithina lafresnayei	Great Iora	LC	C
Rhipiduridae	*Rhipidura javanica*	Pied Fantail	LC	C
Dicruridae	*Dicrurus macrocercus*	Black Drongo	LC	C
	Dicrurus leucophaeus	Ashy Drongo	LC	C
	Dicrurus leucophaeus salangensis	Chinese White-faced Drongo [subsp.]	LC	C
	Dicrurus aeneus	Bronzed Drongo	LC	C
	Dicrurus hottentottus	Hair-crested Drongo	LC	C
	Dicrurus paradiseus	Greater Racket-tailed Drongo	LC	C
Laniidae	*Lanius cristatus*	Brown Shrike	LC	C
Corvidae	*Crypsirina temia*	Racket-tailed Treepie	LC	C
	Urocissa erythrorhyncha	Red-billed Blue Magpie	LC	C
	Corvus macrorhynchos	Large-billed Crow	LC	C
Monarchidae	*Hypothymis azurea*	Black-naped Monarch	LC	C
	Terpsiphone paradisi	Asian Paradise-flycatcher	LC	C
Dicaeidae	*Dicaeum agile*	Thick-billed Flowerpecker	LC	C
Stenostiridae	*Culicicapa ceylonensis*	Grey-headed Canary-flycatcher	LC	C
Cisticolidae	*Prinia flaviventris*	Yellow-bellied Prinia	LC	C
	Prinia polychroa	Brown Prinia	LC	C
Locustellidae	*Locustella lanceolata*	Lanceolated Warbler	LC	C
Acrocephalidae	*Arundinax aedon*	Thick-billed Warbler	LC	C

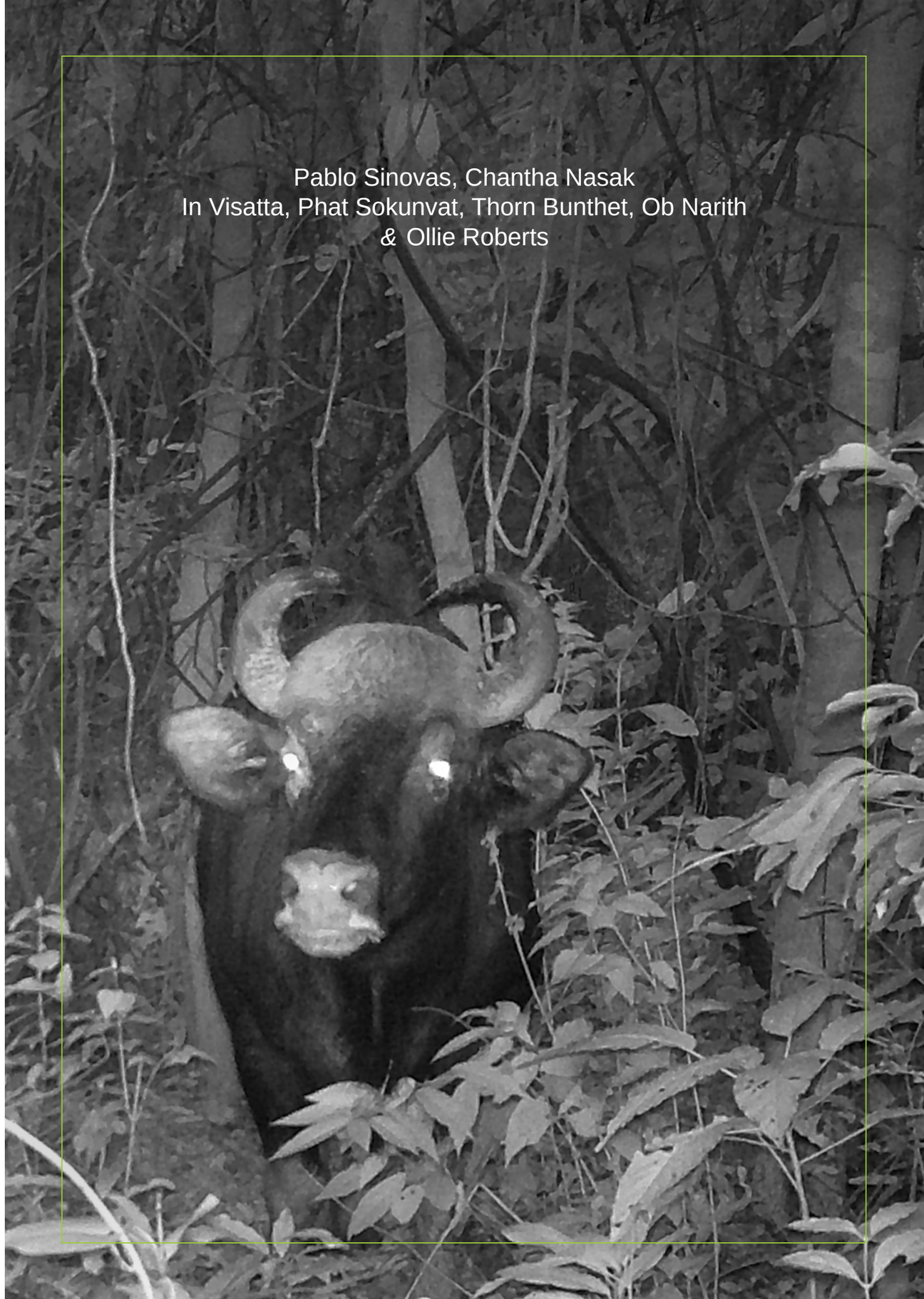
Order/Family	Species Name	Common Name	IUCN status	Cambodian Law[1]
Passeriformes				
Hirundinidae	*Cecropis daurica*	Red-rumped Swallow	LC	C
	Hirundo rustica	Barn Swallow	LC	C
Pycnonotidae	*Alophoixus ochraceus*	Ochraceous Bulbul	LC	C
	Iole propinqua	Grey-eyed Bulbul	LC	C
	Pycnonotus aurigaster	Sooty-headed Bulbul	LC	C
	Pycnonotus finlaysoni	Stripe-throated Bulbul	LC	C
	Pycnonotus goiavier	Yellow-vented Bulbul	LC	C
Phylloscopidae	*Pycnonotus conradi*	Streak-eared Bulbul	LC	C
	Rubigula flaviventris	Black-crested Bulbul	LC	C
	Brachypodius melanocephalos	Black-headed Bulbul	LC	C
	Phylloscopus schwarzi	Radde's Warbler	LC	C
	Phylloscopus borealis	Arctic Warbler	LC	C
Scotocercidae	*Abroscopus superciliaris*	Yellow-bellied Warbler	LC	C
Sturnidae	*Gracula religiosa*	Common Hill Myna	LC	C
	Gracupica nigricollis	Black-collared Starling	LC	C
	Acridotheres tristis	Common Myna	LC	C
	Acridotheres grandis	Great Myna	LC	C
	Copsychus malabaricus	White-rumped Shama	LC	C
Muscicapidae	*Brachypteryx leucophris*	Lesser Shortwing	LC	C
	Saxicola caprata	Pied Bushchat	LC	C

[1] IUCN Red List classifications are, from most threatened with extinction to least: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). CR, EN or VU species are considered threatened species.

[2] Cambodian law classifies wildlife species as Endangered, Rare or Common, the latter two here abbreviated to R or C respectively. No "Endangered" bird species were detected in the survey. N/A refers to any records that are not suitably identified or to species that are not included in the law.

