Draft Environment and Social Impact Assessment

Project Number: 55205-001
29 April 2022

Lao PDR: Monsoon Wind Power Project
Part 18: Appendix F (part 4)

Prepared by Impact Energy Asia Development Limited (IEAD) for the Asian Development Bank.

Monsoon Wind Power Project, Sekong and Attapeu Provinces, Lao PDR

Environmental and Social Impact Assessment

29 April 2022

Project No.: 0598121

The business of sustainability

ERM

Document details	
Document title	Monsoon Wind Power Project, Sekong and Attapeu Provinces, Lao PDR
Document subtitle	Environmental and Social Impact Assessment
Project No.	0598121
Date	29 April 2022
Version	2.0
Author	Aurora Finiguerra, Cheryl Ng, Elaine Wong, Hoa Tran, Jacopo Ventura, Mingkwan Naewjampa, Shubhankar Khare, Tirapon Premchitt, Winee Tammaruk
Client Name	Impact Energy Asia Development Limited (IEAD)

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
1	1.1	As above	Kamonthip Ma-Oon, Sabrina Genter, Les Hatton, George Chatzigiannidis, Simone Poli, Aniket Jalgaonkar	Kamonthip Ma-Oon	18-02-22	Draft to IEAD
1	1.2	As above	As above	Kamonthip Ma-Oon	25-02-22	Draft to IEAD
1	1.3	As above	As above	Kamonthip Ma-Oon	23-03-22	Draft to IEAD and ADB
1	1.4	As above	As above	Kamonthip Ma-Oon	30-03-22	Draft to IEAD and ADB
1	1.4	As above	As above	Kamonthip Ma-Oon	21-04-22	Draft to IEAD and ADB
2	2.1	As above	As above	Kamonthip Ma-Oon	29-04-22	Final ESIA Report

