

Kingdom of Cambodia  
Nation Religion King



# VIRACHEY NATIONAL PARK BIODIVERSITY SURVEY REPORT CAMBODIA 2024

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**Fauna  
& Flora**  
Saving Nature Together

# VIRACHEY NATIONAL PARK BIODIVERSITY SURVEY REPORT CAMBODIA 2024



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Saving Nature Together



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Cover images: (Main) PDoE Ranger at O'Ampae Prok Waterfall.

(Insets) *Cyrtosia nana*; great hornbill; large-antlered muntjac; *Eudiscopus denticulus*;  
*Limnonectes dabanus*.

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Wet season in the Veal Thom grasslands with Phnom Haling Halang massif on the horizon.

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## INTRODUCTION

### Background

Virachey National Park (VNP) is a relatively understudied protected area in Northeast Cambodia, within the Siem Pang District, Stung Treng Province, and Veun Sai, Taveng and Andong Meas Districts in Ratanakiri Province. Situated on two international borders, the park is contiguous with forest in neighbouring Lao PDR and Vietnam. As a south-western extension of the Annamite Mountain range, the park is a key habitat for endemic flora and fauna not found in wider Cambodia, and despite relatively high levels of historic logging, remains a key biodiversity refuge. The park represents one of only two ASEAN Heritage Parks in the country.

Virachey National Park was established in 1993 via Royal Decree, encompassing 332,500 ha. A subsequent contiguous Biodiversity Conservation Corridor was established by Sub-Decree in 2018. In July 2023, likewise by Sub-Decree, the corridor was rezoned into VNP and is now part of the park, increasing the protected area to 405,766 ha.

A number of Indigenous groups live in and around the park including the Brao, Kavet, Kreung, Jarai and Kachork minorities, numbering approximately 35,000 people.

### Biophysical Context

The park's elevation ranges from ca. 70 masl. in the river valleys, to ca. 1,500 masl. in the mountains of the Lao border area. The annual precipitation varies between 187-236 mm, and the average monthly temperature between 19°C-27°C (Fick & Hijmans 2017). These geophysical conditions partly influence the high diversity of habitats, including lowland and mountainous vegetation, such as upland savannah, bamboo thickets, and semi deciduous, mixed deciduous and evergreen forest (Conservation International 2007). High levels of historic logging have left much of the forest within the park degraded and largely stripped of luxury timber species. The majority of this logging occurred from the early 2000s, and peaked in the early-mid 2010s (The NGO Forum on Cambodia 2015; Global Witness 2015).

◁ Bear claw marks and trail signs made by local people in Virachey National Park.

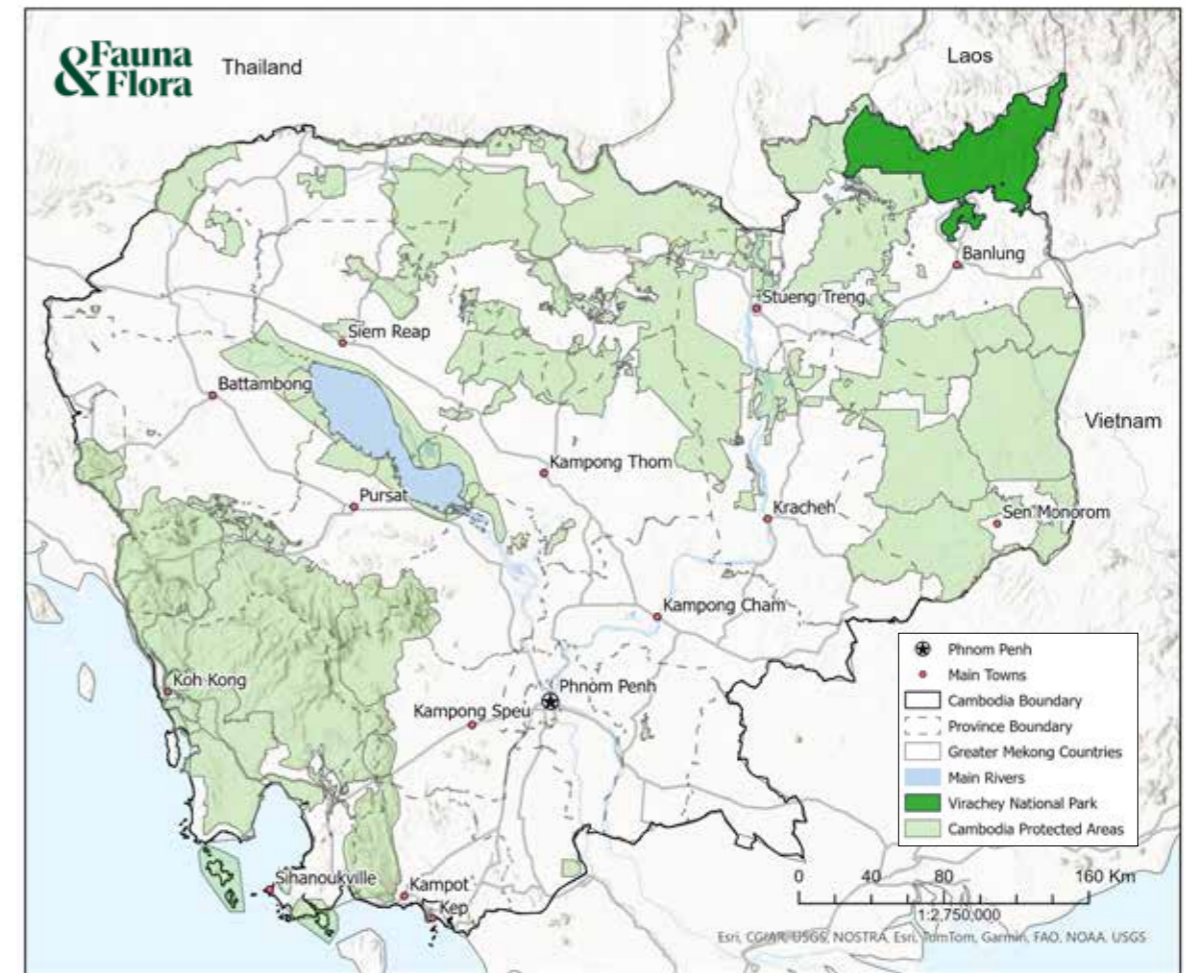


Fig. 1: Virachey National Park's location within Cambodia's protected area system (2023).

Currently, large-scale logging operations in the park are presumed to have largely ceased due to a lack of mature luxury timber species remaining in areas?

The park is part of the Indochina dry evergreen forest ecoregion (Olson et al. 2001) and is within the Indo-Burma biodiversity hotspot. This hotspot is characterized by seasonal weather patterns that are drier between December and March under the influence of the Asian high-pressure system and the north-east monsoon, and wetter between April to November when the south-west monsoon transports moisture from the ocean (Dijk et al. 1999). Only around 5% of the original habitats in the Indo-Burma hotspot remain, with Cambodia as one of the countries that maintain the highest levels of forest cover (CEPF 2020).

◁ An area of intact evergreen forest adjacent to the Veal Thom grasslands.

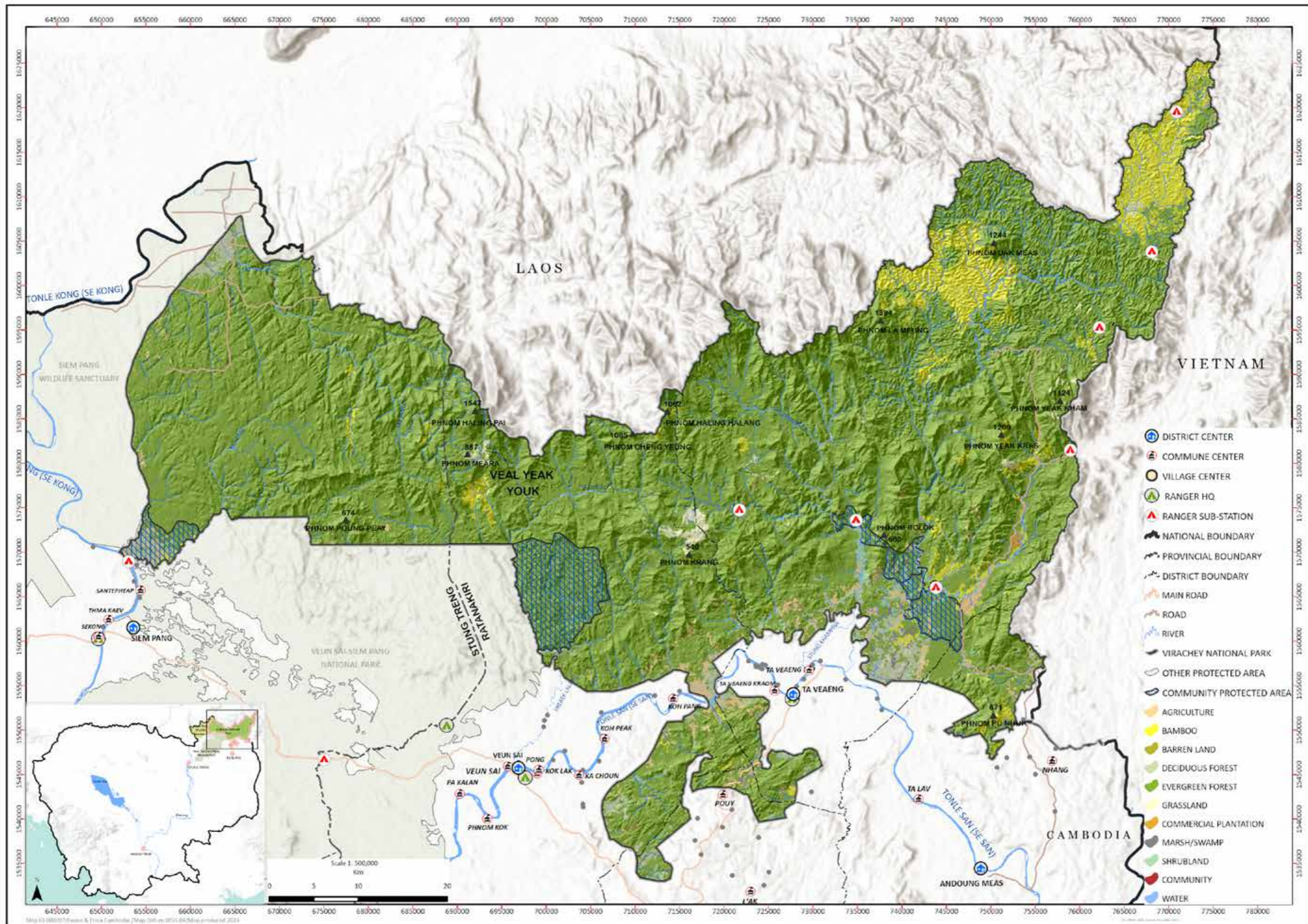


Fig. 2: Virachey National Park (2023).



## SURVEYS

A Conservation International-led rapid assessment in 2007 found Virachey to contain a high diversity and abundance of species – many globally threatened – including clouded leopard *Neofelis nebulosa*, gaur *Bos gaurus*, Asian elephant *Elephas maximus*, and Sunda pangolin *Manis javanica*. Further small-scale studies have been conducted in subsequent years by HabitatID. The biodiversity survey presented in this report represents the largest-scale and broadest across taxa yet conducted in Virachey National Park.

These surveys were a collaboration between Fauna & Flora Cambodia Programme and the Ministry of Environment, with support from the Ratanakiri and Stung Treng Provincial Departments of Environment, with funding from the Darwin Initiative, Fondation Franklinia, the British Embassy in Phnom Penh, the U.S. Fish & Wildlife Service (USFWS), the People's Trust for Endangered Species, and the Prince Bernhard Nature Fund.

Fauna & Flora surveys began in 2018, targeting the northern yellow-cheeked crested gibbon *Nomascus annamensis* and have since expanded to cover a wide array of taxa: terrestrial mammals and ground-dwelling birds via camera trapping, bird surveys, bat surveys, botanic and tree surveys, environmental (eDNA) testing, and herpetological surveys.

The following chapters of this report detail the findings from these various surveys.

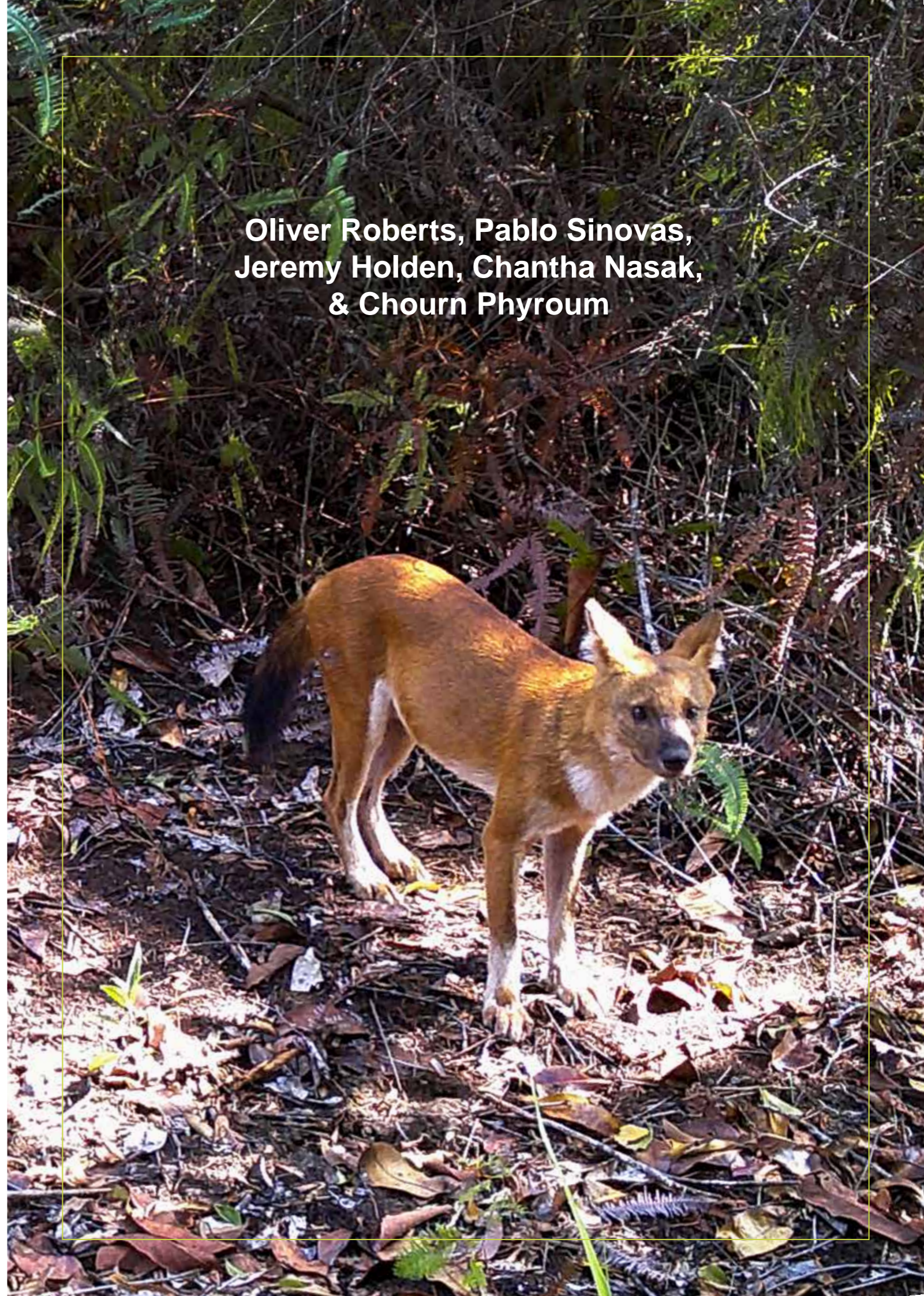
◁ Chinese water dragon *Physignathus cocincinus* recorded during a survey in 2021.



## CAMERA TRAP SURVEY

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Title image: Dhole *Cuon alpinus* camera trapped in Virachey National Park.



## CAMERA TRAP SURVEY VIRACHEY NATIONAL PARK 2021-2023

### SUMMARY

In 2021 and 2023, we deployed 153 cameras across Virachey National Park (VNP), with a total cumulative trapping effort of 11,222 nights, representing the largest such effort conducted in the park to date.

From 7,209 independent records, a total of 89 species were detected, including 20 globally threatened species on the IUCN Red List. The survey also marks the first record of a juvenile large-antlered muntjac *Muntiacus vuquangensis*, indicating Virachey's importance in the conservation of this elusive, Critically Endangered deer, that remains endemic to the forests in and around the Annamite Mountains.

### METHODS

A total of 153 cameras were deployed across Virachey National Park in 2021 and 2023, and consisted of 84 and 69 cameras respectively.

Install teams were variously comprised of Ministry of Environment staff, Fauna & Flora staff, Ratanakiri and Stung Treng Provincial Department of Environment rangers and members of local communities.

In 2021, deployments followed systematic distance-sampling methodologies, with 59 of the 84 cameras installed in 7 sampling areas across the park each consisting of a 9-camera grid, arranged 3 x 3, with spacing of 1.5 km. Sampling areas were identified through GIS and interviews with park rangers and experienced team members familiar with the park. An additional 25 cameras were set up outside of the systematic approach, targeting medium and large mammals, to record species presence. Species records were generally too few to reliably produce population estimates, however.

In 2023, deployments likewise utilized sampling areas consisting of a 3 x 3 grid system, with spacing of 1.5 km x 1.5 km, but did not follow distance sampling techniques due to the previous paucity of records for in-depth analysis. Install locations within these grids instead decided by teams on-site. Placement was generally along a variety of trails, streams, clearings, slopes and areas with wildlife signs, in order to maximise encounter rates for target species. Some grid squares were condensed during deployment to contain multiple cameras, due to either accessibility or the notable presence of wildlife signs. A further two smaller targeted stations in the mountainous O'Ksach and O'Ampae Prok areas were comprised of five cameras each, set for video, and deployed along ridge lines and other topographical features deemed likely to maximise encounter rates in targeting large-antlered muntjac *Muntiacus vuquangensis*.

All cameras deployed were Bushnell 24MP Trophy Cam HDs, Model 119719CW. Cameras were attached to suitable trees using metal boxes, straps and python locks, to prevent damage or theft. Camera placement height varied between 40 cm and 100 cm from the ground (Mean  $77.37 \pm 7.99$  cm). Camera placement elevations ranged between 109 – 1,278 masl. (Mean  $585.94 \pm 312.53$  masl.). The elevation range across the park is ~100 – 1,547 masl., meaning the surveys covered the majority of the elevation range throughout.



**Fig. 1:** The survey used Bushnell 24MP Trophy Cam HDs units with python lock and protective housing.

▽ Department of Environment ranger and local guides set a camera trap in O'Ampae Prok.



## RESULTS

From 33,800 camera trap images, a total of 7,209 independent events were recorded. Of these records, 2,591 could not be identified beyond family and were excluded from the species richness calculations. The remaining 4,618 records were comprised of 89 species: 41 mammal, 46 bird and 2 reptile species. A further 4 genera were detected and included in richness estimates that could not be identified to species level: 2 birds and 2 mammals. Species richness varied between camera stations, from 2 to 31 species recorded (Mean  $9 \pm 5$ ).

Of the 89 species detected, 19 are categorised as globally threatened on the IUCN Red List: three Critically Endangered, 3 Endangered and 13 Vulnerable. A further 5 species are Near Threatened. Notable species included the Critically Endangered large-antlered muntjac *Muntiacus vuquangensis*, an elusive species endemic to the Annamites. These records included the first known image of a juvenile, indicating that eastern Virachey hosts a breeding population of this highly-threatened ungulate.

Other significant threatened species recorded included red-shanked douc langur *Pygathrix nemaeus*, gaur *Bos gaurus*, dhole *Cuon alpinus*, clouded leopard *Neofelis nebulosa*, Asiatic black bear *Ursus thibethanus*, Malayan sun bear *Helarctos malayanus*, Sunda pangolin *Manis javanica* and the ground-dwelling Germain's peacock-pheasant *Polyplectron germaini* (Fig. 21).

Of the 153 deployed cameras, 30 (19.61%) were rendered inoperable or did not record data and have been discounted from further analysis; 12 in 2021 (14.29% of the 2021 cameras) and 18 in 2023 (26.09%). Camera failures were caused by a variety of reasons, including theft, destruction, user error or unknown internal faults. A number of the blank cameras were initially active and had recorded images, but had identifiable, albeit unknown, recording faults. As such, the data was discounted due to both unreliability and negligible trapping effort. Any camera with fewer than 14 days active trapping effort was discounted. As the same camera units were deployed across both years, the increased failure rate in 2023 can likely be attributed to higher exposure to field conditions.

Of the 123 active cameras, 19 were set in video mode, while the remaining 104 recorded photos. Photo cameras were set for bursts of three images per trigger, and videos were one minute long (15 seconds in IR conditions due to camera limitations). All cameras were set with an interval delay of 1 second.

The camera traps were active between 23 February 2021 – 27 July 2021 and 01 March – 02 July 2023 - with an additional two cameras active on Haling Halang from 01 July 2023 - 14 September 2023. Excluding discounted cameras, these two year's of surveying produced a total camera trapping effort of 11,222 nights; 7,084 nights in 2021 and 4,138 in 2023, although with variability in each individual camera's effort (Mean  $91 \pm 30$ ).

Images and videos were analysed and assigned metadata tags in DigiKam open source photo software. Independent encounters were tabulated and analysed in the R package camtrapR (Niedballa et al. 2016). Encounters were considered independent if segregated by at least 30 minutes from the previous record of the same species at that camera.

Richness of species and threatened species were calculated for each camera station. Records were excluded from the species richness value if they could not be confidently identified to species, or genus in instances where no species level-identification could be made. For instance, multiple murid species were recorded (1,815 independent records), but as none could be sufficiently identified, they were excluded from species richness values. Capture rates were also calculated for each camera, defined as the number of independent detection events per 100 trap nights of effort.

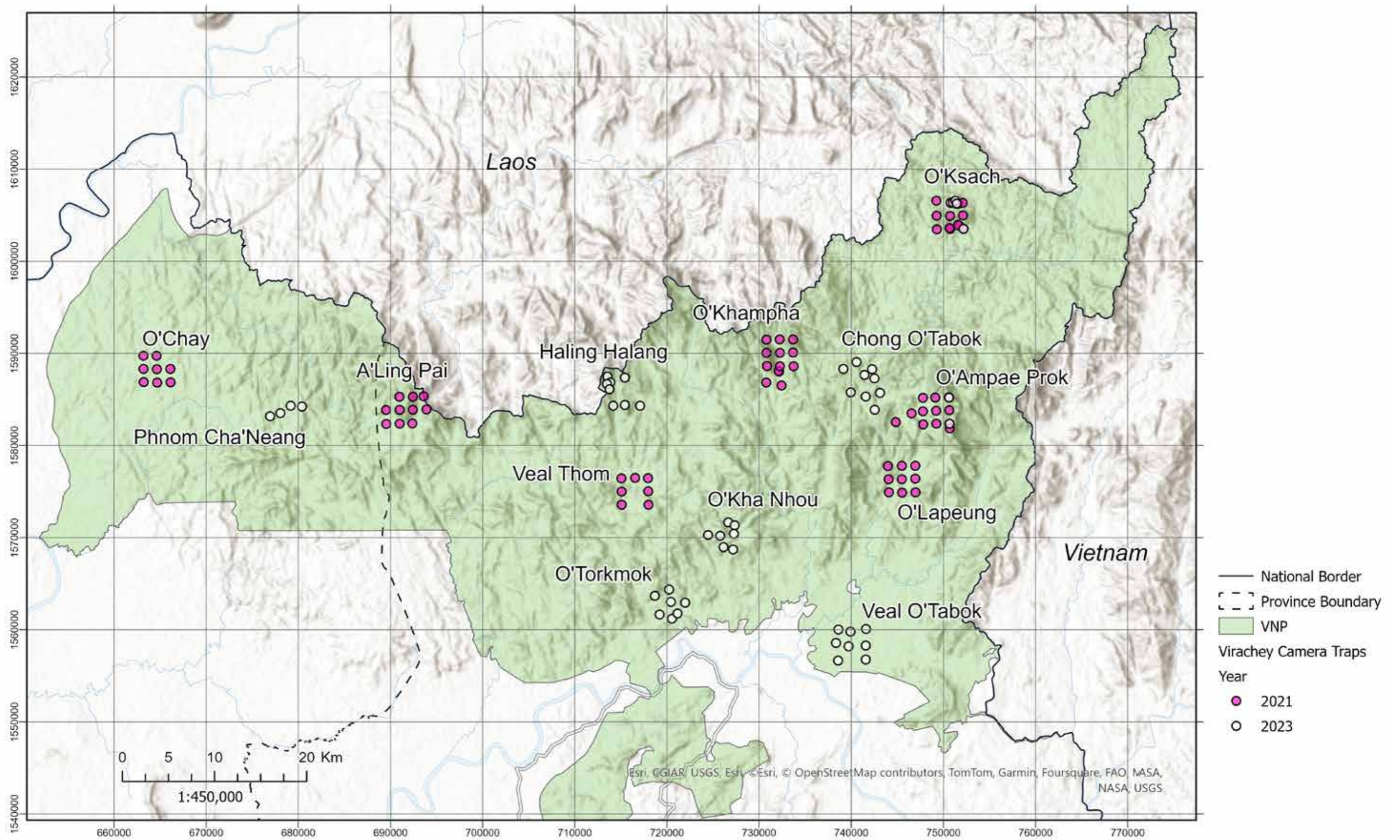


Fig. 2: 2021 and 2023 camera trap install locations and stations.