CAMERA TRAP SURVEY

Pablo Sinovas, Chantha Nasak
In Visatta, Phat Sokunvat, Thorn Bunthet, Ob Narith
& Ollie Roberts



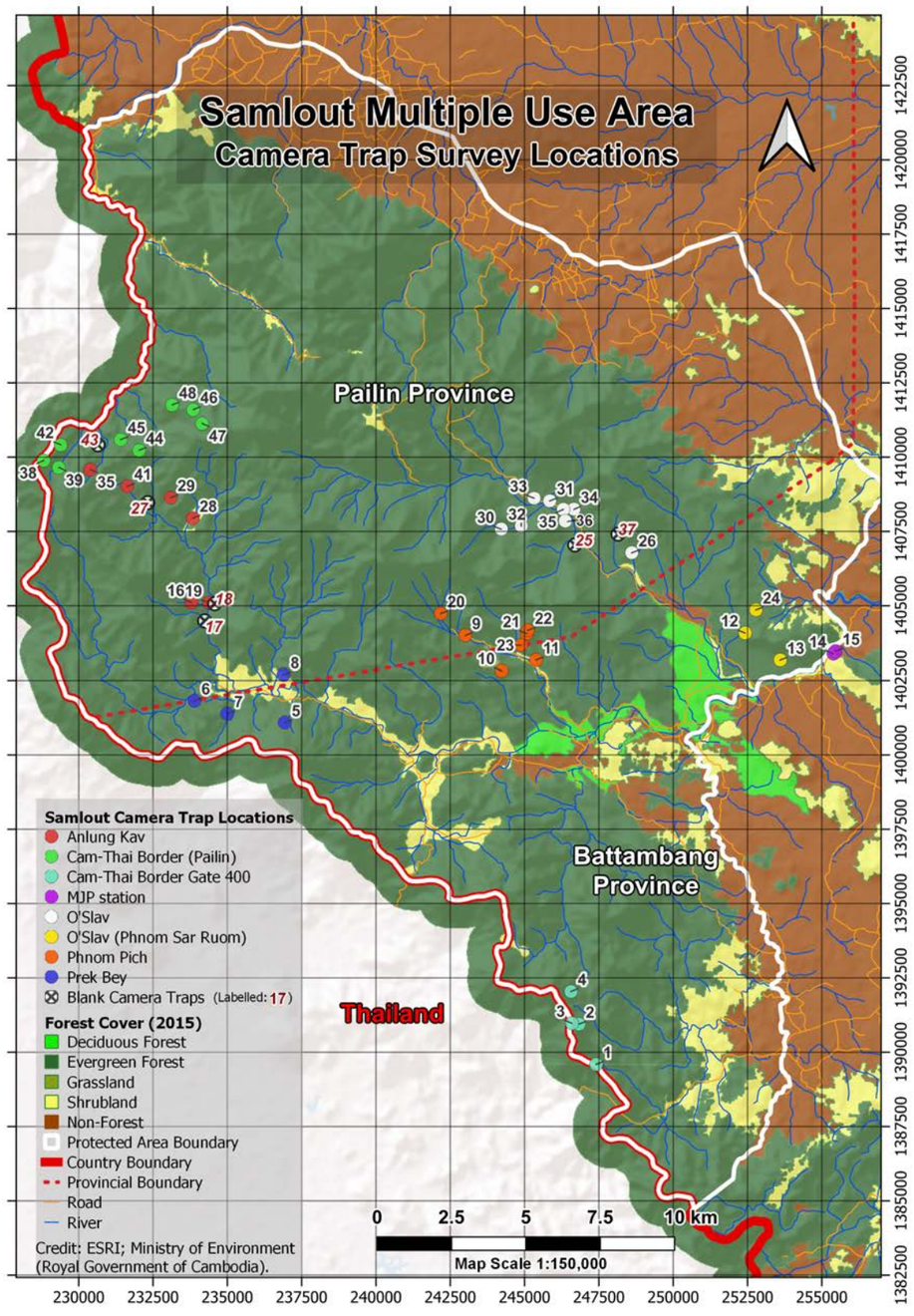
SURVEY METHOD

Forty-eight cameras were deployed within Samlout MUA and in the area around the MJP field station. Of these, five cameras malfunctioned, and one was not recovered, leaving a total of 42 functioning cameras. All 48 cameras were Bushnell 24MP Trophy Cam HDs, Model 119719CW.

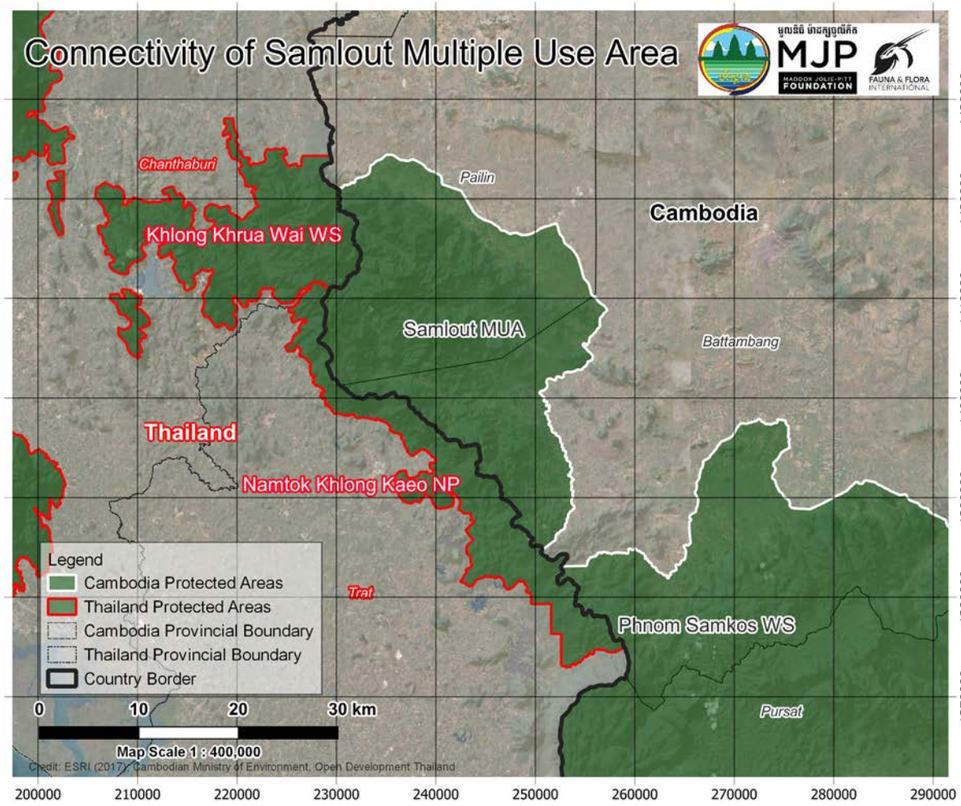
Deployment locations were targeted based on areas deemed likely to have presence of megafauna; primarily Asian elephants *Elephas maximus* and gaur *Bos gaurus*. Using GIS software, Samlout MUA was divided into a grid of 1.5 x 1.5 km squares, and priority cells were selected based on ranger and MJP staff reports of wildlife presence in 8 areas across the MUA, as well as proximity to the border. Sites close to the border were selected as they are contiguous with the Thai Protected Areas of Namtok Khlong Kaeo National Park and Khlong Khrua Wai Wildlife Sanctuary, and thus records may be used to better understand potential cross-border migration of key species (See Map 2). Some grid squares were condensed during deployment to contain multiple cameras, due to either accessibility or the notable presence of wildlife signs of target species. In the southernmost grouping of cameras (the Cambodia-Thailand Border Post 400 area), deployment was heavily impacted by the high risk of landmines in the area, which did not allow for cameras to be placed far from the road.

Set-up teams were comprised of a combination of MoE, MJP and FFI staff, including MoE rangers, and in some areas supported by the Border Police. Exact placement was generally along trails, streams, clearings and areas with wildlife signs, to maximise records. Cameras were attached to suitable trees using metal boxes, straps and python locks, to prevent damage or theft. Camera placement height varied between 30 cm and 120 cm from the ground (M = 73.68 cm, SD = 20).