APPENDIX F BIODIVERSITY BASELINE SURVEY REPORTS

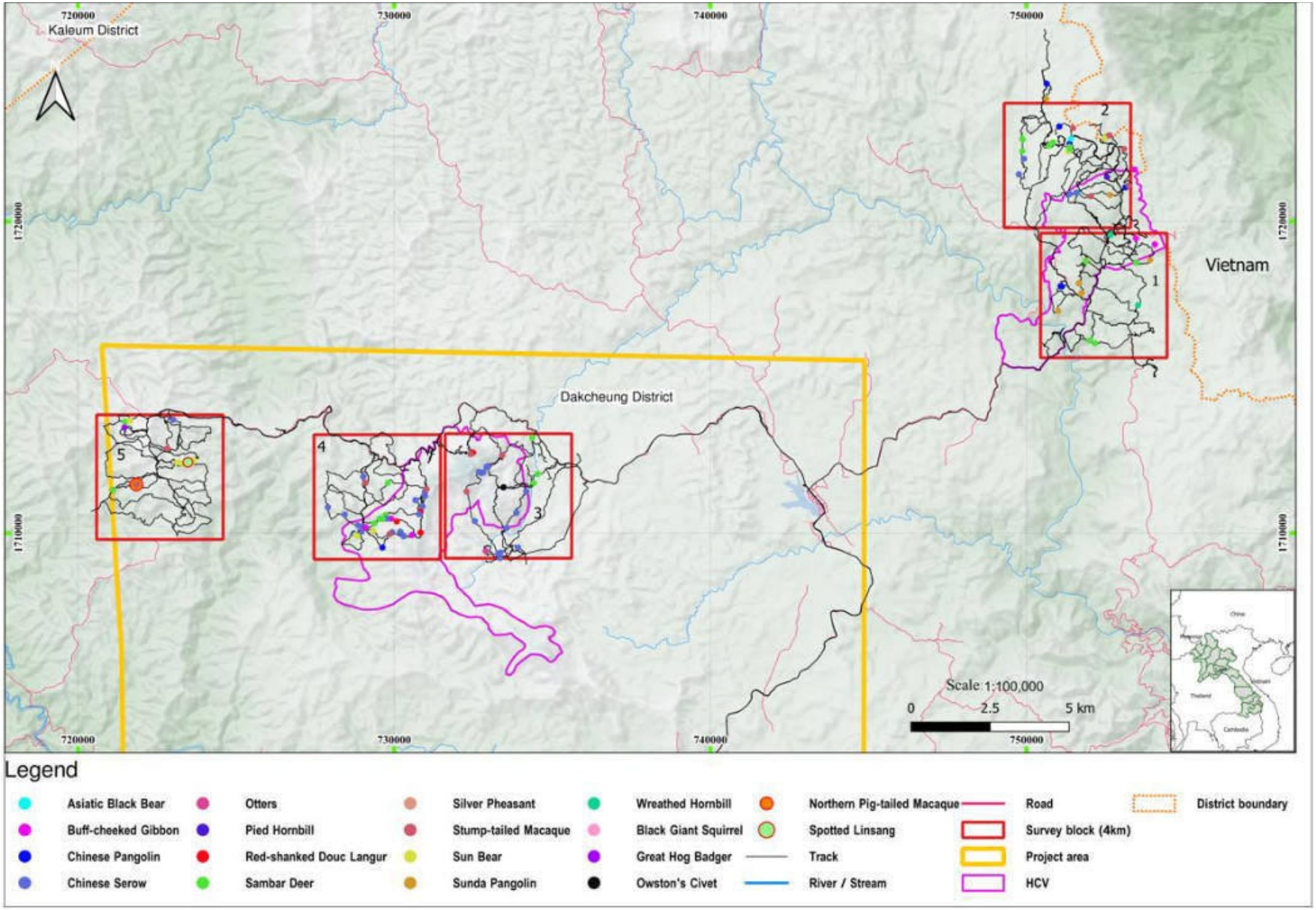


Figure 14. Locations of key wildlife species in the survey blocks

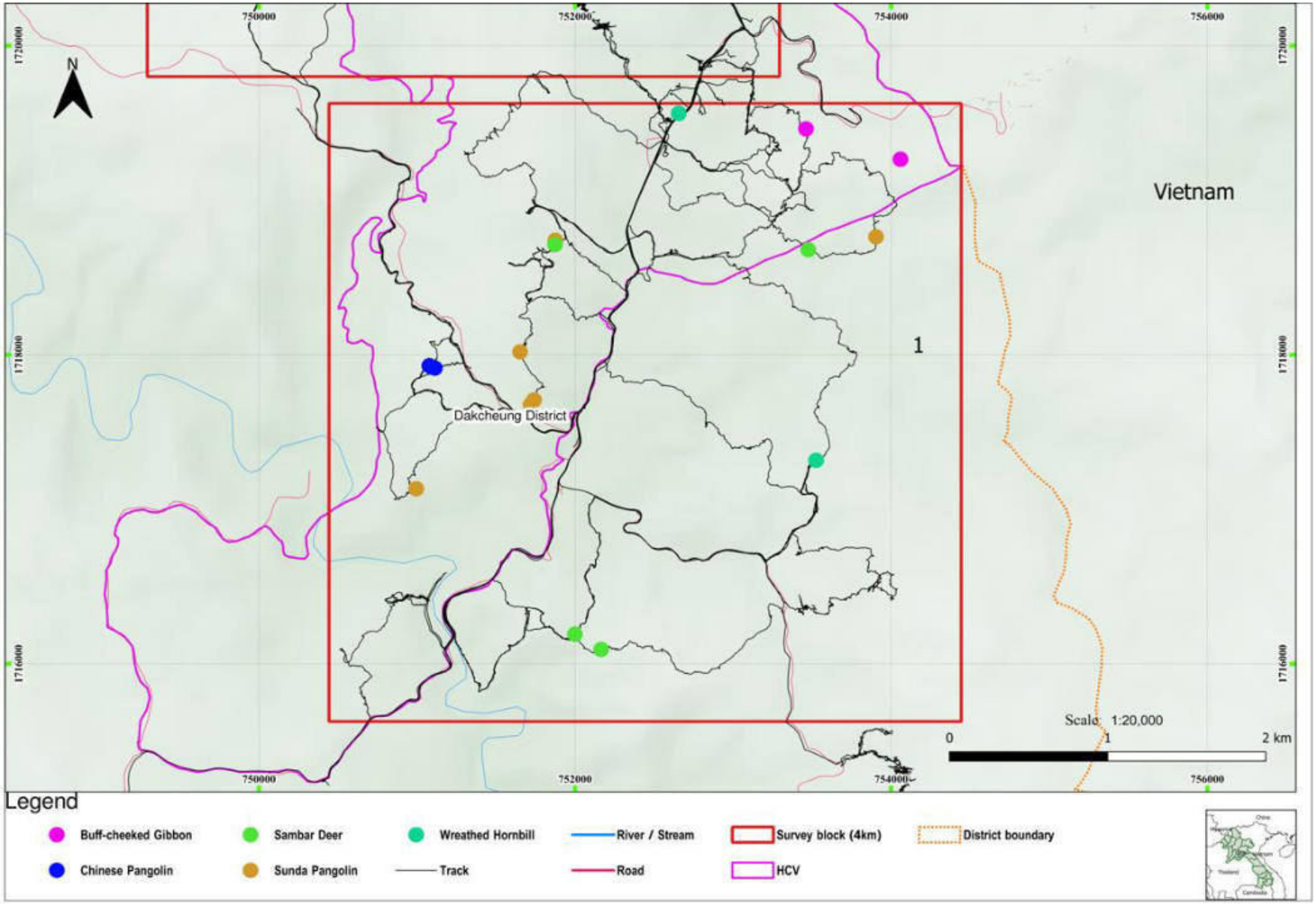


Figure 14a. Locations of key wildlife species in the survey block 1

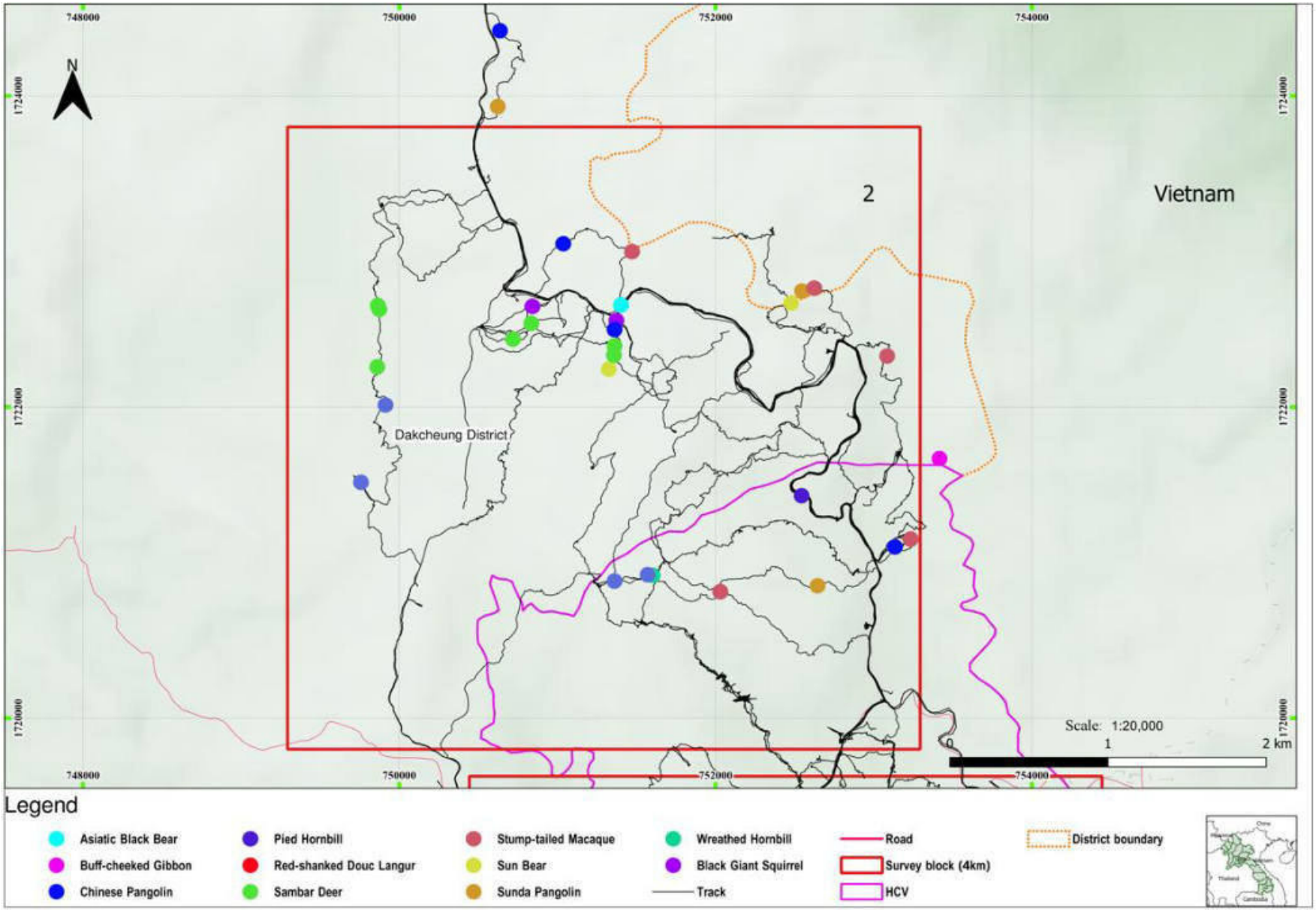


Figure 14b. Locations of key wildlife species in the survey block 2

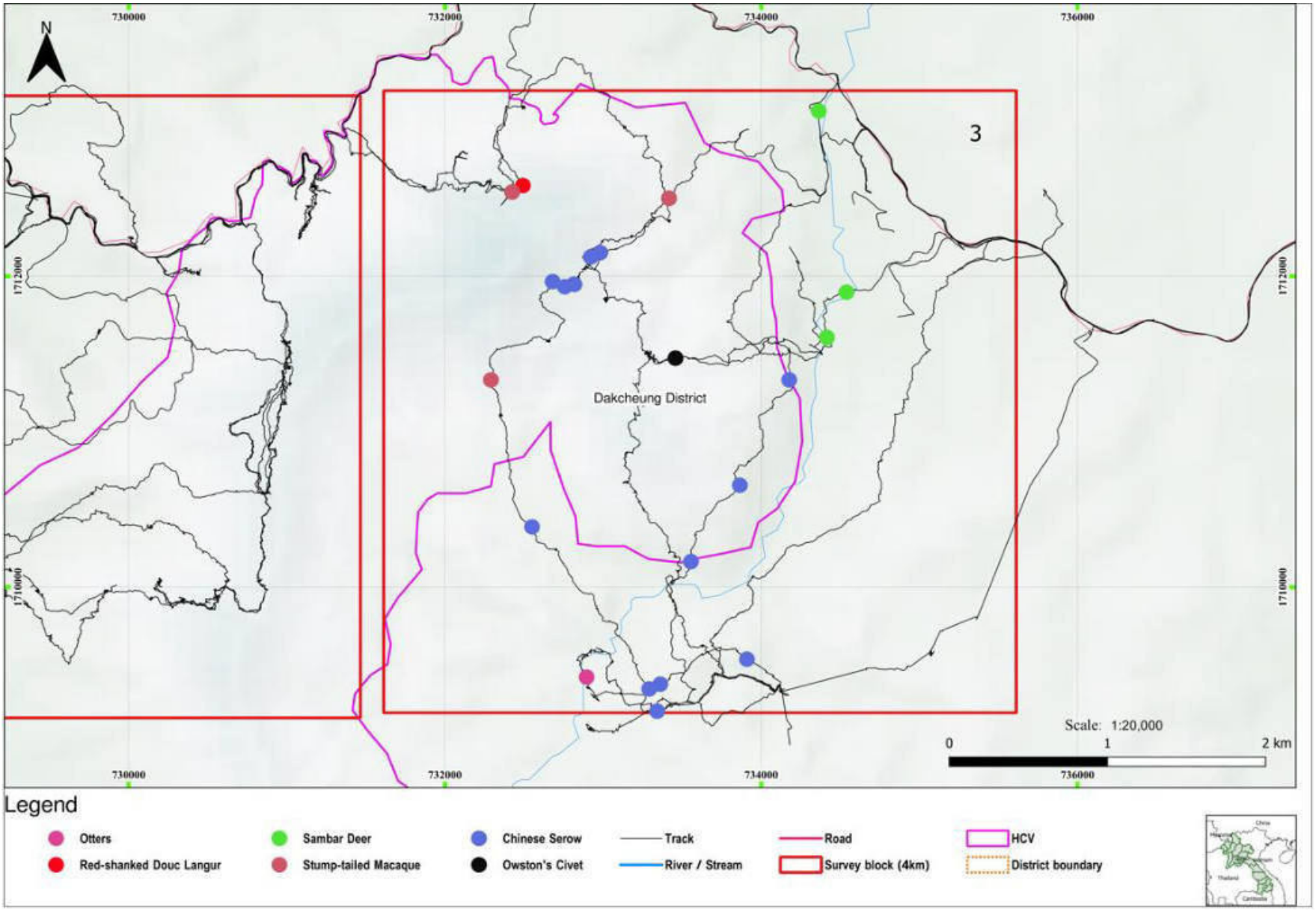


Figure 14c. Locations of key wildlife species in the survey block 3

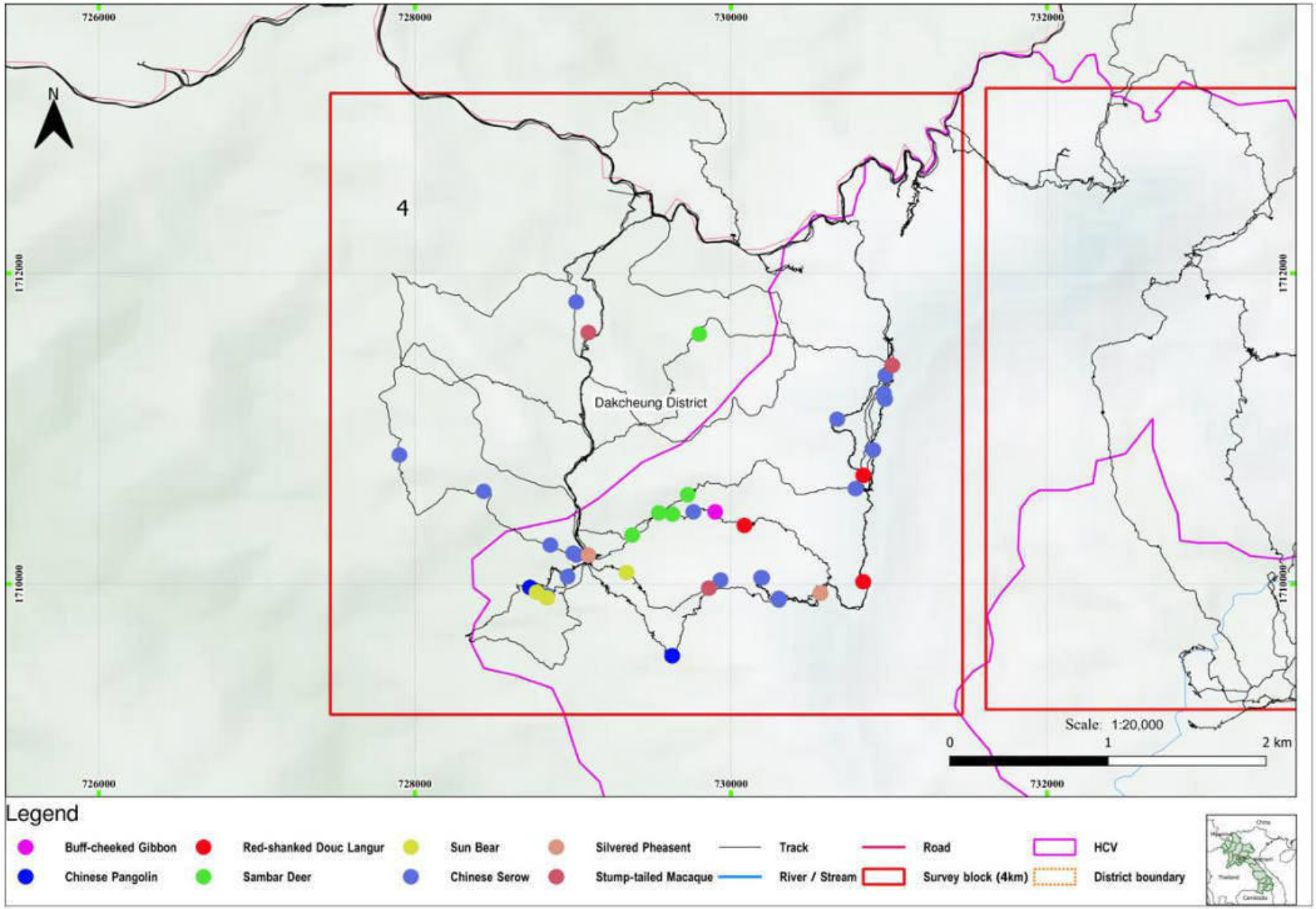


Figure 14d. Locations of key wildlife species in the survey block 4

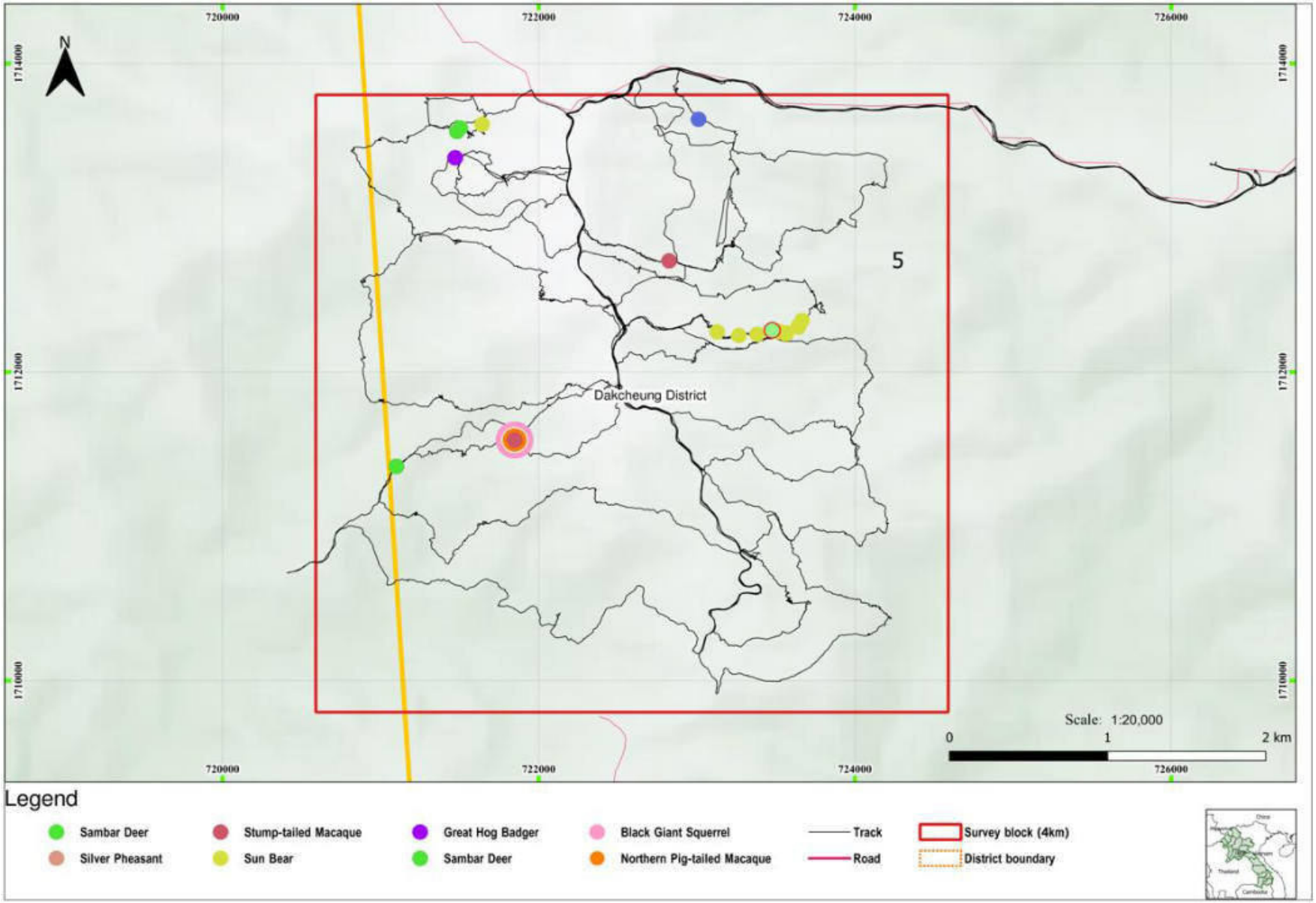
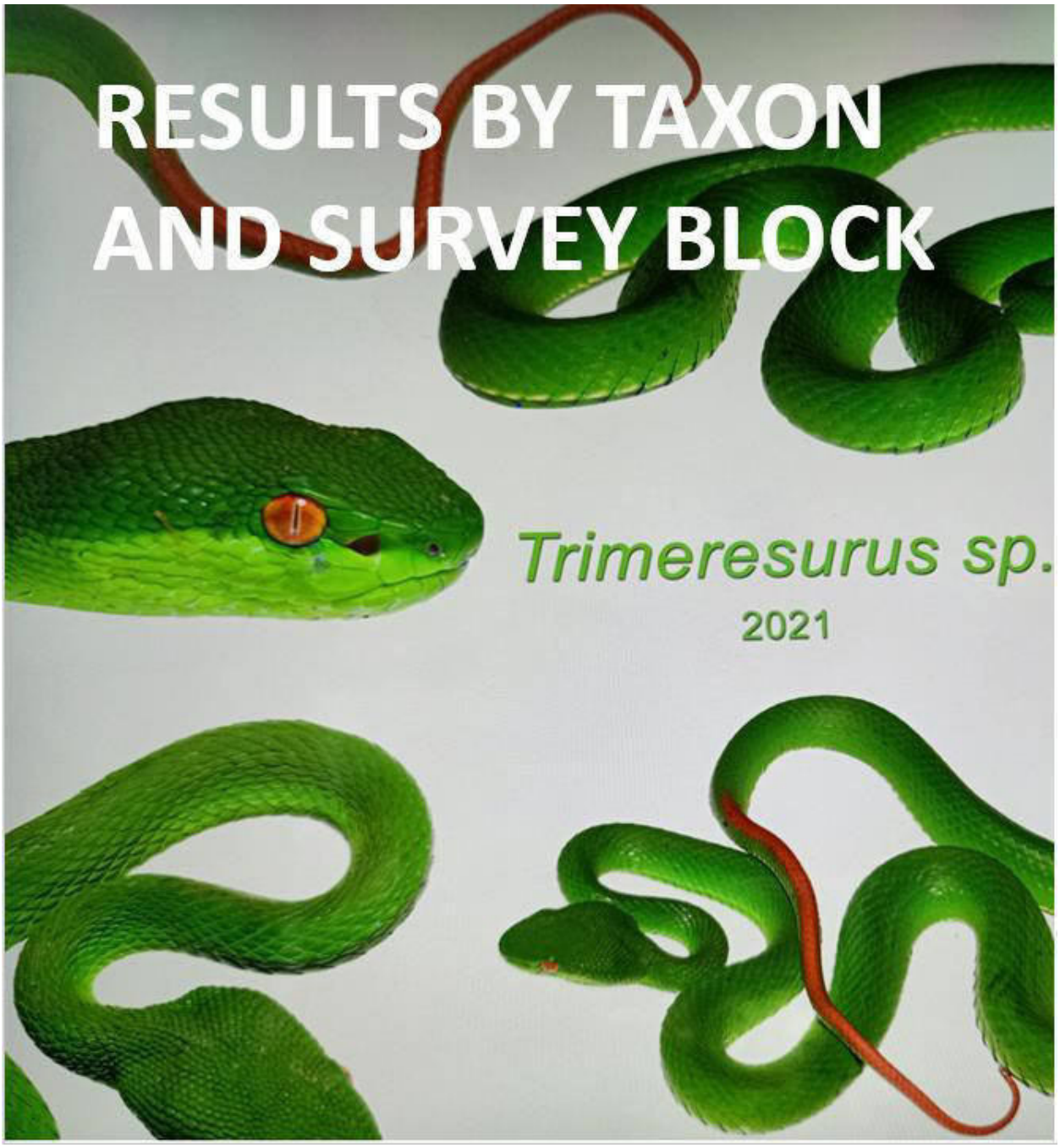


Figure 14e. Locations of key wildlife species in the survey block 5



5.3 RESULTS OF THE ASSESSMENT BY TAXON AND SURVEY BLOCK

5.3.1 Vegetation and Flora

5.3.1.1 Introduction

According to characteristics of habitats and field conditions, the forest zones of the Monsoon Windfarm Power Project, were divided into 3 forest zones as eastern, northern and central-southern zones. The Eastern zone "Zone A" where the alignment of the proposed transmission line will run through is the dominance of Upper Evergreen Forest. It is part of the Southern Annamite Mountain Range with good forest condition, receives high precipitation; the Northern zone "Zone B" is the highest elevation of the district at peak of 1,700m a.s.l., as sporadic Annamite with influencing by high precipitation, this area is considered Upper Evergreen Forest and partly Montane Forest; the Central zone to west and southwestern section is semi-evergreen forest with pine forest found in scatter especially in the southern and central-partly northwestern section.

Upper Evergreen Forest is found at high elevation of over 1,000m a.s.l., and that receives high precipitation. As most part of the defined priority areas of biodiversity of the project is totally dominated by the UEF. If this forest is located at higher 1,500m a.s.l., which is considered Montane Forest[12] and found in north of the project "Phou Koungking". The floristic composition of lower elevation of the UEF is higher with larger tree size. On average of the trees have around 25-30m in height and around 60cm in diameter, but taller and larger at lower while shorter and smaller at higher elevation especially at above 1,500m a.s.l. In general, this habitat consists of two layers, but three layers at lower elevation.

Based on the literature reviews for Sekong Province, the southern Biodiversity Conservation Corridor (BCC) including the Dak Cheung (Nanthavong *et al*., 2019), there were 6 GT species in the area such as Mai Ketsana (*Aquilaria crossna*, CR), Mai ket dam (*Dalbergia oliveri*, EN), Mai khaen hin (*Hopea ferrea*, EN), Mai Khapa lamxay (*Meistera Celsa*, EN), Mai hoa lanoy (*Cycas micholitzii*, VU) and Mai yang deng (*Dipterocarpus costatus*, VU). Nevertheless, the project area has not been surveyed before and due to habitat uniqueness of high elevation of the Annamite there some endemic plant species would occur.

Apart from the target tree species (GT species) the botanical team also paid attention to those non-target tree species that are of conservation significance and categorized under a national category - the prohibited species that would occur in the survey blocks.

5.3.1.2 Key findings

Within the five survey blocks (30 plant plots) were conducted at elevation on average of 1,312m a.s.l., which ranges from 1,029m of the SB 1 to 1,615m of the SB3. A total of 626 records, representing 538 plant species from 178 families (including non-tree species), of which 250 tree species and 58 families were recorded. The numbers of plant species count also included some species that were found just adjacent to the relevant plant plots as to generate a full list of plants in the survey area. Non-tree species were just counted but not used for analysis. Therefore, the result showed that the Rubiaceae, Lauraceae and Fagaceae, Annonaceae and Febaceae were the dominant families with 83 species (see Table 5). The trees were defined for dominant and abundant species, also rare species which distributed

[12]*Montane Forest is a sub-type of Upper Evergreen Forest that is located at above 1,500m a.s.l., has little difference in forest structure and tree characteristics. The shorter and quite smaller tree, basically covers with mosses and lichens.*

dispersedly. The rare species were recorded and on average of 8 rare species from 3 species in SB1 to 17 species in SB5. Some of these were first record and possible new species.

The whole part of the survey area was Upper Evergreen Forest (UEF) which was found in SB1 and SB2 as the elevation from 1,029m to 1,208m a.s.l., and but small part of the area, the high elevation has a sub-type of the Upper Evergreen Forest which is known Montane Evergreen Forest and that found at upper part of the mountain in SB3 and SB4.

Table 5. List of plant groups with number of species and families

No	Plant Group	No. of Species	No. of Families		No	Plant Group	No. of Species	No. of Families
1	Trees	250	58		8	Orchids	10	1
2	Herb	96	45		9	Palm	12	1
3	Climber	32	14		10	Bamboo	4	1
4	Aquatic plants	5	2		11	Parasite	6	1
5	Shrubs	52	15		12	Green Algae	-	-
6	Epiphytic plants	10	3		13	Mosses	16	8
7	Fern	45	26					

The habitat structures of the survey area were quite open with basically 3 layers of forest structures (canopy, understory and shrub layer), as it has no emergent layer. The shrub layer was short vegetation including young trees which excluded short ground vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose. As observed, the survey area was dominated by UEF with no emergent layer but trees basically covering with mosses and lichens, and shorter and quite smaller trees in MEF which was found in SB3 and SB4 (Phou Koungking).

Tree species richness was found in lower elevation such as SB1 and SB2 as ca. 72 and 68 species per hectare whereas higher elevation such as SB5, SB3 and SB4 were relatively low species richness: 50, 32 and 28 species, respectively. There were only 2 globally threatened species (1 EN and 1 VU) were identified as the Endangered species *Zingiber mellis* was found in SB3 and the Vulnerable species *Pittostorum pauciflorum* was found in SB4 and SB5. Also, other 3 Near-Threatened species (*Nageia fleuryi* (Hickel) de Laub, *Nageia fleuryi* (Hickel) de Laub, *Pinus dalatensis* Ferré) were identified and summarized by SB (see Table 6).

Table 6. Summary of GT and important plants in the survey area

Survey Block	Key plant species				Total
	CR	EN	VU	NT	
SB1	0	0	0	1	1
SB2	0	0	0	2	2
SB3	0	1	0	0	1
SB4	0	0	1	0	1
SB5	0	0	1	0	1

Remarks: jus same GT species were found in different survey blocks.

Interestingly, 10 possible new species to science and 29 first records of Laos were found in the survey blocks especially the Survey block 2, SB3 and SB4 (see Table 8), but some of them need further verification with their flowers and fruits. Of these species, SB1 (4 first records and 2 possible new species), SB2 (11 first records, 6 possible new species and 2 NT species), SB3 (11 first records, 1 GT and 1 NT species), SB4 (11 first records, 1 GT and 1 NT species), SB5 (6 first records, 2 possible new species). But, please note that many of these species were found in more than one survey block.

According to the tree species records the high number of trees species were recorded in SB1 and SB2 (Annamite), and then SB5 (Phou Yai). The tree species were defined as the top 40 dominant species in the Survey area and presented in flora groups and families (see Table 7) and including non-tree species in Table 8.

Table 7. List of most dominant families that were presented in all 5 survey blocks

No	Family Name	No species	No	Family name	No species
1	Rubiaceae	27	21	Theaceae	5
2	Lauraceae	20	22	Cyperaceae	4
3	Fagaceae	15	23	Lamiaceae	4
4	Annonaceae	11	24	Polygalaceae	4
5	Fabaceae	10	25	Smilacaceae	4
6	Melastomataceae	10	26	Apocynaceae	3
7	Myrtaceae	10	27	Aquifoliaceae	3
8	Phyllanthaceae	10	28	Araliaceae	3
9	Primulaceae	10	29	Asparagaceae	3
10	Symplocaceae	8	30	Calophyllaceae	3
11	Zingiberaceae	8	31	Celastraceae	3
12	Euphorbiaceae	6	32	Daphniphyllaceae	3
13	Acanthaceae	5	33	Elaeocarpaceae	3
14	Anacardiaceae	5	34	Ericaceae	3
15	Araceae	5	35	Escalloniaceae	3
16	Orchidaceae	5	36	Juglandaceae	3
17	Pentaphylacaceae	5	37	Piperaceae	3
18	Poaceae	5	38	Sapotaceae	3
19	Podocarpaceae	5	39	Schisandraceae	3
20	Rutaceae	5	40	Stemonuraceae	3

Table 8. List of important plant species including endemic species in the Survey area

No	Local Name	Scientific Name	G/N	F/S	Survey Block				
					SB1	SB2	SB3	SB4	SB5
I	**Tree – (high tree)**								
1	ແກ້ມອົ້ນ (Kaem-on)	Adinandra integerrima		F				X	
2	ຂີ້ໝົ້ນຕົ້ນ (Khemin ton)	Alseodaphne bidoupensis		F		X			
3	ພັບດົ່ງ (Phab dong)	Apodytes dimidiata		F			X		

4	ໝ້ຽງ (Miang)	Camellia sp. 1		S					X
5	ດິກດົງ (Dik dong)	Daphniphyllum beddomei		F			X		
6	ແຊງແຊວ (Saeng seo)	Elaeocarpus dubius		F	X	X			
7	ມຸນດົງ (Moun dong)	Elaeocarpus limitaneus		F		X			
8	ປິກ (Pik)	Gymnanthes remota		F				X	
9	ຕ້ຳງ (Tang)	Heptapleurum cambodianum		F	X		X		X
10	ໄຂ່ມົດຊາປ່າ (Khai mod sapa)	Ilex chapaensis		F				X	X
11	ບົງບໍກໍ (Bong bokor)	Lindera bokorensis		F		X		X	
12	ກໍ່ຊ້ຳງ (Kor xang)	Lithocarpus elephantum		F			X		
13	ກັກ (Kor Kak)	Lithocarpus pierrei		F	X	X	X		X
14	ຕອງຫອມ (Tong Hom)	Machilus sp.		S		X			
15	ລະມຸດຊ້ຳງ (Lamout sang)	Madhuca cochinchinensis		F		X			
16	ພະຍາໄມ້ (Phaya mai)	Nageia fleuryi	N			X			X
17	ໄຟເດືອນຫ້າ (Fai deuanha)	Neolitsea sp.		S	X				
18	ແປກຫ້າໃບ (Peak habai)	Pinus dalatensis	N			X			
19	ສຸ່ມດອກນ້ອຍ (Soum dok-noi)	Pittosporum pauciflorum	G					X	X
20	ເໝືອດດົງ (Maud dong)	Polyosma dolichocarpa		F		X			
21	ດຸກໄກ່ (Douk kai)	Psychotria cambodiana		F				X	
22	ກໍ່ລັ່ງບຽງ (Kor langbian)	Quercus langbianensis	N	F				X	
23	ກໍ່ (Kor)	Quercus sp.1		S	X				
24	ເໝືອດກອນຕຸ່ມ (Maud kontum)	Sarcosperma kontumense		F		X			
25	ຄອມປ່າ (Khom pa)	Symplocos wikstroemiifolia		F				X	X
26	ແຂ້ງ (Khaeng)	Urophyllum sp. 1		S		X			
27	ແຂ້ງ (Khaeng)	Urophyllum sp. 2		S		X			
28	ແຂ້ງ (Khaeng)	Urophyllum sp. 3		S		X			
29	ພວງໄຂ່ມຸກ (Phouang khaimouk)	Vaccinium sp. 1		S		X			
30	ແສງດົງ (Seng dong)	Xanthophyllum ellipticum		F	X	X			
31	ແສງດົງ (Seng dong)	Xanthophyllum sp. 1		S					X
II	**Tree – (bush)**								
32	ກຸດກິບມ້ຳ (Khoud kipma)	Angiopteris wangii		F		X			
33	ຕິນຈຳ (Tin cham)	Ardisia gracilenta		F			X	X	X
34	ປະດັບຫີນ (Padab hin)	Argostemma bariense		F		X			
35	ມັດ (Mud)	Bredia sp.		S		X			
36	ມຸຍ (Moiu)	Brachytome wallichii		F				X	
47	ເຂັ້ມດົງ (Khem dong)	Chassalia curviflora		F			X		
38	ມ້ວຍ (Mouay)	Gnetum gnemon		F			X		
39	ຂິງຂຽວ (Khing khiew)	Zingiber mellis	G	F			X		
III	**Non-tree (weed and mushroom)**								
40	ເຫັດກ້ານຈອງດຳ/Wood-decay Fungi	Amauroderma rugosum		F			X		X
41	ເຫັດລະໂງກເຫຼືອງ/Yellow Half-dyed slender Caesar Mushroom	Amanita hemibapha		F			X	X	
42	ເຫັດລະໂງກແດງ/Caesar's mushroom	Amanita caesarea		F				X	

Remarks: GT = Globally Threatened Species is representing CR, EN and VU of IUCN Redlist; G = GT, Globally Threatened species; N = NT, Near -Threatened species; F = FR, First Record; and S = NS, New Species candidate. Some of the potential new plant and first plant records of Laos need further verify with their flowers and fruits.