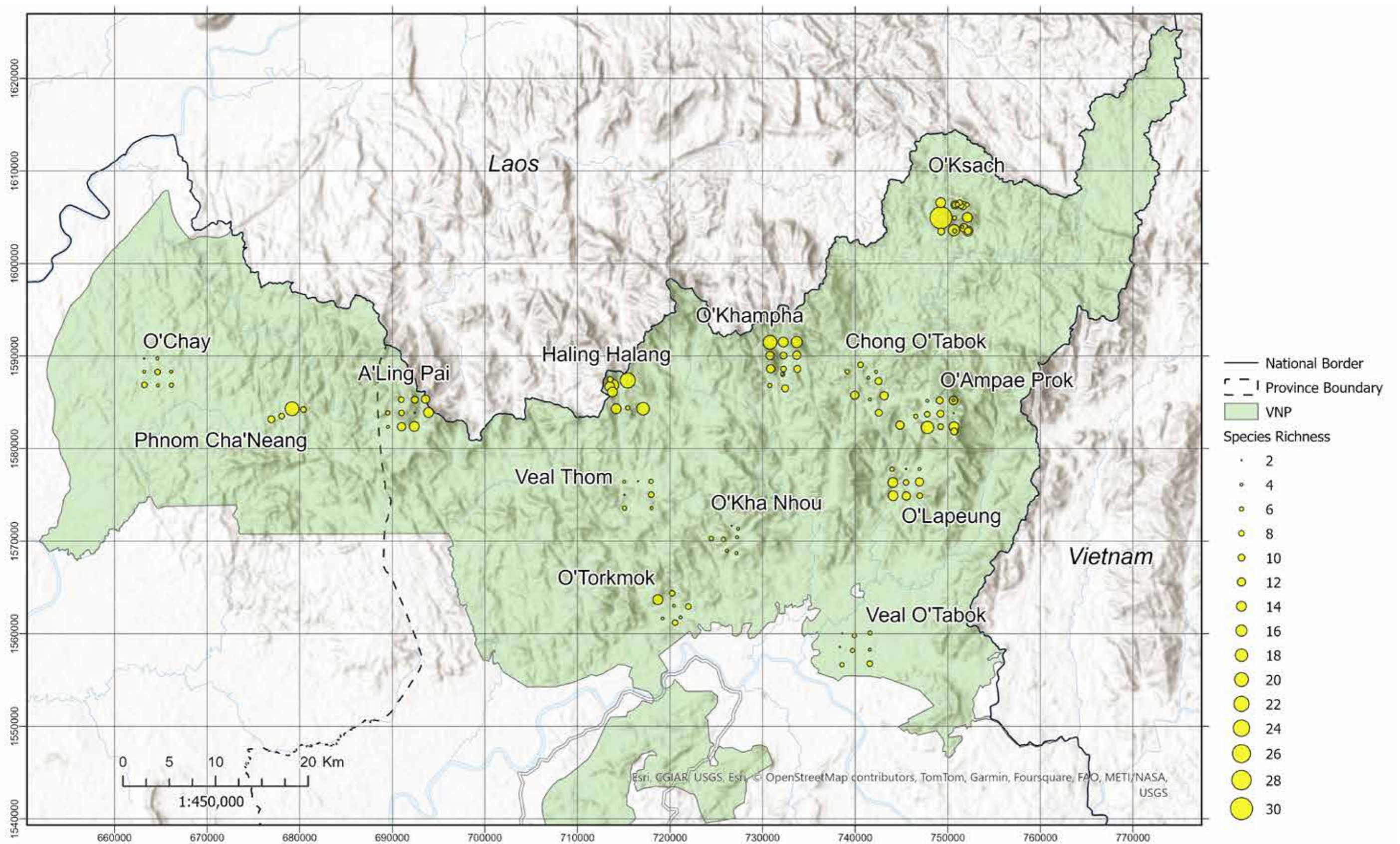


Fig. 3: Species richness.

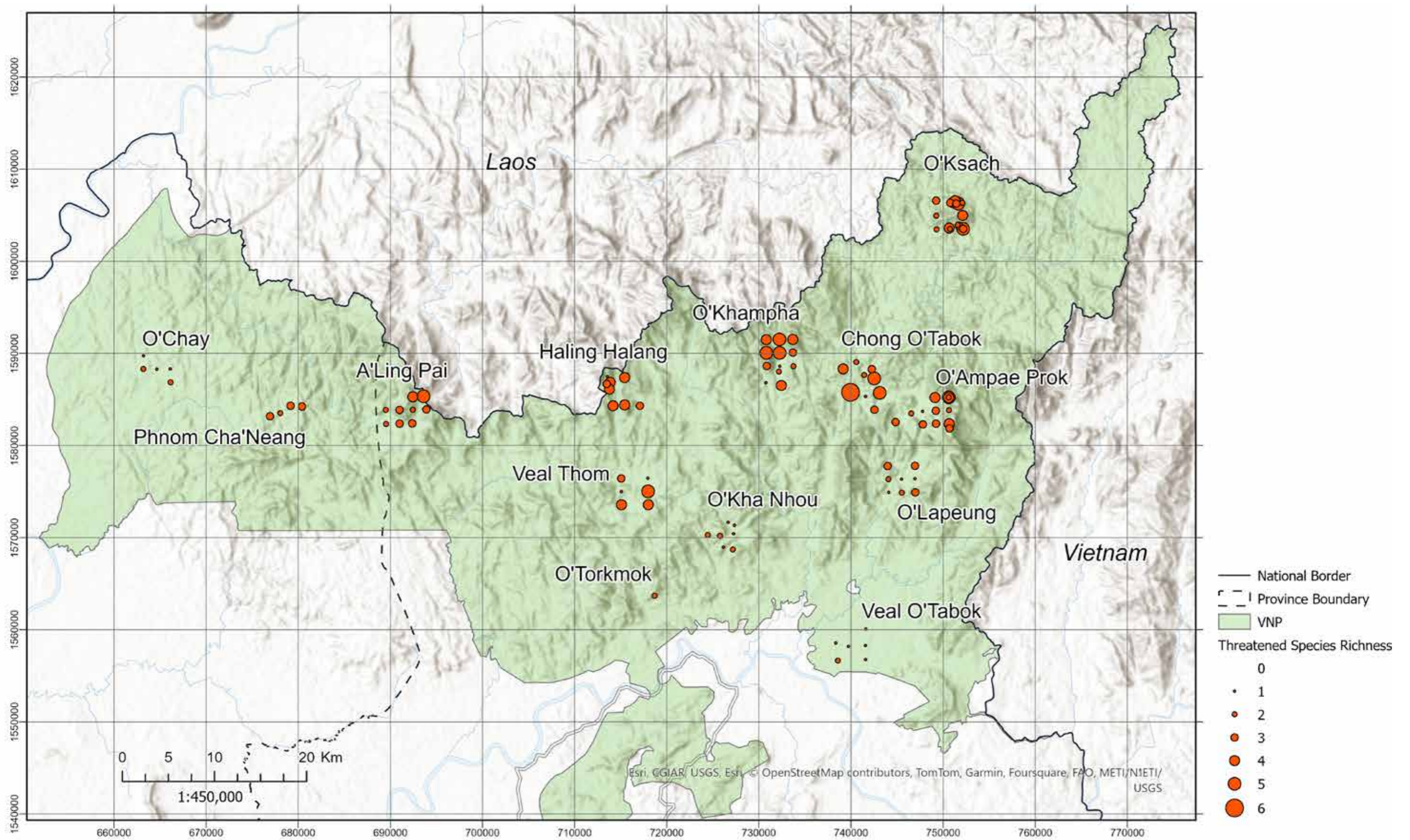


Fig. 4: Threatened species richness

**Table 1:** Full capture and species list from 2021 and 2023 showing IUCN Red List status,\* independent events and number of stations from which a species was recorded.

Class/Order/ Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>MAMMALIA</b>					
<b>RODENTIA</b>					
<b>Hystricidae</b>	<i>Atherurus macrourus</i>	Brush-tailed porcupine	LC	274	6
	<i>Hystrix brachyura</i>	Malayan porcupine	LC	144	11
<b>Sciuridae</b>	<i>Callosciurus erythraeus</i>	Pallas's squirrel	LC	110	10
	<i>Callosciurus finlaysonii</i>	Variable squirrel	LC	15	3
	<i>Dremomys rufigenis</i>	Asian red-cheeked squirrel	LC	167	5
	<i>Hylopetes</i> sp.	Unidentified <i>Hylopetes</i> flying squirrel	-	2	2
	<i>Menetes berdmorei</i>	Indochinese ground squirrel	LC	317	12
	<i>Pteromyini</i>	Unidentified flying squirrel	-	1	1
	<i>Ratufa bicolor</i>	Black giant squirrel	NT	2	2
	<i>Tamiops rodolphii</i>	Cambodian striped squirrel	LC	6	2
<b>Muridae</b>	-	Unidentified murid	-	1,815	13
<b>Spalacidae</b>	<i>Rhizomys</i> sp.	Bamboo rat	-	5	4
<b>SCANDENTIA</b>					
<b>Tupaiaidae</b>	<i>Dendrogale murina</i>	Northern smooth-tailed treeshrew	LC	1	1
	<i>Tupaia belangeri</i>	Northern treeshrew	LC	158	9

Class/Order/ Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>MAMMALIA</b>					
<b>DERMOPTERA</b>					
<b>Cynocephalidae</b>	<i>Galeopterus variegatus</i>	Sunda colugo	LC	1	1
<b>PRIMATA</b>					
<b>Cercopithecidae</b>	<i>Macaca arctoides</i>	Stump-tailed macaque	VU	281	9
	<i>Macaca fascicularis</i>	Long-tailed macaque	EN	45	4
	<i>Macaca leonina</i>	Northern pig-tailed macaque	VU	310	11
	<i>Macaca</i> sp.	Unidentified macaque	-	10	3
	<i>Pygathrix nemaeus</i>	Red-shanked douc langur	CR	3	2
<b>ARTIODACTYLA</b>					
<b>Bovidae</b>	<i>Bos gaurus</i>	Gaur	VU	14	5
	<i>Capricornis sumatraensis</i>	Southern Serow	VU	61	9
<b>Cervidae</b>	<i>Muntiacus vaginalis</i>	Red muntjac	LC	164	13
	<i>Muntiacus vuquangensis</i>	Large-antlered muntjac	CR	55	2
	<i>Muntiacus</i> sp.	Unidentified muntjac	-	39	6
	<i>Rusa unicolor</i>	Sambar	VU	39	4
<b>Tragulidae</b>	<i>Tragulus kanchil</i>	Lesser mouse deer	LC	318	13
<b>Suidae</b>	<i>Sus scrofa</i>	Wild boar	LC	145	13



Class/Order/ Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>MAMMALIA</b>					
<b>PHOLIDOTA</b>					
<b>Manidae</b>	<i>Manis javanica</i>	Sunda pangolin	CR	22	7
<b>CARNIVORA</b>					
<b>Felidae</b>	<i>Catopuma temminckii</i>	Asian golden cat	NT	12	6
	<i>Neofelis nebulosa</i>	Clouded leopard	VU	21	6
	<i>Pardofelis marmorata</i>	Marbled cat	NT	8	4
	<i>Prionailurus bengalensis</i>	Leopard cat	LC	32	12
	-	Unidentified felid	-	1	1
<b>Prionodontidae</b>	<i>Prionodon pardicolor</i>	Spotted linsang	LC	14	4
<b>Viverridae</b>	<i>Arctictis binturong</i>	Binturong	VU	8	4
	<i>Paradoxurus hermaphroditus</i>	Common palm civet	LC	220	13
	<i>Viverra zibetha</i>	Large Indian civet	LC	1	1
	<i>Viverricula indica</i>	Small Indian civet	LC	1	1
	Viverridae	Unidentified civet	-	11	6
Herpestidae	<i>Urva javanica</i>	Javan mongoose	LC	2	1
	<i>Urva urva</i>	Crab-eating mongoose	LC	23	2
<b>Canidae</b>	<i>Cuon alpinus</i>	Dhole	EN	5	4

Class/Order/ Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>MAMMALIA</b>					
<b>Canidae</b>	<i>Canis familiaris</i>	Domestic dog	-	6	6
<b>Ursidae</b>	<i>Helarctos malayanus</i>	Sun bear	VU	50	10
	<i>Ursus thibetanus</i>	Asian black bear	VU	29	7
	Ursidae	Unidentified bear	-	2	2
<b>Mustelidae</b>	<i>Martes flavigula</i>	Yellow-throated marten	LC	25	6
	<i>Arctonyx collaris</i>	Greater hog badger	VU	18	7
	<i>Aonyx cinereus</i>	Asian small-clawed otter	VU	2	2
	<i>Mustela kathiah</i>	Yellow-bellied weasel	LC	4	3
	<i>Mustela strigidorsa</i>	Back-striped weasel	-	3	1
<b>UNIDENTIFIED</b>	-	Unidentified mammal	-	65	9
	Sciuridae or Tupaiidae	Unidentified squirrel or treeshrew	-	256	13
<b>AVES</b>					
<b>GALLIFORMES</b>					
<b>Phasianidae</b>	<i>Arborophila brunneopectus</i>	Bar-backed partridge	LC	65	6
	<i>Gallus gallus</i>	Red junglefowl	LC	410	13
	<i>Lophura diardi</i>	Siamese fireback	LC	281	12
	<i>Lophura nycthemera</i>	Silver pheasant	LC	163	7

Class/Order/Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>AVES</b>					
<b>Phasianidae</b>	<i>Pavo muticus</i>	Green peafowl	EN	1	1
	<i>Polyplectron bicalcaratum</i>	Grey peacock-pheasant	LC	70	8
	<i>Polyplectron germaini</i>	Germain's peacock-pheasant	NT	17	3
	<i>Polyplectron</i> sp.	Unidentified peacock-pheasant	-	16	5
	<i>Tropicoperdix chloropus</i>	Green-legged partridge	LC	11	3
<b>CUCULIFORMES</b>					
<b>Cuculidae</b>	<i>Phaenicophaeus tristis</i>	Green-billed malkoha	LC	1	1
<b>COLUMBIFORMES</b>					
<b>Columbidae</b>	<i>Chalcophaps indica</i>	Grey-capped emerald dove	LC	215	8
	<i>Treron seimundi</i>	Yellow-vented green-pigeon	LC	3	1
<b>PELECANIFORMES</b>					
<b>Ardeidae</b>	<i>Gorsachius melanolophus</i>	Malayan night heron	LC	4	3
<b>ACCIPITRIFORMES</b>					
<b>Accipitridae</b>	<i>Accipiter trivirgatus</i>	Crested goshawk	LC	1	1
	<i>Spilornis cheela</i>	Crested serpent-eagle	LC	2	1
	-	Unidentified raptor	-	5	4
<b>STRIGIFORMES</b>					

Class/Order/Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>AVES</b>					
<b>Strigidae</b>	-	Unidentified owl	-	5	2
<b>TROGONIFORMES</b>					
<b>Trogonidae</b>	<i>Harpactes oreskios</i>	Orange-breasted trogon	LC	1	1
<b>BUCEROTIFORMES</b>					
<b>Bucerotidae</b>	<i>Buceros bicornis</i>	Great hornbill	VU	3	2
<b>PICIFORMES</b>					
<b>Picidae</b>	<i>Blythipicus pyrrhotis</i>	Bay woodpecker	LC	1	1
	<i>Picus rabieri</i>	Red-collared woodpecker	NT	4	2
	<i>Picus</i> sp.	Unidentified <i>Picus</i> woodpecker	-	1	1
<b>PASSERIFORMES</b>					
<b>Pittidae</b>	<i>Hydrornis cyaneus</i>	Blue pitta	LC	22	4
	<i>Hydrornis elliotii</i>	Bar-bellied pitta	LC	8	3
	<i>Hydrornis phayrei</i>	Eared pitta	LC	2	1
	<i>Hydrornis soror</i>	Blue-rumped pitta	LC	3	1
	<i>Pitta nympa</i>	Fairy pitta	VU	1	1
	<i>Pitta sordida</i>	Western hooded pitta	LC	3	1
	<i>Pittidae</i>	Unidentified pitta	-	2	2

Class/Order/Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>AVES</b>					
<b>Dicruridae</b>	<i>Dicrurus</i> sp.	Unidentified drongo	-	1	1
<b>Monarchidae</b>	<i>Hypothymis azurea</i>	Black-naped monarch	LC	2	2
<b>Corvidae</b>	<i>Cissa hypoleuca</i>	Indochinese green magpie	LC	1	1
	<i>Crypsirina temia</i>	Racket-tailed treepie	LC	1	1
	<i>Urocissa erythroryncha</i>	Red-billed blue magpie	LC	1	1
<b>Cisticolidae</b>	<i>Prinia rufescens</i>	Rufescent prinia	LC	1	1
<b>Pycnonotidae</b>	<i>Alophoixus</i> sp.	Unidentified <i>Alophoixus</i> bulbul	-	37	2
	-	Unidentified bulbul	-	1	1
	<i>Rubigula flaviventris</i>	Black-crested bulbul	LC	3	2
<b>Timaliidae</b>	<i>Erythrogonys hypoleucos</i>	Large scimitar-babbler	LC	7	3
	<i>Pomatorhinus schisticeps</i>	White-browed scimitar-babbler	LC	3	3
	<i>Stachyris nigriceps</i>	Grey-throated babbler	LC	1	1
<b>Leiothrichidae</b>	<i>Garrulax leucolophus</i>	White-crested laughingthrush	LC	1	1
	<i>Garrulax milleti</i>	Black-hooded laughingthrush	LC	20	4
<b>Pellorneidae</b>	<i>Gampsorhynchus torquatus</i>	Collared babbler	LC	2	1
	<i>Copsychus malabaricus</i>	White-rumped shama	LC	38	7
	<i>Cyornis sumatrensis</i>	Indochinese blue-flycatcher	LC	1	1

Class/Order/Family	Species Name	Common name	IUCN	Ind. Events	Station
<b>AVES</b>					
	<i>Cyornis</i> sp.	Unidentified <i>Cyornis</i> flycatcher	-	2	2
	<i>Enicurus leschenaulti</i>	White-crowned forktail	LC	1	1
	<i>Larvivora cyane</i>	Siberian blue robin	LC	15	3
	<i>Myophonus caeruleus</i>	Blue whistling thrush	LC	28	5
<b>Muscicapidae</b>	<i>Muscicapa dauurica</i>	Asian brown flycatcher	LC	2	1
	Muscicapidae	Unidentified flycatcher	-	1	1
<b>Turdidae</b>	<i>Geokichla citrina</i>	Orange-headed thrush	LC	7	3
	<i>Turdus obscurus</i>	Eyebrowed thrush	LC	1	1
<b>Irenidae</b>	<i>Irena puella</i>	Asian fairy-bluebird	LC	3	1
<b>UNIDENTIFIED</b>	-	Unidentified bird	LC	104	12
<b>REPTILIA</b>					
<b>SQUAMATA</b>					
<b>Varanidae</b>	<i>Varanus salvator</i>	Water Monitor	LC	1	1
	<i>Varanus</i> sp.	Unidentified Monitor Lizard	-	18	3
<b>Agamidae</b>	<i>Acanthosaura nataliae</i>	-	LC	13	1
<b>UNIDENTIFIED</b>	-	Unidentified	-	228	13

\* 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 and are in bold. Here, blanks are records that cannot have a classification, such as those not reliably identified to species level.

KEY CAMERA TRAP IMAGES



Fig. 5: Large-antlered muntjac *Muntiacus vuquangensis*. Adult male above and fawn below.



Fig. 6: Male large-antlered muntjac above, compared with male red muntjac below. Both individuals recorded on the same camera set on Phnom Yeak Kras.



Fig. 7: Male sambar *Cervus unicolor* (above); Southern serow *Capricornis sumatraensis* (below).



Fig. 8: Gaur *Bos gaurus*.



Fig. 9: Malay sun bear *Helarctos malayanus* (above) and Asiatic black bear *Ursus thibetanus* (below) both recorded on the same camera trap.



Fig. 10: Dhole *Cuon alpinus* (above); clouded leopard *Neofelis nebulosa* (below).



Fig. 11: Long-tailed macaque *Macaca fascicularis* (above); northern pig-tailed macaque *Macaca leonina* (below).



Fig. 12: Stump-tailed macaque *Macaca arctoides* (above); red-shanked douc langur *Pygathrix nemaeus* (below).



Fig. 13: Sunda pangolin *Manis javanus* (above); green peafowl *Pavo muticus* (below).



Fig. 14: Germain's peacock-pheasant *Polyplectron germaini* (above); fairy pitta *Pitta nympha* (below).



**Table 2:** Independent events (N), capture rate (C) species richness (S) and threatened species richness (TS) by station

Station	Year	Effort	Elevation	N	C	S	TS
A'Ling Pai	2021	1,111	675 – 1,221	467	42.03	37	10
Chong O'Tabok	2023	1,051	302 - 480	315	29.97	26	10
Haling Halang	2023	808	548 – 1,056	1212	150.00	36	8
O'Ampae Prok	2021-2023	1,514	340 – 1,278	838	55.35	49	13
O'Chay	2021	730	290 - 411	187	25.62	18	5
O'Kha Nhou	2023	450	388 - 564	107	23.78	17	4
O'Khampha	2021	1,045	325 – 1,111	867	82.97	46	14
O'Ksach	2021-2023	1,581	640 – 1,149	1675	105.95	50	9
O'Lapeung	2021	920	253 - 469	728	79.13	30	5
O'Torkmok	2023	404	120 - 279	209	51.73	22	2
Phnom Cha'Neang	2023	437	337 - 683	255	58.35	25	7
Veal O'Tabok	2023	446	109 - 128	174	39.01	17	2
Veal Thom	2021	725	463 - 519	190	26.21	17	8
<b>TOTAL</b>		<b>11,222</b>	<b>109 – 1,278</b>	<b>7,224</b>	<b>64.37</b>	<b>93</b>	<b>20</b>

## CONCLUSION

As expected, more remote areas of the park had higher levels of species richness, both overall and for threatened species. Large carnivore detection was relatively low, with the two bear species being the most frequently recorded large carnivores

in the landscape. Despite a small population of Asian elephant being known from Virachey (Pawlowski & McCann 2017) none were recorded in this study.

The hills in the east of the park, O'Ksach and O'Ampae Prok areas should be prioritized for targeted studies and protection due to the occurrence of the Critically Endangered large-antlered muntjac. Targeted studies prioritizing large-antlered muntjac would be valuable to better understand the species population, range, and connectivity needs.

All humans recorded on the camera traps displayed no obvious signs of illegal activities (logging or poaching equipment) and showed a mix of ages and genders. Notably, in Chong O'Tabok and Phnom Nha'Cheang, some cameras were lost due to theft, which may indicate the occurrence of illegal activities. During the 2023 install, one camera trapping team in Phnom Nha'Cheang, encountered an active poacher camp with a dead red-shanked douc langur. Other than this occurrence, all camera records of people within the park seemed to show them collecting Non-Timber Forest Products, indicating that these areas may hold economic value for local communities in addition to biodiversity value and this value should be considered when planning conservation actions.

The negative impact of the presence of domestic dogs in protected areas on wildlife from predation, disease transfer and disturbance are well documented (Ladd et al. 2023). Domestic dogs were recorded from O'Kha Nhou, Phnom Cha'Neang and Veal O'Tabok, and their presence inside VNP is an area in which tighter regulations may be placed. Education and outreach with local communities to discourage bringing domestic dogs into the park may reduce incursions.

As in most protected areas across Southeast Asia (Gray et al. 2021) snaring is likely to be a threat in VNP. Two Threatened species were detected with missing limbs, the Asiatic black bear and the northern pig-tailed macaque. In both cases, the wounds had healed. It is likely that significant snaring still occurs in the landscape.

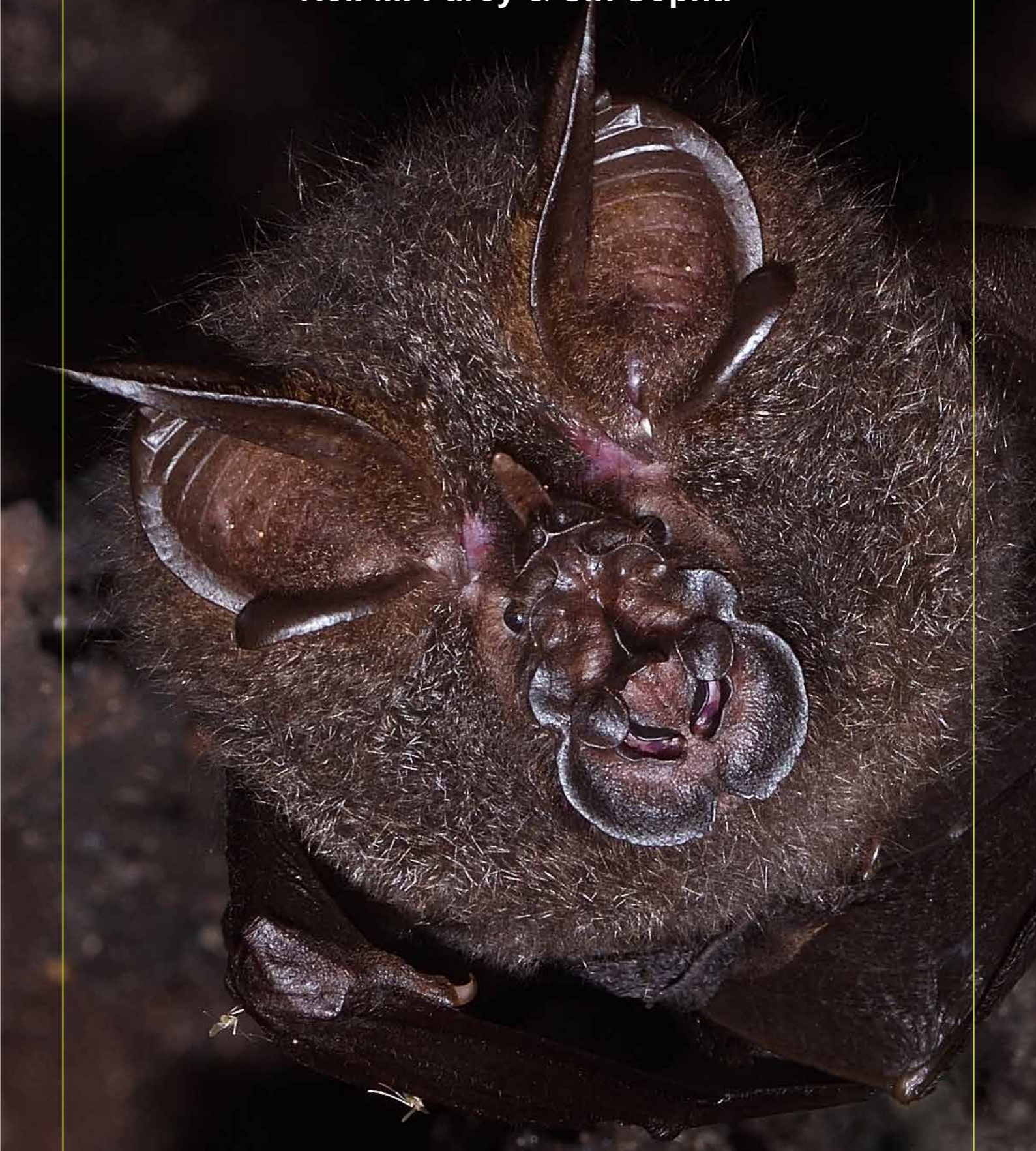
▽ Video still of a male large-antlered muntjac recorded in Virachey National Park .



## BAT SURVEY

Title image: *Rhinolophus* species from the *trifolius* group in Virachey.