The elevation of Camera locations ranged from 160 to 907 m.a.s.l.. The lowest and highest elevations within the PA are 121-1,147 m.a.s.l., therefore the survey was conducted over much of the elevation range.



Map 1: Camera deployment and habitat type in Samlout MUA. Refer to Table 2 for camera reference numbers



Map 2: Connectivity of Samlout MUA with Protected Areas in Thailand. ESRI satellite imagery shows forest cover as of 2017

Fig. 1: Bushnell 24MP Trophy Cam HDs, Model 119719CW

Fig. 2: Installation of camera trap in its protective metal box

RESULTS

Over the survey period, a total of 44 species were detected: 28 mammals, 15 birds and 1 reptile. Of these, 12 were categorised as Threatened species on the IUCN Red List (1 Critically Endangered, 3 Endangered and 8 Vulnerable), and an additional 2 were Near Threatened. 13 Threatened or Near Threatened species were mammals, with the inclusion of one bird species: the coral-billed ground cuckoo *Carpococcyx renauldi*, Vulnerable.

Records were considered independent if they were 30 minutes from the previous record of that species. As such, there were 2,345 independent records recorded over the survey.

In addition to the 44 species identified, multiple murid species were recorded (675 independent records) that could not be confidently identified to species or genus.

Table 1: Species list of reptiles recorded on the camera traps

Order/Family	Species Name	Common English Name	IUCN status	Cambodian Law[2]	No. Records	No. Stations
Squamata	Varanus sp.	Monitor Lizard Un	N/A	N/A	3	3
Varanidae	Agamidae	Unidentified Agamid Lizard	N/A	N/A	1	1
Agamidae						

[1] IUCN Red List classifications are, from most threatened to least: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). CR, EN or VU species are considered threatened species. Here, N/A refers to records that cannot have a classification, such as those not identified to species level.

[2] Cambodian law classifies wildlife species as Endangered, Rare or Common, here abbreviated to E, R or C respectively. N/A refers to any records that are not suitably identified or to species that are not included in the law.

Table 2: Species list of birds recorded on the camera traps

Order/Family	Species Name	Common English Name	IUCN status	Cambodian Law[1]	No. Records	No. Stations
Galliformes	*Arborophila cambodiana*	Chestnut-headed Partridge	LC	C	1	1
Phasianidae	*Lophura nycthemera*	Silver Pheasant	LC	C	22	7
	Tropicoperdix chloropus	Scaly-breasted Partridge	LC	C	13	4
	Gallus gallus	Red Junglefowl	LC	C	41	14
Cuculiformes						
Cuculidae	*Carpococcyx renauldi*	Coral-billed Ground Cuckoo	VU	C	27	3
	Centropus sinensis	Greater Coucal	LC	C	2	2
Columbiformes						
Columbidae	*Spilopelia chinensis*	Spotted Dove	LC	C	2	1
	Chalcophaps indica	Emerald Dove	LC	C	2	2
Pelecaniformes						
Ardeidae	*Gorsachius melanolophus*	Malayan Night Heron	LC	C	14	3
Accipitriformes						
Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	LC	C	1	1
	Accipiter trivirgatus	Crested Goshawk	LC	C	3	2
Piciformes						
Picidae	*Picus guerini*	Black-naped Woodpecker	LC	C	1	1
Passeriformes						
Pittidae	*Hydrornis cyaneus*	Blue Pitta	LC	C	2	1
Dicruridae	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	LC	C	2	1
Leiothrichidae	*Garrulax leucolophus*	White-crested Laughingthrush	LC	C	8	5

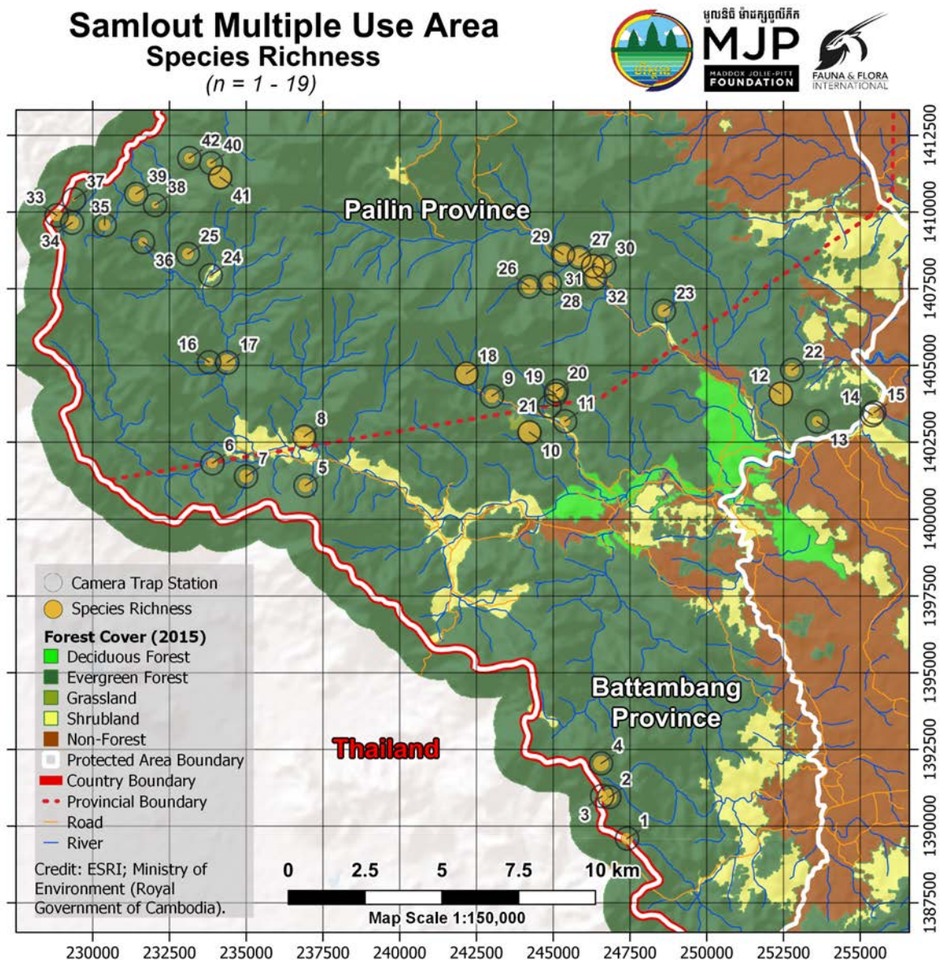
Table 3: Species list of mammals recorded on the camera traps

Order/Family	Species Name	Common English Name	IUCN status	Cambodian Law[1]	No. Records	No. Stations
Proboscidea						
Elephantidae	*Elephas maximus*	Asian Elephant	EN	E	10	3
Rodentia						
Hystricidae	*Hystrix brachyura*	Malayan Porcupine	LC	C	63	17
	Ratufa bicolor	Black Giant Squirrel	NT	R	1	1
Sciuridae	*Callosciurus finlaysonii*	Variable Squirrel	LC	C	44	16
	Menetes berdmorei	Indochinese Ground Squirrel	LC	C	82	14
Muridae	Muridae	Unidentified Murid	N/A	N/A	675	22
Spalacidae	*Rhizomys* sp.	Bamboo Rat	N/A	N/A	12	6
Scandentia	*Dendrogale murina*	Northern Smooth-tailed Treeshrew	LC	C	9	3
Tupaiidae	*Tupaia belangeri*	Northern Treeshrew	LC	C	100	18
Primates						
Cercopithecidae	*Macaca fascicularis*	Long-tailed Macaque	VU	C	49	9
	Macaca leonina	Northern Pig-tailed Macaque	VU	C	325	32
	Macaca sp.	Unidentified Macaque	N/A	N/A	3	2
	Trachypithecus germaini	Indochinese Silvered Langur	EN	C	1	1
Artiodactyla						
Bovidae	*Bos gaurus*	Gaur	VU	R	13	6
	Capricornis sumatraensis	Serow	VU	R	12	6
	Muntiacus vaginalis	Red Muntjac	LC	C	61	11
Cervidae	*Rusa unicolor*	Sambar	VU	C	183	14
	Tragulus kanchil	Lesser Mouse Deer	LC	C	98	10
Tragulidae						
	Sus scrofa	Wild Boar	LC	C	105	23
Suidae						
Pholidota	*Manis javanica*	Sunda Pangolin	CR	R	4	4
Manidae						