5.3.1.3 Findings by survey block and sampling

A total of 30 plant plots in 5 survey blocks as the detailed assessment was conducted for each plant plot using the DAFOR form to obtain a number of species, their dominances, densities and frequencies, plot structures regarding forest canopy cover, canopy height, ground vegetation cover, water cover etc. For each SB, 6 plant plots were consolidated for each and presented by survey block as following:

5.3.1.3.1 Findings by Survey block 1 (Annamite)

The Survey block 1 was dominated by Upper Evergreen Forest with no emergent layer, trees, soil and rocks are basically covering with some mosses and lichens. The plant plots at the survey block (Annamite) were surveyed to obtain a number of plant species with descriptions of the plant plots regarding forest canopy cover, canopy height, species dominance etc. The plant plots were UEF with quite high density of trees and canopy cover.

The forest structures of the plant plots in this SB were similar but some plant plots were selected partly in secondary forest which were closed to the road. On average of the SB from these plant plots showed that the canopy mean height of 14 (ranging up to 30m), canopy mean cover of 85%. The habitat structures of the SB were quite open with 3 layers of forest structures (canopy, understory and shrub layer), as it has no emergent layer. The shrub layer was short vegetation including young trees which excluded short vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose[13]. The plot profile of the SB1 was summarized as below and see detail in Annex 1a:

For forest habitat describe canopy, understorey and ground flora					
Canopy mean height (m)	12	Canopy mean cover (%)	80	Understorey mean height (m)	4
Approx age of canopy (yrs)	60	Bare ground cover (%)	20	Water cover (%)	
For other habitats record overall max and mean height of vegetat					
Mean veg height (cm)	120	Max veg height (cm)	300		
Vegetation cover (%)	90	Bare ground cover (%)	10	Water cover (%)	0

The Upper Evergreen Forest at low elevation (1,000m a.s.l.) was dominated by the family of Fagaceae (8 species) and Lauraceae (8 species), following by Myrtaceae (6 species) from a total of 72 tree species in 36 families, as no threatened tree species. There were 13 dominant and 10 abundant and 3 rare species found and distributed in different plots. The rare species including *Monoon* sp.1 (P1), *Syzygium* sp.1 (P3), and *Neolitsea* sp.1 (P5). In addition, two herbaceous plants such as *Ardisia* sp.1 and *Zingiber* are considered rare species.

Interestingly, 4 species of trees have not been known in Laos which were defined as the first plant records of Laos including *Elaeocarpus dubius*, *Heptapleurum cambodianum*, *Lithocarpus pierrei*, and *Xanthophyllum ellipticum* and 2 candidates for new tree species to science including *Neolitsea* sp.1 and *Quercus* sp.1.

[13] *Ground cover as short vegetation covering the ground especially wild gingers and weeds which were found widely in the SB.*

***Tree species**:* a total of 162 records of 72 tree species and 36 families that were recorded, of which, no any threatened tree species was found, but 4 first records of Laos and 2 possible new species to science. The most dominant tree species in the Survey block 1 were provided in Table 9-1 and more detail of the species records can be found in Annex 1a-1 and 1a-2.

Table 9-1. List of top 25 tree species in the Survey block 1

No	Scientific Name	Local Name	Family Name	IUCN Redlist
1	Acronychia pedunculata	ເປົ້າແຂບທອງ (Pao khaeb thong)	Rutaceae	
2	Aglaia tomentosa	ຍົງກະສັງ (Gnong kasang)	Meliaceae	
3	Alniphyllum	ຍານດົງ (Gnan dong)	Styracaceae	
4	Anacolosa clarkei	ແຄະ (Khae)	Olacaceae	
5	Anacolosa griffithii Mast.	ແຊະ (Sae)	Olacaceae	
6	Aporosa yunnanensis	ໝອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
7	Artocarpus	ມີ້ປ່າ (Mee pa)	Moraceae	
8	Calophyllum pisiferum	ກະທຶງ (Ka thueng)	Calophyllaceae	
9	Carallia brachiata	ບົ້ງນັ່ງ (Bong nang)	Rhizophoraceae	
10	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
11	Cinnamomum curvifolium	ຈວງ (Juang)	Lauraceae	
12	Clerodendrum cyrtophyllum	ພວງພີ້ (Phoung phee)	Lamiaceae	
13	Cleyera cf. bokorensis	ໄກ່ (Kaii)	Pentaphylacaceae	
14	Cratoxylum sumatranum	ຕຶ້ອ (Tiew)	Hypericaceae	
15	Dacrydium elatum	ຮິ້ງຫອມ (Hinh hom)	Podocarpaceae	
16	Diospyros filipendula	ຄັນຈ້ອງ (Khan jong)	Ebenaceae	
17	Diplospora sp.1	ສ້ຽນ (Sean)	Rubiaceae	
18	Diplospora sp.2	ສ້ຽນ (Sean)	Rubiaceae	
19	Elaeocarpus dubius	ແຊງແຊ (Saeng seo)	Elaeocarpaceae	
20	Elaeocarpus griffithii	ມູນ (Moun)	Elaeocarpaceae	
21	Endospermum diadenum	ຕະພົງ (Ta phong)	Euphorbiaceae	
22	Engelhardtia serrata	ພ່າຂຽວໜາມ (Phao khiew)	Juglandraceae	
23	Engelhardtia cf. roxburghiana	ພ່າຂຽວ (Phao khiew)	Juglandraceae	
24	Engelhardtia sp.1	ພ່າ (Phao)	Juglandraceae	
25	Exbucklandia tonkinensis	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	

Also, the survey obtained the number of 72 tree species with their frequencies and densities were collected and presented in Table 9-1a and 9-1b as below:

Density: the highest density of species were *Castanopsis acuminatissima* (ไม้ก่อเดือย, Mai Kor deau) with its density of 13.33 tree/ha following by *Symplocos atriolivacea* (ໝອດຄອມ, Maud khom), Maud) and *Syzygium lineatum* (ຫວ້າຈ່ອຍ, Wha joi) with their densities of 11.67 trees/ha each; and by *Machilus* sp.1 (ຕອງຫອມ, Tong Hom), *Schima crenata Korth* (ຄາຍໂສ້, Khai Soh) and *Syzygium antisepticum* (ສະເມັກແດງ, Samek deang) with their densities of 10.00 each (see Table 9-1a).

Table 9-1a. Density of top 15 tree species in the Survey block 1

No.	Scientific Name	Local Name	Family Name	IUCN Red List	No of records	Density tree/ha	Relative Density %
1	Castanopsis acuminatissima	ไม้ก่าเดือย (Mai Kor deau)	Fagaceae		8	13.33	4.94
2	Symplocos atriolivacea	เหมือดคอม (Maud khom)	Symplocaceae		7	11.67	4.32
3	Syzygium lineatum	หว้าจ่อย (Wha joi)	Myrtaceae		7	11.67	4.32
4	Machilus sp.1	ตองหอม (Tong Hom)	Lauraceae		6	10.00	3.70
5	Schima crenata Korth.	คายโส้ (Khai Soh)	Theaceae		6	10.00	3.70
6	Syzygium antisepticum	สะเม็กแดง (Samek deang)	Myrtaceae		6	10.00	3.70
7	Lithocarpus corneus	ไม้ก่าหยับ (Mai Kor Rab)	Fagaceae		5	8.33	3.09
8	Litsea umbellata	บงร้าง (Bong hang)	Lauraceae		5	8.33	3.09
9	Nephelium hypoleucum	คอแลน (Kho lane)	Sapindaceae		5	8.33	3.09
10	Aglaia tomentosa	ยงกะสัง (Gnong kasang)	Meliaceae		4	6.67	2.47
11	Aporosa yunnanensis	เหมือดใบแหลม (Maud bai-laem)	Phyllanthaceae		4	6.67	2.47
12	Cinnamomum curvifolium	จวง (Chuang)	Lauraceae		4	6.67	2.47
13	Cleyera cf. bokorensis	ไก่ (Kaii)	Pentaphylacaceae		4	6.67	2.47
14	Quercus sp.1	ก่า (Kor)	Fagaceae		4	6.67	2.47
15	Sterculia parviflora	ปอใบใหญ่ (Por baiyai)	Malvaceae		4	6.67	2.47

Frequency: The highest frequency of species were *Castanopsis acuminatissima* (ก่าเดือย, Kor deau); *Symplocos atriolivacea* (เหมือดคอม, Maud khom); *Lithocarpus corneus* (ก่าหยับ, Kor Rab); *Aglaia tomentosa* (ยงกะสัง, Gnong kasang); *Cinnamomum curvifolium* (จวง, Chuang), *Madhuca pierrei* (ละมุดขาง, Lamout sang), and *Magnolia braianensis* (จำปีป่า, Champi Pa) with their frequency of 50% each following by *Machilus sp.1* (ตองหอม, Tong Hom), *Schima crenata* (คายโส้, Khai Soh), *Syzygium antisepticum* (สะเม็กแดง, Samek deang) and *Litsea umbellata* (บงร้าง, Bong hang) with its frequency of 33% each (see Table 9-1b).

Table 9-1b. Frequency of top 15 tree species in Survey block 1

No	Scientific Name	Local Name	Family Names	IUCN	No of plots	Freq. %	Relative Freq. %
1	Castanopsis acuminatissima	ก่าเดือย (Kor deau)	Fagaceae		3	50.00	2.91
2	Symplocos atriolivacea	คอม (Maud khom)	Symplocaceae		3	50.00	2.91
3	Lithocarpus corneus	ก่าหยับ (Kor Rab)	Fagaceae		3	50.00	2.91

4	Aglaia tomentosa	ยิงกะสัง (Gnong kasang)	Meliaceae		3	50.00	2.91
5	Cinnamomum curvifolium	จอง (Chuang)	Lauraceae		3	50.00	2.91
6	Madhuca pierrei	ละมุดซาง (Lamout sang)	Sapotaceae		3	50.00	2.91
7	Magnolia braianensis	จำปีป่า (Champi Pa)	Magnoliaceae		3	50.00	2.91
8	Machilus sp.1	ตองหอม (Tong Hom)	Lauraceae		2	33.33	1.94
9	Schima crenata	คายโส้ (Khai Soh)	Theaceae		2	33.33	1.94
10	Syzygium antisepticum	สะเม็กแดง (Samek deang)	Myrtaceae		2	33.33	1.94
11	Litsea umbellata	บงฮ้าง (Bong hang)	Lauraceae		2	33.33	1.94
12	Nephelium hypoleucum	คำแลน (Kho lane)	Sapindaceae		2	33.33	1.94
13	Cleyera cf. bokorensis	ไก่ (Kaii)	Pentaphylacaceae		2	33.33	1.94
14	Quercus sp.1	ก่อ (Kor)	Fagaceae		2	33.33	1.94
15	Sterculia parviflora	ปอใบใหญ่ (Por baiyai)	Malvaceae		2	33.33	1.94

5.3.1.3.2 Findings by Survey block 2 (Annamite)

The survey block 2 was dominated by Upper Evergreen Forest with no emergent layer, trees, soil and rocks are basically covering with some mosses and lichens. The plant plots at the survey block (Annamite) were surveyed to obtain a number of plant species with descriptions of the plots regarding forest cover, canopy height, species dominance etc. The plant plots with high density of trees and canopy cover.

The forest structures of the plant plots in this SB were similar and in good forest status. On average of the SB from these plant plots showed that the canopy mean height of 14 (ranging up to 35m), canopy mean cover of 85%. The habitat structures of the SB were quite open with 3 layers of forest structure (canopy, understory and shrub layer), as it has no emergent layer. The shrub layer was short vegetation including young trees which excluded short vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose. The plot profile of the SB2 was summarized below and see detail in Annex 1b:

For forest habitat describe canopy, understorey and ground flora					
Canopy mean height (m)	14	Canopy mean cover (%)	85	Understorey mean height (m)	7
Approx age of canopy (yrs)	80	Bare ground cover (%)	15	Water cover (%)	
For other habitats record overall max and mean height of vegetation					
Mean veg height (cm)	150	Max veg height (cm)	280		
Vegetation cover (%)	85	Bare ground cover (%)	10	Water cover (%)	5

As Upper Evergreen Forest at low elevation (1,000m a.s.l.) was dominated by the family Lauraceae (9 species) and Fagaceae (7 species) following by Rubiaceae (6 species) from a total of 68 tree species in 35 families. There were 10 dominant, 8 abundant and 6 rare species were found and distributed in different plots. The rare plant species were *Pinus dalatensis* (P1), *Vaccinium cf. bidoupensis* (P2), *Meliosma cambodiana* and *Sterculia lissophylla* (P4), *Lithocarpus* sp.4 and *Madhuca cochinchinensis* (P5). In addition, 2 Orchids (*Bolbitis* and *Bulbophyllum*) and 1 ginger (*Zingiber* sp.) were also rare due to small portion was found.

A total of 11 species (8 tree and 3 non-tree species) have not been known in Laos which were condidered first records of Laos, the first plant records were *Alseodaphne bidoupensis*, *Elaeocarpus dubius*, *Elaeocarpus limitaneus*, *Lindera bokorensis*, *Lithocarpus pierrei*, *Madhuca cochinchinensis*, *Polyosma dolichocarpa*, and *Sarcosperma kontumense*.

Also, the species of fern *Angiopteris wangii* and other other 2 species of the family Rubiaceae (*Argostemma bariense* and *Bredia* sp.) were first records of Laos. There were also 6 candidates (5 tree and 1 non-tree species) for possible new species to science as *Lithocarpus* sp.4, *Machilus* sp.1, *Urophyllum* sp. 1, *Urophyllum* sp. 2, *Urophyllum* sp. 3.

Tree species: a total of 179 records of 68 tree species and 35 families that were recorded, of which, no any GT tree species but 2 NT species *Pinus dalatensis* and *Nageia fleury* were found and 11 first records and 6 possible new species to science. The most dominant tree species in the Survey block 2 were provided in Table 9-2 and more detail of the species records can be found in Annex 1b-1 and 1b-2.

Table 9-2. List of top 25 tree species in the Survey block 2

No	Scientific Name	Local Name	Family	IUCN Red List
1	Acer laurinum	ກ່ອມ (Kuam)	Sapindaceae	
2	Alangium sp.1	ສະລິກດົງ (Salik dong)	Cornaceae	
3	Alseodaphne bidoupensis	ຂີ້ໝົ້ນຕົ້ນ (Khemin ton)	Lauraceae	
4	Anneslea fragrans	ແກ້ມອົ້ນ (Kaem oun)	Pentaphylacaceae	
5	Aporosa yunnanensis	ໝຶ້ອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
6	Calophyllum dryobalanoides	ພະອົງ (Pha-ong)	Calophyllaceae	
7	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
8	Castanopsis piriformis	ກໍ່ຂີ້ໝູ (Kor khemou)	Fagaceae	
9	Chionanthes ramiflorus	ເຂົ້າສານຫຼວງ (Khaosan luang)	Oleaceae	
10	Cinnamomum javanicum	ແຄຫອມ (Khae hom)	Lauraceae	
11	Dacrycarpus imbricatus	ຮິ້ງຂຽວ (Hinh khiew)	Podocarpaceae	
12	Dacrydium elatum	ຮິ້ງຫອມ (Hing hom)	Podocarpaceae	
13	Diospyros filipendula	ຄັນຈ້ອງ (Khan jong)	Ebenaceae	
14	Elaeocarpus dubius	ແຊງແຊວ (Saeng seo)	Elaeocarpaceae	
15	Elaeocarpus griffithii	ມຸນ (Moun)	Elaeocarpaceae	
16	Elaeocarpus limitaneus	ມຸນດົງ (Moun dong)	Elaeocarpaceae	
17	Endospermum diadenum	ຕະພົງ (Ta phong)	Euphorbiaceae	
18	Engelhardtia serrata	ພ່າວຂຽວໜາມ (Phao khiew)	Juglandraceae	
19	Eurya	ຫາງດີ (Hang dee)	Pentaphylacaceae	
20	Exbucklandia	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
21	Fagraea ceilanica	ຕ້ັງນົກ (Tang nok)	Gentianaceae	
22	Garcinia hanburyi	ສົ້ມປ່ອງ (Som pong)	Clusiaceae	
23	Garcinia pedunculata	ສົ້ມໂມງ (Som mong)	Clusiaceae	
24	Gironniera subaequalis	ຫາງແມງໄຮ່ (Hang maeng-ai)	Cannabaceae	
25	Heptapleurum cambodianum	ຕ້ າງ (Tang)	Araliaceae	

Also, the survey obtained the number of 68 tree species with their frequencies and densities collected and presented in Table 9-2a and 9-2b as below:

Density: the highest density of species were *Heptapleurum cambodianum* (ต้าง, Tang) and *Symplocos anomala* (เหมือดน้อย, Maud noi), Maud) with their densities of 15.00 tree/ha each, following by *Dacrydium elatum* (ธี้งหอม, Hinh hom) with its density of 13.33 tree/ha; and *Litsea baviensis* (บ้งหอม, Bong hom), *Polyosma* sp.1 (เหมือดโลด, Maud lod), *Xanthophyllum ellipticum* (แสงดิง, Seng dong)) with their densities of 11.67 trees/ha each (see Table 9-2a).