Neil M. Furey & Sin Sopha





**DRY SEASON BAT SURVEY  
VIRACHEY NATIONAL PARK 2023**

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**SUMMARY**

Bats form an important component of Cambodia's mammal fauna with 81 species presently confirmed in the kingdom (Furey et al. 2021, Csorba & Furey 2022). With further research in the country's under-studied border regions, this figure will almost certainly increase because at least 20 other bat species present in southern Laos and/or southern Vietnam (below 15°15' N in either country) may also occur in northern and eastern parts of the kingdom (Furey et al. 2021).

To determine whether such species occur in Ratanakiri Province, a bat survey was undertaken in Virachey National Park by the Centre for Biodiversity Conservation (Royal University of Phnom Penh) with support from the national park authorities and Fauna & Flora (Cambodia Programme) from 1-14 March 2023. Eleven nights of sampling effort were achieved using a combination of mist nets, harp traps and acoustic detectors in two areas of the park during the survey: O'Yeak Kim–O'Chadongyol (14.39886 N, 107.36584 E; six nights: 2–8 March) and O'Kha Nhou–Veal Thom–Thmor Damrei (14.20528 N, 107.00862 E, five nights: 9–14 March).

Desk review revealed that 66 bat species have been recorded in the Cambodia-Vietnam-Laos tri-border area to date (including eight which had yet to be documented in Cambodia), although only two were confirmed in Virachey before the survey. Live-trapping within the park resulted in the live-capture and release of 155 bats representing 21 species (Table 1), whereas acoustic sampling detected 16 phonically distinct taxa, 12 of which were identifiable to species. As one of the latter was not captured, this increases the number of bat species recorded in the park to at least 22 and likely as many as 26 taxa (with the inclusion of four presently unidentified phonic types).

◁ Dry season landscape at Veal Thom grasslands.

All of bat species currently confirmed in Virachey are presently recognised as or would qualify upon evaluation as Least Concern, although they notably include the first country records for two species (*Rhinolophus stheno* & *Eudiscopus denticulus*) in Cambodia (Fig. 1). One of these (*E. denticulus*) appears to be relatively common within the park, in direct contrast to the few localities it is currently known from worldwide. Other notable species that also appear to be common in the park include *Glischropus bucephalus*, which was first described from eastern Cambodia (Mondulkiri Province) in 2011.



**Fig.1:** *Eudiscopus denticulus* (left) and *Rhinolophus stheno* (right), two new species for Cambodia confirmed in Virachey National Park, March 2023.

The current bat species list for Virachey represents 27–31% of the known bat fauna of Cambodia (83/22–26 species), although this figure clearly falls short of the true site total for several reasons. As such, further bat surveys will undoubtedly reveal additional species in the park (and in all likelihood for Cambodia as a whole, as in the present survey) and should employ multiple detection methods during both the dry and wet seasons. These should be regarded as highly desirable to improve understanding of Virachey’s importance for biodiversity and its related conservation needs.

## 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 1,460 bat species are currently recognized (Simmons & Cirranello 2023), and this figure continues to grow each year with the discovery of new species, particularly in SE Asia (Tsang et al. 2016).

Bats constitutes ca. 30% of the Southeast Asia'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 81 species now confirmed (Furey et al. 2021, Csorba & Furey 2022) however, knowledge regarding species composition has increased dramatically in recent years. As elsewhere in SE Asia, the group is seriously threatened by habitat loss, hunting —particularly of flying foxes and cave-dwelling bats— and other disturbance (Furey et al. 2012, 2016, Ravon et al. 2014, Lim et al. 2018).

To date, 81 species known in Cambodia. While discovery of additional species is likely, particularly in understudied border areas (Furey et al. 2021), only 11 bat species known for the country are currently listed by IUCN in categories other than Least Concern (2022)<sup>1</sup>, whereas three are listed in CITES Appendix II<sup>2</sup>, and one is listed in Cambodian legislation as nationally rare (*P. hypomelanus*: MAFF 2007), although the species annexes in this legislation are currently being revised.

<sup>1</sup> Although several species in Cambodia have yet be formally assessed, including two which qualify as data deficient, thus far being known from 1–3 individuals globally (Furey et al. 2021, Csorba & Furey 2022).

<sup>2</sup> Convention on International Trade in Endangered Species of Wildlife Fauna and Flora, Annex II: *Pteropus hypomelanus*, *P. lylei* & *P. vampyrus*.

### Survey Area

Virachey National Park is located in the Ratanakiri and Stung Treng provinces of north-east Cambodia and encompasses 3,381 km<sup>2</sup> in the Cambodia-Vietnam-Laos tri-border area (Fig. 2). Contiguous with Siem Pang Wildlife Sanctuary to the west, Veun Sai-Siem Pang National Park to the southwest, Chu Mom Ray National Park (Vietnam) to the east and marginally with Dong Ampham National Protected Area (Laos) to the north-east, the site includes a mix of evergreen and semi-evergreen forests, many of which are dominated by bamboo, and several areas of grassy uplands (referred to as *veal* in Khmer).

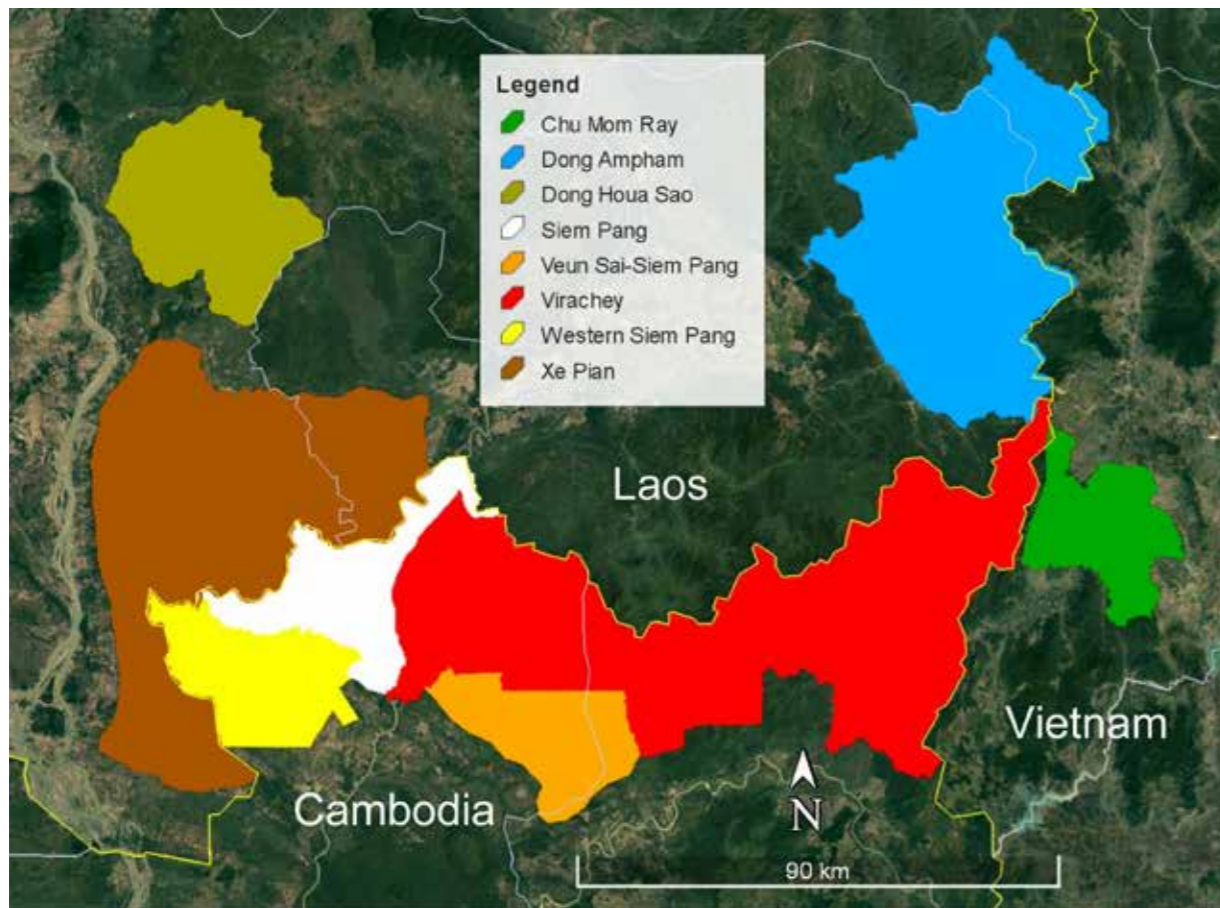


Fig.2: National protected areas in the Cambodia-Vietnam-Laos tri-border area.

### METHODS

Alongside review of literature and specimen collections, the survey focused on passive and active sampling for bats within Virachey National Park. Sampling methods comprised live-trapping using mist nets and a harp trap and acoustic surveys using passive ultrasound detectors.

A desk review of previous records of bats from the Ratanakiri & Stung Treng provinces was undertaken. This included review of specimens from the provinces in the zoological collection of the Centre for Biodiversity Conservation (CBC), Royal University of Phnom Penh.

Away from roost sites, the success of live-sampling efforts in any bat survey are largely determined by the extent to which the terrain and habitat concentrate commuting bats into discreet flyways. Selection of sampling locations therefore 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. 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., 7x3 m, 10x3 m & 12x3 m), all of which were 70 denier nets (Fig. 3). One four-bank harp trap was employed, with a capture surface of 2.9 m<sup>2</sup> (Fig. 3). To standardize sampling effort between these, effort for mist nets was calculated as m<sup>2</sup> of net multiplied by the hours of use (m<sup>2</sup>mnh), whereas harp trap effort was similarly calculated as m<sup>2</sup> multiplied by the hours of use (m<sup>2</sup>hth).



Fig.3: Mist net (left) and harp trap (right).

Each evening, the mist nets and harp trap were employed from  $\approx 1730$  to 2100 (seven nights) or 2200 hrs (four nights). These were checked for captures every 10–30 minutes and live-trapping 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 excepting a minimal number of individuals retained as voucher specimens (and subsequently deposited in the CBC zoological collection at the Royal University of Phnom Penh), released at their capture sites 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 Elektronik AB, Sweden), connected to an Android smartphone (Samsung Galaxy S6) running the Bat Recorder app (vers. 1.0R156) was employed to this end.

### 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 each sampling night with two Song Meter 4 full spectrum (SM4) bat detectors (Wildlife Acoustics, USA: Fig. 4). The SM4 detectors were moved each night during the survey and were set to record from 30 minutes before sunset until sunrise (although they ultimately had to be retrieved by 2200 hrs each night for logistical reasons), with recordings triggered by sounds between 16–384 kHz. Local sunset and sun rise times during the survey period were  $\approx 1800$  and  $\approx 0600$  hrs, respectively. Geo-coordinates, basic habitat data and photo-documentation were recorded at all sampling sites.



Fig. 4: Song Meter 4 bat detector in Virachey National Park

Phonically distinct bat species were identified through visual inspection of the recordings (via call frequencies, structure and duration) in Adobe Audition (Adobe Systems, USA) and Batsound (Pettersson Elecktronic, Sweden) and 19 parameters were measured per call for each phonic type using SCAN'R software (Binary Acoustic Technology, USA). Identifications were made to the lowest taxonomic level possible based on discriminant function analysis employing A) reference call data generated by the survey for identified species (this study), and B) datasets of verified recordings for known bat species from Cambodia (e.g., Phauk et al. 2013) and neighbouring countries held by the lead author. These reference data were subsequently employed to determine the presence/absence of species and phonic types in each location using a filtering pipeline in SZAPP software (Armstrong & Aplin 2014, Armstrong et al. 2016).

## ANALYSIS

The conservation significance of all bat species recorded was evaluated using IUCN (2022) and refined where necessary with reference to existing literature and unpublished data held by the authors for Cambodia and mainland SE Asia. Taxonomy and nomenclature follow Simmons & Cirranello (2023). Ecological trait data for each bat species were obtained from Francis (2019), Kruskop (2013), Furey et al. (2010a, 2011), Furey & Racey (2016) and unpublished data held by the first 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

Review of literature and specimen collections indicate that at least 66 bat species have been documented in the Cambodia-Vietnam-Laos tri-border area to date (Table 1), 58 of which are currently known in Cambodia (Furey et al. 2021). The 66 taxa include four species which are listed in categories other than Least Concern by IUCN (2022) (*Rousettus leschenaulti* [NT], *Hipposideros griffini* [VU], *Hypsugo doliochodon* [DD], *Murina walstoni* [DD]), although seven other taxa have yet to be evaluated, including two which would qualify as Data Deficient (*Myotis ancriola* & *Cassistrellus yokdonensis*).

While 27 and 23 bat species have been documented in the Ratanakiri and Stung Treng provinces (respectively) to date (Table 1), just two were confirmed in Virachey prior to the present study (*Rhinolophus affinis* & *R. perniger*: Kingsada et al. 2011, Holden, unpubl. data) as the results of surveys undertaken by RUPP (Biology Department) in the park in 2022 had yet to be released at the time of writing.



Table 1: Bat species documented in Cambodia–Vietnam–Laos tri-border area.

#	Family / Species	IUCN Status	Cambodia		Vietnam	Laos	
			Ratanakiri	Stung Treng	Chu Mon Ray	Champasak	Attapu
<b>I Pteropodidae</b>							
1	<i>Rousettus leschenaultii</i>	NT					
2	<i>Rousettus amplexicaudatus</i>	LC	3	9		12	12
3	<i>Cynopterus sphinx</i>	LC	3,11	11	13	12	12
4	<i>Cynopterus brachyotis</i>	LC	11	11	13		
5	<i>Cynopterus horsfieldii</i>	LC	4,11				
6	<i>Megaerops niphanae</i>	LC	3,11	11	13	12	12
7	<i>Eonycteris spelaea</i>	LC				12	12
8	<i>Sphaerias blanfordi</i> *	LC			13		
<b>II Emballonuridae</b>							
9	<i>Taphozous longimanus</i>	LC				12	
10	<i>Taphozous melanopogon</i>	LC		10			12
11	<i>Taphozous theobaldi</i>	LC		10		12	
<b>III Megadermatidae</b>							
12	<i>Lyroderma lyra</i>	LC		10		12	
13	<i>Megaderma spasma</i>	LC	3,11	10,11	13	12	12
<b>IV Hipposideridae</b>							
14	<i>Hipposideros armiger</i>	LC		11		12	12
15	<i>Hipposideros cineraceus</i>	LC	3	10		12	12
16	<i>Hipposideros diadema</i>	LC	5,11	11		12	12
17	<i>Hipposideros galeritus</i>	LC		10,11	13		
18	<i>Hipposideros gentilis</i>	LC		10	13	12	12
19	<i>Hipposideros griffini</i> *	VU			14		
20	<i>Hipposideros cf. larvatus</i>	LC		10,11	13	12	12
<b>V Rhinolophidae</b>							
21	<i>Rhinolophus acuminatus</i>	LC	3,11	11		12	12
22	<i>Rhinolophus affinis</i>	LC	1		13	12	12
23	<i>Rhinolophus chaseni</i>	NE	3		13	12	12
24	<i>Rhinolophus malayanus</i>	LC		10	13	12	12
25	<i>Rhinolophus marshalli</i>	LC		7			
26	<i>Rhinolophus microglobosus</i>	LC		10	14		12
27	<i>Rhinolophus pearsonii</i>	LC			13	12	
28	<i>Rhinolophus perniger</i>	NE	2			12	12
29	<i>Rhinolophus pusillus</i>	LC		10	13	12	12
30	<i>Rhinolophus shameli</i>	LC		10,11	13,14	12	12
31	<i>Rhinolophus siamensis</i>	LC			13		
32	<i>Rhinolophus thomasi</i> *	LC				12	12

#	Family / Species	IUCN Status	Cambodia		Vietnam	Laos	
			Ratanakiri	Stung Treng	Chu Mon Ray	Champasak	Attapu
<b>VI Vespertilionidae</b>							
33	<i>Eudiscopus denticulus</i> *	LC			15		
34	<i>Myotis horsfieldii</i>	LC	5		13	12	12
35	<i>Myotis alticraniatus</i>	NE			13	12	
36	<i>Myotis ancriola</i> *	NE					12
37	<i>Myotis annectans</i>	LC					12
38	<i>Myotis ater</i>	LC	5,11				
39	<i>Myotis rosseti</i>	LC	11	11			12
40	<i>Myotis rufoniger</i> *	LC					12
41	<i>Pipistrellus coromandra</i>	LC	3,11				12
42	<i>Pipistrellus javanicus</i>	LC			13	12	
43	<i>Pipistrellus paterculus</i>	LC	6,11	11	13	12	
44	<i>Pipistrellus tenuis</i>	LC		10		12	12
45	<i>Hypsugo cadornae</i>	LC	6				12
46	<i>Hypsugo dolichodon</i>	DD					12
47	<i>Eptesicus pachyomus</i>	LC	7				
48	<i>Cassistrellus yokdonensis</i>	NE	7				
49	<i>Hesperoptenus blanfordi</i>	LC	3			12	12
50	<i>Hesperoptenus tickelli</i>	LC	11			12	
51	<i>Scotophilus heathii</i>	LC	11			12	12
52	<i>Tylonycteris malayana</i>	NE			13	12	12
53	<i>Tylonycteris fulvida</i>	NE			13		12
54	<i>Harpiocephalus harpia</i>	LC	3				
55	<i>Murina cyclotis</i>	LC	5		13	12	12
56	<i>Murina feae</i>	LC			13		12
57	<i>Murina walstoni</i>	DD	8			12	
58	<i>Kerivoula papillosa</i>	LC					12
59	<i>Kerivoula kachinensis</i>	LC			14	12	
60	<i>Kerivoula hardwickii</i>	LC	3		13	12	
61	<i>Kerivoula titania</i>	LC			13		12
62	<i>Kerivoula depressa</i>	LC				12	12
63	<i>Kerivoula dongduongana</i>	LC				12	
64	<i>Phoniscus jagorii</i> *	LC				12	
<b>VII Miniopteridae</b>							
65	<i>Miniopterus magnater</i> *	LC				12	
66	<i>Miniopterus pusillus</i>	LC				12	
<b>TOTAL</b>			<b>27</b>	<b>23</b>	<b>29</b>	<b>40</b>	<b>38</b>

\* Not documented in Cambodia prior to the present survey. IUCN status (as of November 2022): DD=Data Deficient, LC=Least Concern, NE=Not Evaluated, NT=Near Threatened, VU=Vulnerable. References: <sup>1</sup> Kingsada et al. 2011, <sup>2</sup> Holden, unpubl. data, <sup>3</sup> Furey et al. 2010b, <sup>4</sup> Chheang et al. 2013, <sup>5</sup> Ith et al. 2011, <sup>6</sup> Furey et al. 2012, <sup>7</sup> Furey et al. 2021, <sup>8</sup> Csorba et al. 2011, <sup>9</sup> CBC Collection (RUPP), <sup>10</sup> Furey 2015, <sup>11</sup> Furey, unpubl. data, <sup>12</sup> Furey & Douangboubpha in press, <sup>13</sup> Ly & Nguyen 2020, <sup>14</sup> Kruskop 2013, <sup>15</sup> Saikia et al. 2021.

### Sampling Effort

Over the course of the survey (11 sampling nights), a total of 6,805.5 m<sup>2</sup> mist-net-hours, 102.2 m<sup>2</sup> harp-trap-hours and 85.0 hrs of acoustic sampling with SM4 detectors were achieved at 11 locations within Virachey National Park (Table 2, Fig. 5).

Six sampling locations (VR-02 to -07) were located in the O'Chadongyol area (in the eastern portion of the park), whereas five were located in the O'Kha Nhou (VR-08), Veal Thom (VR-09 & -10) & Thmor Damrei (VR-11 & -12) areas (in the central portion of the park). Three small caves were also explored and sampled with a M500-384 detector during the daytime in the Veal Thom area (Cave #1: 14.20528°N, 107.00862°E, 726 masl; Cave #2: 14.20035°N, 107.00919°E, 717 masl; Cave #3: 14.211263°N, 106.994776°, ≈760 masl). Indicative images of habitats at each sampling location are provided in Figs. 6-7. No rain fell during the survey.



Fig. 5: Bat survey locations in Virachey National Park, March 2023.

Table 2: Sampling locations and effort in Virachey National Park, March 2023.

Date	Site Code	Lat/Long	Altitude (masl)	Mist net (m <sup>2</sup> mnh)	Harp trap (m <sup>2</sup> hth)	SM4 Hours	Habitat
<b>O'Yeak Kim (VR-01) &amp; O'Chadongyol (VR-02 to VR-07) Areas</b>							
2/3	VR-01	14.260250 107.35702 <sup>1</sup>	2101				Bamboo forest along main N-S road
2/3	VR-02	14.35653 107.36083	831	431		7.0	Bamboo forest
3/3	VR-03	14.41958 107.38433	690	601		9.0	Bamboo forest
4/3	VR-04	14.41488 107.37196	645	657		9.0	Bamboo forest
5/3	VR-05	14.38726 107.36288	710	483	34.6	7.0	Bamboo forest
6/3	VR-06	14.39120 107.36298	674	397	34.6	9.0	Bamboo forest
7/3	VR-07	14.39886 107.36584	659	431	10.1	7.0	Bamboo forest
<b>O'Kha Nhou (VR-08), Veal Thom (VR-09 &amp; -10) &amp; Thmor Damrei (VR-11 &amp; -12) Areas</b>							
9/3	VR-08	14.27144 106.99572	431	640.5		7.0	Mixed bamboo / semi-evergreen forest
10/3	VR-09	14.22053 107.00861	601	588.0		9.0	Semi-evergreen forest
11/3	VR-10	14.20574 106.99689	657	756.0	13.0	9.0	Semi-evergreen forest
12/3	VR-11	14.18955 107.02079	483	682.5	10.1	7.0	Semi-evergreen forest
13/3	VR-12	14.18191 107.02184	397	535.5		9.0	Mixed bamboo / semi-evergreen forest
<b>Total</b>				<b>6,805.5</b>	<b>102.2</b>	<b>85.0</b>	

<sup>1</sup> Approximate; although sampling was not undertaken at this location, it is included for completeness as a single bat was encountered there.



Forest around Thmor Damrei below the Veal Thom grasslands.

Fig. 6: Indicative images of sampling habitats in Virachey National Park, March 2023



Fig. 7: Indicative images of sampling habitats in Virachey National Park, March 2023



### Bat Species Composition

During the field survey, 155 bats representing 21 species arranged in five families were captured in live traps (Table 3, Fig. 8–9). Horseshoe bats (Rhinolophidae) accounted for most captures (55%, 85 bats) with seven species, followed by evening bats (Vespertilionidae, 21%, 33 bats) with eight species, frugivorous bats (Pteropodidae, 14%, 22 bats) with two species, leaf-nosed bats (Hipposideridae, 9%, 14 bats) with three species and false vampire bats (Megadermatidae, one individual) with a single species. With the exception of *Tylonycteris malayana* and *T. fulvida* which have yet to be evaluated<sup>3</sup>, all of the species captured during the survey are presently regarded as Least Concern (IUCN 2022).

Two species recorded during the survey constitute the first country records for Cambodia: *Rhinolophus steno* and *Eudiscopus denticulus* (Fig. 1). The occurrence of both species was predicted by Furey et al. (2021) and to be expected given known localities in southern Vietnam, including areas adjacent to the Vietnam-Cambodia border (such as Chu Mom Ray and Bu Gia Map) in the case of *E. denticulus* (Kruskop 2013, Burgin 2019, Saikia et al. 2021). In contrast to the few localities where the latter has been recorded worldwide however, *E. denticulus* appears to be relatively common in Virachey, being registered in seven of the 11 sample locations (Table 3). Other notable species that appear to be similarly common within the park include *Glischropus bucephalus*, which was first described from Mondulkiri Province (Keo Seima Wildlife Sanctuary) in 2011.

During in the acoustic sampling, 16 phonically distinct bat taxa were detected, including five not captured during the survey. Presence/absence data for these are provided in Table 3 and exemplar calls are shown in Figs. 10-11. Reference data from Virachey and other sites in Cambodia and neighbouring countries permitted specific assignment of 12 of these taxa, including one species not captured in live-traps: *Rhinolophus perniger*, which has yet to be evaluated by IUCN (2022) but would qualify as Least Concern due to its widespread occurrence in mainland SE Asia and China (Burgin 2019).

<sup>3</sup> Although they will undoubtedly qualify as Least Concern, being relatively common and widespread in mainland SE Asia (Tu et al. 2017).

The remaining taxa cannot be identified with certainty at present, although phonic type (PT) 1 clearly represents a large-bodied aerial insectivore (such as *Mops plicatus* or *Hesperoptenus tickelli*), whereas PT-2 likely represents one of the three *Taphozous* spp. in Cambodia (e.g., *melanopogon*, *longimanus* or *theobaldi*) and PT-3 & PT-4 may represent vespertilionids such as *Scotophilus* spp. or *Myotis* spp. Discriminating between these possibilities will require validated reference data on the calls of these and other bat species which are currently lacking for north-east Cambodia. Nonetheless, the present survey indicates that at least 22 and likely as many as 26 bat species (including the four unidentified phonic types) occur in Virachey National Park.

Table 3: Bat species recorded in Virachey National Park, March 2023.