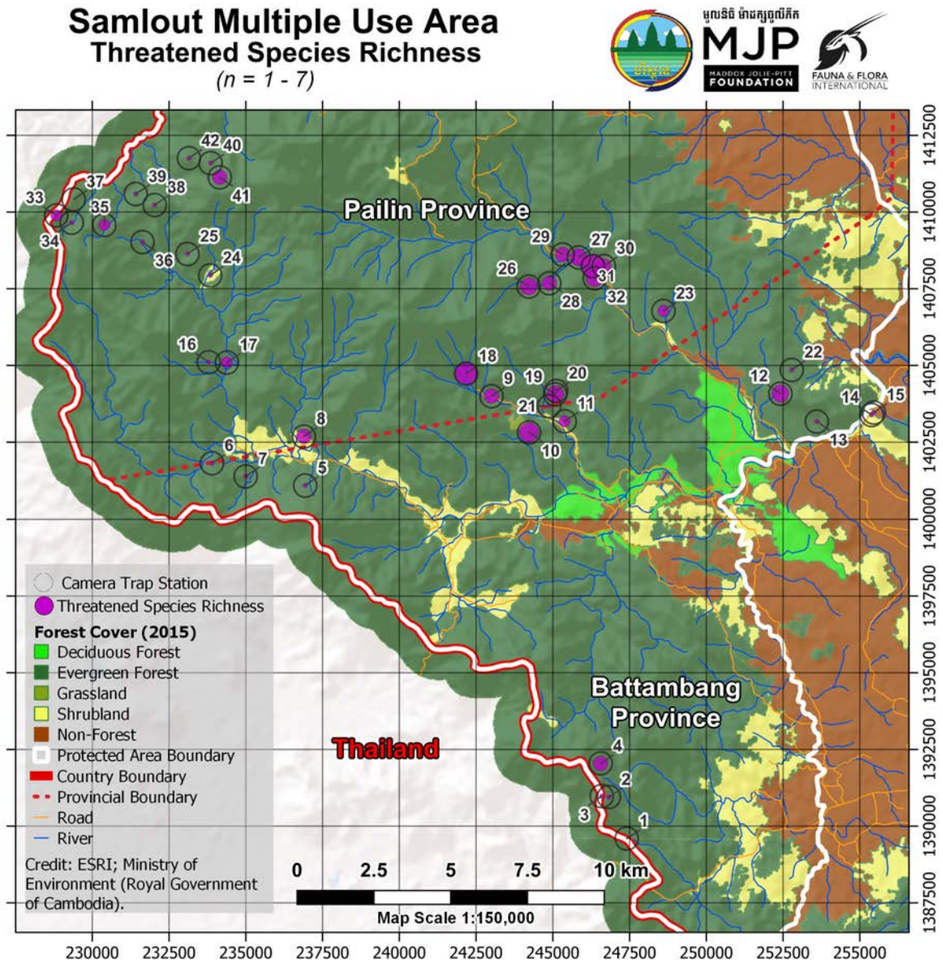
Order/Family	Species Name	Common English Name	IUCN status	Cambodian Law[1]	No. Records	No. Stations
Carnivora						
Felidae	*Catopuma temminckii*	Asian Golden Cat	NT	R	1	1
Viverridae	*Prionailurus bengalensis*	Leopard Cat	LC	C	30	15
	Viverricula indica	Small Indian Civet	LC	C	15	4
	Paradoxurus hermaphroditus	Common Palm Civet	LC	C	114	19
Herpestidae						
	Urva urva	Crab-eating Mongoose	LC	C	20	7
Canidae						
	Cuon alpinus	Dhole	EN	R	3	2
Ursidae						
	Ursus thibetanus	Asian Black Bear	VU	E	22	2
Mustelidae						
	Martes flavigula	Yellow-throated Marten	LC	C	22	9
	Melogale personata	Large-toothed Ferret Badger	LC	C	5	3
	Arctonyx collaris	Greater Hog Badger	VU	R	3	3

[1] IUCN Red List classifications are, from most threatened to least: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). CR, EN or VU species are considered threatened species. Here, N/A refers to records that cannot have a classification, such as those not identified to species level.

[2] Cambodian law classifies wildlife species as Endangered, Rare or Common, here abbreviated to E, R or C respectively. N/A refers to any records that are not suitably identified or to species that are not included in the law.



Map 3: Species richness (number of species identified) detected across the survey. The size of each point corresponds to the richness detected at that station



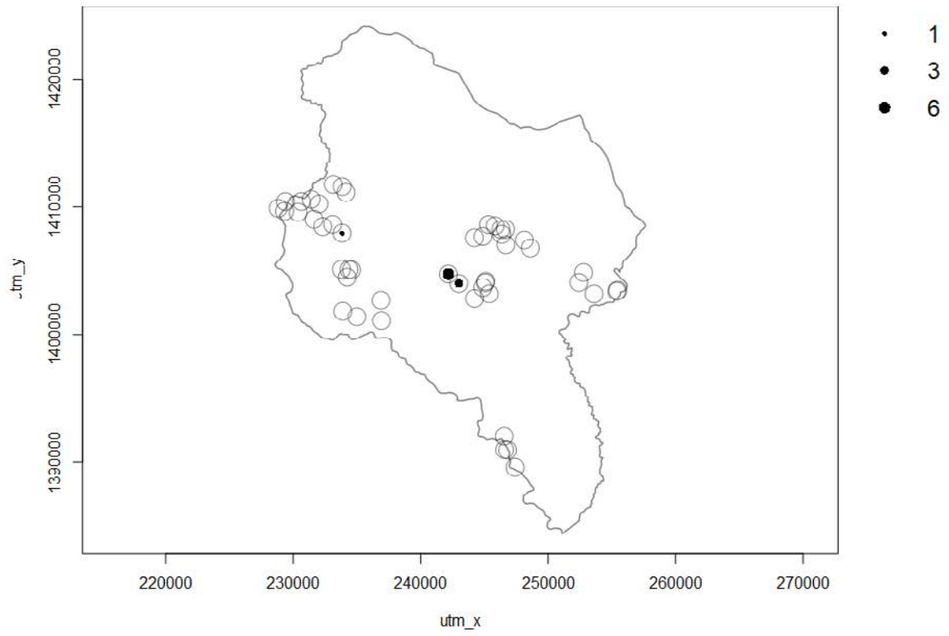
Map 4: Threatened species richness, shown by the size of each point (number of species considered Threatened by the IUCN Red List that were identified at each camera station). Null values do not have a point

Asian elephant

Elephas maximus

The survey detected 10 independent records of Asian elephants across 3 camera trap stations (SL104, SL123 and SL154a).