Table 9-2a. Density of top 15 tree species in the Survey block 2

No.	Scientific Name	Local Name	Family Name	IUCN Red List	No of records	Density of tree/ha	Relative Density %
1	Heptapleurum cambodianum	ต้าง (Tang)	Araliaceae		9	15.,00	5.03
2	Symplocos anomala	เหมือดน้อย (Maud noi)	Symplocaceae		9	15.00	5.03
3	Dacrydium elatum	ธี้งหอม (Hing hom)	Podocarpaceae		8	13.33	4.47
4	Litsea baviensis	บ้งหอม (Bong hom)	Lauraceae		7	11.67	3.91
5	Polyosma sp.1	เหมือดโลด (Maud lod)	Escalloniaceae		7	11.67	3.91
6	Xanthophyllum ellipticum	แสงดิง (Seng dong)	Polygalaceae		7	11.67	3.91
7	Castanopsis piriformis	ก่อขี้หมู (Kor khemou)	Fagaceae		6	10.00	3.35
8	Lithocarpus corneus	ก่อหูบ (Kor Rab)	Fagaceae		6	10.00	3.35
9	Machilus angustifolia	ตองหอมใบแคบ (Tong Hom bai khaeb)	Lauraceae		6	10.00	3.35
10	Neolitsea tomentosa	ไฟเดือนห้าขึน (Fai deuanha khon)	Lauraceae		6	10.00	3.35
11	Garcinia pedunculata	ส้มโมง (Som mong)	Clusiaceae		5	8.33	2.79
12	Ilex excavata	ไข่มด (Khai mod)	Aquifoliaceae		5	8.33	2.79
13	Alseodaphne bidoupensis	ขี้หมิ้นต้น (Khemin ton)	Lauraceae		4	6.67	2.23
14	Castanopsis acuminatissima	ก่อเดือย (Kor deau)	Fagaceae		4	6.67	2.23
15	Illicium roseum	จันบาน (Chan ban)	Schisandraceae		4	6.67	2.23

Frequency: The highest frequency of species were *Symplocos anomala* (เหมือดน้อย, Maud noi), *Xanthophyllum ellipticum* (แสงดิง, Seng dong), and *Castanopsis acuminatissima* (ก่อเดือย, Kor deau) with their frequencies of 66.67% each, following by *Heptapleurum cambodianum* (ต้าง, Tang), Dacrydium elatum (ธี้งหอม, Hing hom), and Litsea baviensis (บ้งหอม, Bong hom) with their frequencies of 50% each (see Table 9-2b).

Table 9-2b. Frequency of top 15 tree species in Survey block 2

No	Scientific Name	Local Name	Family Names	IUCN	No of plots	Freq. %	Relative Freq. %
1	Symplocos anomala	เหมือดน้อย (Maud noi)	Symplocaceae		4	66.67	3.74
2	Xanthophyllum ellipticum	แสงดิง (Seng dong)	Polygalaceae		4	66.67	3.74
3	Castanopsis acuminatissima	ก่อเดือย (Kor deau)	Fagaceae		4	66.67	3.74
4	Heptapleurum cambodianum	ต้าง (Tang)	Araliaceae		3	50.00	2.80
5	Dacrydium elatum	ธี้งหอม (Hing hom)	Podocarpaceae		3	50.00	2.80
6	Litsea baviensis	บ้งหอม (Bong hom)	Lauraceae		3	50.00	2.80

7	Neolitsea tomentosa	ไฟเดือนห้าขิน (Fai deuanha khon)	Lauraceae		3	50.00	2.80
8	Ilex excavata	ไข่มิด (Khai mod)	Aquifoliaceae		3	50.00	2.80
9	Lithocarpus pierrei	ก่ำกัก (Kor Kak)	Fagaceae		3	50.00	2.80
10	Aporosa yunnanensis	เหมือดใบแหม (Maud bai-laem)	Phyllanthaceae		3	50.00	2.80
11	Elaeocarpus dubius	แซงแซอ (Saeng seo)	Elaeocarpaceae		3	50.00	2.80
12	Polyosma sp.1	เหมือดโลด (Maud lod)	Escalloniaceae		2	33.33	1.87
13	Castanopsis piriformis	ก่ำขี้หมู (Kor khemou)	Fagaceae		2	33.33	1.87
14	Machilus angustifolia	ตองหอมใบแถบ (Tong Hom bai khaeb)	Lauraceae		2	33.33	1.87
15	Alseodaphne bidoupensis	ขี้หมิ้นต้น (Khemin ton)	Lauraceae		2	33.33	1.87

5.3.1.3.3 Findings by Survey block 3 (Phou Koungking E)

The survey block 3 was dominated by Upper Evergreen Forest with no emergent canopy layer but trees basically covering with mosses and lichens as all was greenish, including on rocks and soil in SB3. The plant plots at the survey block (Phou Koungking E) were surveyed to obtain a number of plant species with descriptions of the plots regarding forest cover, canopy height, species dominance etc. The upper part of the mountain "Phou Koungking" was sub-type to MEF with fairly low density, quite small trees but fairly dense and short canopy cover.

The forest structures of the plant plots in this SB were quite similar but some plant plots were selected partly in secondary forest nearby the road. On average of the SB from these plant plots showed that the canopy mean height of 14 (ranging up to 21m), canopy mean cover of 90%. The habitat structures of the SB were quite open as the lower part of the mountain has 3 layers of forest (canopy, understory and shrub layer), but at high elevation has 2 layers of forest structure (short canopy and shrub layer), as it has no emergent layer. The shrub layer was short vegetation including young trees which excluded short vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose. The plot profile of the SB3 was summarized below and see detail in Annex 1c:

For forest habitat describe canopy, understorey and ground flora					
Canopy mean height (m)	14	Canopy mean cover (%)	90	Understorey mean height (m)	5
Approx age of canopy (yrs)	70	Bare ground cover (%)	10	Water cover (%)	
For other habitats record overall max and mean height of vegetation					
Mean veg height (cm)	150	Max veg height (cm)	350		
Vegetation cover (%)	85	Bare ground cover (%)	15	Water cover (%)	0

As Montane Evergreen Forest was dominated by the family of Fagaceae (4 species), Myrtaceae (4 species) and Theaceae (2 species) from a total of 32 tree species and in 26 families. There were 6 dominant and 8 abundant and 6 rare species were found and distributed in different plots. There were 12 rare species (4 tree species) were *Ilex* sp.1 (P1), *Rhodomyrtus tomentosa* (P3), *Madhuca pierrei* (P4), *Acer laurinum* and *Engelhardtia serrata* (P5). Apart from trees, 3 Orchids (*Dendrobium* sp., *Goodyera* sp. and *Liparis bootanensis*) and

5 herbaceous species including *Amomum* sp., *Ampelopsis cantoniensis*, *Barleria* sp., *Begonia difformis*, and *Impatiens hirsutisepala* are rare due to small population found in each plot.

A total of 11 species (9 trees and 2 non-tree) have not been known from Laos were considered first records of Laos. The first plant records of Laos, including *Apodytes dimidiate*, *Daphniphyllum beddomei*, *Heptapleurum cambodianum*, *Lithocarpus elephantum*, *Lithocarpus pierrei*. In addition, 4 species of lower plants: *Ardisia gracilenta*, *Chassalia curviflora*, *Gnetum gnemon* and *Zingiber mellis*.

Tree species: a total of 160 records of 32 tree species and 26 families that were recorded, of which, 1 globally threatened tree species (EN) but it was bush tree species, 1 Near-Threatened species in this survey block and 11 first records. The most dominant tree species in the Survey block 3 were provided in Table 10-1 and more detail of the species records can be found in Annex 1c-1 and 1c-2.

Table 10-1. List of top 25 tree species in the Survey block 3

No	Scientific Name	Local Name	Family Name	IUCN Redlist
1	Acer laurinum	ກ່ອມ (Kuam)	Sapindaceae	
2	Anneslea fragrans	ແກ້ມອຶ້ນ (Kaem oun)	Pentaphylacaceae	
3	Apodytes dimidiata	ພັບດົງ (Phab dong)	Icacinaceae	
4	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
5	Castanopsis clarkei	ກໍ່ໜາມ (Kor nam)	Fagaceae	
6	Chionanthes sp.1	ເຂົ້າສານຫຼວງ (Khaosan luang)	Oleaceae	
7	Dacrycarpus imbricatus	ຮິ້ງຂຽວ (Hinh khiew)	Podocarpaceae	
8	Daphniphyllum beddomei	ດິກດົງ (Dik dong)	Daphniphyllaceae	
9	Engelhardtia serrata	ພ່າວຂຽວໜາມ (Phao khiew)	Juglandaceae	
10	Exbucklandia tonkinensis	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
11	Gironniera subaequalis	ຫາງແມງໄຮ່ (Hang maeng-ai)	Cannabaceae	
12	Heptapleurum cambodianum	ຕ້ານ (Tang)	Araliaceae	
13	Ilex sp.1	ໄຂ່ມົດ (Khai mod)	Aquifoliaceae	
14	Illicium roseum	ຈັນບານ (Chan ban)	Schisandraceae	
15	Liquidambar excelsa	ສົບດາວ (Sob dao)	Altingiaceae	
16	Lithocarpus elephantum	ກໍ່ຊ້າງ (Kor xang)	Fagaceae	
17	Lithocarpus pierrei	ກໍ່ກັກ (Kor Kak)	Fagaceae	
18	Litsea martabanica	ໝີ່ບົ່ງຫອມ (Mee bonghom)	Lauraceae	
19	Madhuca pierrei	ລະມຸດຊາງປ່າ (Lamout sang pa)	Sapotaceae	
20	Neolitsea zeylanica	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae	
21	Pinus kesiya	ແປກສາມໃບ (Peak sambai)	Pinaceae	
22	Rhododendron simsii	ກຸ່ຫຼາບປ່າ (Koulab pa)	Ericaceae	
23	Rhodomyrtus tomentosa	ໂພງແກ້ມ (Phong kaem)	Myrtaceae	
24	Schima crenata	ຄາຍໂສ້ (Khai Soh)	Theaceae	
25	Semecarpus reticulata	ນ້ຳກ້ຽງດຳ (Namkieng dam)	Anacardiaceae	

Also, the survey obtained the number of 32 tree species with their frequencies and densities collected and presented in Table 10-1a and 10-1b as below:

Density: the highest density of species were *Schima crenata* (ຄາຍໂສ້, Khai Soh) with its density of 25.00 tree/ha, following by *Lithocarpus elephantum* (ຊ້າງ, Kor xang) with its densities of 23.33 tree/ha; and *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau) and *Litsea martabanica* (ໝີ່ບົ່ງຫອມ, Mee bonghom) with their densities of 16.67 trees/ha each; *Symplocos lucida* (ເໝືອດພູ, Maud phou) with its density of 15.00 tree/ha (see Table 10-1a).

Table 10-1a. Density of top 15 tree species in the Survey block 3

No.	Scientific Name	Local Name	Family Name	IUCN Redlist	No of records	Density tree/ha	Relative Density %
1	Schima crenata	ຄາຍໂສ້ (Khai Soh)	Theaceae		15	25.00	9.37
2	Lithocarpus elephantum	ກໍ່ຊ້າງ (Kor xang)	Fagaceae		14	23.33	8.75
3	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		10	16.67	6.25
4	Litsea martabanica	ໝີ່ບົ່ງຫອມ (Mee bonghom)	Lauraceae		10	16.67	6.25
5	Symplocos lucida	ເໝືອດພູ (Maud phou)	Symplocaceae		9	15.00	5.62
6	Neolitsea zeylanica	ໄฟเดือนห้า (Fai deuanha)	Lauraceae		8	13.33	5.00
7	Liquidambar excelsa	ສົບດາວ (Sob dao)	Altingiaceae		7	11.67	4.37
8	Daphniphyllum beddomei	ດິກດົ່ງ (Dik dong)	Daphniphyllaceae		7	11.67	4.37
9	Syzygium attenuatum	ຫວ້າສະເມັກ (Wha samek)	Myrtaceae		7	11.67	4.37
10	Dacrycarpus imbricatus	ຮົ້ງຂຽວ (Hinh khiew)	Podocarpaceae		7	11.67	4.37
11	Illicium roseum	ຈັນບານ (Chan ban)	Schisandraceae		6	10.00	3.75
12	Symplocos caudata	ເໝືອດມົນ (Maud mon)	Symplocaceae		6	10.00	3.75
13	Rhododendron simsii	ກຸ່ຫຼາບປ່າ (Koulab pa)	Ericaceae		5	8.33	3.12
14	Castanopsis clarkei	ກໍ່ໜາມ (Kor nam)	Fagaceae		5	8.33	3.12
15	Syzygium antisepticum	ສະເມັກແດງ (Samek deang)	Myrtaceae		5	8.33	3.12

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

Frequency: The highest frequency of species were *Schima crenata* (ຄາຍໂສ້, Khai Soh), *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau), and *Litsea martabanica* (ໝີ່ບົ່ງຫອມ, Mee bonghom) with their frequencies of 100%, following by *Daphniphyllum beddomei* (ດິກດົ່ງ, Dik dong), *Lithocarpus elephantum* (ຊ້າງ, Kor xang) and *Symplocos lucida* (ເໝືອດພູ, Maud phou) with their frequencies 83.33% (see Table 10-1b).

Table 10-1b. Frequency of top 15 tree species in Survey block 3

No	Scientific Name	Local Name	Family Names	IUCN Redlist	No of plots	Freq. %	Relative Freq. %
1	Schima crenata	ຄາຍໂສ້ (Khai Soh)	Theaceae		6	100	5.88

2	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		6	100	5.88
3	Litsea martabanica	ໝີ່ຍົງຫອມ (Mee bonghom)	Lauraceae		6	100	5.88
4	Daphniphyllum beddomei	ດິກດົງ (Dik dong)	Daphniphyllaceae		6	100	5.88
5	Lithocarpus elephantum	ກໍ່ຊ້າງ (Kor xang)	Fagaceae		5	83.33	4.90
6	Symplocos lucida	ເໝືອດພູ (Maud phou)	Symplocaceae		5	83.33	4.90
7	Neolitsea zeylanica	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae		5	83.33	4.90
8	Liquidambar excelsa	ສົບດາວ (Sob dao)	Altingiaceae		5	83.33	4.90
9	Syzygium attenuatum	ຫວ້າສະເມັກ (Wha samek)	Myrtaceae		5	83.33	4.90
10	Dacrycarpus imbricatus	ຮິ້ງຂຽວ (Hinh khiew)	Podocarpaceae		4	66.67	3.92
11	Illicium roseum	ຈັນບານ (Chan ban)	Schisandraceae		4	66.67	3.92
12	Symplocos caudata	ເໝືອດມົນ (Maud mon)	Symplocaceae		4	66.67	3.92
13	Syzygium antisepticum	ສະເມັກແດງ (Samek deang)	Myrtaceae		4	66.67	3.92
14	Exbucklandia tonkinensis	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae		4	66.67	3.92
15	Castanopsis clarkei	ກໍ່ໜາມ (Kor nam)	Fagaceae		3	50.00	2.94

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

5.3.1.3.4 Findings by Survey block 4 (Phou Koungking W)

The survey block 4 was dominated by Upper Evergreen Forest with no emergent canopy layer but trees basically covering with mosses and lichens as all was greenish, including on rocks and soil in SB4. The plant plots at the survey block (Phou Koungking W) were surveyed to obtain a number of plant species with descriptions of the plots regarding forest cover, canopy height, species dominance etc. The part mountain of Phou Koungking was sub-type to MEF with fairly low density, quite small trees but fairly dense and short canopy cover.

The forest structures of the plant plots in this SB were similar and in good forest status at Phou Koungking and some plant plots were partly selected in secondary forest. On average of the SB from these plant plots showed that the canopy mean height of 14 (ranging up to 25m), canopy mean cover of 90%. The habitat structures of the SB were quite open as the lower part of the mountain has 3 layers, but at high elevation has 2 layers of forest at the peak, as it has no emergent layer. The shrub layer was short vegetation including young trees which excluded short vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose. The plot profile of the SB4 was summarized below and see detail in Annex 1d:

For forest habitat describe canopy, understorey and ground flora					
Canopy mean height (m)	14	Canopy mean cover (%)	90	Understorey mean height (m)	6
Approx age of canopy (yrs)	80	Bare ground cover (%)	10	Water cover (%)	
For other habitats record overall max and mean height of vegetation					
Mean veg height (cm)	150	Max veg height (cm)	250		
Vegetation cover (%)	85	Bare ground cover (%)	15	Water cover (%)	0

As Montane Evergreen Forest was dominated by the family Lauraceae (4 species) from a total of 28 tree species in 20 families. There were 7 dominant, 4 abundant and 5 rare species were found and distributed in different plots. The rare plant species were *Illicium* sp. 1 (P1 & P5), *Pittosporum pauciflorum* and *Polygala tonkinensis* (P2), *Engelhardtia serrata* (P3) and *Daphniphyllum majus* (P5).

A total of 11 species (8 tree and 3 non-tree species) have not been known from Laos which were condidered first records of Laos, the first plant records were *Adinandra integerrima, Gymnanthes remota*, *Ilex chapaensis*, *Lindera bokorensis*, *Pittosporum pauciflorum*, Psychotria *cambodiana, Quercus langbianensis*, *Symplocos wikstroemiifolia.*

Tree species: a total of 154 records of 28 tree species and 20 families that were recorded, of which 1 Globally Threatened species *Pittosporum pauciflorum* (VU), 1 Near-Threatened species *Quercus langbianensis* (NT) and 11 first records. The most dominant tree species in the Survey block 4 were provided in Table 11-1 and the detail of the species records can be found in Annex 1d-1 and 1d-2.

Table 11-1. List of top 25 tree species in the Survey block 4

No	Scientific Name	Local Name	Family Name	IUCN Redlist
1	Antidesma japonicum	ເໝົ້າພູ (Mao phou)	Phyllanthaceae	
2	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
3	Dacrydium elatum	ຮິ້ງຫອມ (Hinh hom)	Podocarpaceae	
4	Daphniphyllum majus	ດິກດົງ (Dik dong)	Daphniphyllaceae	
5	Elaeocarpus griffithii	ມູນ (Moun)	Elaeocarpaceae	
6	Exbucklandia tonkinensis	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
7	Garcinia pedunculata	ສົ້ມໂມງ (Som mong)	Clusiaceae	
8	Gironniera subaequalis	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae	
9	Gymnanthes remota	ປີກ (Pik)	Euphorbiaceae	
10	Ilex chapaensis	ໄຂ່ມົດຊາປ່າ (Khai mod sapa)	Aquifoliaceae	
11	Ilex excavata Pierre	ໄຄ້ຂາວ (Khai mod)	Aquifoliaceae	
12	Illicium sp. 1 ***	ຈັນ (Chan)	Schisandraceae	
13	Lindera bokorense	ບົ່ງບໍກໍ (Bong bokor)	Lauraceae	
14	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae	
15	Litsea martabanica	ໝີ່ບົ່ງຫອມ (Mee bonghom)	Lauraceae	
16	Litsea umbellata	ບົ່ງຮ້າງ (Bong hang)	Lauraceae	
17	Macaranga kurzii	ແສ້ (Sae)	Euphorbiaceae	
18	Millettia leucantha	ຄຳພີ້ຕາຄວາຍ (Khamphee ta-khouay)	Fabaceae	
19	Morinda sp.	ຍໍປ່າ (Gno pa)	Rubiaceae	
20	Neolitsea zeylanica	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae	
21	Pinus kesiya	ແປກສາມໃບ (Peak sambai)	Pinaceae	
22	Pittosporum pauciflorum	ສຸມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae	VU
23	Polygala tonkinensis	ຕ້າງໄກ່ (Tang kai)	Polygalaceae	
24	Pyrenaria poilaneana	ໝ້ຽງດົງ (Miang dong)	Theaceae	
25	Quercus langbianensis	ກໍ່ລັງບຽງ (Kor langbian)	Fagaceae	NT

Also, the survey obtained the number of 28 tree species with their frequencies and densities collected and presented in Table 11-1a and 11-1b as below:

***Density*:** the highest density of species were *Litsea umbellata* (ບົ່ງຮ້າງ, Bong hang) with its density of 18.33 tree/ha, following by *Garcinia pedunculata* (ສົ້ມໂມງ, Som mong) and *Ilex chapaensis* (ໄຂ່ມົດຊາປ່າ, Khai mod sapa) with their densities of 16.67 tree/ha; and *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau), *Elaeocarpus griffithii* (ມູນ, Moun), *Lithocarpus harmandii* (ກໍ່ໝັ້ນ, Kor man) with their densities of 15.00 trees/ha each (see Table 9-4a).