#	Date Site Code, VR-	02/3	02/3	03/3	04/3	05/3	06/3	07/3	09/3	10/3	11/3	12/3	13/3	Caves		
		01	02	03	04	05	06	07	08	09	10	11	12	#1	#2	#3
I	<b>Pteropodidae</b>															
1	<i>Cynopterus sphinx</i>					2							8			
2	<i>Megaerops niphanae</i>					1					1		10			
II	<b>Megadermatidae</b>															
3	<i>Megaderma spasma</i>											1				
III	<b>Rhinolophidae</b>															
4	<i>Rhinolophus affinis</i>		A	1 <sup>A</sup>	1 <sup>A</sup>	7 <sup>A</sup>	2 <sup>A</sup>	A	1 <sup>A</sup>	A	A	1 <sup>A</sup>	2 <sup>A</sup>			
5	<i>Rhinolophus malayanus</i>											1				
6	<i>Rhinolophus microglobosus</i>		A		2 <sup>A</sup>	16 <sup>A</sup>	3 <sup>A</sup>	1					A			
7	<i>Rhinolophus pearsonii</i>	1														
8	[ <i>Rhinolophus perniger</i> ]										A	A				
9	<i>Rhinolophus pusillus</i>			A	A		A		A	A	A	2 <sup>A</sup>	A			
10	<i>Rhinolophus shameli</i>		A	A	A	1 <sup>A</sup>	1 <sup>A</sup>		A	1 <sup>A</sup>	A	30 <sup>A</sup>	A	A		A
11	<i>Rhinolophus stheno</i> <sup>1</sup>		A		2 <sup>A</sup>	9 <sup>A</sup>	A									
IV	<b>Hipposideridae</b>															
12	<i>Hipposideros galeritus</i>					1	1				A					
13	<i>Hipposideros gentilis</i>					1										
14	<i>Hipposideros cf. larvatus</i>			2 <sup>A</sup>				1	1		1 <sup>A</sup>	6 <sup>A</sup>				
V	<b>Vespertilionidae</b>															
15	<i>Eudiscopus denticulus</i> <sup>1</sup>		A	A	1		1 <sup>A</sup>	7 <sup>A</sup>				A	1 <sup>A</sup>			
16	<i>Tylonycteris malayana</i>			A		A	1 <sup>A</sup>	3 <sup>A</sup>			A	A	1 <sup>A</sup>			
17	<i>Tylonycteris fulvida</i>						1	1								
18	<i>Glischropus bucephalus</i>			1 <sup>A</sup>	2 <sup>A</sup>	3 <sup>A</sup>	3 <sup>A</sup>	1 <sup>A</sup>	A	A	1 <sup>A</sup>	A	1 <sup>A</sup>			
19	<i>Harpiocephalus harpia</i>								1							
20	<i>Kerivoula papillosa</i>							1								
21	<i>Kerivoula cf. hardwickii</i>										1					
22	<i>Kerivoula titania</i>											1				
	<b>Phonic Types</b>															
	Phonic Type 1 [ShFM-22]		A				A	A	A	A	A	A				
	Phonic Type 2 [QCF-25]		A	A	A	A					A				A	
	Phonic Type 3 [StFM-32]						A	A			A					
	Phonic Type 4 [StFM-43]		A			A					A					
	<b>Bats captured</b>	<b>1</b>	<b>0</b>	<b>4</b>	<b>8</b>	<b>41</b>	<b>13</b>	<b>15</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>42</b>	<b>23</b>	-	-	-
	<b>Species captured</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>5</b>	<b>9</b>	<b>8</b>	<b>7</b>	<b>3</b>	<b>1</b>	<b>4</b>	<b>7</b>	<b>6</b>	-	-	-
	<b>Combined species</b> <sup>2</sup>	<b>1</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>12</b>	<b>12</b>	<b>10</b>	<b>7</b>	<b>5</b>	<b>14</b>	<b>12</b>	<b>9</b>	<b>1</b>	<b>1</b>	<b>1</b>

<sup>1</sup> First country record, <sup>2</sup> Including species recorded in acoustic sampling, A Acoustic detection. Square brackets indicate taxa solely recorded in acoustic sampling.

Fig. 8: Bat species recorded in live-sampling in Virachey National Park, March 2023 [not to scale]



Fig. 9: Bat species recorded in live-sampling in Virachey National Park, March 2023 [not to scale]



## INTERPRETATION

Current data indicate at least 22 and possibly as many as 26 bat species occur in Virachey National Park. These figures represent 27–31% of the known bat fauna of Cambodia (83/22–26 species), but undoubtedly fall short of the true site total for several reasons including:

- The absence of diverse genera (e.g., *Myotis*, *Pipistrellus*, *Murina*), common place taxa and limited representation of other genera (e.g., *Hipposideros*) on the current species list for the site;
- The known occurrence of at least 44 other bat species in the Cambodia-Vietnam-Laos tri-border area (Table 1), many of which may also occur within the park; and,
- The relatively limited survey coverage and effort achieved at the site to date (Fig. 5), coupled with the reality that detection of many bat species requires sustained effort.

As a consequence, further sampling will undoubtedly reveal additional bat species for the national park and, as in the present survey, Cambodia as a whole. The latter include at least eight species that occur in the tri-border area (Table 1) and as many as 18 species present in southern Laos and/or southern Vietnam (below 15°15' N in either country), all of which could occur in Cambodia (Furey et al. 2021). As such, the bat species richness of Virachey National Park 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.

Desk review and observations during the field survey suggests that limestone karst outcrops and therefore significant cave bat roosts (>100 individuals) are unlikely to exist within the national park. If so, 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)

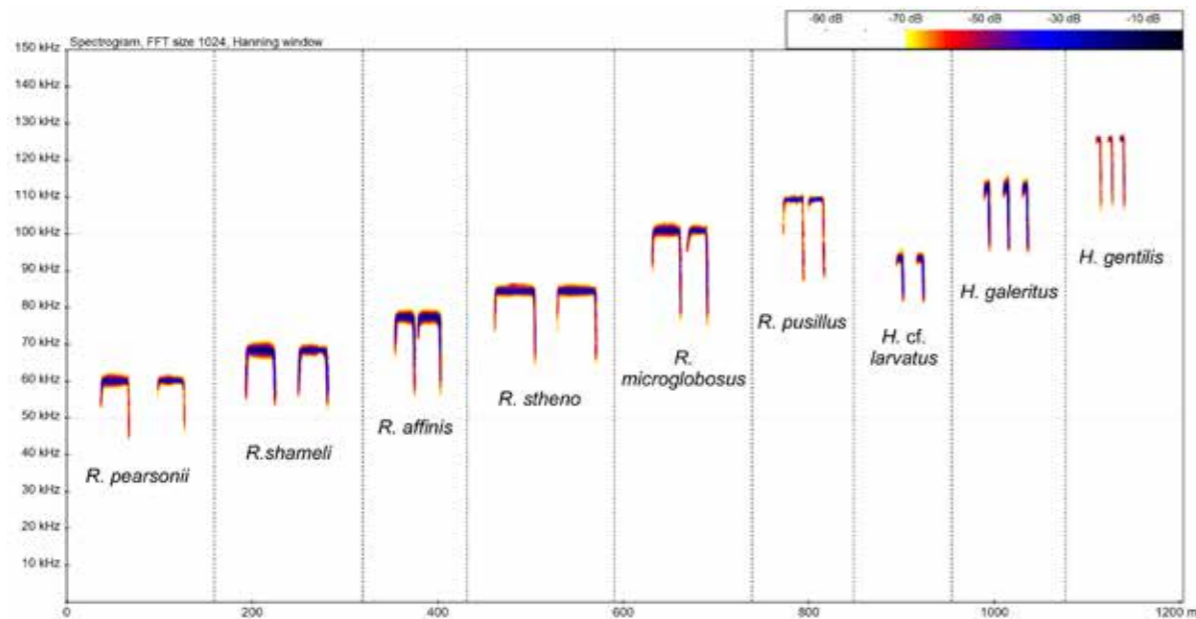


Fig. 10: Echolocation calls of bat species in Virachey National Park, March 2023

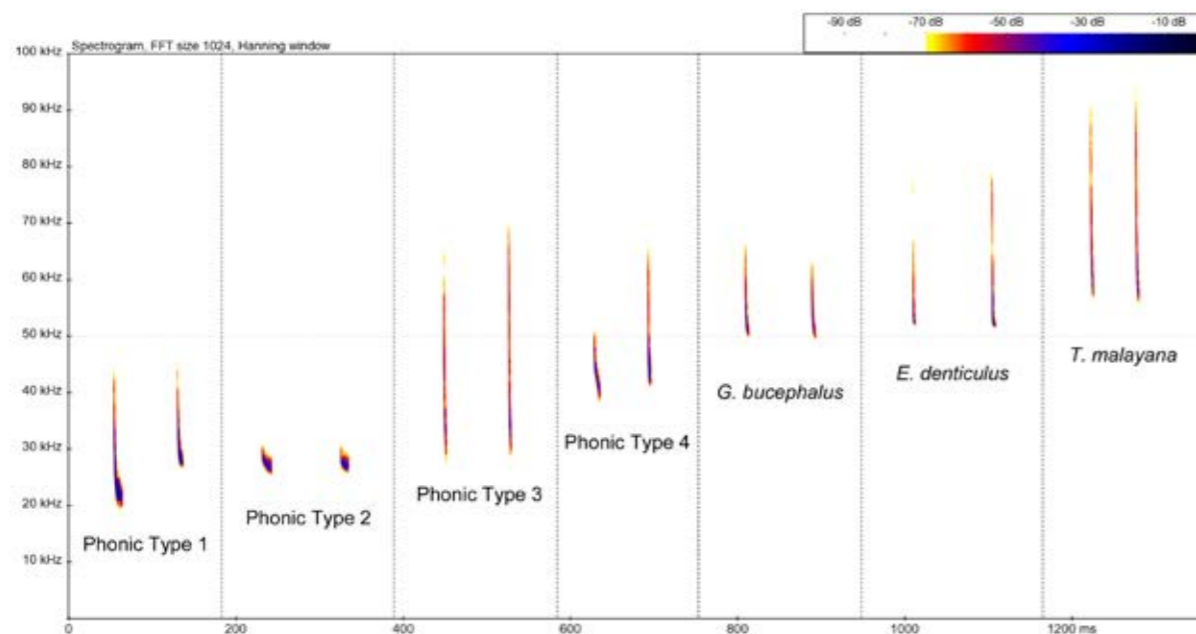


Fig. 11: Echolocation calls of bat species in Virachey National Park, March 2023



**Table 4:** Ecological traits and status of bat species recorded in Virachey, March 2023

#	Family / Species	Typical Roosts <sup>1</sup>	Foraging Strategy <sup>2</sup>	IUCN Status <sup>3</sup>
<b>I Pteropodidae</b>				
1	<i>Cynopterus sphinx</i>	F	IV	LC
2	<i>Megaerops niphanae</i>	F	IV	LC
<b>II Megadermatidae</b>				
3	<i>Megaderma spasma</i>	A, C, F	I-II	LC
<b>III Rhinolophidae</b>				
4	<i>Rhinolophus affinis</i>	C, F	I-II	LC
5	<i>Rhinolophus malayanus</i>	C	I	LC
6	<i>Rhinolophus microglobosus</i>	C, F	I	LC
7	<i>Rhinolophus pearsonii</i>	C	I-II	LC
8	[ <i>Rhinolophus perniger</i> ]	A, C, F	I-II	NE
9	<i>Rhinolophus pusillus</i>	A, C, F	I	LC
10	<i>Rhinolophus shameli</i>	C	I	LC
11	<i>Rhinolophus stheno</i>	C	I	LC
<b>IV Hipposideridae</b>				
12	<i>Hipposideros galeritus</i>	C	I	LC
13	<i>Hipposideros gentilis</i>	C, F	I	LC
14	<i>Hipposideros cf. larvatus</i>	A, C	I-II	LC
<b>V Vespertilionidae</b>				
15	<i>Eudiscopus denticulus</i> <sup>1</sup>	F	I-II	LC
16	<i>Tylonycteris malayana</i>	F	I-II	NE
17	<i>Tylonycteris fulvida</i>	F	I-II	NE
18	<i>Glischropus bucephalus</i>	F	I-II	LC
19	<i>Harpiocephalus harpia</i>	F	I-II	LC
20	<i>Kerivoula papillosa</i>	F	I	LC
21	<i>Kerivoula cf. hardwickii</i>	F	I	LC
22	<i>Kerivoula titania</i>	F	I	LC
<b>Phonic Types</b>				
	Phonic Type 1 [ShFM-22]	-	III	-
	Phonic Type 2 [QCF-25]	-	III	-
	Phonic Type 3 [StFM-32]	-	II-III	-
	Phonic Type 4 [StFM-43]	-	II-III	-

<sup>1</sup> A=Artificial (anthropogenic) roosts, C=Caves, F=Foliage. <sup>2</sup> See Methods, <sup>3</sup> As of November 2022: LC=Least Concern, NE=Not evaluated. Square brackets indicate taxa solely recorded in acoustic sampling.

these will occur throughout the forests of the park.

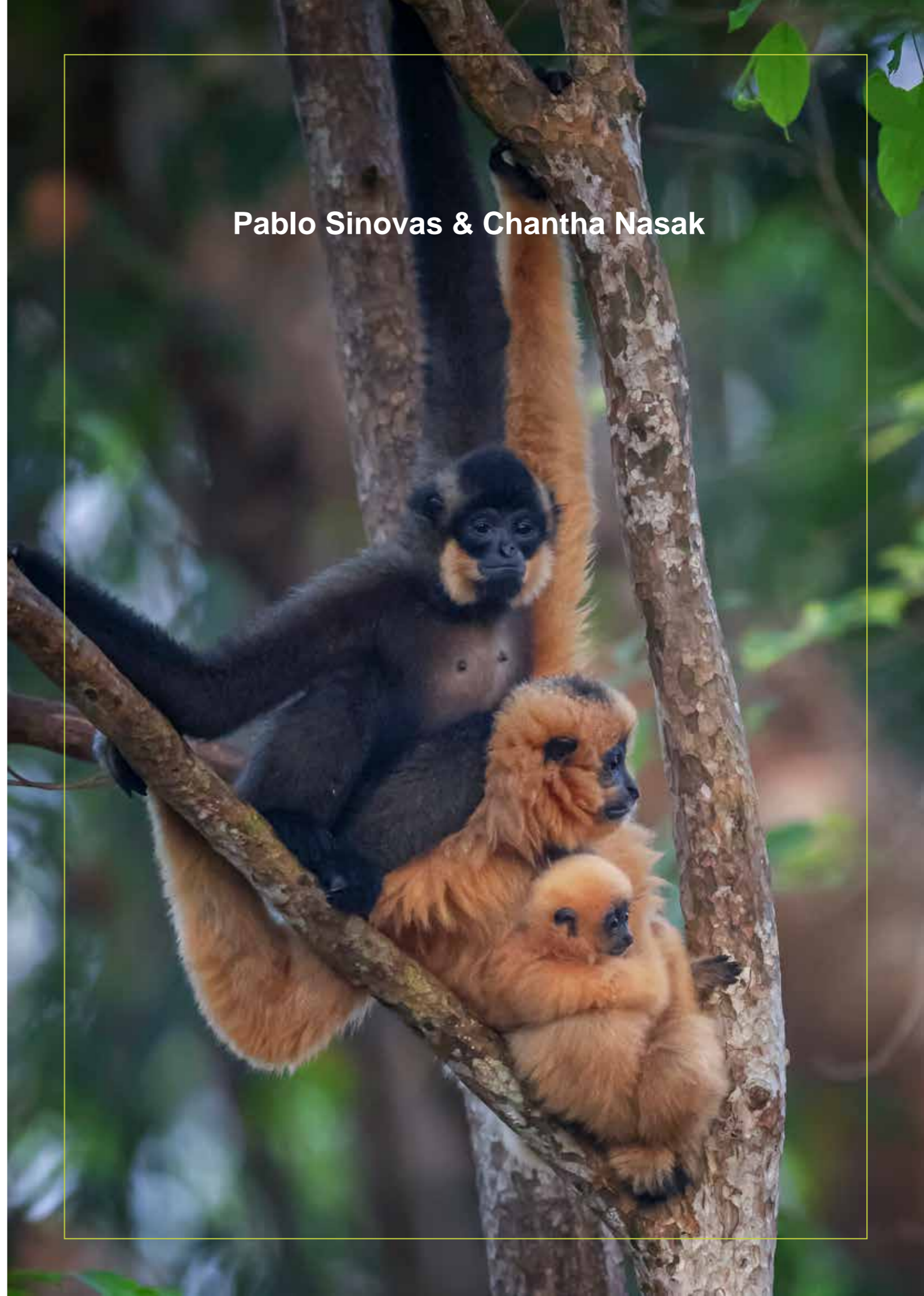
In this context, studies in Vietnam and Thailand have demonstrated dramatic declines in bat abundance between areas with natural and mature forest cover compared to areas with disturbed formations or plantations (Furey et al. 2010, Phommexay et al. 2011). As such, priority should be given to maintaining natural forest condition and cover within the park, since the loss of older, larger trees (which typically provide more cavities 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 4).

In conclusion, the present work indicates further surveys will reveal additional bat species for Virachey National and in all likelihood, Cambodia as a whole. As multi-year sampling in neighbouring countries indicates that sampling during the dry and wet seasons is critical to inventory completeness (e.g., Furey et al. 2010a), such work should ideally encompass both seasons and employ multiple detection methods e.g., live-trapping and acoustic sampling. These should be regarded as highly desirable to improve understanding of Virachey's importance for biodiversity conservation from a national and international perspective, in addition to its related management needs.

## GIBBON SURVEY

Pablo Sinovas & Chantha Nasak

Title image: *Nomascus gabriellae* in Cat Tien, Vietnam © Bjorn Olesen.





## GIBBON SURVEY VIRACHEY NATIONAL PARK 2018

### SUMMARY

The northern yellow-cheeked gibbon *Nomascus annamensis* is a recently discovered primate species. It was formally described in 2010 as distinct from the closely related *N. gabriellae* on the basis of vocal and mitochondrial DNA analyses (Van Ngoc Thinh, Mootnick, Vu Ngoc Thanh, Nadler, & Roos 2010). It remains a relatively poorly studied species, known only from forested areas of Southern Laos, Northern Cambodia and Central Vietnam (Hoang Van Chuong et al. 2018). While its conservation status has not been assessed, it is likely to be Endangered, with only a few hundred wild groups so far recorded (Ibid.). Virachey National Park is expected to represent a stronghold for the species.

This study aimed to assess population size and density of northern yellow-cheeked gibbons in Virachey, and determine the importance of the park for this species.

### METHODS

Density and population size was estimated using the Spatially-Explicit-Capture-Recapture (SECR) method designed by Kidney et al. (2016) which focuses on call detection to estimate density.

Field surveys were conducted over four field trips totalling 22 days of data collection during the dry season in April-June, 2018. We made a total of 24 listening arrays across the park (see Fig. 1) each consisting of 3 listening posts arranged linearly 500 m from each other. Arrays were placed at least 2 km apart. Due to accessibility issues, we were able to cover 21 of the 24 proposed listening arrays. During the visit to the arrays, each listening post was manned by one field team member. The team recorded the compass bearing of all gibbon group calls heard, the estimated distance from the listening post, and notes on weather

conditions, habitat type, as well as and date and time. Only group calls, were recorded; lone males calling were not. Detections of solo males were ignored for the purposes of the analysis, since it is difficult to determine whether they represent roaming individuals or members were group (Brockelman & Srikosamatara 1993). The acoustic data was collected from each array in the morning, between 0500 hrs and 0730 hrs.

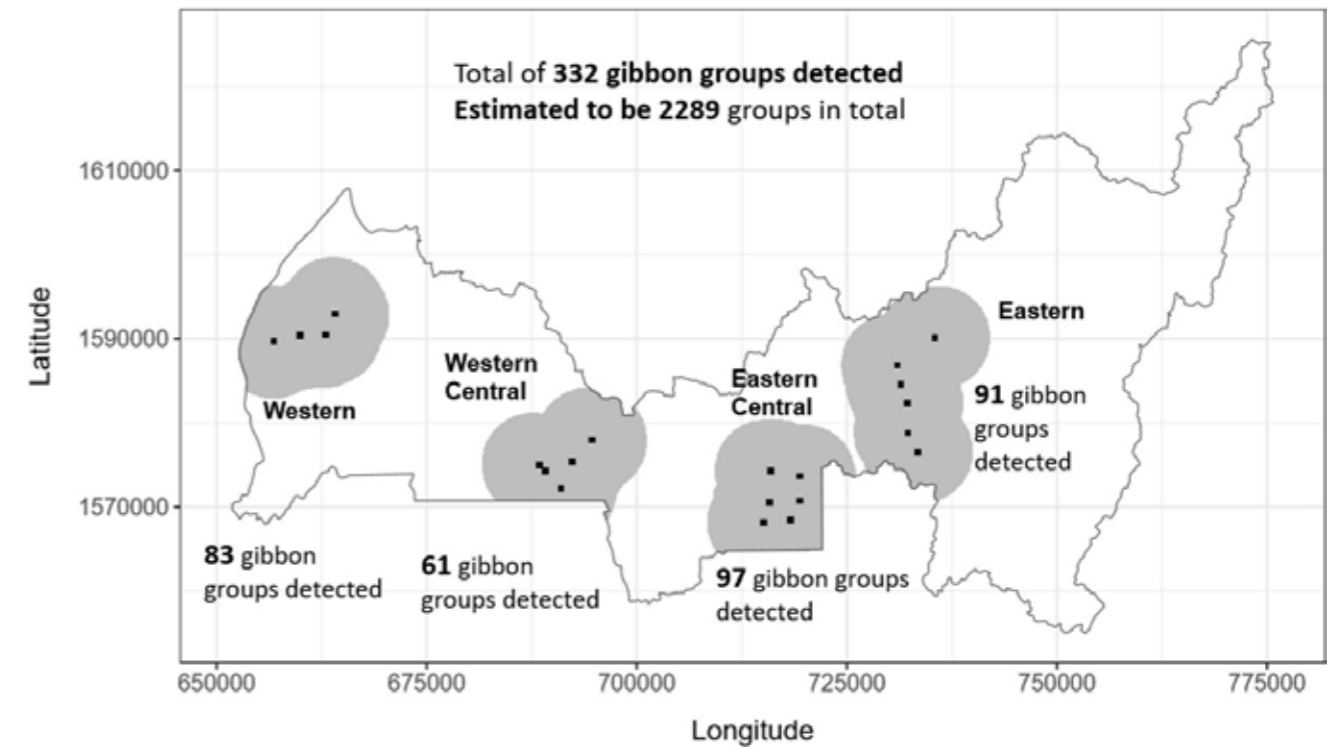
In addition to the density and distribution survey, we also conducted a primate hunting interview survey, with a particular focus on gibbons. Key respondent, semi-structured interviews were conducted between 19-26 March 2019, targeting 27 local community participants from 13 villages in Taveng Leu and Taven Kroam Communes, Taveng District, Ratanakiri Province. Interviewees were asked about the presence of various primate species, with focus on gibbon hunting and consumption, with additional questions regarding resource extraction.

## RESULTS

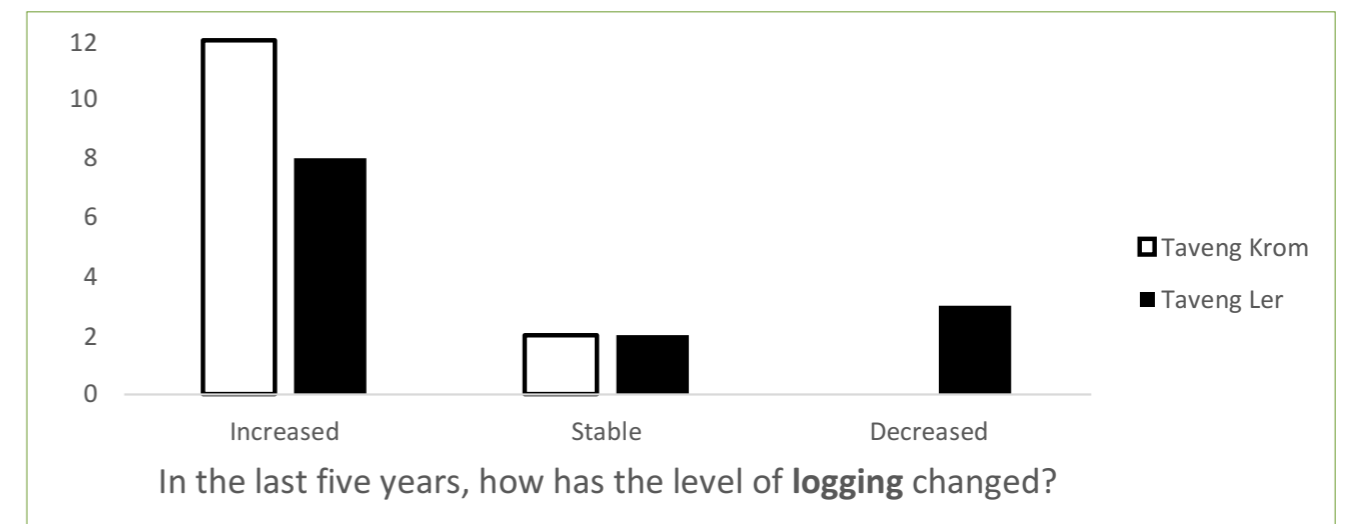
During the four trips, a total of 332 gibbon groups were recorded from 461 different calling detections. This provided an estimated density of 0.71 groups/km<sup>2</sup>, with the lowest estimate at 0.35 groups/km<sup>2</sup> and the highest at 1.42 groups/km<sup>2</sup>. Using the density value of 0.71 groups/km<sup>2</sup>. These preliminary results show that there are approximately 2289 groups of northern yellow-cheeked gibbon in Virachey National Park.

### Primate hunting survey

The majority of interview respondents reported frequently using the forest, and all reported having seen northern yellow-cheeked gibbons. Most participants in Taveng Leu Commune believe that hunting has generally decreased; while those from Taveng Kroam were divided equally between considering hunting to have decreased, increased, or remained stable. Most participants, however, believed that logging pressure has increased (Fig. 2). Based on the interview results, hunting of gibbons appears to be low and primarily for consumption. However, 14 of the 27 participants admitted to having eaten gibbon in the past. (Fig. 3).



**Fig. 2:** Numbers of gibbon groups directly recorded from each of the four array zones. The black dots represent listening arrays, each of which consists of 3 listening posts.



**Fig. 3:** Participants' perception logging within Virachey National Park during the past five years.



Fig. 4: Year of gibbon consumption by interview participants in Virachey National Park.



Fig. 5: Gibbon survey team in Virachey National Park.

## CONCLUSION

According to Hoang Van Chuong et al. (2018) the population of northern yellow-cheeked gibbon in Vietnam and Laos is estimated at ca. 260 and 50 groups respectively. In the Veun Sai - Siem Pang National Park, which is adjacent to Virachey National Park, Kidney et al. (2016) estimated a population of 77 groups. The species' range across Indochina does span multiple protected areas, but these populations are often fragmented and likely to become increasing more so in the future. This study confirms that Virachey National Park is currently the most significant stronghold for this species.

## BIRD SURVEY

**Title image:** Great slaty woodpecker *Mulleripicus pulverulentus*, currently the world's largest extant woodpecker species.

Sean Mardy, Oeung Hang, Jeremy Holden,  
Pablo Sinovas & Oliver Roberts





## BIRD SURVEY VIRACHEY NATIONAL PARK 2021

### SUMMARY

The Kingdom of Cambodia is currently recognized as hosting 629 species of wild birds, including vagrants and passage migrants (CBGA 2019). Some species found here are either globally extremely rare, or are endemic to the Kingdom – such as Cambodia’s national bird, the giant ibis *Pseudibis gigantea*. As a result, wildlife tourism in Cambodia, is primarily focused on bird tours, with a wide range of important sites where rare birds can be seen, and an increasing number of local bird guides with sound ornithological knowledge.