Elephas maximus

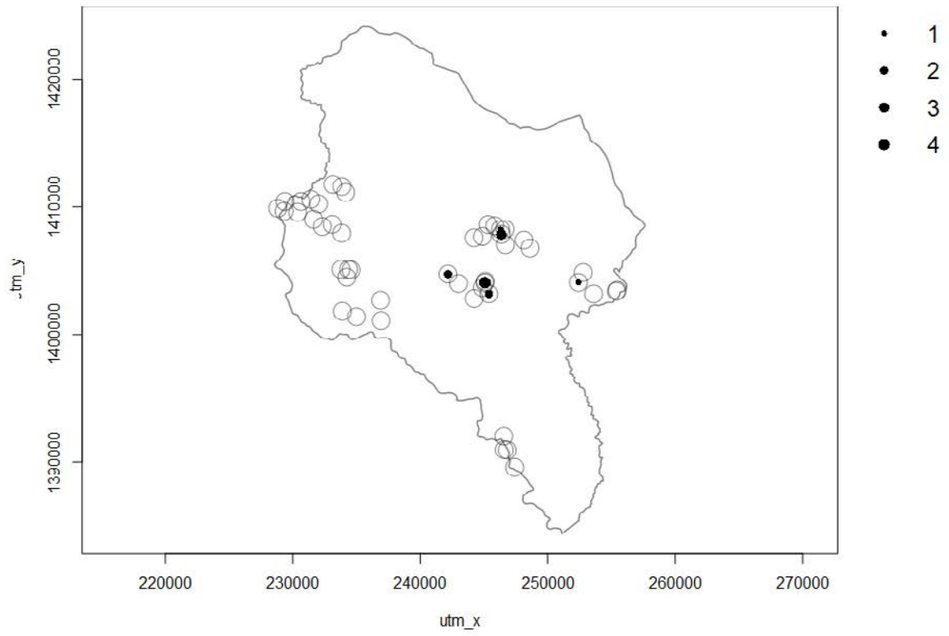


Gaur

Bos gaurus

The survey detected 13 independent records of gaur across 5 camera trap stations (SL106, SL111a, SL123, SL125a, SL163b and SL163c). Of these, there were 2 records of a total of 3 calves, a promising sign. However, there were also three possible records of lumpy skin disease, which may significantly impact population recovery (see Threats section).

Bos gaurus

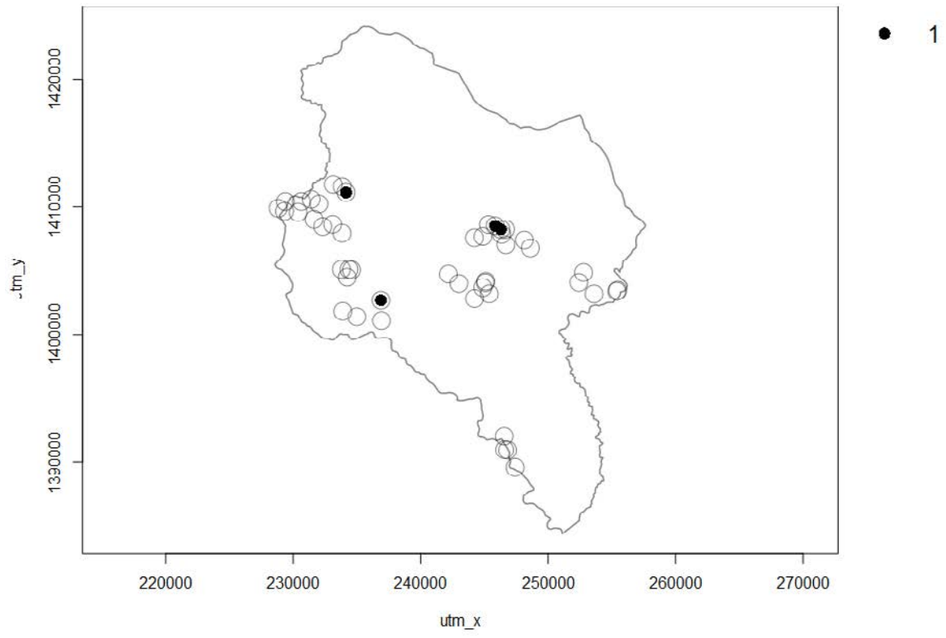


Sunda pangolin

Manis javanica

Sunda pangolins were detected 4 times, each on a different camera trap (SL83, SL162a, SL162b and SL193).

Manis javanica

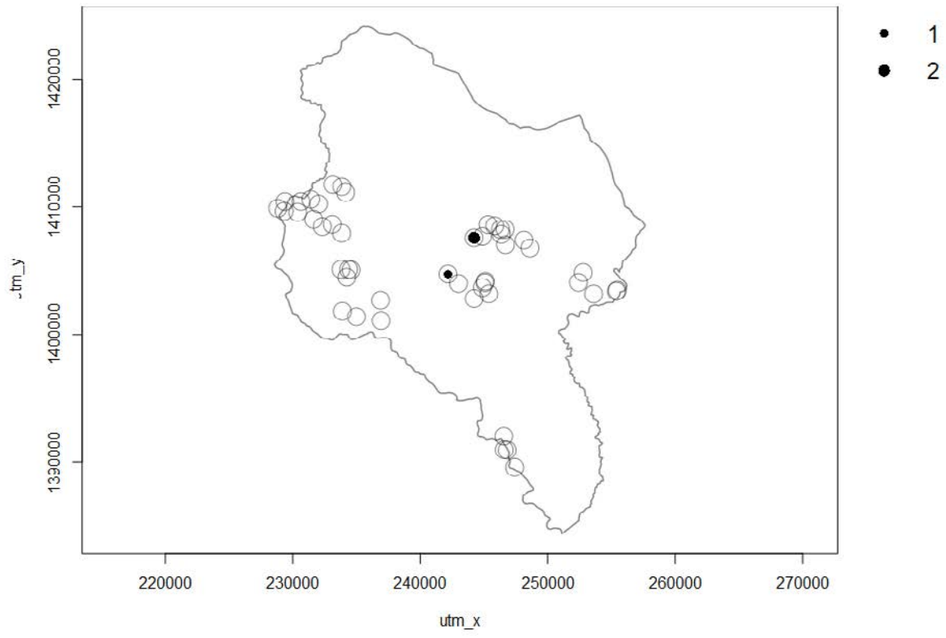


Dhole

Cuon alpinus

There were 3 records of dholes across 2 camera trap stations (SL123 and SL161). With the high numbers of Sambar (*Rusa unicolor*) recorded, they seem to have an ample prey base. However, the presence of domestic dogs through the PA is undoubtedly a threat to this species (see above).

Cuon alpinus

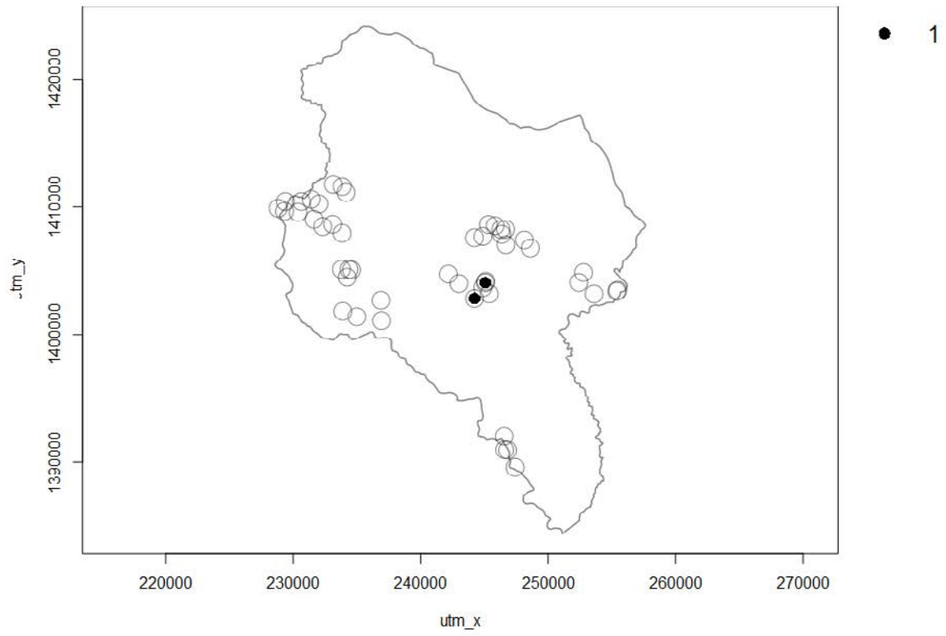


Asiatic black bear

Ursus thibetanus

Asiatic black bears were recorded on two stations (SL105 and SL125a).