Table 11-1a. Density of top 15 tree species in the Survey block 4

No.	Scientific Name	Local Name	Family Name	IUCN Redlist	No of records	Density tree/ha	Relative Density %
1	Litsea umbellata	ບົ່ງຮ້າງ (Bong hang)	Lauraceae		11	18.33	7.14
2	Garcinia pedunculata	ສົ້ມໂມງ (Som mong)	Clusiaceae		10	16.67	6.49
3	Ilex chapaensis	ໄຂ່ມົດຊາປ່າ (Khai mod sapa)	Aquifoliaceae		10	16.67	6.49
4	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		9	15.00	5.84
5	Elaeocarpus griffithii	ມູນ (Moun)	Elaeocarpaceae		9	15.00	5.84
6	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae		9	15.00	5.84
7	Symplocos wikstroemiifolia	ຄອມປ່າ (Khom pa)	Symplocaceae		8	13.33	5.19
8	Gymnanthes remota	ປີກ (Pik)	Euphorbiaceae		7	11.67	4.55
9	Dacrydium elatum	ຮົ້ງຫອມ (Hinh hom)	Podocarpaceae		6	10.00	3.90
10	Daphniphyllum majus	ດິກດົ່ງ (Dik dong)	Daphniphyllaceae		6	10.00	3.90
11	Litsea martabanica	ໝີ່ບົ່ງຫອມ (Mee bonghom)	Lauraceae		6	10.00	3.90
12	Pittosporum pauciflorum	ສຸ່ມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae		6	10.00	3.90
13	Polygala tonkinensis	ຕ້າງໄກ່ (Tang kai)	Polygalaceae		6	10.00	3.90
14	Gironniera subaequalis	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae		5	8.33	3.25
15	Ilex excavata Pierre	ໄຄ້ຂາວ (Khai mod)	Aquifoliaceae		5	8.33	3.25

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

Frequency: The highest frequency of species were *Litsea umbellata* (ບົ່ງຮ້າງ, Bong hang), *Ilex chapaensis* (ໄຂ່ມົດຊາປ່າ, Khai mod sapa), *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau), *Lithocarpus harmandii* (ກໍ່ໝັ້ນ, Kor man), *Gymnanthes remota* (ປີກ, Pik), *Daphniphyllum majus* (ດິກດົ່ງ, Dik dong), *Pittosporum pauciflorum* (ສຸ່ມດອກນ້ອຍ, Soum dok-noi), and *Polygala tonkinensis* (ຕ້າງໄກ່, Tang kai) with their frequencies of 100% each, following by *Garcinia pedunculata* (ສົ້ມໂມງ, Som mong) and *Elaeocarpus griffithii* (ມູນ, Moun) with their frequencies of 83.33 % each (see Table 11-1b).

Table 11-1b. Frequency of top 15 tree species in Survey block 4

No	Scientific Name	Local Name	Family Names	IUCN Redlist	No of plots	Freq. %	Relative Freq. %
1	Litsea umbellata	ບົ່ງຮ້າງ (Bong hang)	Lauraceae		6	100	4.92
2	Ilex chapaensis	ໄຂ່ມົດຊາປ່າ (Khai mod sapa)	Aquifoliaceae		6	100	4.92
3	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		6	100	4.92
4	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae		6	100	4.92
5	Gymnanthes remota	ປີກ (Pik)	Euphorbiaceae		6	100	4.92
6	Daphniphyllum majus	ດິກດົ່ງ (Dik dong)	Daphniphyllaceae		6	100	4.92
7	Pittosporum pauciflorum	ສຸ່ມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae		6	100	4.92
8	Polygala tonkinensis	ຕ້າງໄກ່ (Tang kai)	Polygalaceae		6	100	4.92
9	Garcinia pedunculata	ສົ້ມໂມງ (Som mong)	Clusiaceae		5	83.33	4.10
10	Elaeocarpus griffithii	ມຸນ (Moun)	Elaeocarpaceae		5	83.33	4.10
11	Symplocos wikstroemiifolia	ຄອມປ່າ (Khom pa)	Symplocaceae		5	83.33	4.10
12	Dacrydium elatum	ຮິ້ງຫອມ (Hinh hom)	Podocarpaceae		5	83.33	4.10
13	Gironniera subaequalis	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae		5	83.33	4.10
14	Ilex excavata Pierre	ໄຄ້ຂາວ (Khai mod)	Aquifoliaceae		5	83.33	4.10
15	Pyrenaria poilaneana	ໝ້ຽງດົ່ງ (Miang dong)	Theaceae		5	83.33	4.10

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

5.3.1.3.5 Findings by Survey block 5 (Phou Yai)

The survey block 5 was dominated by Upper Evergreen Forest with no emergent canopy layer and some large portion of secondary forest. The plant plots at the SB5 (Phou Yai) were surveyed to obtain a number of plant species with descriptions of the plots regarding forest cover, canopy height, species dominance etc. The plant plots were mainly disturbed evergreen forest with quite reasonable density and canopy cover as summarized below and see detail in Annex 1e:

The forest structures of the plant plots in this SB were similar and in quite poor forest status as some plant plots were partly selected in secondary forest. On average of the SB from these plant plots showed that the canopy mean height of 12 (ranging up to 18m), canopy mean cover of 85% as mainly secondary forest. The habitat structures of the SB in some plots were considerably thick as some forest has 3 layers (original forest) but mainly 2 layers as old fallow. The shrub layer was short vegetation including young trees which excluded short vegetation e.g weeds and wild gingers. The ground cover although its presence it was not counted as layer of the forest structure for this purpose. The plot profile of the SB5 was summarized below and see detail in Annex 1e:

For forest habitat describe canopy, understorey and ground flora					
Canopy mean height (m)	12	Canopy mean cover (%)	85	Understorey mean height (m)	5
Approx age of canopy (yrs)	50	Bare ground cover (%)	15	Water cover (%)	
For other habitats record overall max and mean height of vegetation					
Mean veg height (cm)	120	Max veg height (cm)	260		
Vegetation cover (%)	85	Bare ground cover (%)	15	Water cover (%)	0

As Montane Evergreen Forest was dominated by the family Lauraceae (6 species) and Fagaceae (4 species) following by Myrtaceae (3 species) from a total of 50 tree species in 35 families. There were 6 dominant and 13 abundant and 3 rare species were found and distributed in different plots. The rare plant species were *Camellia* sp. 1 (P1 & P6), *Illicium tenuifolium* (P3), and *Benkara* sp. (P6). Apart from trees, 3 herbaceous plants were also rare due to small distribution in the area included *Alpinia* sp., *Ixor*a sp., and an unknown species of Menispermaceae.

A total of 6 species (5 tree and 1 non-tree species) have not been known from Laos which were considered first records of Laos, the first plant records were *Heptapleurum cambodianum*, *Ilex chapaensis*, *Lithocarpus pierrei*, *Pittosporum pauciflorum*, and *Symplocos wikstroemiifolia*. Also, 1 herbaceous plant (*Ardisia gracilenta*) as first record of Laos. In addition, 2 candidates for new species to science: *Camellia* sp. 1 and *Xanthophyllum* sp. 1.

Tree species: a total of 179 records of 50 tree species and 25 families that were recorded, of which, 6 first records of Laos and 1 NT (*Nageia fleury*) species were found in this survey block. The most dominant tree species in the Survey block 5 were provided in Table 12-1 and the detail of the species records can be found in Annex 1e-1 and 1e-2.

Table 12-1. List of top 25 tree species in the Survey block 5

No	Scientific Name	Local Name	Family Name	IUCN Redlist
1	Acer laurinum	ກ່ວມ (Kuam)	Sapindaceae	
2	Aporosa terapleura	ໝີອດພຸ (Maud phou)	Phyllanthaceae	
3	Aporosa yunnanensis	ໝີອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
4	Balakata baccata	ລັບແລ (Lab lae)	Euphorbiaceae	
5	Benkara	ຄັດເຄົ້າ (Khat khao)	Rubiaceae	
6	Calophyllum pisiferum	ກະທືງ (Ka thueng)	Calophyllaceae	
7	Camellia kissii	ໝ້ຽງອາມ (Miang arm)	Theaceae	
8	Camellia sp.1	ໝ້ຽງ (Miang)	Theaceae	
9	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
10	Cinnamomum curvifolium	ຈວງ (Juang)	Lauraceae	
11	Cinnamomum	ຈວງ (Juang)	Lauraceae	
12	Diospyros	ໝາກເກືອ (Mak keau)	Ebenaceae	
13	Elaeocarpus griffithii	ມຸນ (Moun)	Elaeocarpaceae	
14	Engelhardtia serrata	ພ່າອຂຽວໝາມ (Phao khiew)	Juglandraceae	
15	Garcinia pedunculata	ສົ້ມໂມງ (Som mong)	Clusiaceae	
16	Gardenia	ພຸດຜາ (Phout pha)	Rubiaceae	
17	Gironniera subaequoalis	ຫ້າງແມງໄຢ່ (Hang maeng-ai)	Cannabaceae	
18	Gomphandra	ພູ່ພ່າ (Phou pha)	Stemonuraceae	
19	Goniothalamus	ເຂົ້າຫຼາມດົງ (Khao-larm dong)	Annonaceae	
20	Gymnanthes remota	ປິກ (Pik)	Euphorbiaceae	
21	Heptapleurum cambodianum	ຕ້າງ (Tang)	Araliaceae	
22	Ilex chapaensis	ໄຂ່ມົດຊາປ່າ (Khai mod sapa)	Aquifoliaceae	
23	Illicium tenuifolium	ຈັນບານ (Chan ban)	Schisandraceae	
24	Lindera annamensis	ລິນດາລາກ້ານແດງ (Lindara Kan-daeng)	Lauraceae	
25	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae	

Also, the survey obtained the number of 50 tree species with their frequencies and densities collected and presented in Table 12-1a and 12-1b as below:

***Density*:** the highest density of species were *Machilus angustifolia* (ຕອງຫອມໃບແຄບ, Tong Hom bai khaeb) with its density of 23.33 tree/ha, following by *Litsea martabanica* (ໝີ່ບົ່ງ ຫອມ, Mee bonghom) with its density of 21.67 tree/ha; and *Lithocarpus harmandii* (ກໍ່ໝັ້ນ, Kor man) with its density of 20 trees/ha, *Calophyllum pisiferum* (ກະທືງ, Ka thueng) with its density of 16.67 and *Acer laurinum* (ก่อม, Kuam) with its density of 15 (see Table 12-1a).

Table 12-1a. Density of top 15 tree species in the Survey block 5

No.	Scientific Name	Local Name	Family Name	IUCN Redlist	No of records	Density tree/ha	Relative Density %
1	Machilus angustifolia	ຕອງຫອມໃບແຄບ (Tong Hom bai khaeb)	Lauraceae		14	23.33	7.82
2	Litsea martabanica	ໝີ່ບົ່ງຫອມ (Mee bonghom)	Lauraceae		13	21.67	7.26
3	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae		12	20.00	6.70
4	Calophyllum pisiferum	ກะທືງ (Ka thueng)	Calophyllaceae		10	16.67	5.59
5	Acer laurinum	ก่อม (Kuam)	Sapindaceae		9	15.00	5.03
6	Aporosa terapleura	ເໝືອດພູ (Maud phou)	Phyllanthaceae		5	8.33	2.79
7	Balakata baccata	ລັບແລ (Lab lae)	Euphorbiaceae		5	8.33	2.79
8	Lithocarpus pierrei	ກໍ່ກັກ (Kor Kak)	Fagaceae		5	8.33	2.79
9	Litsea cambodianum	ບົ່ງຂະໝນ (Bong khmer)	Lauraceae		5	8.33	2.79
10	Pinus kesiya	ແປກສາມໃບ (Peak sambai)	Pinaceae		5	8.33	2.79
11	Symplocos theifolia	ເໝືອດດົ່ງ (Maud dong)	Symplocaceae		5	8.33	2.79
12	Syzygium claviflorum	ຫວ້າຫີນ (Wha hin)	Myrtaceae		5	8.33	2.79
13	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		4	6.67	2.23
14	Gymnanthes remota	ປີກ (Pik)	Euphorbiaceae		4	6.67	2.23
15	Heptapleurum cambodianum	ต้าง (Tang)	Araliaceae		4	6.67	2.23

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

Frequency: The highest frequency of species were *Machilus angustifolia* (ตองหอมใบแคบ, Tong Hom bai khaeb) and *Acer laurinum* (ก่อม, Kuam) with their frequencies of 83.33%, following by *Balakata baccata* (ลับแล, Lab lae), *Symplocos theifolia* (เหมือดดิ่ง, Maud dong), *Castanopsis acuminatissima* (ก่อเดือย, Kor deau)), *Gymnanthes remota* (ปิก, Pik) and *Quercus* (ก่อ, Kor)) with their frequencies 66.67% (see Table 12-1b)

Table 12-1b. Frequency of top 15 tree species in Survey block 5

No	Scientific Name	Local Name	Family Names	IUCN Redlist	No of plots	Freq. %	Relative Freq. %

1	Machilus angustifolia	ຕອງຫອມໃບແຄບ (Tong Hom bai khaeb)	Lauraceae		5	83.33	4.67
2	Acer laurinum	ກ່ອມ (Kuam)	Sapindaceae		5	83.33	4.67
3	Balakata baccata	ລັບແລ (Lab lae)	Euphorbiaceae		4	66.67	3.74
4	Symplocos theifolia	ເໝືອດດົ່ງ (Maud dong)	Symplocaceae		4	66.67	3.74
5	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		4	66.67	3.74
6	Gymnanthes remota	ປີກ (Pik)	Euphorbiaceae		4	66.67	3.74
7	Quercus	ກໍ່ (Kor)	Fagaceae		4	66.67	3.74
8	Lithocarpus harmandii	ກໍ່ໝັ້ນ (Kor man)	Fagaceae		3	50.00	2.80
9	Calophyllum pisiferum	ກະທືງ (Ka thueng)	Calophyllaceae		3	50.00	2.80
10	Lithocarpus pierrei	ກໍ່ກັກ (Kor Kak)	Fagaceae		3	50.00	2.80
11	Litsea cambodianum	ບົ່ງຂະໝນ (Bong khmer)	Lauraceae		3	50.00	2.80
12	Lindera annamensis	ລິນດາລາກ້ານແດງ (Lindara Kan-daeng)	Lauraceae		3	50.00	2.80
13	Nephelium hypoleucum	ຄໍແລນ (Kho lane)	Sapindaceae		3	50.00	2.80
14	Podocarpus pilgeri	ກະດອງ (Ka-dong)	Podocarpaceae		3	50.00	2.80
15	Camellia kissii	ໝ້ຽງອາມ (Miang arm)	Theaceae		3	50.00	2.80

Remarks: the plant species have not been assessed yet and not classified for any category of the IUCN Redlist.

5.3.1.4 Plant community

Only a single Upper Evergreen Forest in the survey blocks, but some part of it in some survey blocks were modified to agricultural land as fallows which were observed especially largely in the SB5, partly in other SBs and that considered secondary forest. The elevation of higher 1,500m a.s.l. is considered Montane Evergreen Forest which was found in SB3 and SB4 (Phou Koungking) and that lower density of forest diversity, whereas higher density of the forest diversity in the survey area was found at lower elevation of the UEF such as SB2.

5.3.1.5 Globally threatened species accounts

King khiew, *Zingiber mellis Škorničk., H.Đ.Trần & Šída f.* (Zingiberaceae)

Globally Threatened: Endangered (EN) and it is first record species of Laos.

This is not a tree species, native to Indochina especially Cambodia, Laos and Vietnam. For Laos, this species was found in mixed deciduous forest and evergreen forest of over 400m a.s.l. This species is still currently threatened by habitat loss to agricultural practice, made consequently its population has declined dramatically in the last decade. It was found outside protected areas and not listed in the National Category I (Prohibited species). As economic species and used for medicinal purpose. It is under high threat due to logging and habitat loss to agricultural practice. This species still presents in the Survey area; it was recorded in the Survey block 3 (Phou Koungking E).

Mak kom dok noy *Pittosporum pauciflorum Hook. & Arn*. (Pittosporaceae)

Globally Threatened: Vulnerable (VU)

This is a small tree species (bush), native to south China, Cambodia, Vietnam, Thailand and recent records in Laos. For Laos, this species was found in mixed deciduous forest and evergreen forest of over 700m a.s.l. It was listed for socio-economic plant as it is used for medicinal purpose, purchased by China. However, this species has not been yet listed in the National Category I (Prohibited species). This species still presents in the Survey block 4 (Phou Koungking West) and SB5 (Phou Yai) at 1,200m a.s.l., (see Fig. 15).

Meanwhlie, some GT species from literature views of the previous survey in the southern region (Nanthavong *et al*., 2019) which were believed they would occur in the survey area; however, they were not found in the Survey blocks. In addition, there are 3 Near-Threatened species were recorded in the area as *Nageia fleuryi* (Hickel) de Laub, *Nageia fleuryi* (Hickel) de Laub, *Pinus dalatensis* Ferré. Globally, these species have a large distribution and not considered as globally threatened species. Yet, if their habitats do largely lose would shift their threatened status to Vulnerable species of IUCN Redlist.

There are 3 Near-threatened plant species as below:

Phaya mai *(Nageia fleuyi),* it is a tree, found in SB2 and SB5

Peak habai *(Pinus dalatensis),* it is a tree, found in SB2.

Kor langbian *(Quercus langnianesis),* it is a tree, found in SB4.

5.3.1.6 First record and possible new species by survy block

First record and possible new species of plants were identified in all the Survey blocks, mainly in SB2 (8 possible new species and 11 first records of Laos), SB1 (2 possible new species and 5 first records of Laos), SB3 (11 first records of Laos), SB4 (11 first records of Laos), SB5 (5 first records of Laos). These possible new species and first records were distributed widely in the area (see Fig. 15). As some species were found in several survey blocks such as *Lithocarpus pierrei* (Hickel & A. Camus) A. Camus, *Ardisia gracilenta* C.M.Hu & J.E. Vidal, *Heptapleurum cambodianum* (Yahara & Tagane) Lowry & G.M.Plunkett.

A total of 29 first plant records of Laos which were mostly and firstly discovered in Vietnam and named in Vietnamese endemic species, yet since Lao and Vietnam have share the Annamite habitat, many of the endemic species to Vietnam would be reconsidered endemic to the Annamite or Indochina. A majority of not only plants but also other small creatures firstly recorded in Vietnam in the Annamite by Vietnamese scientists they considered Vietnamese endemic species. However, some of them were delisted from the endemic species list of Vietnam after rediscovering in neighboring countries. With publication of these species will make some endemic species of Vietnam no longer since they occur in Laos. For the publication it will take time for 2 years to get it done officially in peer review journals.