Due to difficulty of access, Virachey National Park has received only scant ornithological study. However, it is recognised by Cambodian Bird Guide Association (2019) as an important bird area, with a number of species recorded from the park that occur nowhere else in Cambodia.

In collaboration with Fauna & Flora, two professional bird guides from the Sam Veasna Conservation Tours Ltd., Sean Mardy and Oeung Hang, participated in a 9-day survey of Virachey National Park, focusing on the eastern part of the protected area. This short survey ran between 22 February – 1 March 2021 in conjunction with a team installing camera traps across the east and north-east of the park.

In addition to this dedicated survey, additional data on bird sightings was opportunistically collected during visits made to the park during camera trap placement work and during surveys focused on other taxa during 2021 and 2023. Results from the camera trap programme provided a complimentary set of bird records.

◁ Sean Mardy and Oeung Hang in Virachey National Park.

## METHODS

During the dedicated survey, work was conducted independently from 0545 hrs for 2-3 hours each day near the expedition camps at a steady walking pace. Additional findings were recorded during the day when travelling alongside the main camera trapping expedition team. If the main expedition team finished early, an additional survey was conducted from 1700 hrs to 2000 hrs. The second period would occasionally be extended to survey nocturnal species such as nightjar and owl species.

Both professional guides were equipped with Swarovski binoculars and scopes and recorded their findings using the Ebird mobile app.

During the assessment of the camera trap results, careful attention was paid to spotting and identifying any birds that had triggered the cameras.

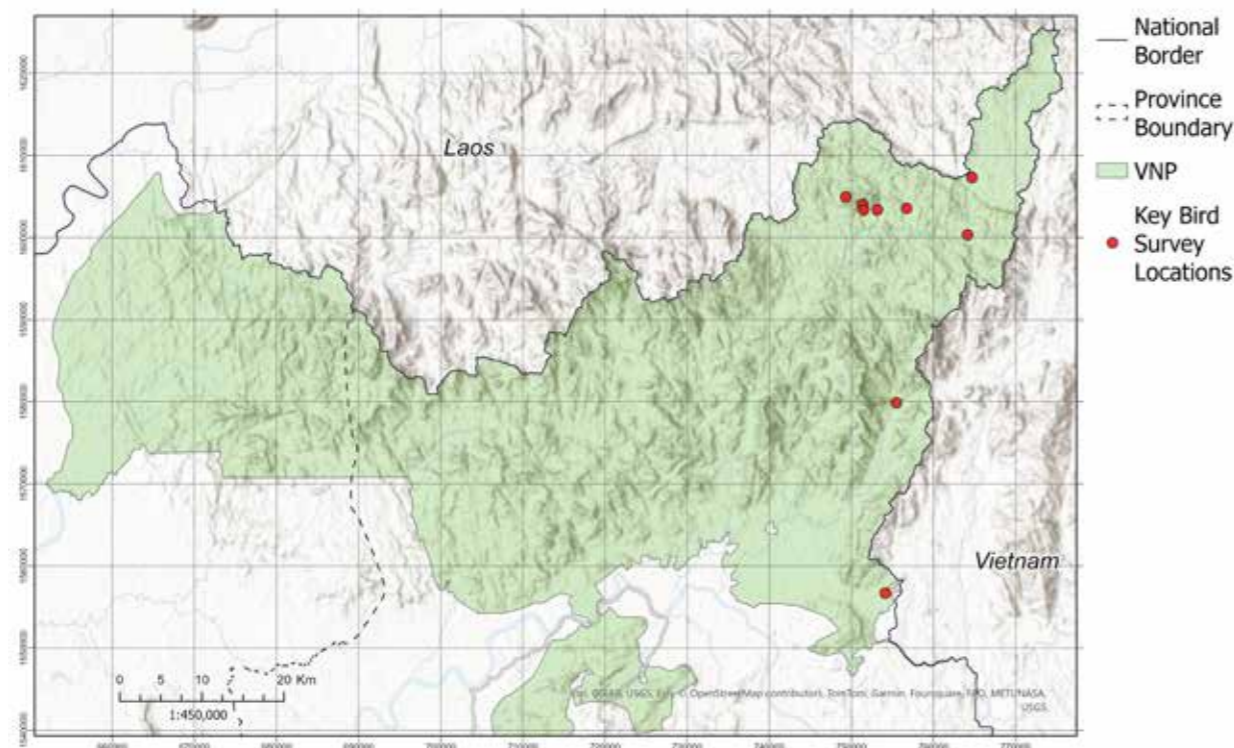


Fig. 1: Map showing key 2021 bird survey locations marked in red.

## RESULTS

In total, 126 bird species were recorded from the 9-day survey, including 2 Near Threatened species and 2 Vulnerable species - as classified in the IUCN Red List. All 126 species were identified as being resident to Virachey National Park, i.e. not migratory or vagrant. Vulnerable species identified were the great hornbill *Buceros bicornis* and the wreathed hornbill *Rhyticeros undulatus*, both threatened due to habitat loss and hunting pressure.

Near Threatened species identified were the ashy-headed green pigeon *Treron phayrei* and the red-breasted parakeet *Psittacula alexandri*. Other species of interest were the red-vented barbet *Psilopogon lagrandieri*, bar-backed partridge *Arborophila brunneopectus*, grey-peacock pheasant *Polyplectron bicalcaratum*, laced woodpecker *Picus vittatus*, bay woodpecker *Blythipicus pyrrhotis*, greater flame back *Chrysocolaptes guttacristatus* and great eared nightjar *Lyncornis macrotis*, all of which hold special interest for bird tourism.

The camera traps recorded 44 bird species, 19 of which were not seen on the 9-day survey. Many of the camera trapped species were difficult to see terrestrial birds, such as the pittas. A single pitta was recorded on the 9-day survey, whereas six species appeared on the camera traps. The camera traps also operated over periods when migrants pass through the park, and a number of these were recorded, such as Siberian blue robin *Larvivora cyane*. Some of the camera traps were set in higher elevation forest not visited during the 9-day survey, which provided records of some babbler species and a laughing thrush not seen at lower altitudes, plus Germain's peacock pheasant *Polyplectron germaini*.

A survey by Nielsen (2015) found five new country records: crested kingfisher *Megaceryle lugubris*, golden babbler *Cyanoderma chrysaeum*, grey-throated babbler *Stachyris nigriceps*, red-billed scimitar babbler *Pomatorhinus ochraceiceps* and mountain fulvetta *Alcippe peracensis*. Of these, only the mountain fulvetta was identified on this survey. Austen's brown hornbill *Anorrhinus austeni*, another key species found in 2015, was likewise not seen.



Table 1: Virachey National Park 2021 bird survey species list.

No.	Common Name	Scientific Name	IUCN Status
1	Bar-backed partridge	<i>Arborophila brunneopectus</i>	LC
2	Green-legged partridge	<i>Arborophila chloropus</i>	LC
3	Grey peacock-pheasant	<i>Polyplectron bicalcaratum</i>	LC
4	Chinese francolin	<i>Francolinus pintadeanus</i>	LC
5	Red jungle fowl	<i>Gallus gallus</i>	LC
6	Siamese fireback	<i>Lophura diardi</i>	LC
7	Oriental turtle dove	<i>Streptopelia orientalis</i>	LC
8	Spotted dove	<i>Streptopelia chinensis</i>	LC
9	Ashy-headed green pigeon	<i>Treron phayrei</i>	NT
10	Pin-tailed green pigeon	<i>Treron apicauda</i>	LC
11	Green Imperial pigeon	<i>Ducula aenea</i>	LC
12	Great-eared nightjar	<i>Lyncornis macrotis</i>	LC
13	Large-tailed nightjar	<i>Caprimulgus macrurus</i>	LC
14	Silver-backed needletail	<i>Hirundapus cochinchinensis</i>	LC
15	Germain's swiftlet	<i>Aerodramus fuciphagus</i>	LC
16	House swift	<i>Apus nipalensis</i>	LC
17	Greater coucal	<i>Centropus bengalensis</i>	LC
18	Green-billed malkoha	<i>Phaenicophaeus tristis</i>	LC
19	Violet cuckoo	<i>Chrysococcyx xanthorhynchus</i>	LC
20	Banded bay cuckoo	<i>Cacomantis sonneratii</i>	LC
21	Square-tailed drongo-cuckoo	<i>Surniculus lugubris</i>	LC
22	Chinese pond-heron	<i>Ardeola baccus</i>	LC
23	Little egret	<i>Egretta garzetta</i>	LC
24	Brown boobook	<i>Ninox scutulata</i>	LC
25	Collared owlet	<i>Glaucidium brodiei</i>	LC
26	Asian barred owlet	<i>Glaucidium cuculoides</i>	LC
27	Collared scops-owl	<i>Otus lettia</i>	LC
28	Mountain scops-owl	<i>Otus spilocephalus</i>	LC
29	Crested serpent-eagle	<i>Spilornis cheela</i>	LC
30	Mountain hawk-eagle	<i>Nisaetus nipalensis</i>	LC
31	Black eagle	<i>Ictinaetus malaiensis</i>	LC

No.	Common Name	Scientific Name	IUCN Status
32	Orange-breasted trogon	<i>Harpactes oreskios</i>	LC
33	Red-headed trogon	<i>Harpactes erythrocephalus</i>	LC
34	Great hornbill	<i>Buceros bicornis</i>	VU
35	Oriental pied hornbill	<i>Anthracoceros albirostris</i>	LC
36	Wreathed hornbill	<i>Rhyticeros undulates</i>	VU
37	Blue-bearded bee-eater	<i>Nyctornis athertoni</i>	LC
38	Asian green bee-eater	<i>Merops orientalis</i>	LC
39	Chestnut-headed bee-eater	<i>Merops leschenaulti</i>	LC
40	Oriental dollarbird	<i>Eurystomus orientalis</i>	LC
41	Indochinese roller	<i>Coracias affinis</i>	LC
42	Banded kingfisher	<i>Lacedo pulchella</i>	LC
43	Blue-eared barbet	<i>Psilopogon cyanotis</i>	LC
44	Red-vented barbet	<i>Psilopogon lagrandieri</i>	LC
45	Green-eared barbet	<i>Psilopogon faiostrictus</i>	LC
46	Moustached barbet	<i>Psilopogon incognitus</i>	LC
47	Annam barbet	<i>Psilopogon annamensis</i>	LC
48	White-browed piculet	<i>Sasia ochracea</i>	LC
49	Bay woodpecker	<i>Blythipicus pyrrhotis</i>	LC
50	Greater flameback	<i>Chrysocolaptes guttacristatus</i>	LC
51	Rufous woodpecker	<i>Micropternus brachyurus</i>	LC
52	Greater yellownape	<i>Chrysophlegma flavinucha</i>	LC
53	Laced woodpecker	<i>Picus vittatus</i>	LC
54	Grey-headed woodpecker	<i>Picus canus</i>	LC
55	Great slaty woodpecker	<i>Mulleripicus pulverulentus</i>	LC
56	Collared falconet	<i>Microhierax caerulescens</i>	LC
57	Vernal hanging parrot	<i>Loriculus vernalis</i>	LC
58	Red-breasted parakeet	<i>Psittacula alexandri</i>	NT
59	Blue pitta	<i>Hydornis cyaneus</i>	LC
60	Silver-breasted broadbill	<i>Serilophus lunatus</i>	LC
61	Black-hooded oriole	<i>Oriolus xanthornus</i>	LC
62	Black-naped oriole	<i>Oriolus chinensis</i>	LC
63	White-bellied erpornis	<i>Erpornis zantholeuca</i>	LC
64	Scarlet minivet	<i>Pericrocotus flammeus</i>	LC

No.	Common Name	Scientific Name	IUCN Status
65	Brown-rumped minivet	<i>Pericrocotus cantonensis</i>	LC
66	Ashy woodswallow	<i>Artamus fuscus</i>	LC
67	Bar-winged flycatcher-shrike	<i>Hemipus picatus</i>	LC
68	Large woodshrike	<i>Tephrodornis virgatus</i>	LC
69	Ashy drongo	<i>Dicrurus leucophaeus</i>	LC
70	Lesser racket-tailed drongo	<i>Dicrurus remifer</i>	LC
71	Hair-crested drongo	<i>Dicrurus hottentottus</i>	LC
72	Greater racket-tailed drongo	<i>Dicrurus paradiseus</i>	LC
73	Black-naped monarch	<i>Hypothymis azurea</i>	LC
74	Blyth's paradise flycatcher	<i>Terpsiphone incei</i>	LC
75	Racket-tailed treepie	<i>Crypsirina temia</i>	LC
76	Grey-headed canary-flycatcher	<i>Culicicapa ceylonensis</i>	LC
77	Rufescent prinia	<i>Prinia rufescens</i>	LC
78	Common tailorbird	<i>Orthotomus sutorius</i>	LC
79	Dark-necked tailorbird	<i>Orthotomus atrogularis</i>	LC
80	Red-rumped swallow	<i>Cecropis daurica</i>	LC
81	Barn swallow	<i>Hirundo rustica</i>	LC
82	Ochraceous bulbul	<i>Alophoixus ochraceus</i>	LC
83	Grey-eyed bulbul	<i>Lole propinqua</i>	LC
84	Black-bulbul	<i>Hypsipetes leucocephalus</i>	LC
85	Black-crested bulbul	<i>Rubigula flaviventris</i>	LC
86	Red-whiskered bulbul	<i>Pycnonotus jocosus</i>	LC
87	Stripe-throated bulbul	<i>Pycnonotus finlaysoni</i>	LC
88	Black-headed bulbul	<i>Brachypodius atriceps</i>	LC
89	Radde's warbler	<i>Phylloscopus schwarzi</i>	LC
90	Yellow-browed warbler	<i>Phylloscopus inornatus</i>	LC
91	Two-barred warbler	<i>Phylloscopus plumbeitarsus</i>	LC
92	Pale-legged leaf-warbler	<i>Phylloscopus tenellipes</i>	LC
93	Sulphur-breasted warbler	<i>Phylloscopus ricketti</i>	LC
94	Yellow-bellied warbler	<i>Abroscopus superciliaris</i>	LC
95	Oriental white-eye	<i>Zosterops plapebrosus</i>	LC
96	White-browed scimitar-babbler	<i>Pomatorhinus schisticeps</i>	LC
97	Grey-throated babbler	<i>Stachyris nigriceps</i>	LC

No.	Common Name	Scientific Name	IUCN Status
98	Pin-stripe tit babbler	<i>Mixornis gularis</i>	LC
99	Grey-faced tit babbler	<i>Mixornis kelleyi</i>	LC
100	Buff-breasted babbler	<i>Trichastoma tickelli</i>	LC
101	Mountain fulvetta	<i>Alcippe peracensis</i>	LC
102	White-crested laughingthrush	<i>Garrulax leucolophus</i>	LC
103	Velvet-fronted nuthatch	<i>Sitta frontalis</i>	LC
104	Vinous-breasted starling	<i>Acridotheres leucocephalus</i>	LC
105	Great myna	<i>Acridotheres grandis</i>	LC
106	Common hill myna	<i>Gracula religiosa</i>	LC
107	White-rumped shama	<i>Kittacincla malabarica</i>	LC
108	Verditer flycatcher	<i>Eumyias thalassinus</i>	LC
109	Hill blue-flycatcher	<i>Cyornis banyumas</i>	LC
110	Siberian blue robin	<i>Larvivora cyane</i>	LC
111	Asian fairy bluebird	<i>Irena puella</i>	LC
112	Blue-winged leafbird	<i>Chloropsis moluccensis</i>	LC
113	Thick-billed flowerpecker	<i>Dicaeum agile</i>	LC
114	Scarlet-backed flowerpecker	<i>Dicaeum cruentatum</i>	LC
115	Little spiderhunter	<i>Arachnothera longirostra</i>	LC
116	Purple-naped spiderhunter	<i>Arachnothera hypogrammica</i>	LC
117	Olive-backed sunbird	<i>Cinnyris jugularis</i>	LC
118	Black-throated sunbird	<i>Aethopyga saturate</i>	LC
119	Crimson sunbird	<i>Aethopyga siparaja</i>	LC
120	White-rumped munia	<i>Lonchura striata</i>	LC
121	Grey wagtail	<i>Motacilla cinerea</i>	LC
Additional records from Jeremy Holden 2021			
122	Shikra	<i>Accipiter badius</i>	LC
123	White-crowned forktail	<i>Enicurus leschnaulti</i>	LC
124	Buffy fish owl	<i>Ketupu ketupu</i>	LC
125	Oriental dwarf kingfisher	<i>Ceyx erithaca</i>	LC
126	Maroon oriole	<i>Oriolus trailli</i>	LC



Fig. 2: Buffy fish owl was recorded along O'Khampa Touch.

Table 2: Bird species captured on camera traps.

No.	Common Name	Scientific Name	IUCN Status
1	Bar-backed partridge	<i>Arborophila brunneopectus</i>	LC
2	Green-legged partridge	<i>Arborophila chloropus</i>	LC
3	Red junglefowl	<i>Gallus gallus</i>	LC
4	Siamese fireback	<i>Lophura diardi</i>	LC
5	Silver pheasant*	<i>Lophura nycthemera</i>	LC
6	Germain's peacock-pheasant*	<i>Polyplectron germaini</i>	NT
7	Grey peacock pheasant	<i>Polyplectron bicalcaratum</i>	LC
8	Green peafowl*	<i>Pavo muticus</i>	EN
9	Grey-capped emerald dove*	<i>Chalcophaps indica</i>	LC
10	Yellow-vented green pigeon	<i>Treron seimundi</i>	LC
11	Malayan night heron*	<i>Gorsachius melanolophus</i>	LC
12	Crested goshawk*	<i>Accipiter trivirgatus</i>	LC
13	Crested serpent eagle	<i>Spilornis cheela</i>	LC
14	Orange-breasted trogon	<i>Harpactes oreskios</i>	LC
15	Great hornbill	<i>Buceros bicornis</i>	VU
16	Bay woodpecker	<i>Blythipicus pyrrhotis</i>	LC
17	Red-collared woodpecker	<i>Picus rabieri</i>	NT
18	Blue pitta	<i>Hydrornis cyaneus</i>	LC
19	Bar-bellied pitta*	<i>Hydrornis elliotii</i>	LC
20	Eared pitta*	<i>Hydrornis phayrei</i>	LC
21	Blue-rumped pitta*	<i>Hydrornis soror</i>	LC
22	Fairy pitta*	<i>Pitta nympha</i>	LC
23	Hooded pitta*	<i>Pitta sordida</i>	LC
24	Black-naped monarch	<i>Hypothymis azurea</i>	LC
25	Indochinese green magpie	<i>Cissa hypoleuca</i>	LC
26	Racket-tailed treepie	<i>Crypsirina temia</i>	LC
27	Red-billed blue magpie	<i>Urocissa erythroryncha</i>	LC
28	Rufescent prinia	<i>Prinia rufescens</i>	LC
29	Black-crested bulbul	<i>Rubigula flaviventris</i>	LC
30	Large scimitar-babbler*	<i>Erythrogeus hypoleucos</i>	LC
31	White-browed scimitar-babbler	<i>Pomatorhinus schisticeps</i>	LC
32	Grey-throated babbler	<i>Stachyris nigriceps</i>	LC

No.	Common Name	Scientific Name	IUCN Status
33	White-crested laughingthrush	<i>Garrulax leucolophus</i>	LC
34	Black-hooded laughingthrush*	<i>Garrulax milleti</i>	LC
34	Collared babbler*	<i>Gampsorhynchus torquatus</i>	LC
35	White-rumped shama	<i>Copsychus malabaricus</i>	LC
36	Indochinese blue-flycatcher	<i>Cyornis sumatrensis</i>	LC
37	White-crowned forktail*	<i>Enicurus leschenaulti</i>	LC
38	Siberian blue robin*	<i>Larivora cyane</i>	LC
39	Blue whistling thrush*	<i>Myophonus caeruleus</i>	LC
40	Asian brown flycatcher	<i>Muscicapa dauurica</i>	LC
41	Orange-headed thrush*	<i>Geokichla citrina</i>	LC
42	Eyebrowed thrush*	<i>Turdus obscurus</i>	LC
43	Asian fairy-bluebird	<i>Irena puella</i>	LC
44	Green-billed malkoha	<i>Phaenicophaeus tristis</i>	LC

\*Bird species only captured on camera traps and not directly seen.

## CONCLUSION

The combined species total including the camera trap records brings the number of bird species recorded over the surveys to 145. This figure clearly represents only a fraction of the total number of species that are either resident, pass through the park on migration, or over-winter in the area. Bird survey work in the higher elevation areas closer to the Laos border would increase the species count considerably, and undoubtedly lead to new country records.

No new records were made during this work, but records of both Germain's and grey peacock-pheasant suggest that Virachey National Park is one of the few, if not the only protected area known, where both of these species occur.

Further survey work is needed on some of the higher mountains along the Laos and Vietnam border areas in order to fill some of the gaps in the Virachey bird species list.

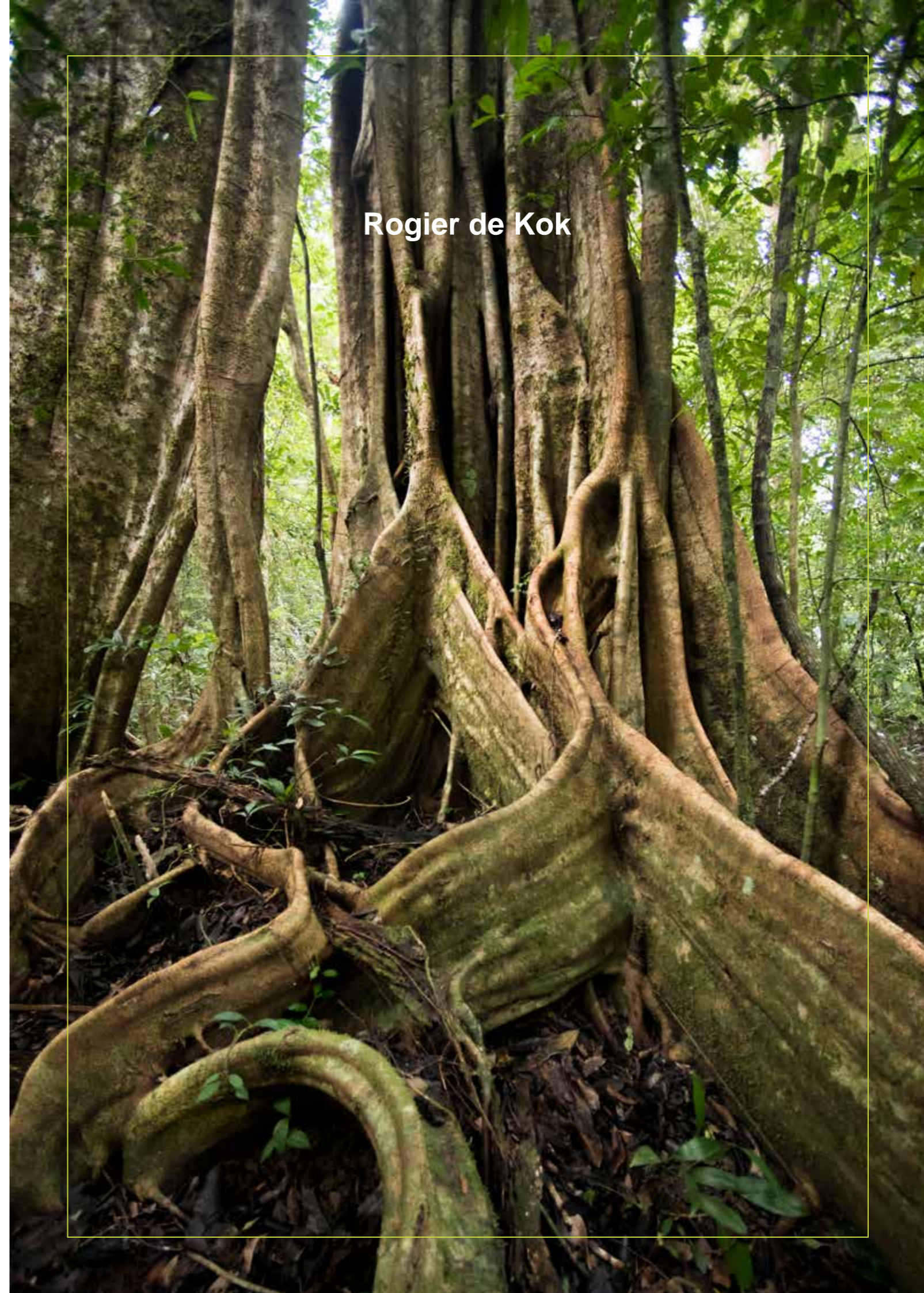


Fig. 3: *Lophura* pheasants captured on a camera trap in Virachey: Siamese fireback group (above); a male silver pheasant (below).



# TREE SURVEY

Title image: Huge *Ficus* in Virachey National Park.





## TREE SURVEY VIRACHEY NATIONAL PARK, 2023

### SUMMARY

Tree surveys were conducted at two key sites in Virachey National Park in 2023, initiated by Fauna & Flora and supported by Fondation Franklinia. The following text is a preliminary report produced prior to the full analysis of the specimens collected.

Virachey National Park hosts at least 8 rare and threatened tree species. This number is undoubtedly an underestimation of the real number. Thirteen new plant species records for Cambodia were recorded during this work, and further results are pending an additional analysis. More fieldwork is needed to compile a full checklist of the tree species occurring in the park.

### METHODS

The trip was undertaken over 14 days, starting between 15-28 November 2023 and led by international and national tree experts: Dr Rogier de Kok, Honorary Research Associate at the Singapore Botanic Gardens, Mrs. Pove Youleng, lecturer at Royal University of Phnom Penh (RUPP), and Mr Lay Darith, Chief Officer of Research and Data Management at Ministry of Environment. The experts were assisted by Park Rangers and staff from Fauna & Flora Cambodia. The team visited two different survey areas within the National Park: O' Yeak Kim and Veal Thom, in order to target a range of vegetations types (hill forests, wet (dipterocarp) forests and secondary vegetation). The emphasis of the survey was on the native trees, their occurrence and status.

Specimens of interest were collected and preserved primarily through the use of a botanical specimen press. In total, 88 specimens were collected at O' Yeak Kim and 51 at Veal Thom. The specimens were dried at RUPP and will be sent to the Royal Botanic Gardens in Kew, England for further identification.

◀ Open Dipterocarp forest in Virachey National Park.