Ursus thibetanus

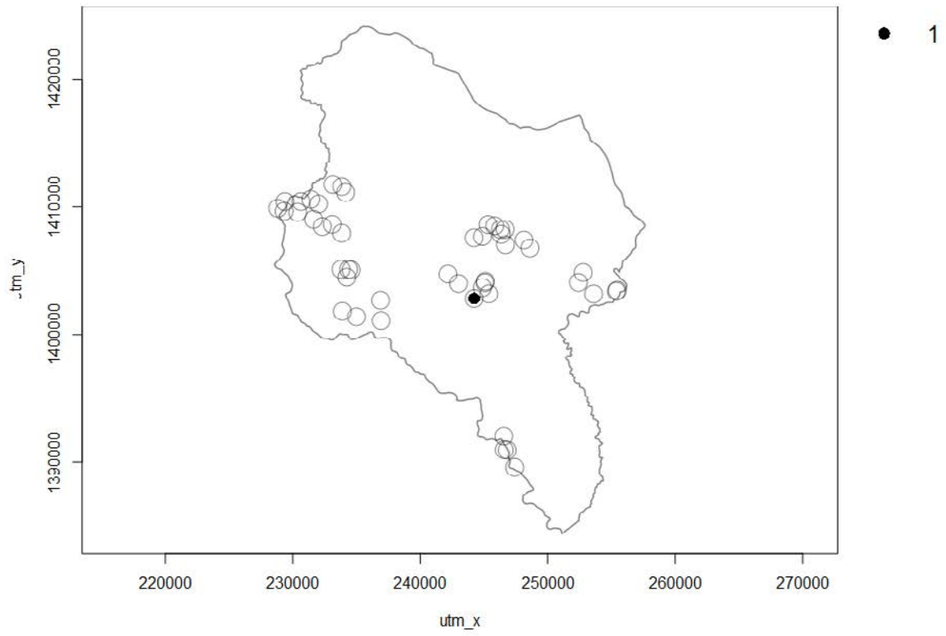


Asian golden cat

Catopuma temminckii

Asian golden cat was recorded once at station SL105. This was the only medium-sized felid record in the survey, and with dhole, the joint largest predator.

Catopuma temminckii

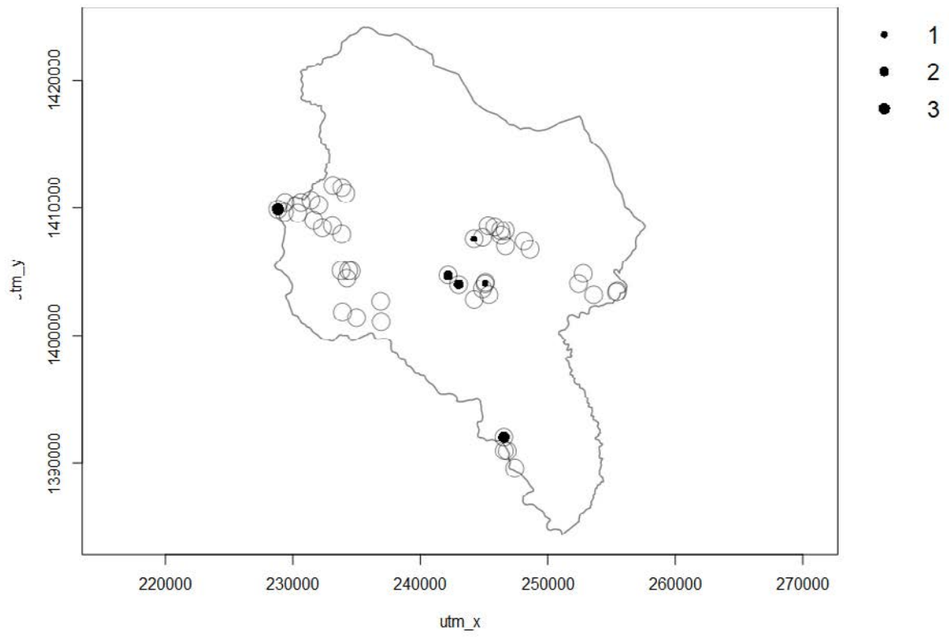


Mainland serow

Capricornis sumatraensis

Mainland serow appeared 12 times, across 6 camera stations (SL16c, SL104, SL123, SL125a, Sl161 and SL170a).

Capricornis sumatraensis

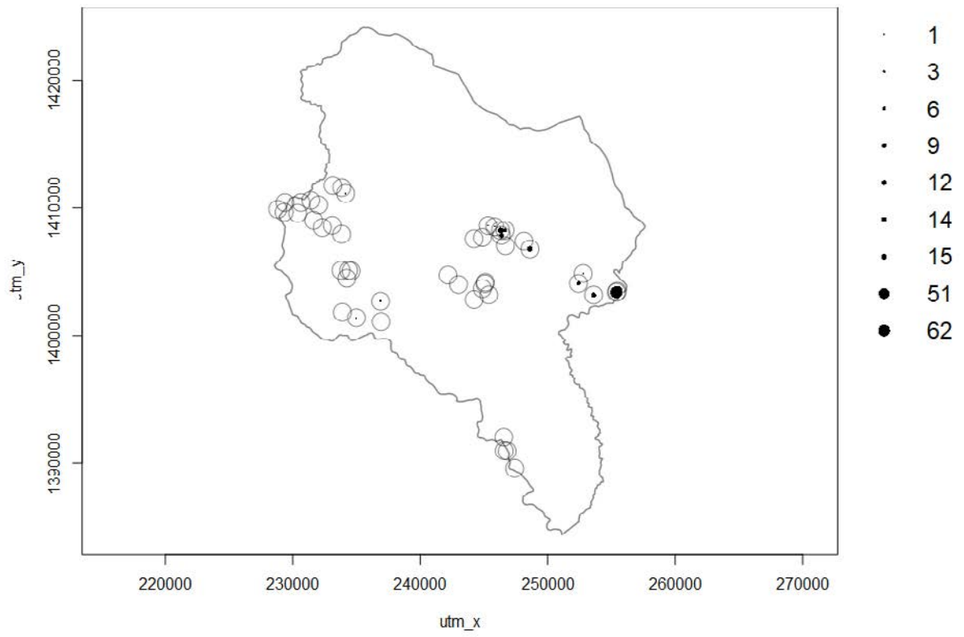


Sambar

Rusa unicolor

Sambar were detected in relatively high numbers, with a total of 183 independent records across 14 camera stations (SL82, SL83, SL111a, SL111b, SL113a, SL113b, SL130, SL145, SL162a, SL162c, SL163a, SL163b, SL163c and SL193). However, may of these records are likely a group of individuals found close to the MJP station, and do not necessarily reflect the total population size throughout the PA.