New species candidate *(possible new species to science)*, 10 possible new species to science were recorded and already checked with relevant experts that these plant species have not been described yet, they are probably endemic species to Laos and Indochina. Upon

publication of these species in peer review journals made will be officially proved to a new species to science, but it will take time, probably 2-3 years to get the publication done.

5.3.1.7 Some other interesting plant species in the survey area

Some other plant species were counted in the Survey area and that mostly non-tree species. Particularly, ground orchid and epiphytic orchid species were interesting, some of them were offered in lucrative market price such as Dok Pheung Nga Xang "orchidaceae - epiphytic" and Bia Lai (Orchidaceae - terrestrial). Locally known 6 distinct species of ground orchid according to morphology but they were identified to only 1 species (Orchidaceae - *Anoectochilus roxburghii*) from the survey (see Fig. 15), as color pattern of terrestrial orchid does not be meant in different species. This species is native to Indochina especially Cambodia, Laos and Vietnam. The ground orchids were found in quite often during the surveys in SB3 and SB4 and SB5 by other sub-teams. Their populations have declined due to highly market demands made overharvest for exporting to Vietnam and China. Price of ground orchid species in dry weight is ca. US$50 per kg and that they become important economic source of the local communities that they do harvest them annually.

Figure 15. Ground Orchid (*Anoectochilus roxburghii*)

5.3.1.8 Distribution of important plant species in the survey area

The important plant species in the survey area, those globally threatened and endemic species as first rcords of Laos and possible new species to science are widely distributed especially in SB1 and SB2 (Zone A) – the Annamite (see Fig. 16-1 and 16-2).

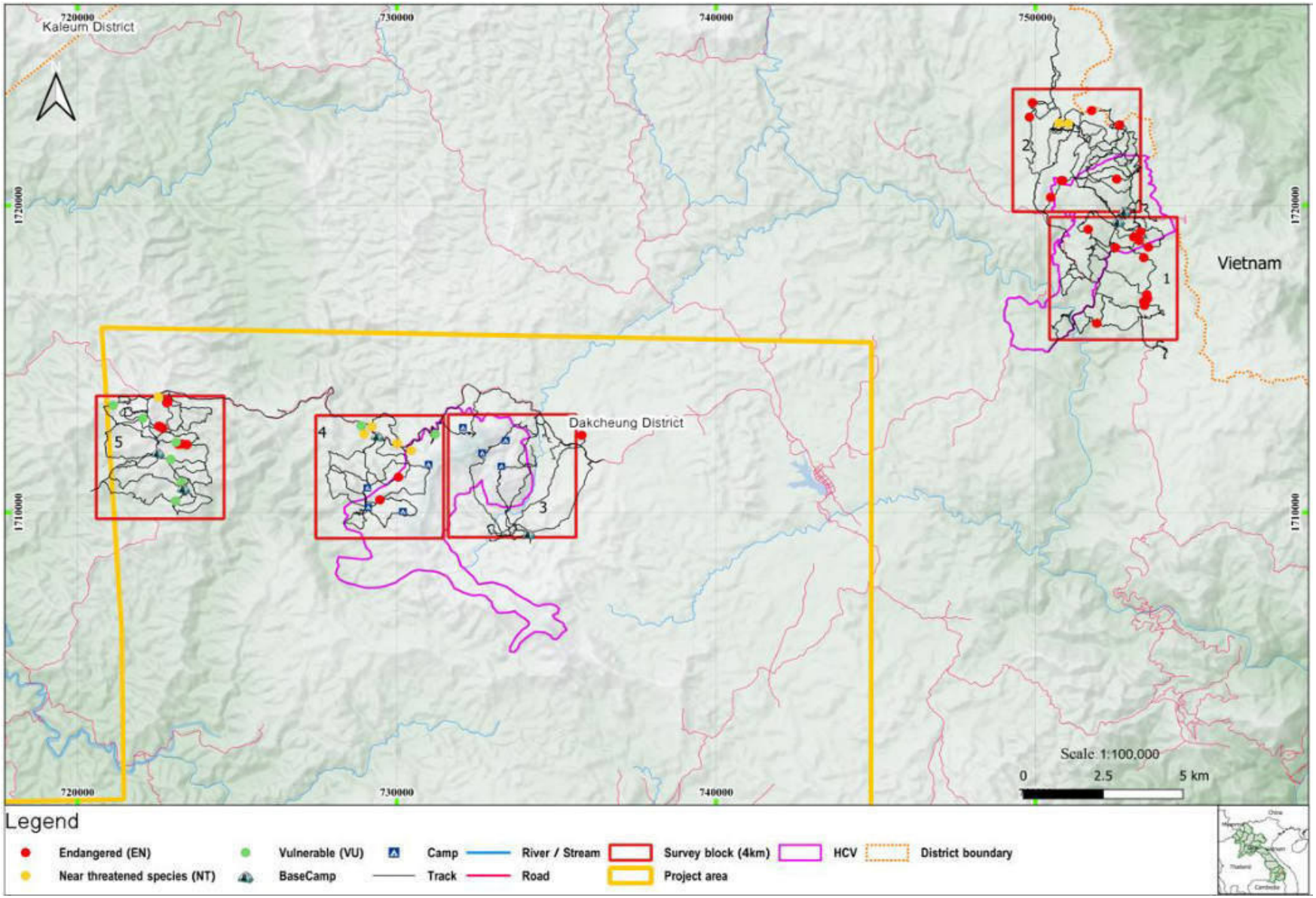


Figure 16-1. Locations of Global Threatened and Near-Threatened plant species in the survey blocks

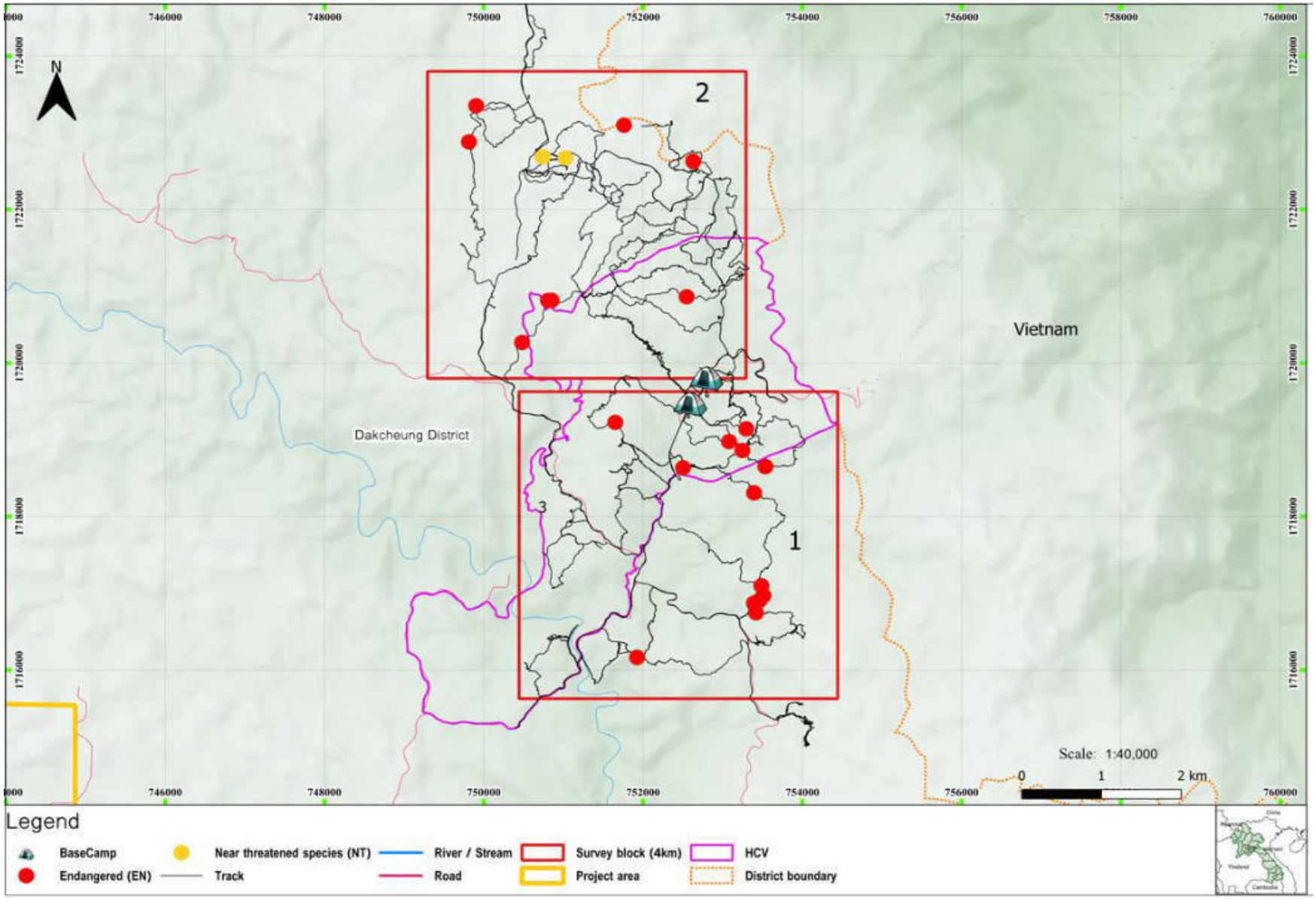


Figure 16-1a. Locations of Global Threatened and Near-Threatened plant species in the Zone A (Annamite)

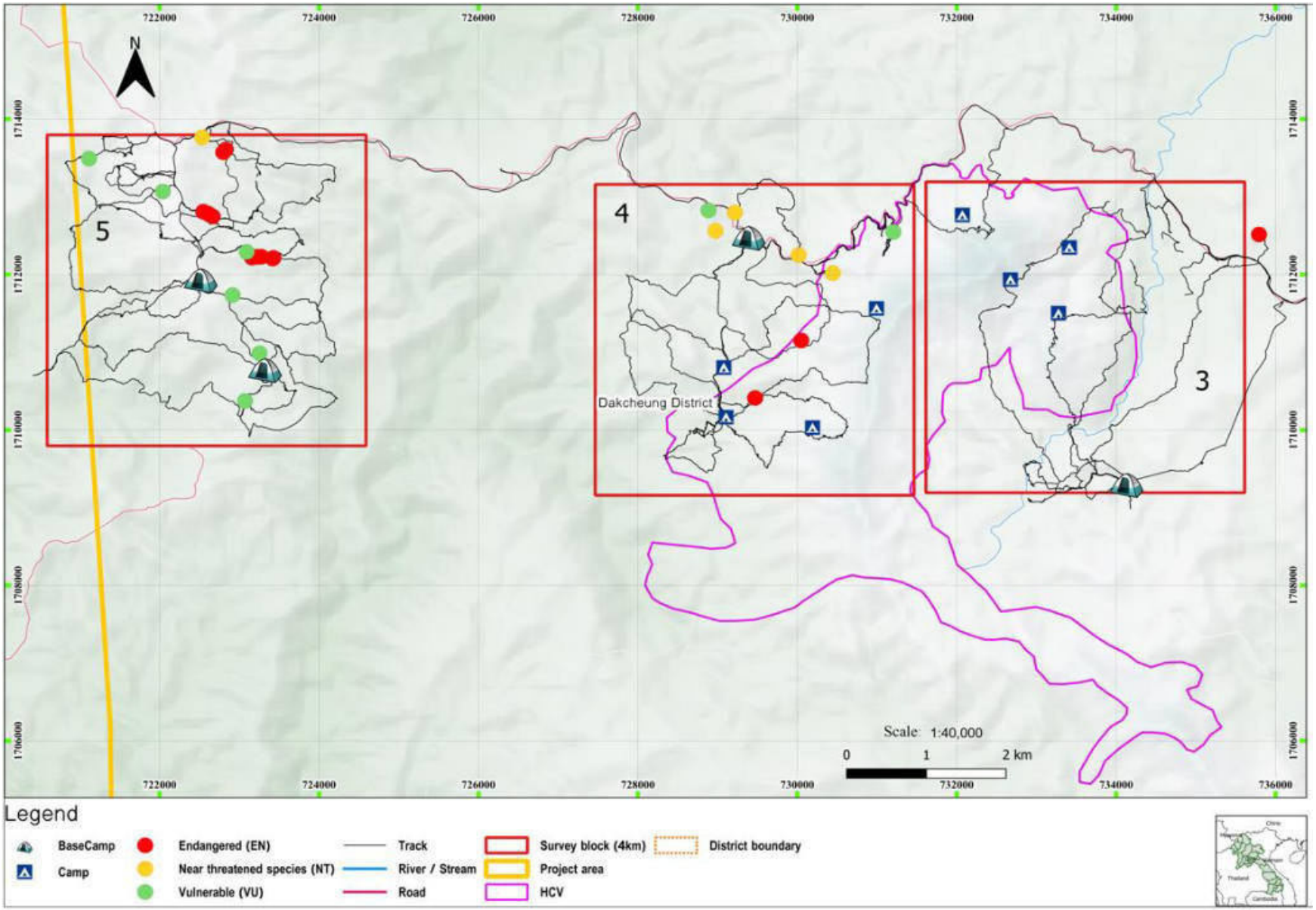


Figure 16-1b. Locations of Global Threatened and Near-Threatened plant species in the Zone B (Phou Koungking)

5.3.1.9 First record and possible new species accounts

FIRST RECORDS OF LAOS

Khaem-on *(Adinandra integerrima),* as first plant record of Laos, it is a tree, found in SB4, also found in SB2 and SB3.

Khemin ton *(Alseodaphne bidoupensis),* as first plant record of Laos, it is a tree, found in SB2

Phab dong *(Apodytes dimidiata),* as first plant record of Laos, it is a tree, found in SB3

Dik dong *(Daphniphyllum beddomei),* as first plant record of Laos, it is a tree, found in SB3

Saeng seo *(Elaeocarpus dubius),* as first plant record of Laos, it is a tree, found in SB1 and SB2

Moum doung *(Elaeocarpus limitaneus),* as first plant record of Laos, it is a tree, found in SB2

Pik *(Gymnanthes remota),* as first plant record of Laos, it is a tree, found in SB4

Tang *(Heptapleurum cambodianum),* as first plant record of Laos, it is a tree, found in SB1, SB3, SB5

Khai mod sapa *(Ilex chapaensis),* as first plant record of Laos, it is a tree, found in SB4 and SB5

Bong bokor *(Lindera bokorensis),* as first plant record of Laos, it is a tree, found in SB2 and SB4

Kor xang *(Lithocarpus elephantum),* as first plant record of Laos, it is a tree, found in SB3

Kor kak *(Lithocarpus pierrei),* as first plant record of Laos, it is a tree, found in SB1, SB2, SB3 and SB5

Lamout sang *(Madhuca cochinchinesis),* as first plant record of Laos, it is a tree, found in SB2

Maud dong *(Polyosma dolichocarpa),* as first plant record of Laos, it is a tree, found in SB2

Douk kai *(Psychotria cambodiana),* as first plant record of Laos, it is a tree, found in SB4

Kor langbian *(Quercus langbianensis),* as first plant record of Laos and Near-threatened species, it is a tree, found in SB4

Maud kontum *(Sarcosperma kontumense),* as first plant record of Laos, it is a tree, found in SB2

Khom pa *(Symplocos wikstroemiifolia),* as first plant record of Laos, it is a tree, found in SB4 and SB5

Seng dong *(Xanthophyllum ellipticum),* as first plant record of Laos, it is bush-tree, found in SB1 and SB2

Khoud kipma *(Angiopteris wangii),* as first plant record of Laos, it is bush-tree, found in SB2

Tin champ *(Ardisia gracilenta),* as first plant record of Laos, it is bush-tree, found in SB3, SB4 and SB5

Padab hin *(Argostemma bariense),* as first plant record of Laos, it is bush-tree, found in SB2

Moiu *(Brachytome wallichii),* as first plant record of Laos, it is bush-tree, found in SB4

Khem dong *(Chassalia curviflora),* as first plant record of Laos, it is bush-tree, found in SB3

Mouay *(Gnetum gnemon),* as first plant record of Laos, it is bush-tree, found in SB3

Het khan chog dam *(Amauroderma rugosum),* as first plant record of Laos, it is non-tree, found in SB3 and SB5

Het la ngok luang *(Amanita hemibapha),* as first plant record of Laos, it is non-tree, found in SB3 and SB4

Het la ngok deng *(Amanita caesarea),* as first plant record of Laos, it is non-tree, found in SB4

NEW SPECIES CANDIDATES

Miang *(Camellia sp. 1),* as possible new species to science, it is a tree, found in SB5 (Phou Yai). It is just medium tree located in upper evergreen forest at 1,000 m a.s.l.

Tong hom *(Machilus sp.),* as possible new species to science, it is a tree, found in SB1 and SB2. It is just medium tree located in upper evergreen forest.

Fai deauan ha *(Neolitsea sp.),* as possible new species to science, it is a tree, found in SB1 (Annamite). It is just medium tree located in upper evergreen forest.

Kor *(Quercus sp. 1),* as possible new species to science, it is a tree, found in SB1, Sb2, SB4 and SB5. It is just quite large tree located in upper evergreen forest and widely distributed in the survey area.

Khaeng *(Urophyllum sp. 1),* as possible new species to science, it is a tree, found in SB2 (Annamite). it is just medium tree located in upper evergreen forest.

Khaeng *(Urophyllum sp. 2),* as possible new species to science, it is a tree, found in SB2 (Annamite). It is just medium tree located in upper evergreen forest.

Khaeng *(Urophyllum sp. 3),* as possible new species to science, it is a tree, found in SB1 and SB2 (Annamite). It is just medium tree located in upper evergreen forest.

Phouang khai mouk *(Vaccinium sp. 1),* as possible new species to science, it is a tree, found only in SB2 (Annamite). It is just medium tree located in upper evergreen forest.

Seng dong *(Xanthophyllum sp. 1),* as possible new species to science, it is a tree, found in SB5, SB2 and SB1. It is just quite large tree located in upper evergreen forest and widely distributed in the survey area.

Mud *(Bredia sp. 1),* as possible new species to science, it is a bush-tree, found in SB2, SB1 and SB4. It is just bush tree located in upper evergreen forest and widely distributed in the survey area.