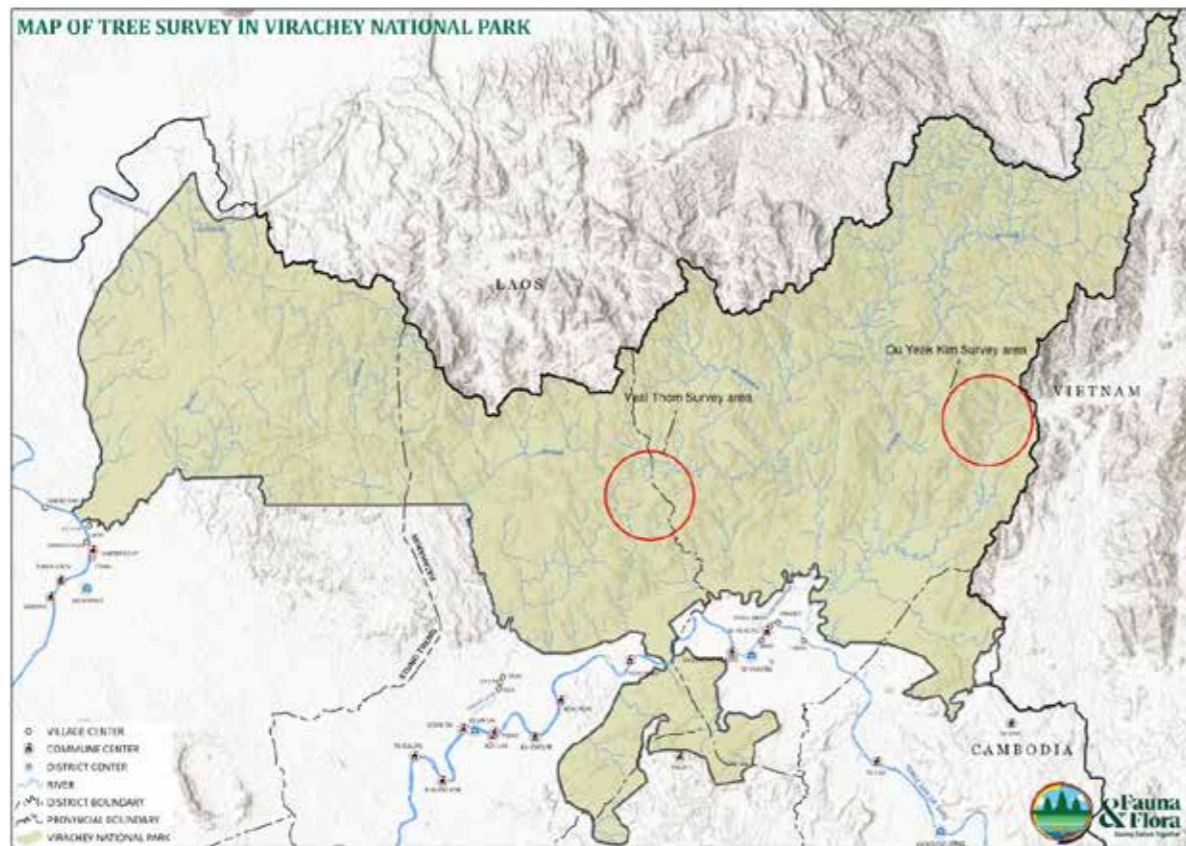


Fig 1: Map of Virachey National Park showing the two tree survey areas.



Fig 2: Tree survey team labelling plant specimens in Veal Thom .

## RESULTS

At O'Yeak Kim, the 88 specimens collected comprised at least 28 plant families. North of the camp, the area consists mainly of logged over wet (dipterocarp) forests and bamboo forests. In this type of wet forests most of the plant biodiversity is in the subcanopy and shrub layers. Species of the Rubiaceae (coffee Family), which are a common element in these layers, are also particularly susceptible to large scale disturbances. Many Rubiaceae species were common in these logged forests and the bamboo forest, indicating that most of the species that grow in these biodiversity-rich subcanopy and shrub layers are very likely still present in the area. They mainly seem to survive in the more intact forest remnants and in the larger and denser bamboo forests. In areas south of the camp, members of this family were almost absent and their vegetation was dominated by species common to secondary vegetations.

At Veal Thom, the 51 specimens collected comprised at least 27 plant families, with a high number of canopy tree species. In this type of hill forests most of the plant biodiversity is in the tree canopy. The large number of tree species found in these forests are in indication that these forests are in good condition. The grasslands are most likely anthropogenic, due to the low species diversity found within, with annual fire regimens maintaining the area.



## Threatened Tree Species

### Critically Endangered:

*Dalbergia cochinchinensis*

### Endangered:

*Dipterocarpus grandiflorus*

*Litsea clemensii*

### Vulnerable:

*Anthoshorea roxburghii*

*Dipterocarpus alatus*

*Dipterocarpus costatus*

*Dipterocarpus turbinatus*

### Near Threatened:

*Dipterocarpus obtusifolius*

## CONCLUSION

The main reason for tree species becoming threatened in Virachey is due to logging operations, either from commercial companies or by local people. In the case of Dipterocarp species, this threat is predominantly historical, as technically any remaining trees are protected from any future large-scale logging. Local people will use Dipterocarp timber for their own construction needs - something that should be monitored. Tapping Dipterocarp trees for damar resin may influence the survival of some species in the park, but it is the indirect effect of tree tappers camping out in the forest (which would include hunting and fishing) which may have a bigger effect on conservation (Sunderland et al. 2013, Baird & Dearden 2003).

Most of the rosewood *Dalbergia cochinchinensis* from the park was cut in the 1990s (Singh 2014: 143). However, given the price of even relatively small pieces of rosewood timber, it remains lucrative for local communities even when harvested on a small scale (Sunderland et al. 2013, Chanrith et al. 2016).

It has been reported (Ironsides & Baird 2003) that the species of genus *Aquilaria* Lam. (Agarwood, Thymelaeaceae) growing in Virachey National Park have been destructively harvested by people from Vietnam, and that the remaining populations are under severe threat. Agarwood is harvested as a source of incense and perfume and is so valuable that usually the whole tree (including roots) is harvested. All species of *Aquilaria* fall under CITES regulations, and the two known species occurring in Cambodia - *Aquilaria baillonii* Pierre ex Lecomte and *Aquilaria crassna* Pierre ex Lecomte (Cho et al. 2016)) are listed as Data Deficient, with few wild populations left in Cambodia (Harvey-Brown 2018a) or as Critically Endangered. Populations of these trees declined by 80% during the 1990s (Harvey-Brown 2018b). As this genus has not been collected in any survey so far, it is unclear which species of *Aquilaria* occur in the park, or their abundance. In any case, if either species does still occur, they are under a clear threat from destructive harvesting.

A similar problem was reported for rattan, of which large amounts were harvested to supply the rattan factories in Vietnam (Ironsides & Baird 2003). Rattan is a general name for about 600 species of climbing palms in the subfamily Calamoideae. Its durable running stems are used in making furniture and other household goods. Several species are known from Cambodia, but none were collected in this survey.

The fire regimens that maintain Veal Thom should be considered for inclusion into Virachey National Park's management plan in order to preserve the site for historic, cultural and ecotourism purposes.

## eDNA SURVEY

Title image: eDNA filter with compacted river material.

Pablo Sinovas  
& Benjamin Barca





## eDNA SURVEY VIRACHEY NATIONAL PARK, 2021

### SUMMARY

Environmental DNA (eDNA) metabarcoding is a survey technique wherein genetic samples are extracted from water sources, amplified and matched to genetic a specie's reference. Eighteen eDNA samples were collected in Virachey National Park (VNP) and analysed by Nature Metrics Ltd.

A total of 161 vertebrate taxa were recorded, including 15 threatened species.

### METHODS

Environmental DNA (eDNA) samples were collected by survey teams consisting of Fauna & Flora Cambodia staff, led by Pablo Sinovas, and MoE Rangers. The samples were taken at 18 locations throughout VNP by collecting water samples using a syringe and forcing the sample through an eDNA filter that trapped DNA fragments. The samples were then exported to the UK, where DNA was extracted and analysed by Nature Metrics Ltd. Key sequences were taxonomically assigned, and common contaminant sequences (e.g. human) were removed. The abundance of taxa cannot be directly inferred from the proportion of total sequence reads. While the proportion of sequence reads is a consequence of abundance, it is also impacted by biomass, activity, surface area, condition, distance from the physical sample, primer bias, and species-specific variation in the genome.

<Fig. 1: Protocol for collecting eDNA.

**Table 1.** Volume of filtered water and resultant concentration of purified DNA and index PCRs

Kit ID	Sample ID	Volume filtered	DNA (ng/μl)	Index (ng/μl)
WAT20-1271	D20040258	1200ml	3.38	7.68
WAT20-1273	D20040258	2500ml	2.08	7.02
WAT20-1277	D20040258	1300ml	63.4	8.88
WAT20-1257	D20040258	1600ml	35.6	8.06
WAT20-1263	I O'Tung	1400ml	2.24	14.1
WAT20-1254	O'Kranhoung	700ml	1.39	7.76
WAT20-1261	O'Khampha	1500ml	3.84	6.76
WAT20-1260	O'Lalay	800ml	1.15	5.66
WAT20-1265	O'Tabok I	1600 ml	10.2	3.42
WAT20-1259	O'Tayak	1100ml	20.4	4.04
WAT20-1255	O'Kranhoung	1000ml	1.61	7.64
WAT20-1290	O'Paneang clear stream	8000ml	29	4.58
WAT20-1286	O'Paneang stream	11000ml	100	5.06
WAT20-1293	Sample #2 O'Paneang forest pool	11200ml	69.2	4.28
WAT20-1258	TV O'Khampha	1500ml	8	8.5
WAT20-1268	VNP-G1T151	6000ml	27.4	5.74
WAT20-1256	VNP-G1T1S2	5500ml	7.66	3.84
WAT20-1291	VNP-G1T2-S1	2600ml	28.4	5.9

## RESULTS

A total of 161 taxa were detected (Table 2). 42.8% (69 taxa) were at least 99% similar to a species in the global reference databases, and species names are suggested. The remaining taxa were identified to the lowest possible taxonomic level: 37.3% to genus (60 taxa), 16.1% to family (26 taxa), and the remainder to order (6 taxa). A total of 95 unique fish, 14 amphibians, 30 birds, 20 mammals, and 2 reptiles were detected. The taxa belong to 26 orders, 59 families, and 96 genera. Species of note include 15 species categorised on the IUCN Red List: dwarf loach *Ambastaiia sidthimunki* EN; chameleon loach *Syncrossus beauforti* NT; a cyprinid fish *Labeo pierreii* VU; giant devil catfish *Bagarius yarrelli* VU; sambar deer *Rusa unicolor* VU; smooth-coated otter *Lutrogale perspicillata* VU; Asian black bear *Ursus thibetanus* VU; red-shanked douc *Pygathrix nemaeus* CR; Oldham's leaf turtle *Cyclemys oldhamii* EN; Asiatic soft shell turtle *Amyda cartilaginea* VU and 3 taxa identified as either of 2 different species each: Indonesian shortfin eel *Anguilla bicolor* NT or giant mottled eel *Anguilla marmorata* LT; red mahseer *Tor sinensis* VU or Thai mahseer *Tor tambroides* DD and crab-eating macaque *Macaca fascicularis* VU or stump-tailed macaque *Macaca arctoides* VU. These sequences matched perfectly to reference sequences for both species. This means that DNA from one or both species may be present in the samples but cannot be separated with this analysis.

One further sequence was identified as pygmy slow loris *Xanthonycticebus pygmaeus* EN (formerly *Nycticebus pygmaeus*) but was not confirmed by Nature Metrics at species level due to GBIF not containing records of pygmy loris for Cambodia. However, the species is well known from north-east Cambodia, and it can be considered to have been detected in this survey and therefore has been included in the total threatened species number.

Table 2: Taxon richness among the samples.

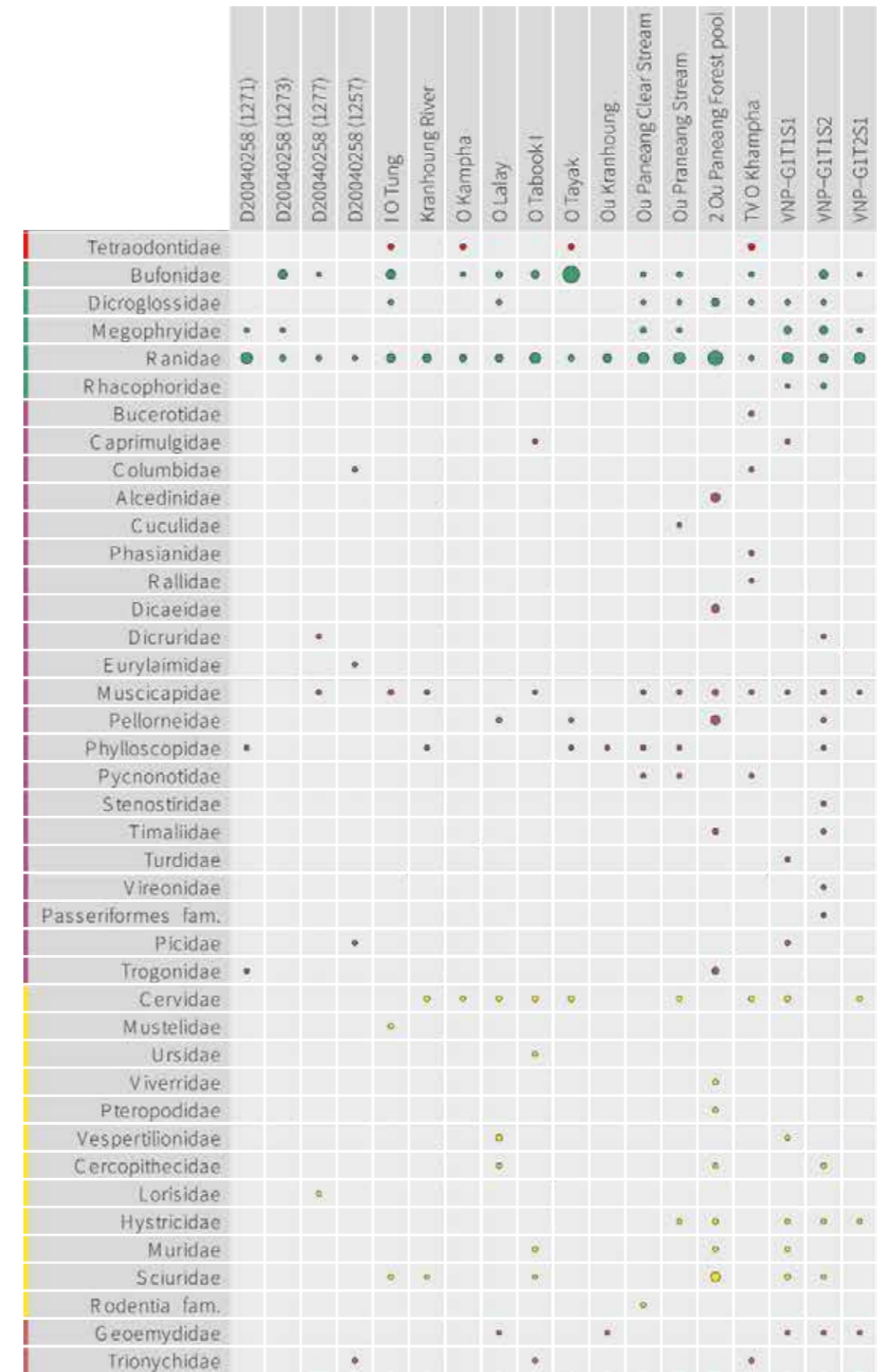
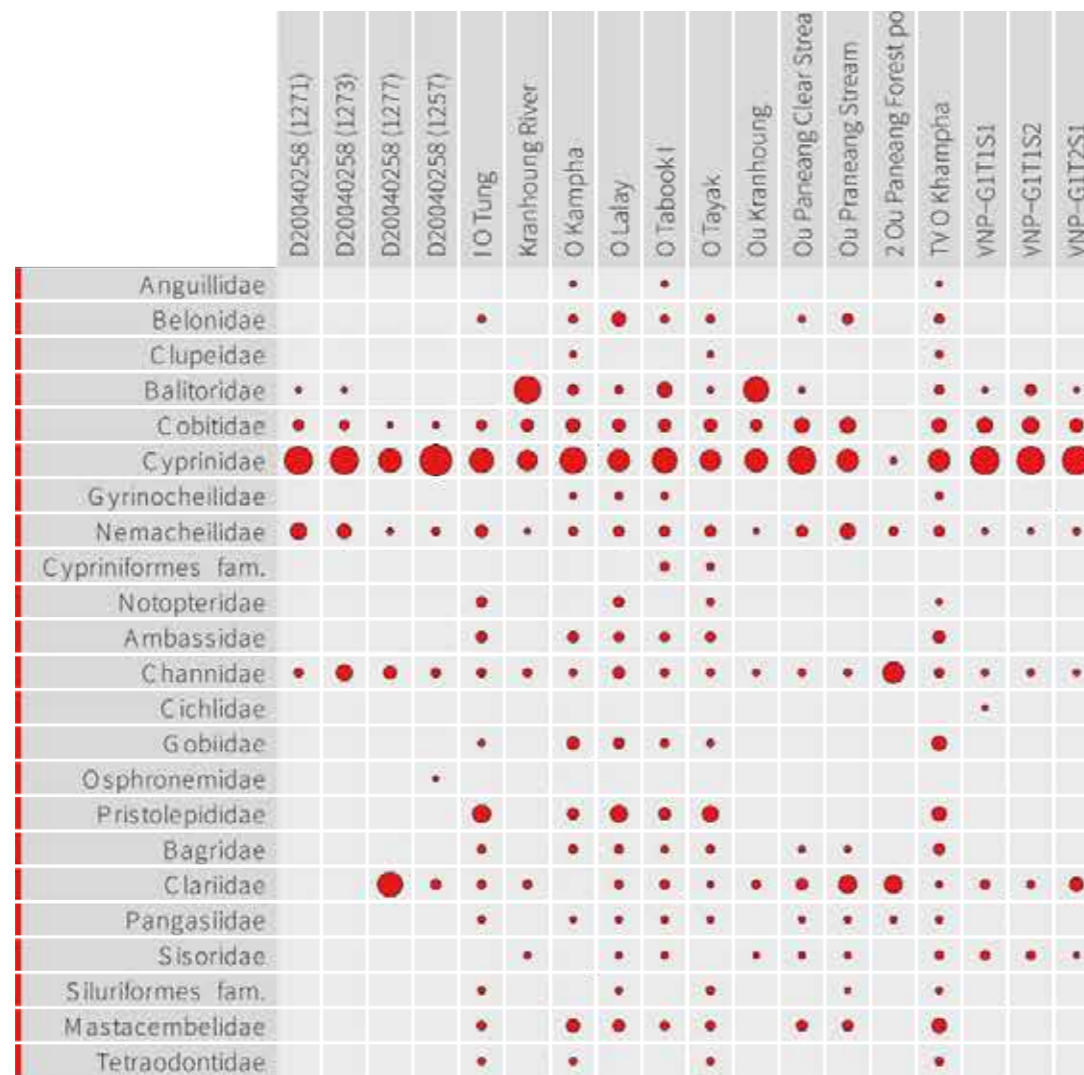
Sample ID	Class	Order	Family	Genus	(IDed Taxa to species)
D20040258 (1271)	3	5	9	10	17 (3)
D20040258 (1273)	2	3	8	6	13 (3)
D20040258 (1277)	4	6	10	10	20 (5)
D20040258 (1257)	4	8	11	12	20 (7)
I O'Tung	4	11	20	29	48 (21)
Kha Nhou River	4	7	12	15	25 (6)
O'Khampha	3	10	19	33	49 (22)
O'Lalay	5	12	24	33	50 (24)
O'Tabok I	5	13	25	42	68 (27)
O'Tayak	4	11	21	42	66 (33)
O'Kha Nhou	4	6	10	14	23 (5)
O'Paneang clear stream	4	8	18	19	30 (10)
O'Paneang stream	4	10	20	21	29 (11)
2 O'Paneang forest pool	4	11	19	17	22 (8)
TV O'Khampha	5	17	30	44	70 (33)
VNP-G1T1S1	5	11	22	23	42 (9)
VNP-G1T1S2	5	8	23	30	49 (17)
VNP-G1T2S1	5	8	14	20	29 (11)

▷ Fig. 2: Fauna & Flora and PDoE staff collecting eDNA samples.



The average species richness was 37.2 and ranged from 13 (D20040258 (1273)) to 70 (TV 2 O'Khampha). The relative proportion of the sequences found in each of the samples is shown in Fig. 1, Fig. 2, and Table 1 and the diversity is summarised in Table 2 and Table 3. A cyprinid species which accounted for 14.5% of the total sequence reads, was among the most abundant in terms of sequences. Among the most commonly detected taxa were the dwarf snakehead *Channa gachua*, a Ranid frog species (likely either *Sylvirana montosa* or *Odorrana banaorum*), and a cyprinid fish species. These species were detected in 18, 18, and 17 of the samples respectively.

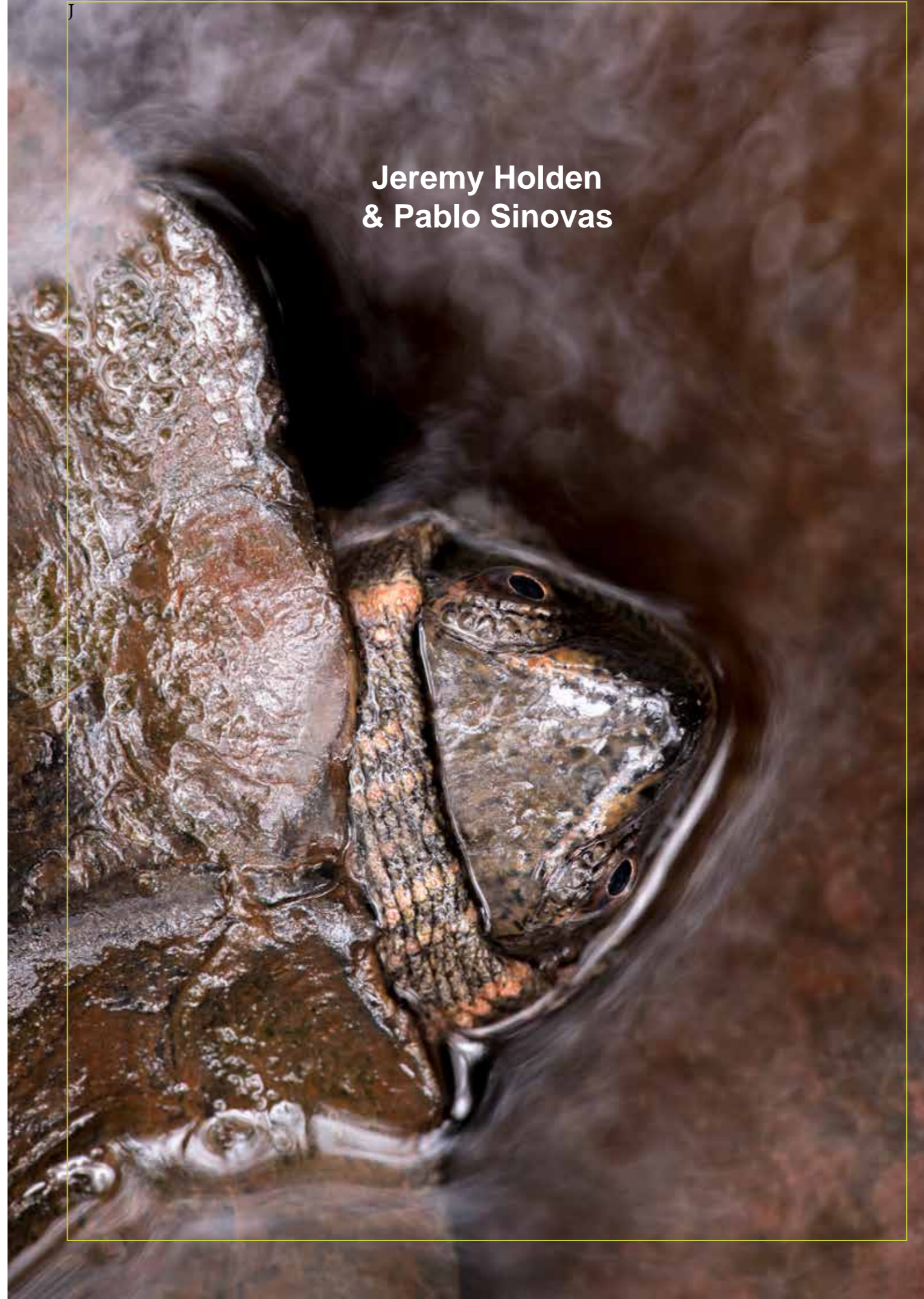
**Fig. 3:** The proportion of the sequencing output allocated to the different families (rows) within each sample (columns). Each bubble per sample represents the proportion of DNA for each family for that sample. The size of the bubble is relative to the number of sequences from all families for that sample.



# HERPETOLOGICAL SURVEY

Title image: *Cyclemys* species, probably *oldhamii* from Veal Thom.

Jeremy Holden  
& Pablo Sinovas





## HERPETOLOGICAL SURVEY VIRACHEY NATIONAL PARK, 2021-2023

### INTRODUCTION

This chapter details the findings made during a series of field surveys in Virachey National Park, Ratanakiri, conducted jointly by Fauna & Flora Cambodia Programme and the Ministry of Environment. The surveys occurred between 25 February 2021 and June 2023, mostly in the dry season. These surveys involved a number of tasks, including setting camera traps, surveying potential camera trapping locations, and photographically recording species of interest over a wide range of taxa. However, this chapter deals with the herpetological finds over this period, with a primary focus on the amphibians of the park.

Despite its size and strategic importance, Virachey National Park has seen limited study throughout most taxa. This is due to the difficulty of accessing much of the park. A number of short herpetological surveys have occurred in Virachey, (Stuart et al. 2006, Rowley et al. 2010) plus additional surveys by Cambodian herpetologist Neang Thy (Geissler et al. 2015). During these surveys, a number of new species and new country records were made, including the discovery of species that were later found to also occur in Vietnam (Stuart & Emmett 2006, Stuart et al. 2010, Stuart & Rowley 2020, Stuart et al. 2020). These findings clearly show that the amphibian fauna in north-east corner of Cambodia is markedly distinct from the majority of the country, with an increasing number of species restricted only to the higher elevation areas of the Annamite Mountains that extend into this corner of the Kingdom.

Siamese crocodile *Crocodylus siamensis* presence and habitat surveys were carried out in March 2023. The survey covered approximately 42 km along the O'Chay and O'Chantong rivers. No sign of crocodiles was encountered and no ideal crocodile habitat discovered. Former presence of *C. siamensis* has been reported from the lowlands of Virachey National Park (Sam et al. 2015) but the absence of recent records suggests that crocodiles no longer inhabit the park.