Rusa unicolor

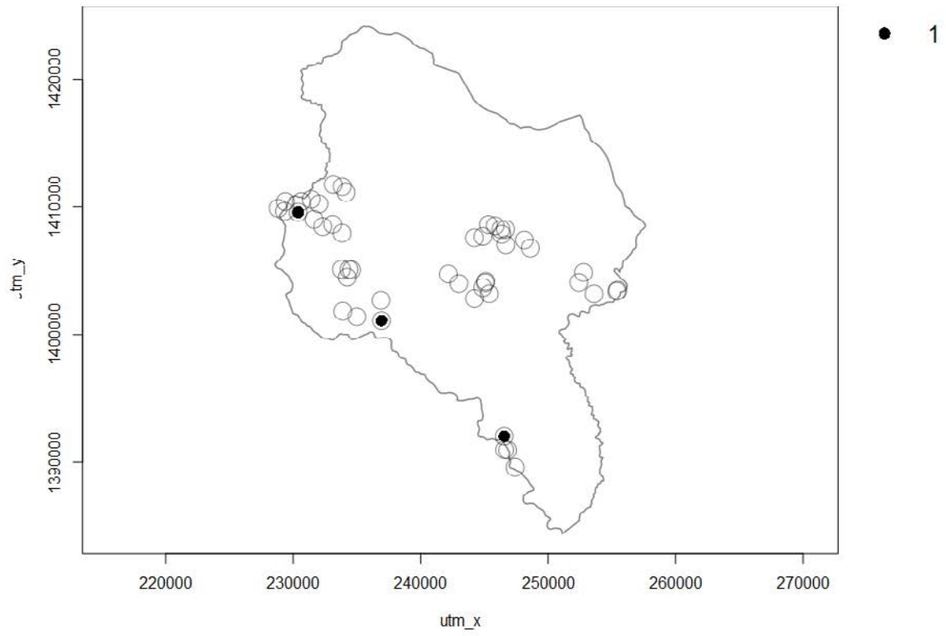


Greater hog badger

Arctonyx collaris

Greater hog badger had 3 independent records of greater hog badgers, across 3 camera stations (SL16c, SL67 and SL171).

Arctonyx collaris

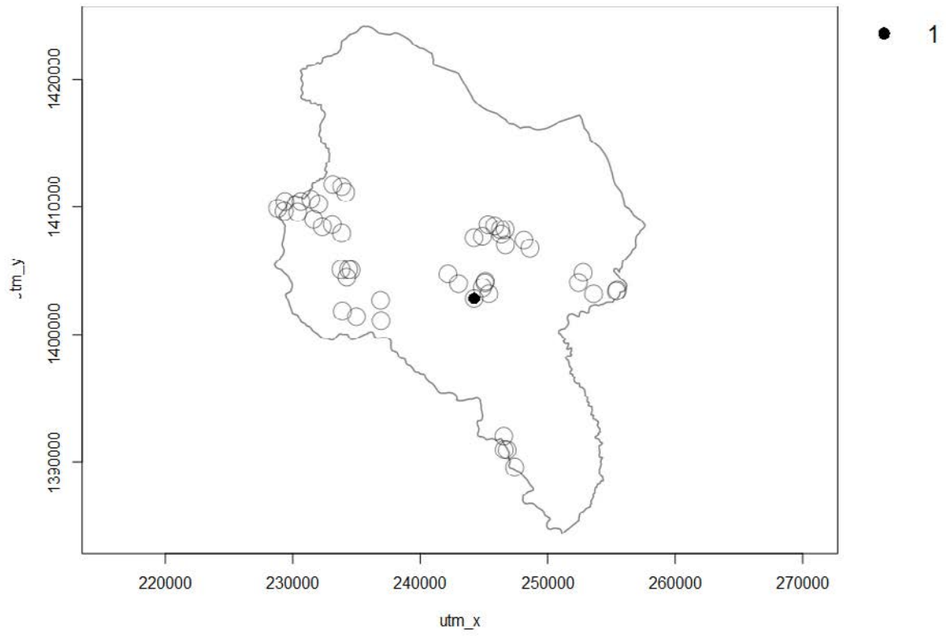


Indochinese silvered langur

Trachypithecus germaini

There was only one record of silvered langurs during the survey (at SL105). However, this is not necessarily indicative of population numbers, as the species is primarily arboreal and is not likely to be detected on camera traps placed terrestrially. This record should be taken only as confirmation of their presence in the PA and not as an indication of their population size.

Trachypithecus germaini

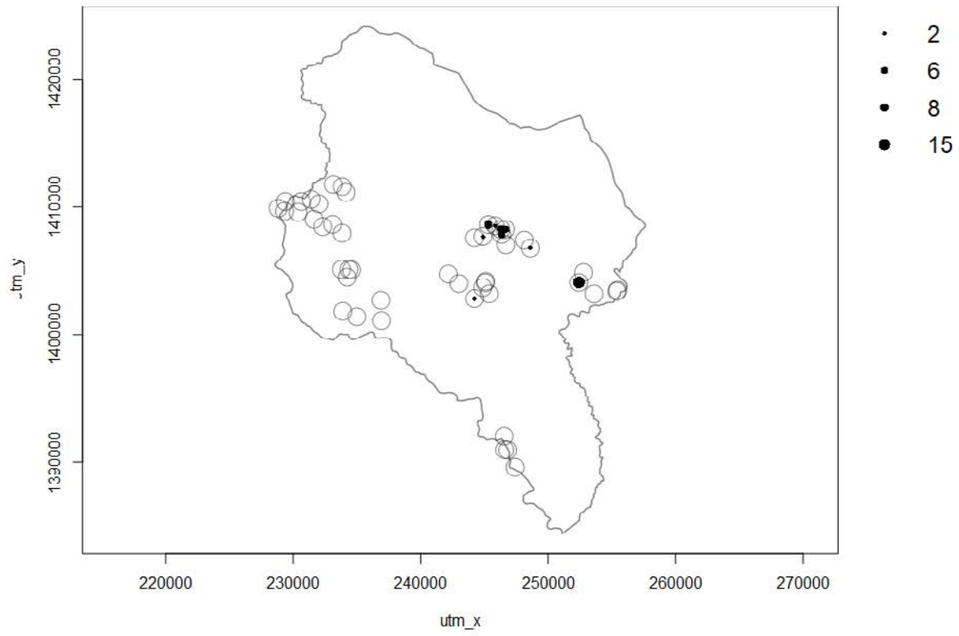


Long-tailed macaque

Macaca fascicularis

Long-tailed macaques achieved 49 records, across 9 camera stations (SL105, SL111a, SL145, SL162a, SL162b, SL162c, SL163a, SL163b and SL163c).

Macaca fascicularis



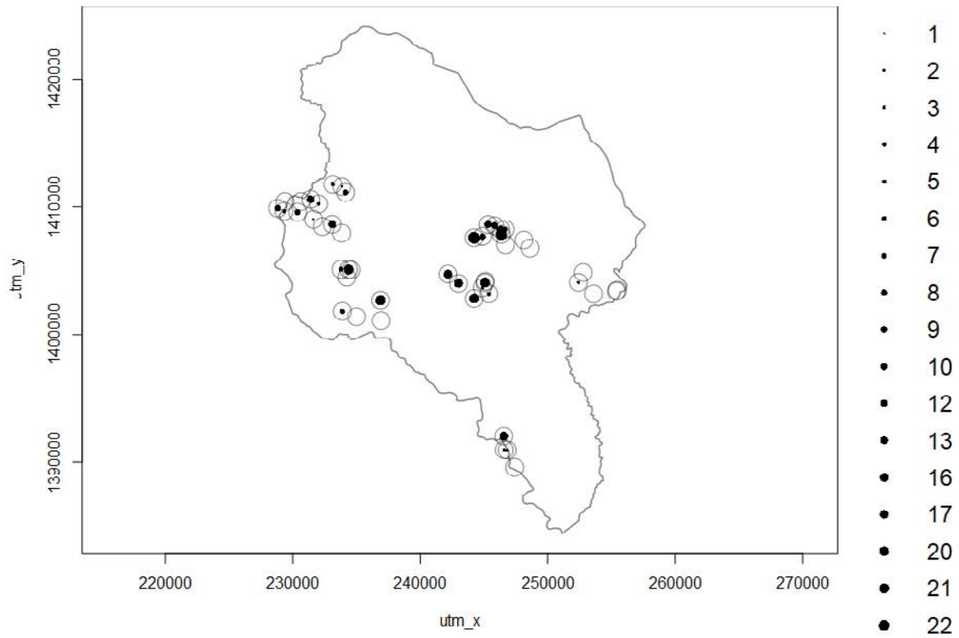
Northern pig-tailed macaque

Macaca leonina

There were 325 independent records of pig-tailed macaques during the survey, more than any other individual species (excluding unidentified murids). They were detected on 32 camera stations (SL16a, SL16b, SL16c, SL81, SL83, SL104, SL105, SL106, SL111a, SL117, SL118c, SL123, SL125a, SL125b, SL125c, SL154b, SL161, SL162a, SL162b, SL162c, SL163a, SL163b, SL163c, SL170a, SL170b, SL171, SL172, SL191a, SL191b, SL192, SL193 and SL209).