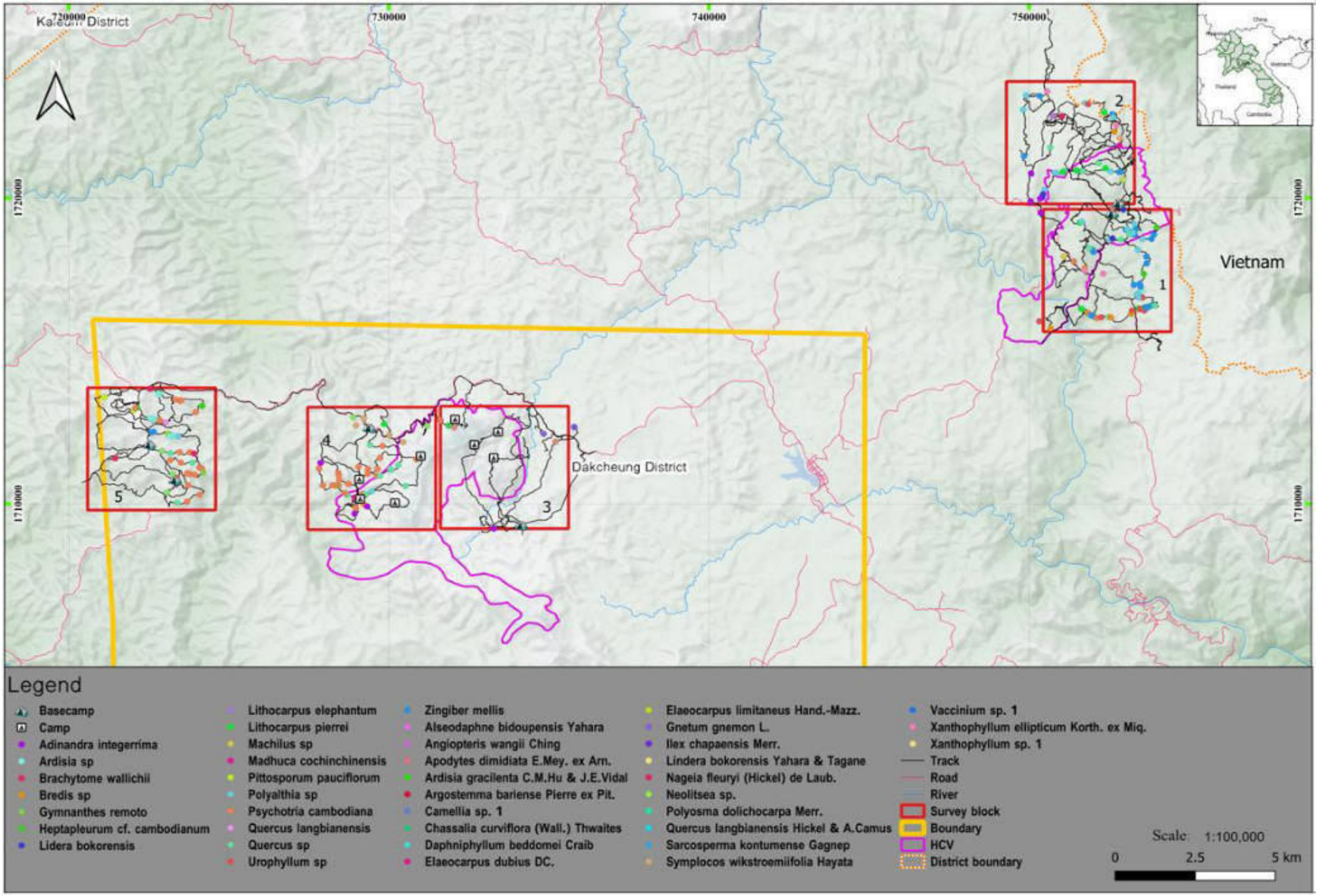


Figure 16-2. Locations of endemic plant species in the survey blocks

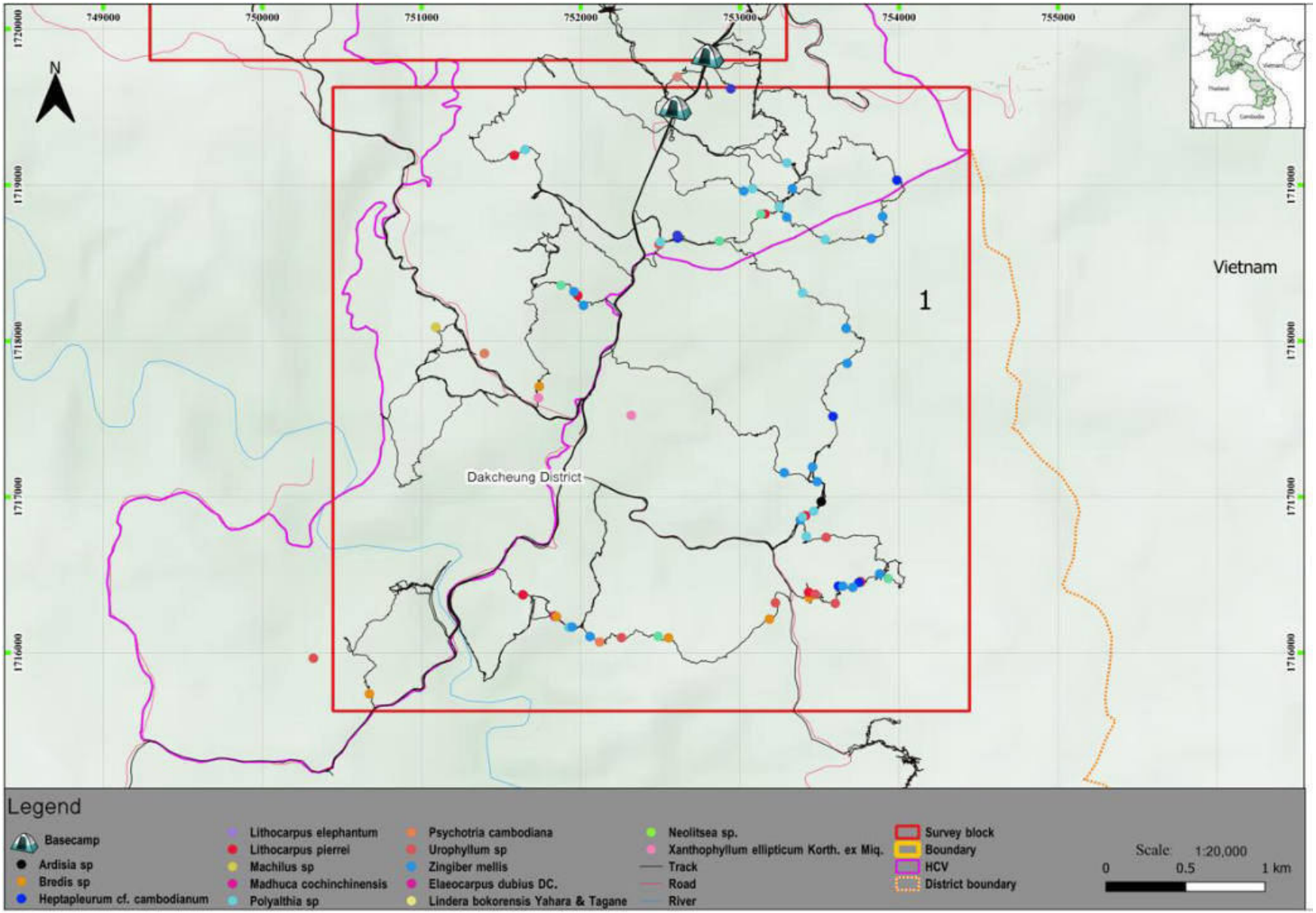


Figure 16-2a. Locations of endemic plant species in the survey block 1

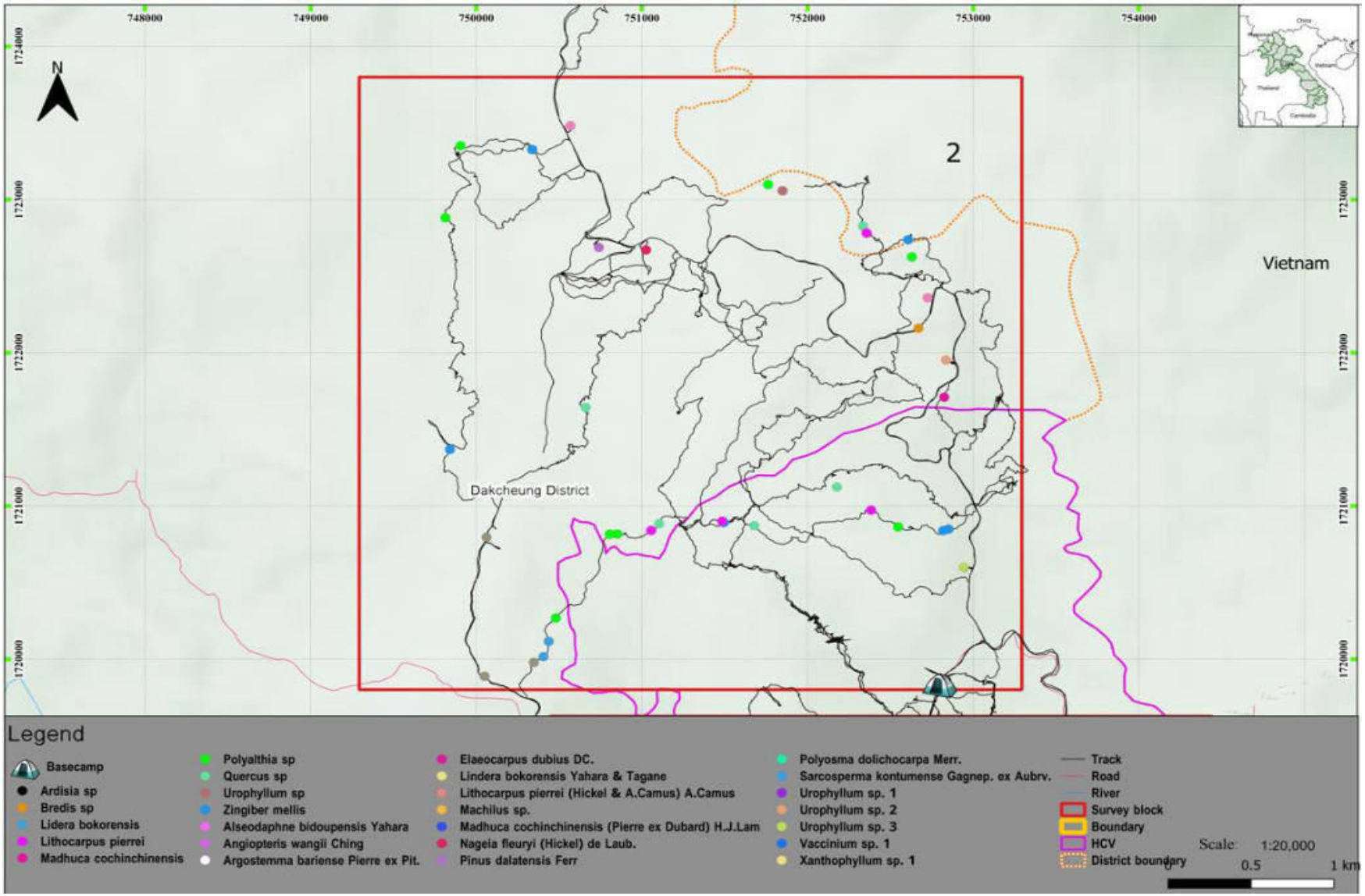


Figure 16-2b. Locations of endemic plant species in the survey block 2

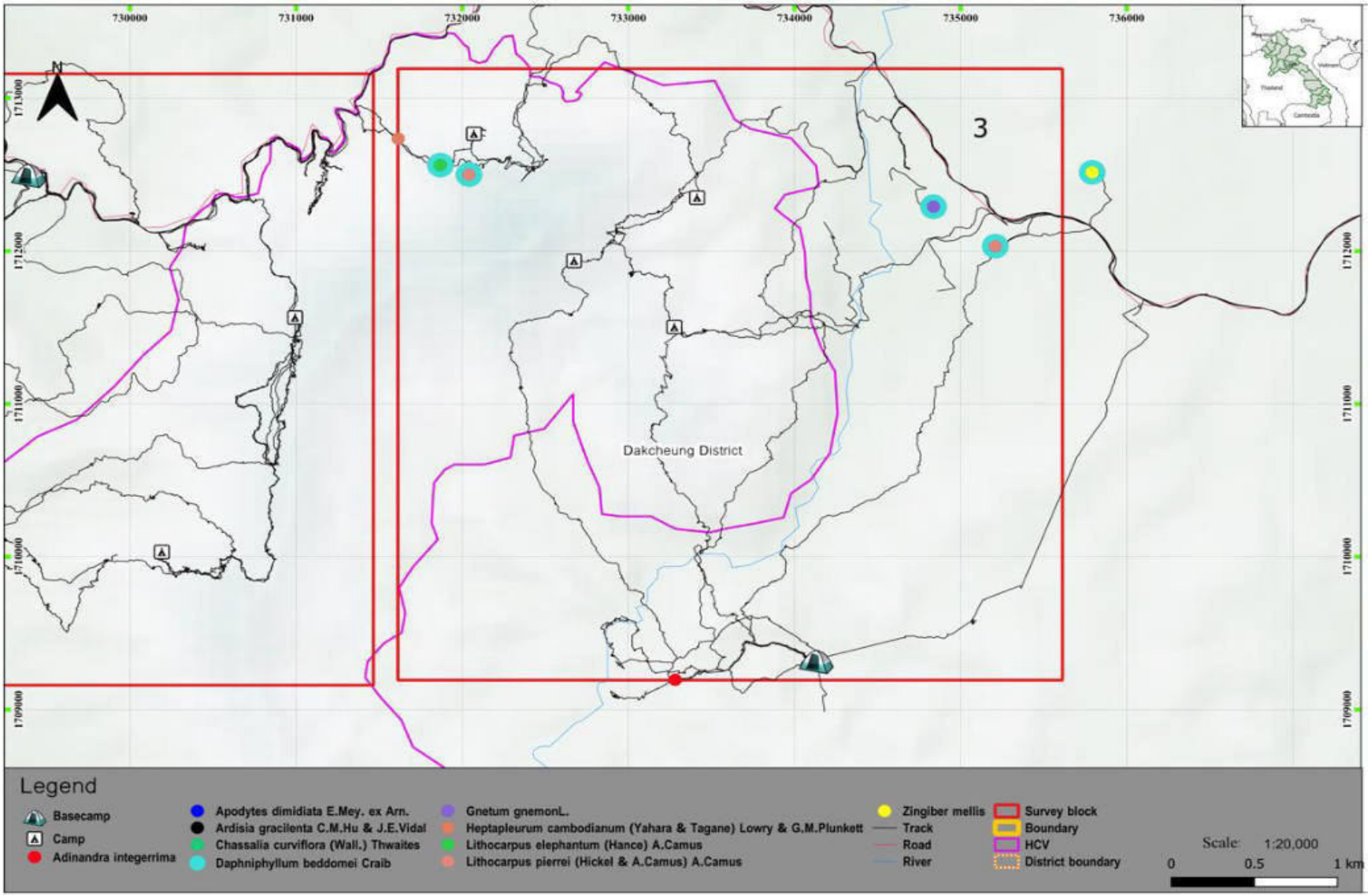


Figure 16-2c. Locations of endemic plant species in the survey block 3

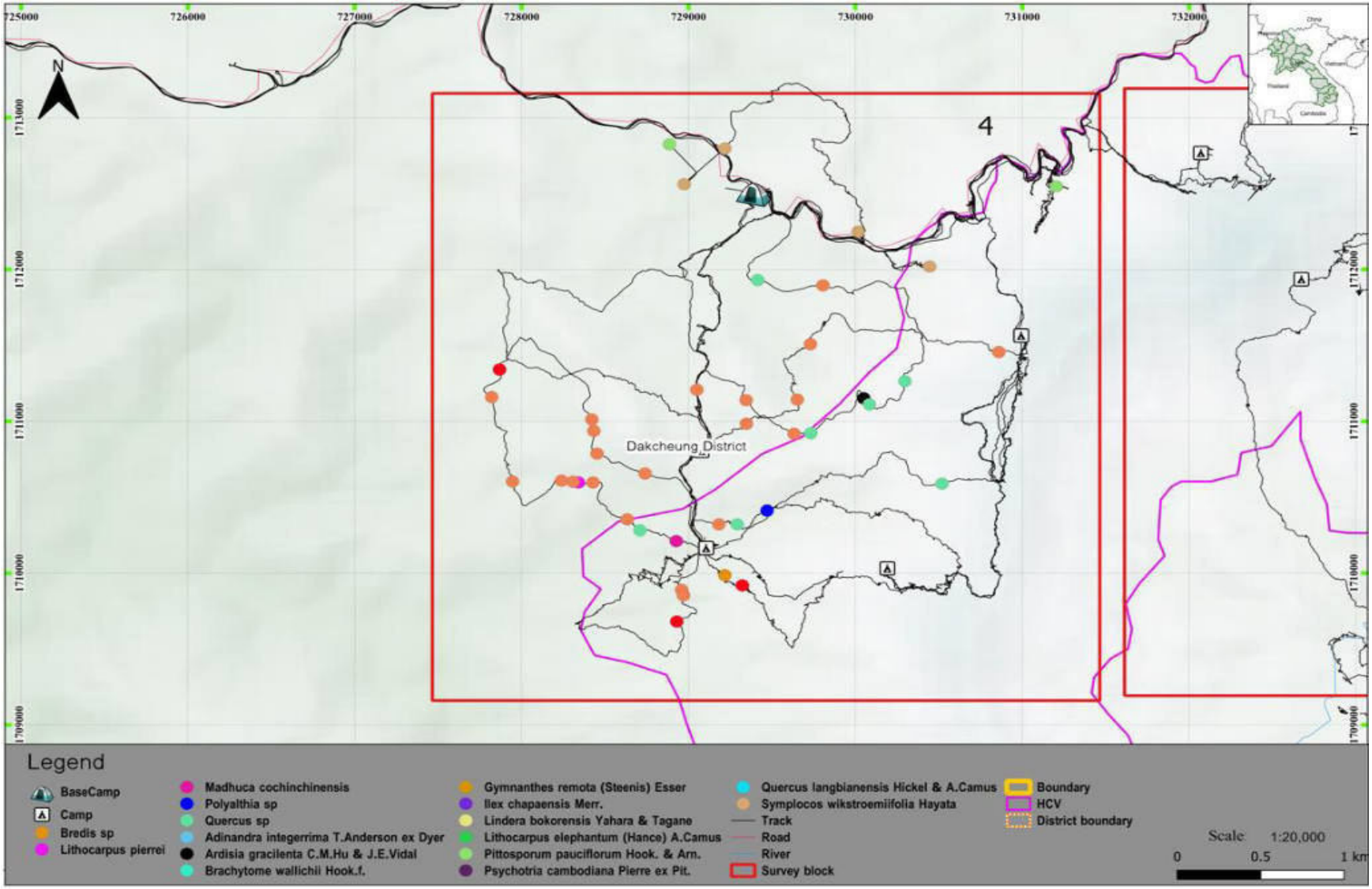


Figure 16-2d. Locations of endemic plant species in the survey block 4

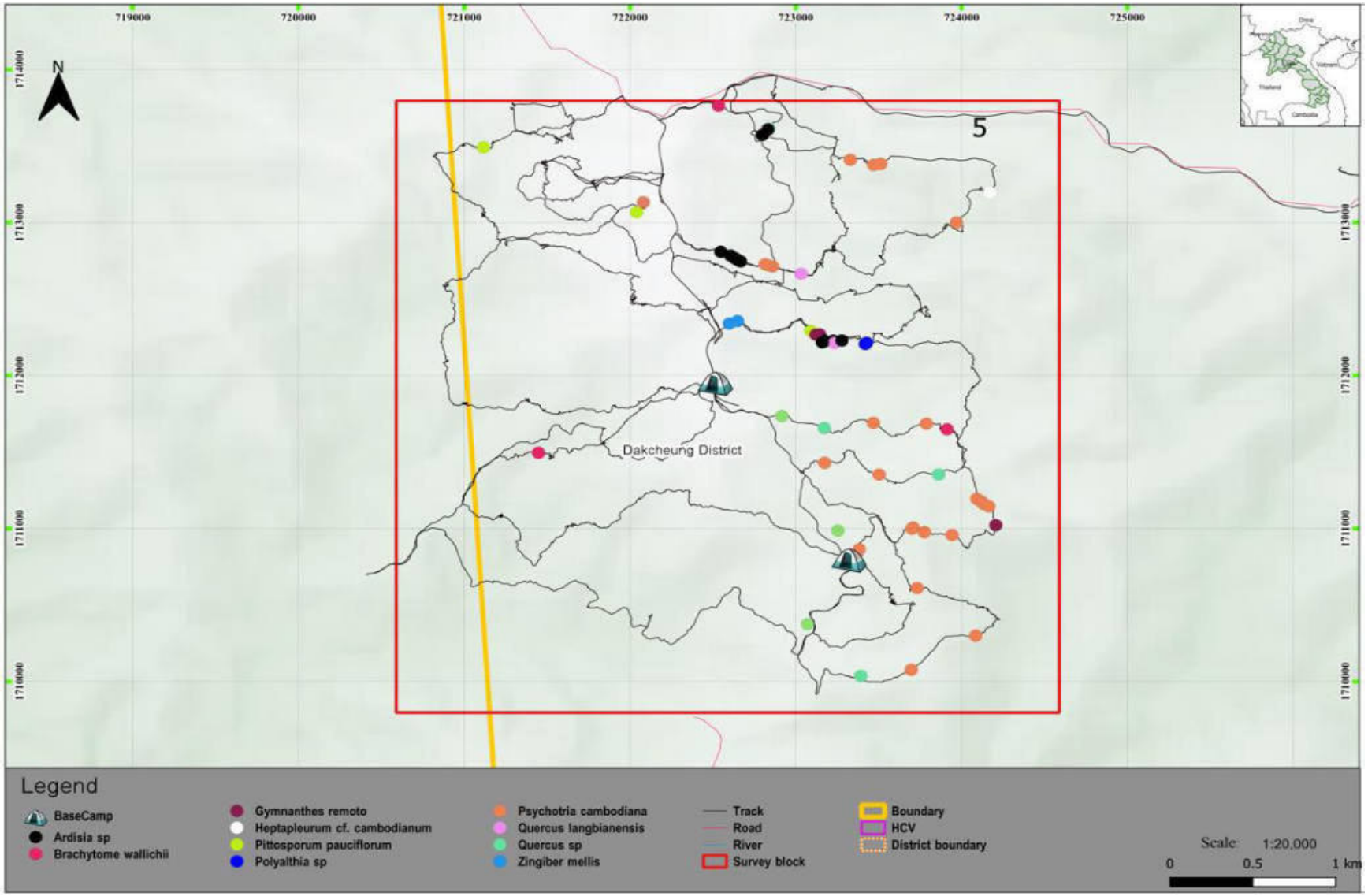


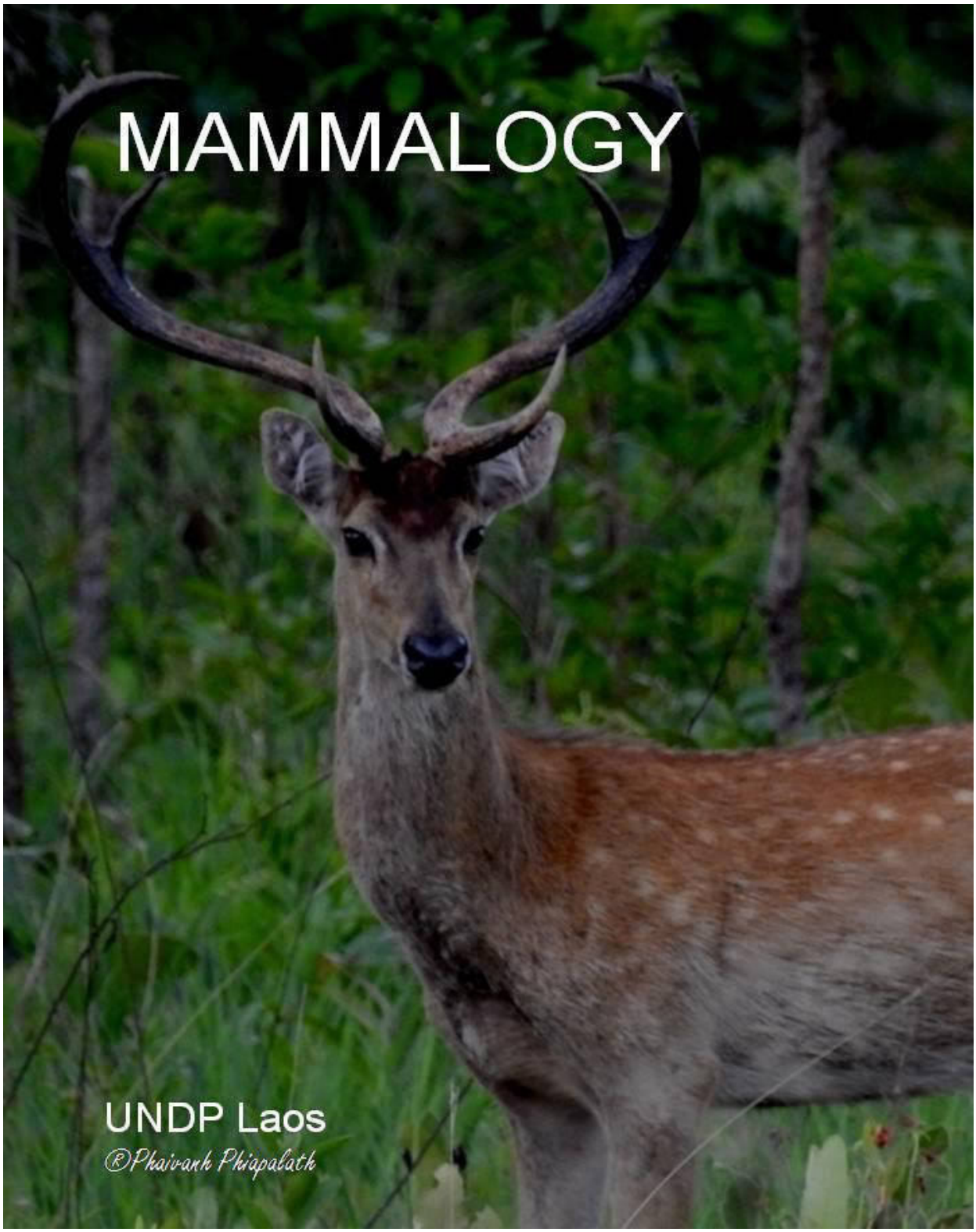
Figure 16-2e. Locations of endemic plant species in the survey block 5

5.3.1.10 Recommendations

Findings of the flora survey are very important to science since 10 plant species were listed as possible new species to science and 29 first plant records of Lao PDR. With some publications will be made and can make the place become better known. Scientists will be interested to do some more researches in the area in the future. As the zones where identified as high priority of biodiversity in the project area could be established - at least Phou Koungking is qualified to a provincial protected area and to function as research station not only flora but also fauna. The SB2 is also another important biodiversity hotspot as highest diversity of flora with some possible new and first record plant species. This section, along the Lao-Vietnam border is part of biodiversity conservation corridor.

5.3.1.11 Conclusions

The plant community in the survey area, although a very few globally threatened species were identified there are a number of possible new species to science and first records of Laos especially the SB2 (Southern Annamite) and SB3 (Phou Koungking). The Southern Annamite having any biodiversity assessment undertaken before, made little is known about the biodiversity status of the area. Also, Phou Koungking where the highest mountain (Montane forest) of the area having no study undertaken. More new plant species to science were identified in SB2 (Annamite) and first records of Laos were found in all the Survey blocks, at least 5 species each. Therefore, the findings provide important information of flora in Lao PDR, the southern Annamite in SB2, in particular.



5.3.2 Mammal

5.3.2.1 Introduction

Evergreen forest is well dominant in the survey area which is a suitable habitat for many terrestrial species. Yet, specific evergreen forest including Montane was found in the area which some specialist species would potentially occur. Mostly the survey area with over 1,000m a.s.l. and considered Upper Evergreen Forest (UEF) and some small portion with a higher elevation of 1,500m a.s.l. is considered Montane Evergreen Forest (MEF). The UEF is part of the Southern Annamite Mountain Range receives high precipitation.

According to the Integrated Biodiversity Assessment Tool (IBAT) of International Union for Conservation of Nature (IUCN) and some reviews generated a list of 19 globally threatened species in the survey area. The rapid ecological assessment showed that some species above are no longer in the survey area such as Saola and also Tiger since they are very rare in the country and no any provisional information in the project area. Therefore, only 6 globally threatened species are the target species for the mammal survey, including Northern buff-cheeked Gibbon (*Nomascus annamensis*, EN), Red-shanked Douc Langur (*Pygathrix nemaeus*, CR), Indochinese Silvered Leaf Monkey (*Trachypethicus germaini*, EN), Large antlered Muntjac (*Muntiacus vuquangensis*, CR), Annamite Striped Rabbit (*Negolagus timminsi*, EN) and Owston's civet (*Chrotogale owston,* EN). While, some other GT species were not defined as target species but important to record if they are present.

It notes that the project area is not part of any nationally conservation area, only Laeng Nam Sekong-Xe Kaman PF and some local PFs, but were not well recognized by local villagers. Only the forest stretch along Lao-Vietnam border was quite well recognized as conservation area "BCC" as project-based support. Consequently, due to low awareness of the local authority in conservation a hunting pressure was reported and that would treat some key mammal species away in the area, made them in lower populations today.

5.3.2.2 Key findings

Through the surveys, the mammal species, including some small mammals, were reported and recorded in the Survey area with a total of 58 species were listed but 44 species were confirmed from the field surveys and some very few species from reliable village reports (see Annex 2). Of these species, a total of 14 GT mammal species were confirmed in the field (3 CR, 3 EN and 8 VU), but including some few species were reported by local villagers (see Table 14a and 14b). Of these species, 3 target mammal species were confirmed during the surveys are Northern buff-cheeked Gibbon (EN), Red-shanked Douc Langur (EN), Owston' Civet (EN) and Sambar (VU).

Table 14a. List of GT mammal species records and reports in the survey area

Survey Block	GT mammal species			GT species count by SB
	CR	EN	VU	
SB1 – Annamite	2	2	2	6
SB2 – Annamite)	2	1	4	8

SB3 – Phou Koungking	2	1	6	9
SB4 – Phou Koungking	2	2	4	8
SB5 – Phou Yai			6	6

Remarks: only the globally threatened species that were confirmed from the survey.

Table 14b. List of GT mammal species records and reports in the survey area

Common Name	Scientific Name	IUCN *Red List*	Field Conf.	Freq	Survey Block					Presence
					1	2	3	4	5	
Northern Buff-cheeked Gibbon	*Nomascus annamensis*	EN	x	+	**x**	**x**	x	**x**		**Yes**
Red-shanked Douc Langur	*Pygathrix nemaeus*	CR	x	+		**x**	**x**	**x**	?	**Yes**
Indochinese Silvered Langur	*Trachypeticus germaini*	EN	Report			?	?	?	?	Uncertain
Large antlered Muntjac	*Muntiacus vuquangensis*	CR	Report		?	?				Uncertain
Chinese Pangolin	*Manis pentadactyla*	CR	x	++	**x**	**x**	**x**	**x**		**YES**
Sunda Pangolin	*Manis javanica*	CR	x	+	**x**	**x**	?	?		**YES**
Owston's Civet	*Chrotogale owstoni*	EN	x			x	**x**	x		**YES**
Annamite Striped Rabbit	*Negolagus timminsi*	EN	Report	?	?		?	?		Uncertain