◁ A male Annam fanged frog *Limnonectes dabanus* in Virachey National Park.





## STUDY AREAS

The park was visited during six field trips leaving from Banlung. Each of the eight areas visited were well within the national park borders, and were previously reported by Ministry of Environment staff to be undisturbed and difficult to access - due to the remoteness of the locations and the mountainous nature of the terrain. Doubts were raised about the possibility of accessing some of the locations within the limited time available. However, this briefing transpired to be overly pessimistic, and although often difficult we managed to successfully reach the target locations. During the surveys, only the Haling Halang area was not accessible via old logging roads. These roads were up to a decade old and many were totally overgrown or had suffered landslides (Fig. 1). For the most part, trails were open enough to allow access by motorbike.

The level of deforestation varied between the survey areas, but showed increased intensity in relation to their proximity to the Vietnamese border. O'Ksach, being the closest we came to the Vietnamese border, appeared to be the worst affected, with major logging roads, large log yards, and evidence of broken canopy forest. Although natural forest cover remained in some of the river valleys, the ridges and hill slopes were almost completely deforested in places. How the original forest cover might have been in these areas is now impossible to determine. During the dry season, the terrain was extremely dry, with virtually no small streams still flowing.

Logging roads and evidence of log yards invaded every area we visited with the exception of Haling Halang and the higher forest around Phnom Yeak Kras. Off the main logging tracks, in areas where logging had occurred, the terrain could be almost impenetrable: a dense thicket of bamboo and bramble with no canopy cover. Moving through the O'Ksach area, our progress (measured by GPS) was sometimes limited to 200 metres per hour, and one direct route we tried to access O'Ksach involved an eight-hour walk to cover less than two kilometres on the map.

◁ Fig.1: Typical overgrown logging road above O'Khampha Touch.

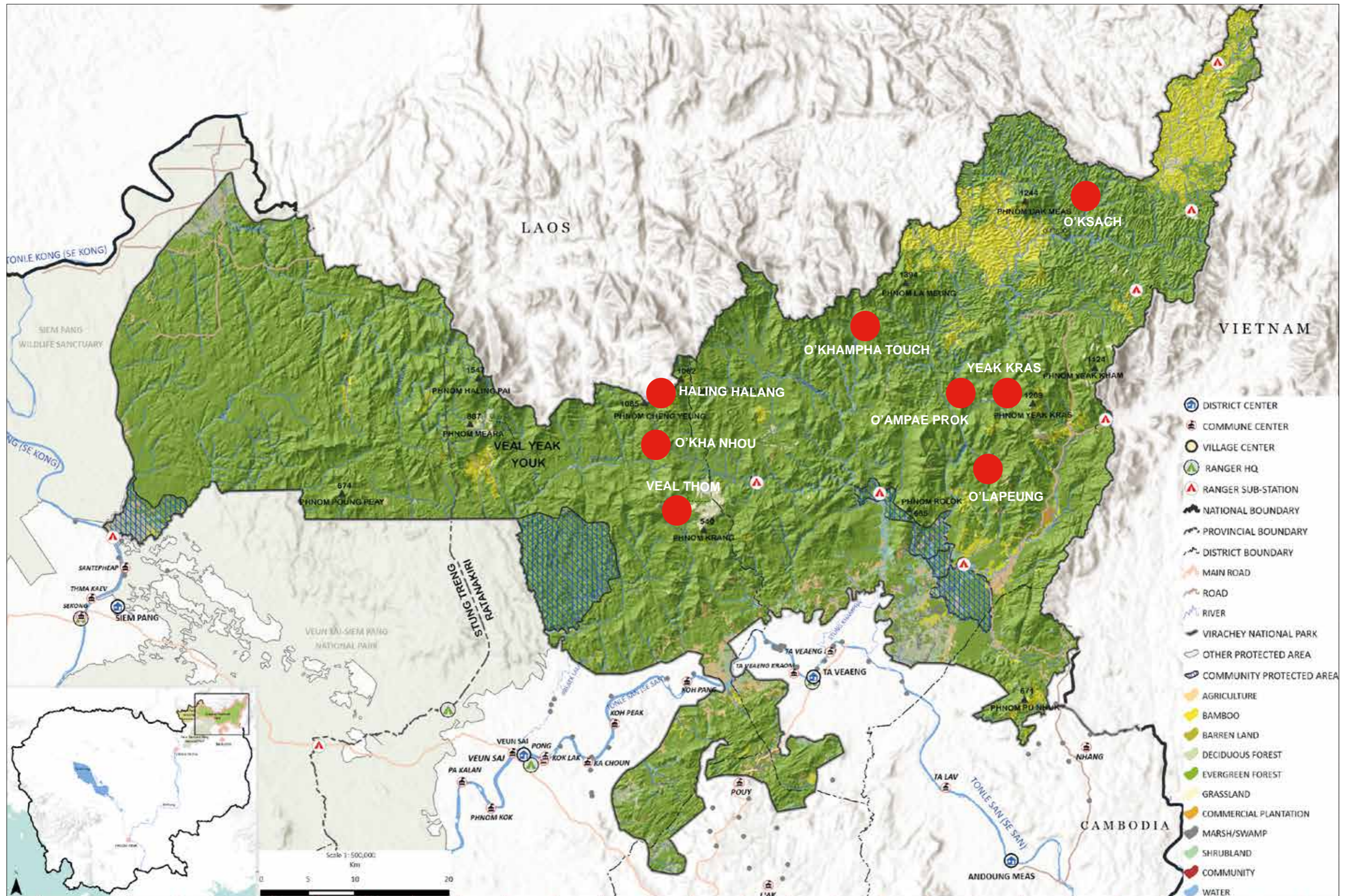


Fig. 2 : Herpetological study areas marked in red.



Fig. 3 : Forest view in north-east Virachey National Park, showing broken canopy.



Fig. 4 : Small shallow stream at the O'Ksach survey location.

Between February 2021 and June 2023 eight areas (Fig. 2) were visited that constituted a variety of different habitat types and altitudes that had a direct bearing on the species we could expect to find. These habitat types could be divided into three main types: Low altitude evergreen forest; mid-altitude grasslands with forested islands, and higher altitude evergreen forest.

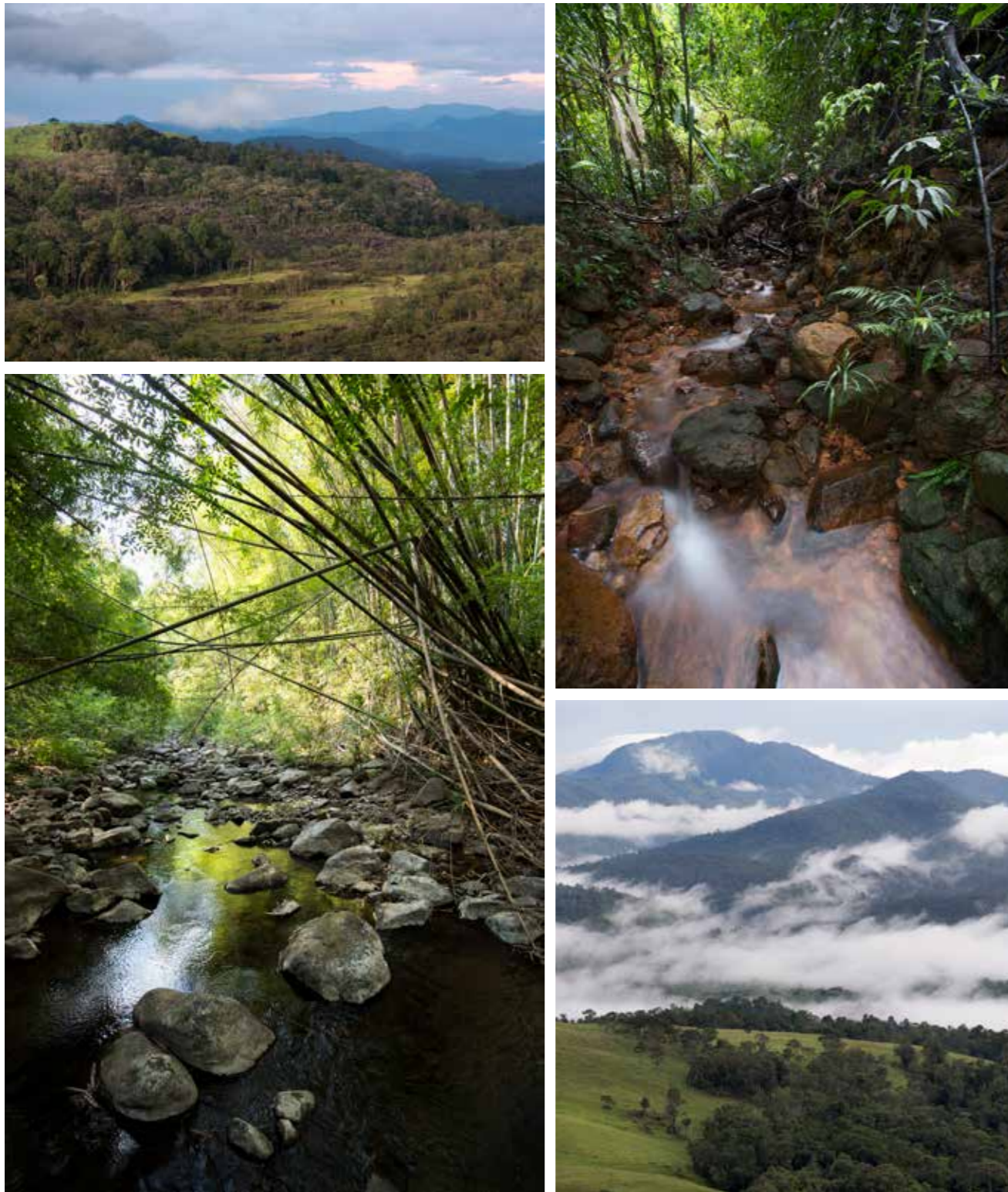
#### Survey locations

**O'Ksach.** The study area here was a small stream between 3-5 metres wide with some small pools and sandy shoals (Fig. 4). The evergreen forest canopy was intact here and the altitude averaged around 800 masl. This area was visited twice, once in February 2021 and again in late March 2023. Both trips occurred during the dry season with camp made at UTM 0764680 1607292.

**Chong O'Ampae Prok** and **Chong O'Lapeung.** These areas had been previously logged, but retained a relatively intact forest in some areas. Altitude was approximately 400-500 masl, with a wide but shallow river and some waterfall features (Fig. 7). Chong O'Lapeung was visited only once; while two trips were made at different camps at Chong O'Ampae Prok - the first in February 2021, the second in April 2023 with a camp at UTM 0748221 1584383.

**Chong O'Khampha Touch** was visited once in late March 2021. Another relatively low altitude site with some evidence of logging, but a largely intact canopy. The survey site was along the O'Khampha Touch River (Fig. 5 ) a four- to five-metre wide water course with some small waterfall features and a series of wide pools. This area was visited in the height of the dry season, perhaps the least optimal time for a herpetological survey in Cambodia.

**Veal Thom** area. This area was the one location in which a prolonged and dedicated herpetological survey was conducted. We spent eight days here towards the latter half of the wet season in September 2022. The survey effort was mostly concentrated on the deep forested gulleys that border the one grasslands. The untouched forest, elevated altitude, and small streams provided the perfect habitat for the Annamitic reptile and amphibian fauna. Our Veal Thom camp UTM



**Fig . 5:** Survey locations clockwise from top left: the Veal Thom grasslands with bordering forest in the wet season 2022; ideal small forest stream in Veal Thom where amphibian surveys were conducted in September 2022; the O'Kha Nhou Valley seen from Veal Thom with the Haling Halang massif behind during the wet season in June 2023; the O'Khampa Touch during the dry season in March 2021.

UTM 0716086 1570405 was at 670 masl and approximately 1 km from the Principle study area in evergreen forest (Fig. 5).

**O'Kha Nhou Valley and Haling Halang foothills.** This area was the most remote location visited during the survey period, and the only one that could not be accessed via old logging roads. The O'Kha Nhou Valley was lowland evergreen forest bordering the O'Kha Nhou. Three camps were made along this section, with the final camp at 900 masl on the flanks of Phnom Haling Halang (UTM 0714705 1579875) close to the Laos border. The O'Kha Nhou was visited in March and June 2023. A base camp at the Haling Halang camp was made for three nights in at the beginning of the wet season in June, giving access to a small stream and primary hill forest with no logging impact (Fig. 5). The Haling Halang camp offered a habitat type and faunal composition found nowhere else in Cambodia.

**Phnom Yeak Kras.** A single night was spent at this location in March 2023, which was situated at around 1100 masl in primary dry hill forest with a small non-flowing stream with remnant water pools. Camp at UTM: 0750670 1582357.



**Fig. 6:** Basalt veal below the Yeak Kras massif.



## METHODS

The nature of the trips – mostly short and peripatetic – meant we couldn't use any longer-term methods, such as pitfall traps targeting the collection of skinks, small snakes and litter-living frogs. Many of the locations were visited only on a single night before moving on to the next camera trapping location. The one dedicated herpetological survey allowed an eight-day search of the forested gullies around Veal Thom, and we had three nights in the foothills of Haling Halang.

When searching specifically for amphibians, searches were made at night using powerful flashlights. During daylight hours, we sought places where reptiles might be hiding: under rocks or fallen logs, beneath bark, or in rock crevices. The majority of the surveys were conducted during the dry season when many reptiles are less active and more likely to be found concealed or in burrows.

These surveys were non-destructive, meaning no herpetological specimens were collected. Instead, live specimens were photographed, either in a natural setting, or from various angles on a white background to allow diagnostics to be clearly seen. The decision to not collect specimens precluded the possibility of describing new species, but fit more with our dedicated conservation ethos to preserve populations of taxa that have a restricted range within Cambodia.

◁Fig.7: Waterfall at O'Ampae Prok where both species of *Odorrana* were found in 2021.

## RESULTS

The results of the herpetological survey were mixed: disappointing for reptiles, but above expectations for amphibians. In total 23 reptile species were found: 6 snakes; 3 skinks, 4 agamid lizards, 3 geckos, 1 glass lizard, 1 true lizard, 1 monitor lizard and 3 turtles (Table 1). A total of 26 amphibians were found (Table 2) making a combined species total of 49.

### Reptiles

With regard to reptiles, these results show an extremely low species total, given the potential number of reptiles expected to occur within Virachey National Park. The primary reason for the low count was undoubtedly the time of year in which the surveys took place, combined with a lesser degree of effort expended in searching for reptiles. The majority of survey work was conducted in the dry season when many reptiles are less active or aestivating. The two surveys made during the wet season (Veal Thom and Haling Halang) produced the highest number of reptile species.

Most of the reptiles found were common species that occur across Cambodia. Only a small percentage were regionally specific, including the snake white-lipped keelback *Hebius leucomystax* a species only known in Cambodia only from the Veal Thom area; Natalia's spiny lizard *Acanthosaura nataliae* is also known only from Virachey National Park. Two of the three geckos found (*Cyrtodactylus* cf. *gialaiensis* - part of the *irregularis* complex) and *Dixonius vietnamensis*) are both species that occur within known species complexes, but genetic study might prove they are separate cryptic species in their own right.

### Amphibians

A greater effort was focused on amphibians, and the 26 species found included all of the recently described regional endemics, plus three species known from Cambodia by only single records, two of which had never been seen as adult frogs. Six species that are known in Cambodia only from Virachey were found but no new species were discovered, and it remains unlikely, although not impossible, that new species occur in the park, given the area's close proximity to Vietnam, a country that has seen a much greater degree of amphibian survey effort.

However, the total species count of 26 species is certainly not the full count expected from Virachey. Although the park is expected to host fewer than 50% of the current count of 75 amphibian species for Cambodia (Holden 2023) additional species certainly occur. Surveys undertaken in some of the lower and more accessible areas of the park should reveal many additional common agricultural and disturbed habitat species that did not occur in the deep forest habitats we surveyed. A single night spent in agricultural land a few kilometres outside Banlung town (results not included here) produced seven common amphibian species that were not encountered in the forest deeper within the park, but would certainly occur in forest closer to villages.

A number of difficult to discover tree frogs, notably from the genus *Theلودerma* are also certainly present but were missed.

Had we been able to make wet season visits to some of the areas only visited during the dry season, additional species would certainly have been discovered, especially those that use temporary water bodies formed during the onset of the first heavy rains.

The potential for additional species of forest Microhylids - notably *Nanohyla* species, and tree frog species, remains high, especially in the higher elevation border areas. In the comprehensive assessment of Indochinese frogs, Poyarkov et al. (2021) in a comprehensive assessment of Indochinese frogs, predicted that a number of species known from Vietnam might extend across the border into Cambodia, most notably the huge Megophryid species *Brachytarsophrys intermedia*.

As expected, frog species composition differed across the various study sites according to altitude and available micro-habitats (Figs. 13-16) with the most interesting assemblages occurring in primary forest above 700 masl.

Table 1: Reptile species found during surveys in Virachey National Park 2021-23.

SPECIES / FAMILY NAME	SCIENTIFIC NAME	SURVEY LOCATIONS							
		HALING HALANG	VEAL THOM	O'AMPAE PROK	O'LAPEUNG	YEAK KRAS	O'KSACH	O'KHA NHOU	O'KHAMPHA
<b>AGAMIDAE</b>									
Chinese water dragon	<i>Physignathus cocincinus</i>			X				X	X
Natalia's spiny lizard*	<i>Acanthosaura nataliae</i>	X							
Forest crested lizard	<i>Calotes emma</i>		X		X				
Indochinese flying lizard	<i>Draco indochinensis</i>	X							
<b>ANGUIDAE</b>									
Sokolov's glass lizard*	<i>Dopasia sokolovi</i>					X			
<b>GEKKONIDAE</b>									
Gia Lai bent-toed gecko	<i>Cyrtodactylus cf. gialaiensis</i> <sup>1</sup>			X					X
Vietnamese leaf-toed gecko*	<i>Dixonius vietnamensis</i> <sup>1</sup>		X						
Common tokay gecko	<i>Gekko (Gekko) gekko</i>			X	X			X	X
<b>LACERTIDAE</b>									
Asian grass lizard	<i>Takydromus sexlineatus</i>		X						
<b>SCINCIDAE</b>									
Many-striped Skink	<i>Eutropis multifasciata</i>			X	X			X	X
Red-tailed ground skink	<i>Scincella rufocaudata</i>	X							
Streamside skink	<i>Sphenomorphus maculatus</i>			X	X			X	X
<b>VARANIDAE</b>									
Water monitor	<i>Varanus salvator</i>		X					X	X
<b>ELAPIDAE</b>									
Malayan krait	<i>Bungarus candidus</i>		X	X					
<b>NATRICIDAE</b>									
Speckle-bellied keelback	<i>Rhabdophis chrysargos</i>			X					
White-lipped keelback*	<i>Hebius leucomystax</i>		X						
<b>COLUBRIDAE</b>									
Red-tailed racer	<i>Gonyosoma oxycephalum</i>								
Lao wolf snake	<i>Lycodon laoensis</i>		X						
<b>VIPERIDAE</b>									
Vogel's pit viper	<i>Trimeresurus vogeli</i>						X		
<b>TESTUIDAE</b>									
Oldham's leaf turtle*	<i>Cyclemys oldhamii</i>		X						
Bourret's box turtle	<i>Cuora bourreti</i>		X						
Asiatic softshell turtle	<i>Amyda cartilaginea</i>								X

\* Species known in Cambodia only from Virachey National Park. <sup>1</sup> Taxonomic status requires further study.



Fig. 8: Chinese water dragon *Physignathus cocincinus* along the O'Ampae Prok.





Fig. 9: From top left: *Cyrtodactylus* cf. *gialaiensis*; *Eutropis multifasciata*; *Physignathus cocincinus*; *Acanthosaura nataliae*; *Varanus salvator*, *Takydromus sexlineatus* ; *Dixonius vietnamensis*; *Calotes emma*.

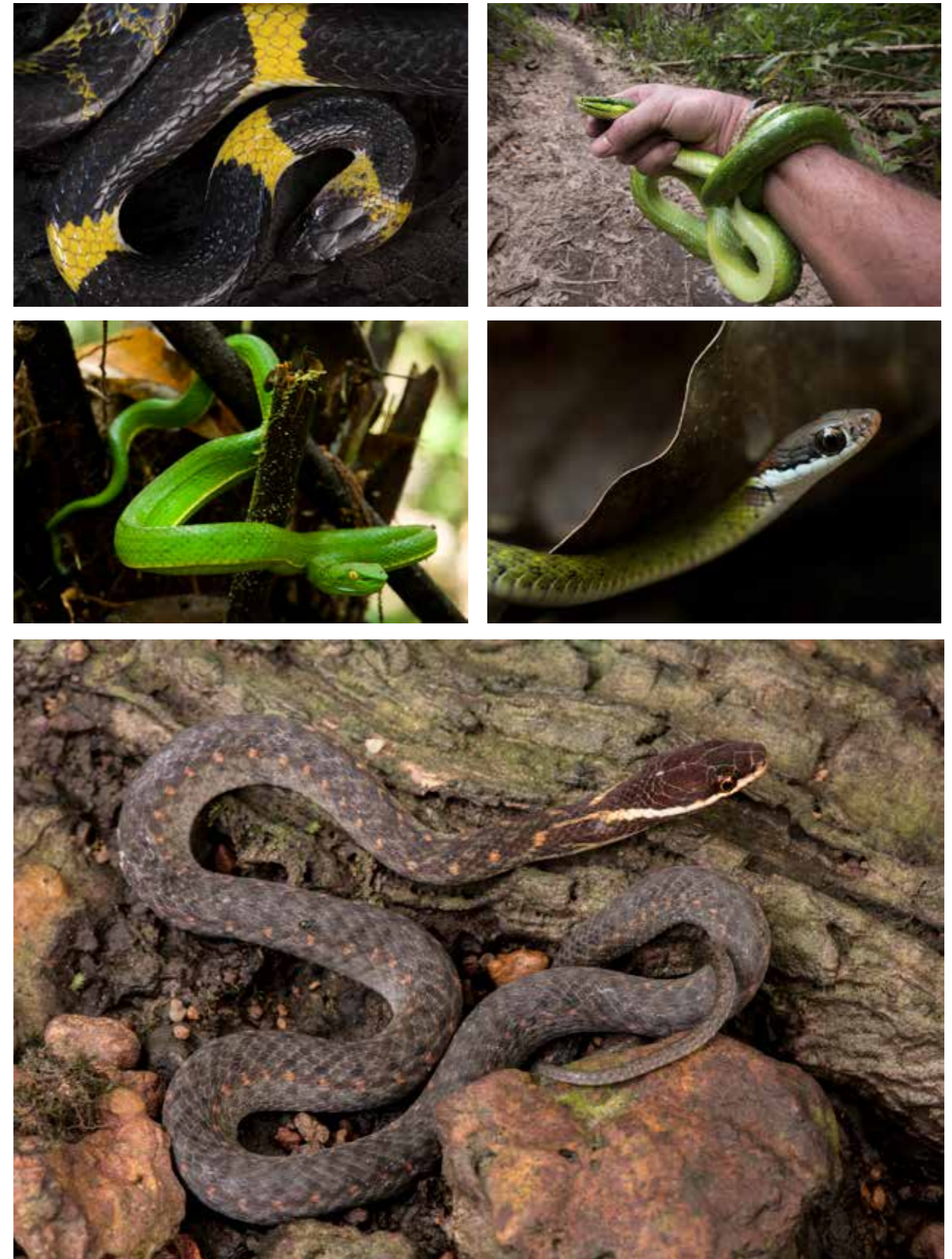


Fig. 10: From top left clockwise: *Lycodon laoensis*; *Gonyosoma oxycephalum*; *Rhabdophis chrysargos*; *Trimeresurus vogeli*; ; Bottom *Hebius leucomystax* from Veal Thom.



Fig. 11: Left: Red-tailed ground skink *Scincella rufocaudata*; Right: Indochinese flying lizard *Draco indochinensis*, both found at the Haling Halang study site in June 2023.

◁ Fig. 12: Gia Lai bent-toed gecko *Cyrtodactylus* cf. *gialaiensis* found in 2021 at O'Khampha.

Table 2: Amphibian species found during surveys in Virachey National Park 2021-23.

SPECIES / FAMILY NAME	SCIENTIFIC NAME	SURVEY LOCATIONS							
		HALING HALANG	VEAL THOM	O'AMPAE PROK	O'LAPEUNG	YEAK KRAS	O'KSACH	O'KHA NHOU	O'KHAMPHA
<b>BUFONIDAE</b>									
Cambodian mountain toad	<i>Ingerophrynus galeatus</i>	X	X	X	X	X	X	X	X
<b>DICROGLOSSIDAE</b>									
Annam fanged frog	<i>Limnonectes dabanus</i>	X	X	X	X	X	X	X	X
Virachey fanged frog*	<i>Limnonectes fastigatus</i>								
Limborg's forest frog	<i>Limnonectes limborgi</i>			X				X	
Poilan's fanged frog	<i>Limnonectes poilani</i>	X	X		X		X		X
Marten's puddle frog	<i>Phrynoglossus martensii</i>		X					X	
<b>MEGOPHRYIDAE</b>									
Similar litter toad*	<i>Leptobranchella isos</i>	X							
Virachey litter toad*	<i>Leptobranchella melica</i>	X	X						
Tay Nguyen spadefoot toad*	<i>Leptobranchium lunatum</i>	X		X		X			
Hansis' mountain toad	<i>Ophryophryne hansii</i>	X	X	X					
Poilan's mountain toad	<i>Ophryophryne poilani</i>	X	X						
Maason horned toad*	<i>Xenophrys maasonensis</i>	X							
<b>MICROHYLIDAE</b>									
Indochinese sticky frog	<i>Kalophrynus interlineatus</i>							X	
Bullfrog	<i>Kaloula sp.</i>								X
Dark-sided narrow-mouthed frog	<i>Microhyla heymonsi</i>			X	X			X	X
Mukhlesur's narrow-mouthed frog	<i>Microhyla mukhlesuri</i>								X
<b>RANIDAE</b>									
Taipei grass frog	<i>Hylarana taipehensis</i>		X						
Bana's odorous frog	<i>Odorrana banaorum</i>			X				X	X
Morafka's odorous frog	<i>Odorrana morafkai</i>			X					
John's frog	<i>Rana johnsi</i>			X					
Mountain stream frog	<i>Sylvirana montosa</i>			X	X		X	X	X
<b>RHACOPHORIDAE</b>									
Loei frilled treefrog	<i>Kurixalus bisacculus</i>							X	
Buon Luoi shrub frog*	<i>Buon Luoi shrub frog</i>						X		
Northern treefrog	<i>Polypedates megacephalus</i>			X					
Dwarf shrub frog	<i>Raorchestes parvulus</i>					X	X		
Annam treefrog	<i>Rhacophorus annamensis</i>	X		X			X	X	
Inger's treefrog	<i>Rhacophorus robertingeri</i>						X	X	

\* Species known in Cambodia only from Virachey National Park.