.

Macaca leonina

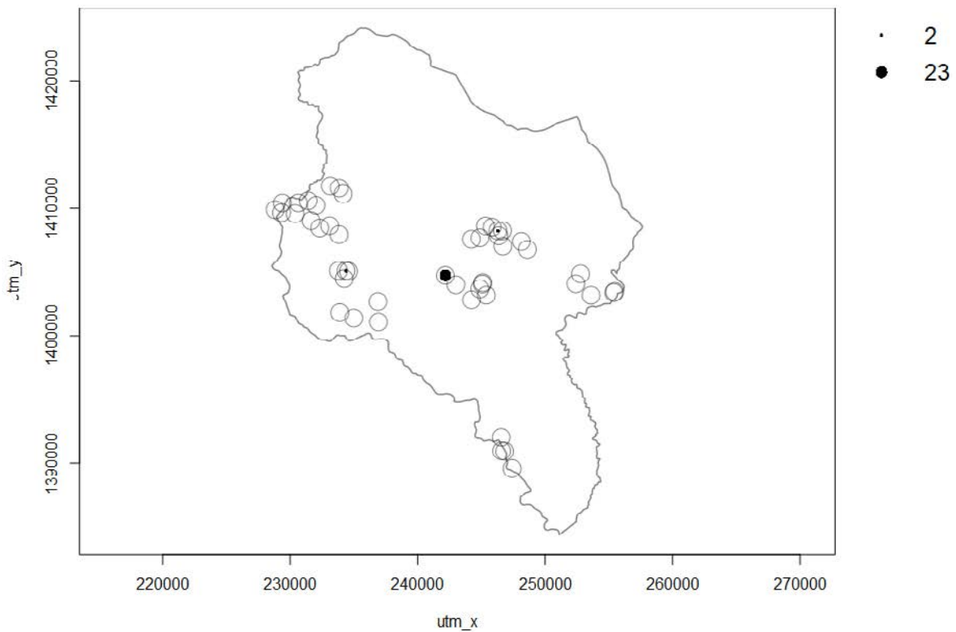


Coral-billed ground cuckoo

Carpococcyx renauldi

The coral-billed ground cuckoo was the only Threatened bird species detected by camera trapping. There were 27 independent records from 3 stations (SL118c, SL123 and SL163b). In multiple records, they were captured alongside wild pigs, likely due to the pigs rooting behaviours unearthing prey such as invertebrates for the cuckoos to forage.

Carpococcyx renauldi



THREATS

Poaching

The camera trap survey did not reveal much direct evidence of poaching, with the majority of the humans recorded not carrying any visible poaching equipment such as guns or snaring material, nor seen with captured wildlife. However, a poacher carrying a gun was recorded (see Fig. 3). In addition, a sambar was recorded with a missing foot, almost certainly due to a snare wound (Fig. 4).

Fig. 3: A poacher carries a gun in the Phnom Pich area of the PA

Domestic Dogs

The notable incidence of domestic dog presence is concerning for their potential impact on many species, but most notably dholes (*Cuon alpinus*), as a highly threatened canid. In addition to the main threats of habitat loss, snaring and depletion of available prey, a significant threat to dholes is disease, particularly in isolated populations. Dholes are susceptible to diseases that are transferred from other canids, such as rabies, canine distemper, canine parvovirus and sarcoptic mange (Durbin et al. 2004). As a result of disease transfer from domestic dogs, an outbreak of canine distemper in 2011-2012 nearly extirpated dholes in Eastern and Northern Cambodia (Kamler et al. 2015).

Of the two stations with dhole detections, domestic dogs were detected at one. The notable presence of domestic dogs throughout the PA is evidentially a substantial threat for this population of dhole.

Lumpy Skin Disease

Three gaur records showed raised skin lesions, which may be symptoms of lumpy skin disease (LSD), a viral infection that affects both wild and domestic cattle species. All three records were from one trap station (SL163c) and were on February 3 and 16. From the placement of the lesions and the size of the gaur, it may be the same individual, but the images are unclear (Fig. 5). No other gaur captured showed obvious signs of disease.

Lumpy Skin Disease is endemic to sub-Saharan Africa, but has spread in recent years to the Mediterranean, the Middle East, South and South-East Asia, including Cambodia (Kumar et al. 2018). The disease is transmitted by biting insects, as well as through contact with the skin lesions and through fluids, including milk (Namazi & Khodakaram Tafti 2021). LSD usually has a mortality rate under 10% in domestic cattle (Tuppurainen, Alexandrov and Beltrán-Alcrudo 2017), with young calves being more susceptible (Namazi & Khodakaram Tafti 2021). Additionally, the disease causes reductions in milk yields, temporary or permanent infertility and miscarriages (Namazi & Khodakaram Tafti 2021). However, the severity of LSD to wild ruminants is still unknown (Roche et al. 2020).

If present, LSD, could therefore pose a significant risk to the gaur population of Samlout MUA, impacting population recovery in addition to causing mortality. Treatment of domestic cattle in and around the MUA for LSD, if present, is important to prevent its spread to wild populations. Surveys on local domestic wildlife are recommended to better understand whether there is need for interventions targeting LSD, and these results should be communicated to the relevant agencies.

Fig. 4: A sambar showing wound probably caused by a wire snare

Fig. 5: Adult gaur showing possible evidence of Lumpy Skin Disease

REFERENCES

Durbin, L.S., Venkataraman, A., Hedges, S. and Duckworth, W. (2004). Dhole *Cuon alpinus*. In: C. Sillero-Zubiri, M. Hoffmann and D.W. Macdonald (eds), Canids: Foxes, wolves, jackals and dogs. Status survey and conservation action plan, IUCN/SSC Canid Specialist Group, Gland, Switzerland and Cambridge, UK.

Kamler, J.F., Songsasen, N., Jenks, K., Srivathsa, A., Sheng, L. & Kunkel, K. (2015). *Cuon alpinus*. The IUCN Red List of Threatened Species 2015: e.T5953A72477893. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T5953A72477893.en

Kumar, P., Kumari, R. R., Devi, S., Tripathi, M. K., Singh, J., Kumar, R., & Kumar, M. (2018). Emergence and transboundary spread of lumpy skin disease in South Asia. Abdallah FM, El Damaty HM and Kotb G F, 1150-58.

Namazi, F., & Khodakaram Tafti, A. (2021). Lumpy skin disease, an emerging transboundary viral disease: A review. Veterinary Medicine and Science, 7(3), 888-896.

Roche, X., Rozstalny, A., TagoPacheco, D., Pittiglio, C., Kamata, A., Beltran Alcrudo, D., Bisht, K., Karki, S., Kayamori, J., Larfaoui, F., Raizman, E., VonDobschuetz, S., Dhingra, M.S. and Sumption, K. 2020. Introduction and spread of lumpy skin disease in South, East and Southeast Asia: Qualitative risk assessment and management. FAO animal production and health, Paper 183. Rome, FAO.
http://doi.org/10.4060/cb1892en

Tuppurainen, E., Alexandrov, T., & Beltrán-Alcrudo, D. J. F. A. P. (2017). Lumpy skin disease field manual-A manual for veterinarians. FAO Animal Production and Health Manual, 20, 1-60.


MJP
MADDOX JOLIE-PITT
FOUNDATION
Fauna
& Flora
Saving Nature Together