Fig. 13: Assemblage in lowland forest at O'Ampae Prok: A. *Kurixalus bisacculus*; B. *Phrynoglossus martensii*; C. *Rhacophorus annamensis*; D. *Leptobrachium lunatum*; E. *Limnonectes limborgi*; F. *Kalophrynus interlineatus*; G. *Microhyla heymonsii*; H. *Limnonectes dabanus*; I. *Ingerophrynus galeatus*; J. *Sylvirana montosa*; K. *Rana johnsi*.

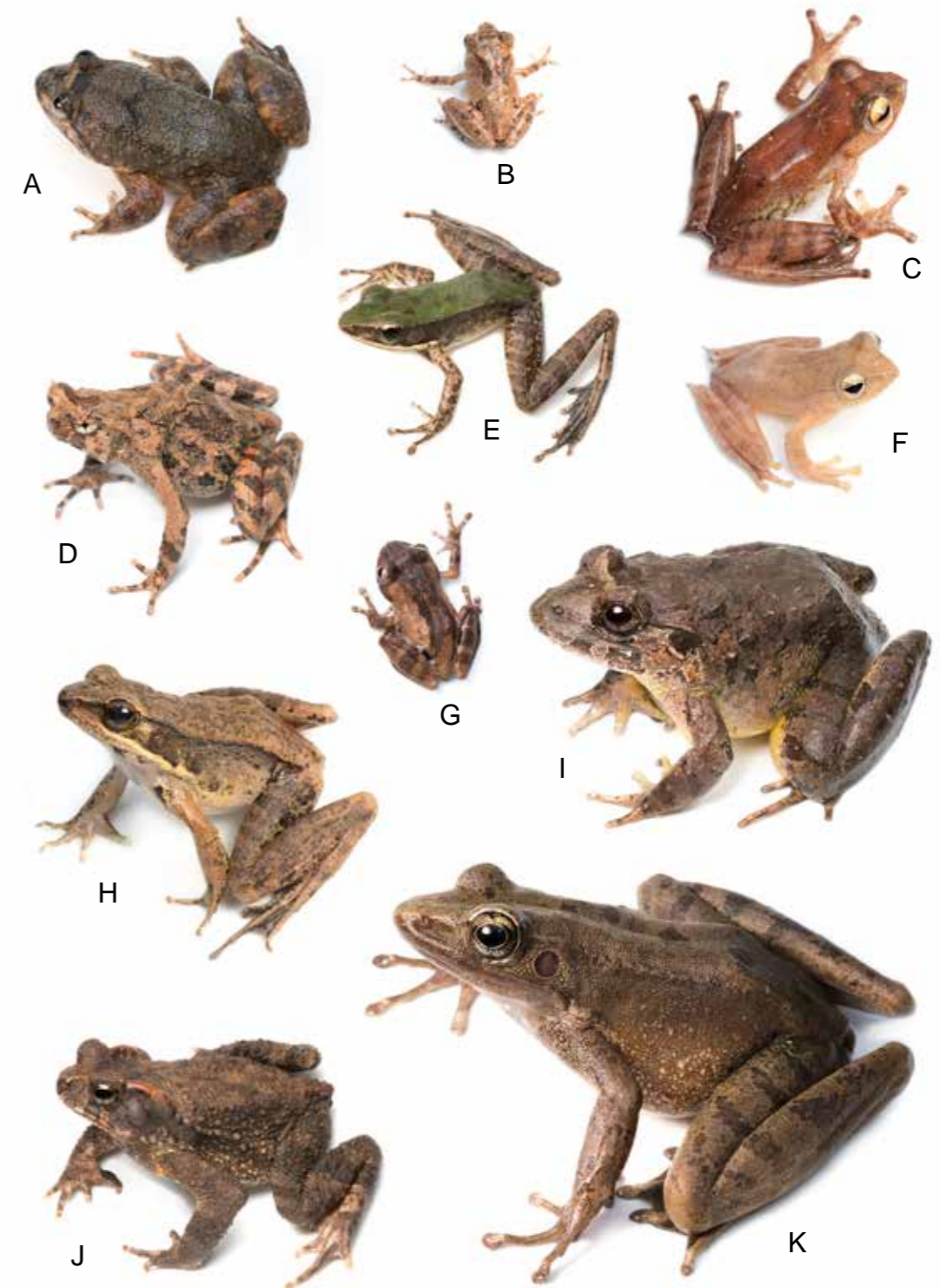


Fig. 14: Assemblage in O'Ksach at 800 masl: A. *Limnonectes fastigatus*; B. *Raorchestes parvulus*; C. *Rhacophorus robertingeri*; D. *Ophryophryne hansii*; E. male *Odorrana banaorum*; F. *Rhacophorus robertingeri*; G. *Philautus abditus*; H. *Sylvirana montosa*; I. *Limnonectes poilani*; J. *Ingerophrynus galeatus* K. female *Odorrana banaorum*.



Fig. 15: Assemblage in Veal Thom at 700 masl: A. *Limnonectes fastigatus*; B. *Phrynoglossus martensii*; C. *Limnonectes dabanus*; D. *Ophryophryne hansii*; E. *Ophryophryne poilani*; F. *Hylarana taipehensis*; G. *Leptobrachella melica*; H. *Limnonectes poilani*; I. *Polypedates megacephalus*; J. *Leptobrachium lunatum*; K. *Ingerophrynus galeatus*.



Fig. 16: Assemblage at Haling Halang at 900 masl: A. *Leptobrachella melica*; B. *Odorrana banaorum*; C. *Rhacophorus robertingeri*; D. *Ophryophryne hansii*; E. *Rhacophorus annamensis*; F. *Ingerophrynus galeatus*; G. *Limnonectes dabanus*; H. *Ophryophryne poilani*; I. *Limnonectes poilani*; J. *Leptobrachella isos*; K. *Limnonectes fastigatus*; L. *Xenophrys maosonensis*.

### Species of interest

During these surveys, neither species new to science nor any new country records were found. However, additional records and new site locations were made for a number of amphibian species. Prior to this work the small bush frog *Philautus abditus* was known in Cambodia from a single juvenile specimen collected in from a small patch of forest in Veal Thom. We found the first adult record for this species in Cambodia at around 800 masl in along the O'Ksach stream in March 2023. At the Haling Halang site we found the first breeding population of *Xenophrys maasonensis*. This species was previously also know from only a single juvenile specimen (Emmett 2006) collected in the east of Virachey. We observed this species breeding along the upper O'Kha Nhou River at around 900 masl in June (Fig. 17). The frogs were noisily active at this time, calling from boulders along the stream, sometimes even in daylight hours.

In the same section of the O'Kha Nhou (Fig. 20) we observed breeding activity of *Leptobrachella isos*, (Fig.17) noting the females pursuing the males beneath the surface of the water and depositing eggs underneath small rocks in the stream. The smaller *L. melica* was also observed in lower numbers. *Leptobrachella isos* was first discovered in Virachey (Rowley et al. 2015) and was thought to be endemic to Cambodia until it was discovered close to the border in Vietnam. However, this species remains extremely difficult to find unless it is actively breeding and its insectile calls allow it to be located. *Leptobrachella melica* was another species first described from Cambodia. Small parties of this species was heard calling from concealed positions along a small stream in Veal Thom in September. Although this species was found in Haling Halang in June, it did not appear to be breeding, suggesting that it does not breed simultaneously with *L. isos*.

Six of the reptiles observed were species known in Cambodia only from Virachey. White-lipped keelback *Hebius leucomystax* has been recorded only twice, both times from Veal Thom. A sighting of *Dopasia sokolovi* by the PDoE rangers on Yeak Kras may be the first Cambodian record. This species was recorded only as a



**Fig. 17:** Above: a female *Xenophrys maasonensis* found at 900 masl along the upper O'Kha Nhou - the first adult record for this species in Cambodia. Below: an actively calling male *Leptobrachella isos* from the same location in June.



Fig. 18: *Philautus abditus* from O'Ksach - the first adult of this species seen in Cambodia.



Fig. 19: *Rana johnsi* from O'Ampae Prok - the first record of this species from Virachey National Park, and only the second record from Cambodia.



low resolution image on a mobile phone camera (Fig. 21) but was easily identified. Another record made outside of the herpetological survey work was evidence of the Asiatic soft shell turtle *Amyda cartilaginea* picked up as an eDNA signature from the O'Khampha.



Fig. 21: Left: Sokolov's glass lizard *Dopasia sokolovi* found on Phnom Yeak Kras by PDoE staff; Right above: Vietnamese leaf-toad gecko *Dixonius vietnamensis*, and below right Gia Lai bent-toed gecko *Cyrtodactylus* cf. *gialaiensis* are both restricted to the north-east in Cambodia and form part of complexes that undoubtedly contain undescribed cryptic species.

◁ Fig. 20 : The upper O'Kha Nhou below Phnom Haling Halang where *Xenophrys maasonensis* and *Leptobrachella isos* frogs were observed breeding in June 2023.





## CONCLUSION

The foremost conclusion drawn from this series of trips to Virachey National Park is that the dry season does not represent the best time to conduct herpetological surveys in this area of Cambodia. The paucity of snakes and geckos discovered during the surveys is most likely due to the dry conditions. Due to the peripatetic nature of the work, we didn't use pit fall traps, something that would certainly have increased the species count had we employed this technique.

In recent years a series of short herpetological surveys in Virachey and the adjacent Veun Sai areas have produced a number of both new species to science and new country records for both reptiles and amphibians (Geissler et al. 2012, Rowley et al. 2015, Stuart et al. 2020). This indicates that both new country records and even new species await discovery in Virachey.

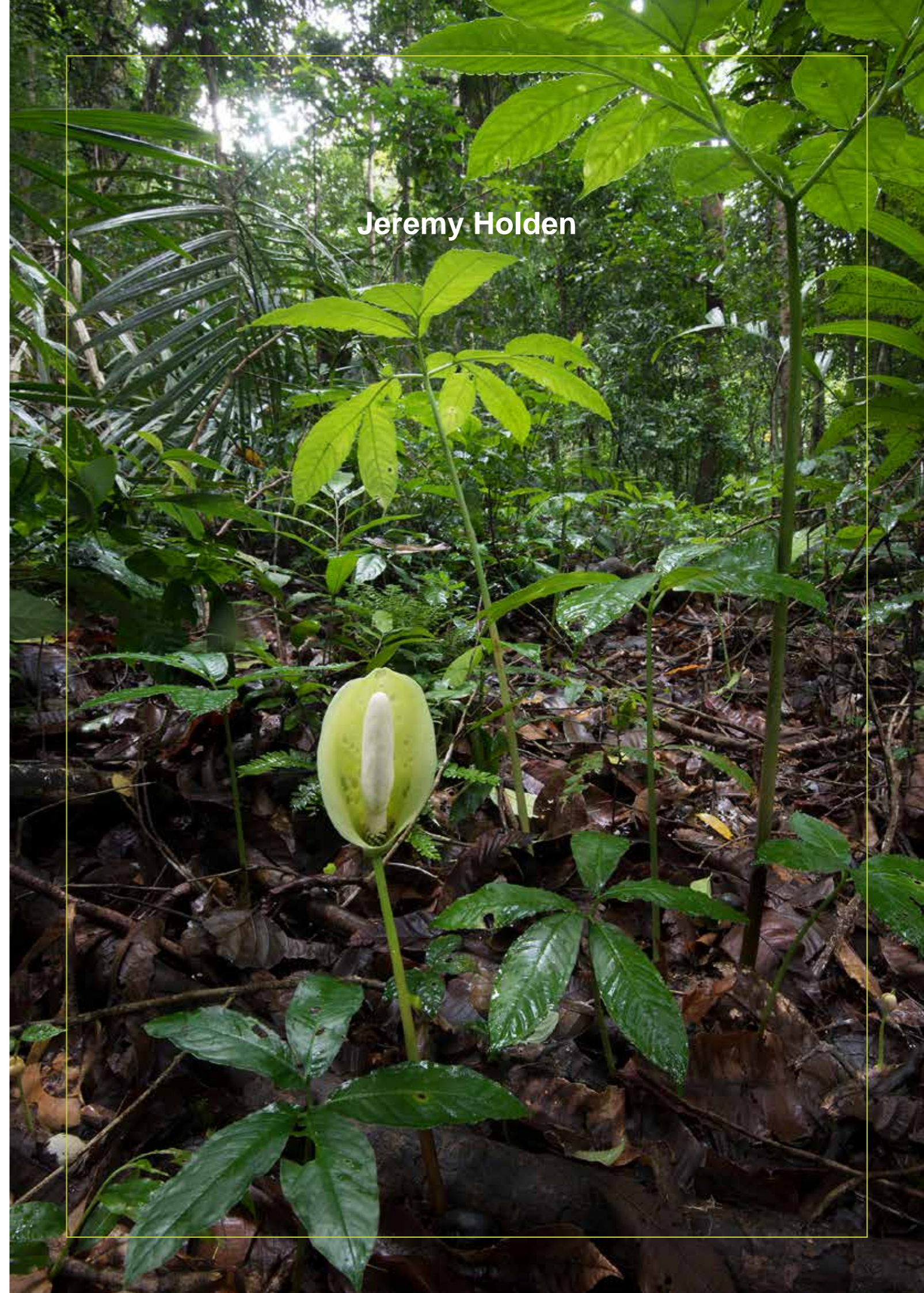
The amphibians surveys were altogether much more successful, with adults of *Xenophrys maosonensis* and *Philautus abditus* being seen for the first time in Cambodia. Our records of *Rana johnsi* from O'Ampae Prok represent the second record from Cambodia and the first from Virachey. Discovering new populations of both of the newly described *Leptobrachella* species illustrates the importance of the higher elevation areas of Virachey, as both of these frogs are restricted to the Kon Tum Plateau and difficult to find - and as of 2024, no female of *Leptobrachella melica* has yet been seen in either Cambodia or Vietnam.

The low diversity of reptiles we encountered clearly means there is much that missed. It is certain that some amphibian species were also missed. What is clear, is that in a Cambodian context, Virachey National Park remains the only location in the Kingdom where many regionally endemic reptiles and amphibians exist, and its loss would spell the loss of these species from the country list.

◁Fig. 22 : The highly cryptic markings of the Indochinese flying lizard *Draco indochinensis* make it particularly difficult to find. This individual was seen on the slopes of Phnom Haling Halang.

## ADDITIONAL RECORDS

Title image: *Amorphophallus* (*tonkinensis* sensu lato) from Haling Halang.





## ADDITIONAL RECORDS VIRACHEY NATIONAL PARK, 2021-2023

### INTRODUCTION

This brief chapter details some additional discoveries made during the field surveys in Virachey National Park between 2021-2023 that did not fit into any of the previous chapters.

Over the course of numerous field trips throughout Virachey National Park, either to place camera traps or while surveying for amphibians and reptiles, a number of other taxa were recorded. These ranged from fungi, through to unusual plants, orchids and insects. Every effort was made to correctly identify these additional finds and various experts from around the world were consulted. In some cases, we potentially discovered new species, while in others we made the first country records for species previously not known to occur in Cambodia.

### BOTANICAL RECORDS

The most notable botanical discovery was a ginger in the genus *Meistera* (formerly *Amomum*). With help from ginger expert Mark Newman at the Royal Botanical Garden Edinburgh, this was identified as *Meistera celsa*, a species previously known only from two localities in Vietnam and Laos. Furthermore, the location in Laos (probably where the species was first discovered) is now unknown, and the two Vietnamese locations both destroyed. As well as being a new record for the Cambodian flora list, Virachey might now be the only place that this species is known to occur (Fig. 2). This plant was found flowering in two locations in O'Ampae Prok and one location in O'Khampha in March 2021. In both locations it was found growing beside the trail in extremely dry soil at between 250-300 masl. Some herbarium samples were collected (inexpertly) – both flowering heads (some with seed capsules) and leaves. These were deposited with the herbarium staff at the Royal University of Phnom Penh for proper treatment and storage.

◀ Fig. 1: *Cyrtosia nana* orchid seen at Haling Halang in June 2023.



Fig. 2: *Meistera celsa* a rare ginger species. Samples sent to the herbarium at RUPP (above). *Meistera celsa* flowering (below) a species now known only from VNP.



Fig. 3: *Amorphophallus (tonkinensis s.l.)* inflorescence found in Haling Halang in June 2023.

In the higher elevation primary forests around the Haling Halang massif a number of Aroid species were observed. The most notable of these was a small *Amorphophallus* species that fit within the *A. tonkinensis* group. No specimens of this plant were collected, but detailed photographs of the leaves and inflorescence were made (Fig. 3) as well as images of the plant in habitat (Title image). The flowering period appears to be June-July. Expert opinion on this taxa (Hettterscheid and Serebryanyi pers. comm.) suggests this plant could be an undescribed species within the *tonkinensis* group. Either way, this represents a new country record for Cambodia. It is unlikely a full determination can be made without collecting herbarium specimens for analysis. Further surveys in the Haling Halang area could lead to further new records for the *Amorphophallus* genus, a group that has had little study in Cambodia despite the geographic importance the country holds for this genus.

In the deep forested gorges around the Veal Thom grasslands the epiphytic aroid *Anadendrum badium* was recorded (Fig. 5).



Fig. 4: *Argostemma* species seen flowering along the upper O'Kha Nhou in June 2023.



Fig. 5: The epiphyte *Anadendrum badium* seen flowering near Veal Thom in September 2021.

From a botanical perspective, the Haling Halang area appeared to be the richest, at least for small terrestrial species, likely due to the higher elevation and greater precipitation. Two species of *Argostemma* were recorded growing on boulders along the upper O'Kha Nhou (Fig.4). In these damper forests, two parasitic plants were seen - the relatively common ginger parasite *Aeginetia indica*, and the scarcer *Christisonia scortechinii* (Fig. 6) that parasitizes the bamboo *Racemobambus gibbsiae*. This species is known from Cambodia but does not appear as occurring here on the official Kew Garden website.

Very few flowering orchids were recorded during the surveys. In O'Ampae Prok in March two common species - *Dendrobium farmeri* and *Dendrolirium latisepalum* were seen in bloom; while *Phalaenopsis pulcherrima* was seen growing on basaltic outcrops around Veal Thom (Fig. 8). The most notable orchid record was of the holomycotrophic orchid *Cyrtosia nana* (Figs.1 & 7) that feeds on decaying leaf matter and does not use photosynthesis. This record is the first from Cambodia.

A single carnivorous plant species - *Utricularia* (possibly *minutissima* but a definitive determination is pending) was seen at Veal Thom in September 2023 (Fig. 9).



Fig. 6: *Christisonia scortechinii* along the upper O'Kha Nhou in June 2023.



Fig. 7: *Cyrtosia nana* flower, seen at 900 masl on Haling Halang in June 2023.



Fig. 8: *Phalaenopsis pulcherrima* a lithophytic orchid in Veal Thom.



Fig. 9: A diminutive carnivorous bladderwort, *Utricularia* species, as yet undetermined, seen in on rocky outcrops around Veal Thom.



## INSECT RECORDS

No specific entomological survey was undertaken during this work, but some scattered records were made and are included below.

The most notable record is represented by *Faunis eumeus incerta* a butterfly of the shady forest floor. This species was seen and photographed in O'Lapeung in February 2021 and is the first record of this species in Cambodia (Fig. 1).

During a five-day survey at O'Khampha Touch, an effort was made to record butterfly species seen along the river (Figs. 2 & 3). A sample of the butterfly diversity encountered in February 2021 includes 52 species (Table 1.).



Fig. 1: *Faunis eumeus incerta*, a new country record for Cambodia, seen at O'Lapeung in mixed deciduous and bamboo forest.

◁ Common cruiser *Vindula erota* and common leopard *Phalanta phalantha* butterflies at O'Khampha Touch in February 2021.

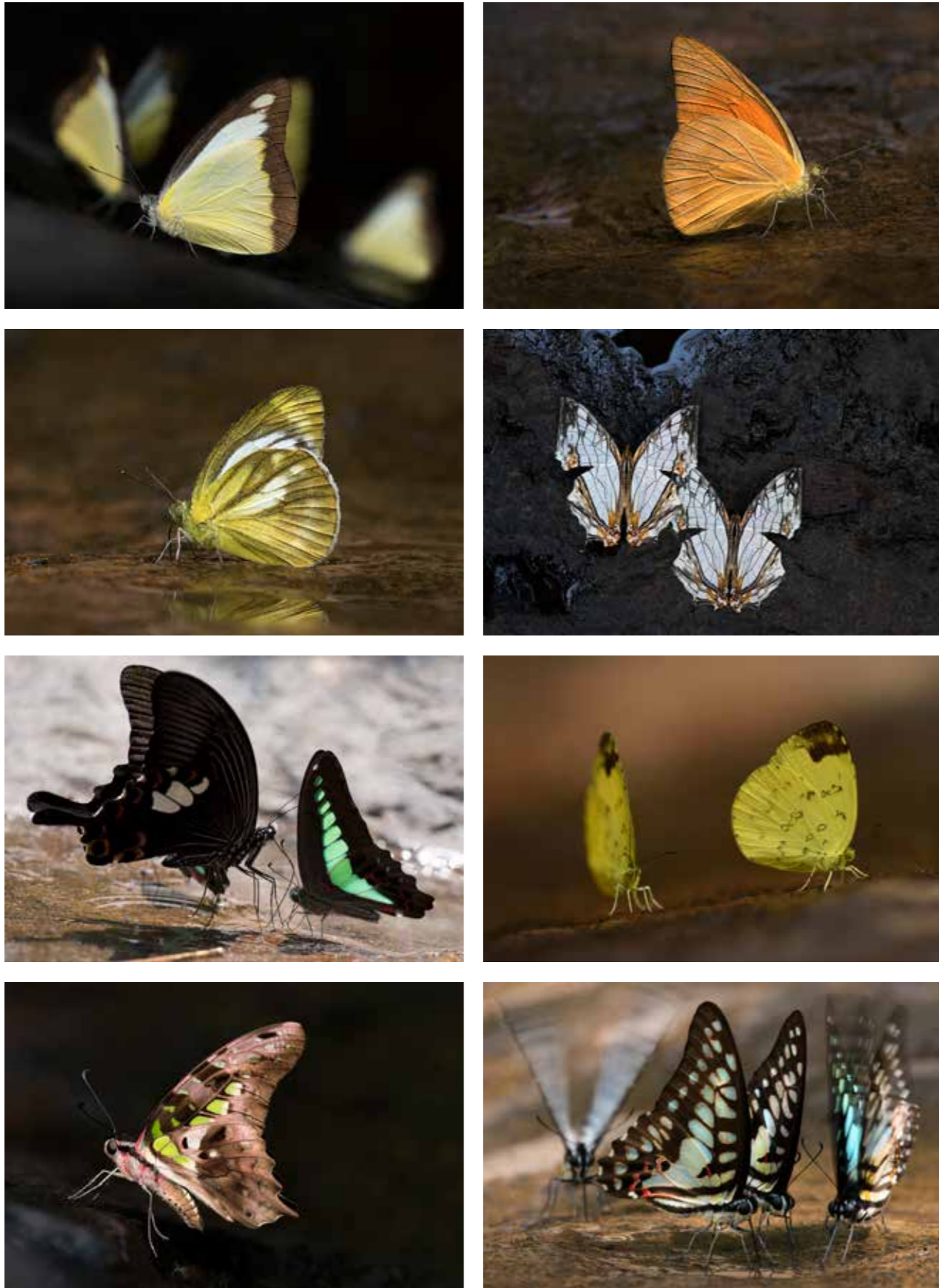


Fig. 2: Numerous butterfly species seen at the O'Khampa camp.



Fig. 3: Eight species of the numerous Lycaenid blues seen in Virachey.





**Table 1.** Butterfly species recorded and identified in February-March 2021 in O'Khampha and O'Lapeung areas.

<b>Lycaenidae</b>	<i>Graphium sarpedon</i>	<b>Nymphalidae</b>
<i>Acytolepis puspa gisca</i>	<i>Lamproptera meges</i>	<i>Cirrochroa surya</i>
<i>Caleta elna</i>	<i>Papilio helenus</i>	<i>Cyrestis thyodamas</i>
<i>Discolampa ethion</i>	<i>Papilio memnon</i>	<i>Faunis canens</i>
<i>Megisba malaya</i>	<i>Troides aeacus</i>	<i>Faunis eumeus</i>
<i>Nacaduba berenice aphyia</i>	<i>Troides helena</i>	<i>Junonia orithya</i>
<i>Nacaduba hermus</i>		<i>Lebadea martha</i>
<i>Nacaduba pavana</i>	<b>Pieridae</b>	<i>Lexias albopunctata</i>
<i>Prosotas dubiosa indica</i>	<i>Appias albina</i>	<i>Lexias pardalis</i>
<i>Zizina otis</i>	<i>Appias lycida</i>	<i>Moduza procris</i>
	<i>Appias nero</i>	<i>Phalanta phalantha</i>
<b>Hesperidae</b>	<i>Cepora nadina</i>	<i>Parthenos sylvia</i>
<i>Bibasis sena</i>	<i>Delias berinda</i>	<i>Polyura athamas</i>
<i>Halpe zema</i>	<i>Eurema hecabe</i>	<i>Polyura delphis</i>
<i>Thoressa masoni</i>	<i>Hebomoia glaucippe</i>	<i>Polyura eudamippus</i>
	<i>Ixias pyrene</i>	<i>Thaumantis diores</i>
<b>Papilionidae</b>	<i>Prioneris philonome</i>	<i>Vagrans egista</i>
<i>Graphium agamemnon</i>		<i>Vindula erota</i>
<i>Graphium bathycles</i>	<b>Satyridae</b>	
<i>Graphium antiphates</i>	<i>Orsotriaena medus</i>	
<i>Graphium eurypylus</i>	<i>Ragadia critolaus</i>	
<i>Graphium nomius</i>	<i>Xanthotaenia busiris</i>	

◁ The large black swallowtail *Papilio helenus* 'puddling' along the O'Khampha Touch in March 2021.

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▽ Department of Environment ranger and local guides from the Brao ethnic minority in the undisturbed forest of the upper O'Kha Nhou Valley.





# Fauna & Flora

Saving Nature Together

Fauna & Flora works to conserve threatened species and ecosystems worldwide, choosing solutions that are sustainable, based on sound science and take account of human needs.

Our vision is to help create a sustainable future for the planet, where biodiversity is effectively conserved by the people who live closest to it, supported by the global community.





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