Sun Bear	*Helarctos malayanus*	VU	x	+	x	**x**	**x**	**x**	**x**	**YES**
Smooth-coated Otter	*Lutrogale perspicillata*	VU	x		x	x	**x**	x		**YES**
Binturong	*Arctictis binturong*	VU	Report			?	?	?		Uncertain
Chinese Serow	*Capricornis*	VU	Report	++			**x**	**x**	**x**	**YES**
Asiatic Black Bear	*Ursus thibetanus*	VU	x	+		**x**	?			**YES**
Stump-tailed Macaque	*Macaca arctoides*	VU	x	+++	**x**	**x**	**x**	**x**	**x**	**YES**
Northern Pig-tailed Macaque	*Macaca leonina*	VU	x	++	x	x	x	x	**x**	**YES**
Bengal Slow Loris	*Nycticebus bengalensis*	EN	Report		x	x	x	x	x	Yes
Pygmy Slow Loris	*Nycticebus pygmaeus*	EN	Report				?	?		Uncertain
Sambar	*Rusa unicolor*	VU	x	+	**x**	**x**	**x**	x	**x**	**YES**
Great Hog Badger	*Arctonyx collaris*	VU			**x**	x	**x**	**x**	**x**	**YES**
Total					**6**	**8**	**9**	**7**	**6**	**14**

*Remarks: The confirmed GT mammal species from the field with some of them from camera traps. The species were confirmed from the field were given bold "**Yes**" and in bold **X** by relevant survey block. Whereas, some species with reliable village report only were given "Yes" and which species with insufficient provisional information were given "uncertain".*

5.3.2.3 Findings from camera trapping

Camera traps were deployed as to assist for identifying the presence of terrestrial animal and other species. There were 2 zones (Zone A and Zone B), due to different number of days for camera operation which was classified as at each zone we deployed the camera trap using satisfy random technique based on the undisturbed habitat. A total of 30 camera traps were deployed and made for 3,233 trap days) as 12 camera traps in Zone A for 1,355 trap days and 17 camera traps in Zone B for 1,878 trap days, but 3 camera traps did not work well as 1 camera trap in the Zone A and 2 camera traps in the Zone B because they were damaged by water. The wildlife species recorded from camera trapping is interesting, among all the photographs for 5 months caught for 31 species as 28 mammal species and 3 bird species. Of which, 7 GT species (1 EN species and 6 VU species), and some Near-threatened species (see Table 16; and see Fig. 17).

Table 16. Relative frequency and abundance of wildlife by camera trap

No.	Species	No. of trapping stations	No. of Trap success	Trap Night	No. of captures/events	Relative Frequency (RF)	Relative abundance (RA)
1	Annamite Muntjac	26	20	3233	104	68.97	3.22
2	Bar-backed Partridge	26	1	3233	1	3.45	0.03
3	Black Giant Squirrel	26	1	3233	2	3.45	0.06
4	Black-h. laughingthrush	26	2	3233	3	6.90	0.09
5	Blue Whistling-thrush	26	1	3233	2	3.45	0.06
6	Brush tailed Porcupine	26	2	3233	28	6.90	0.87
7	Chinese Serow	26	4	3233	5	13.79	0.15
8	Crab-eating Mongoose	26	4	3233	9	13.79	0.28
9	East Asian Porcupine	26	1	3233	2	3.45	0.06
10	Eurasian Wild pig	26	14	3233	25	48.28	0.77
11	Small-toothed Ferret Badger	26	5	3233	16	17.24	0.49
12	Great Hog Badger	26	1	3233	2	3.45	0.06
13	Large Indian Civet	26	1	3233	1	3.45	0.03
14	Long-tailed Giant Rat	26	6	3233	69	20.69	2.13
15	Masked Palm Civet	26	7	3233	15	24.14	0.46
16	North. Pig-tailed Macaque	26	1	3233	2	3.45	0.06
17	Owston's Civet	26	1	3233	1	3.45	0.03
18	Pallas's Squirrel	26	3	3233	8	10.34	0.25
19	Rat sp	26	2	3233	2	6.90	0.06
20	Red checked Squirrel	26	1	3233	2	3.45	0.06
21	Red Janglefowl	26	1	3233	2	3.45	0.06
22	Red Muntjac	26	4	3233	5	13.79	0.15
23	Red-cheeked Squirrel	26	1	3233	3	3.45	0.09
24	Red-shanked Douc Langur	26	1	3233	1	3.45	0.03
25	Sambar Deer	26	1	3233	1	3.45	0.03
26	Silvered Pheasant	26	9	3233	25	31.03	0.77

27	Spotted Linsang	26	1	3233	2	3.45	0.06
28	Stump-tailed Macaque	26	13	3233	50	44.83	1.55
29	Treeshrew sp.	26	1	3233	4	3.45	0.12
30	Wild pig	26	1	3233	1	3.45	0.03
31	Yellow-throated Marten	26	7	3233	7	24.14	0.22

However, some species were unidentified, a group of rodent species and tree shrew species. According to the result of relative abundance and relative frequency analysis of mammal species showed slightly difference among two zones. The Zone A, Annamite Muntjac was maximum of *RAI=1.92*) and 3 species were minimum (*RAI=0.07*), while the Zone B Annamite Muntjac was maximum (*RAI=4.50*) and 5 species were minimum (*RAI=0.05*). For the whole survey area, also the Annamite Muntjac was maximum (*RAI=3.22*) (see Table 16a).

Table 16a. Relative frequency and abundance of wildlife species by camera trap and zone

Zone	Species	No. of trapping stations	No. of Trap success	Trap Night	No. of captures/events	Relative Frequency (RF)	Relative abundance (RA)
A	Annamite Muntjac	10	6	1,355	26	60.00	1.92
	Black-hooded laughingthrush	10	1	1,355	2	10.00	0.15
	Crab-eating Mongoose	10	1	1,355	1	10.00	0.07
	East Asian Porcupine	10	1	1,355	2	10.00	0.15
	Eurasian Wild pig	10	7	1,355	17	70.00	1.25
	Small-toothed Ferret Badger	10	2	1,355	8	20.00	0.59
	Large Indian Civet	10	1	1,355	1	10.00	0.07
	Long-tailed Giant Rat	10	3	1,355	7	30.00	0.52
	Masked Palm Civet	10	2	1,355	3	20.00	0.22
	Red checked Squirrel	10	1	1,355	2	10.00	0.15
	Red Muntjac	10	2	1,355	3	20.00	0.22
	Silvered Pheasant	10	4	1,355	12	40.00	0.89
	Stump-tailed Macaque	10	3	1,355	21	30.00	1.55
	Wild pig	10	1	1,355	1	10.00	0.07
	Yellow-throat. Marten	10	2	1,355	2	20.00	0.15
B	Annamite Muntjac	16	14	1,878	78	87.50	4.15
	Bar-backed Partridge	16	1	1,878	1	6.25	0.05
	Black Giant Squirrel	16	1	1,878	2	6.25	0.11
	Black-h. laughingthrush	16	1	1,878	1	6.25	0.05
	Blue Whistling-thrush	16	1	1,878	2	6.25	0.11
	Brush tailed Porcupine	16	2	1,878	28	12.50	1.49
	Chinese Serow	16	4	1,878	5	25.00	0.27
	Crab-eating Mongoose	16	3	1,878	8	18.75	0.43
	Eurasian Wild pig	16	7	1,878	8	43.75	0.43

	Small-toothed Ferret Badger	16	3	1,878	8	18.75	0.43
	Great Hog Badger	16	1	1,878	2	6.25	0.11
	Long-tailed Giant Rat	16	3	1,878	62	18.75	3.30
	Masked Palm Civet	16	5	1,878	12	31.25	0.64
	North-tailed Macaque	16	1	1,878	2	6.25	0.11
	Owston's Civet	16	1	1,878	1	6.25	0.05
	Pallas's Squirrel	16	3	1,878	8	18.75	0.43
	Rat sp	16	2	1,878	2	12.50	0.11
	Red Janglefowl	16	1	1,878	2	6.25	0.11
	Red Muntjac	16	2	1,878	2	12.50	0.11
	Red-cheeked Squirrel	16	1	1,878	3	6.25	0.16
	Douc Langur	16	1	1,878	1	6.25	0.05
	Sambar Deer	16	1	1,878	1	6.25	0.05
	Silvered Pheasant	16	5	1,878	13	31.25	0.69
	Spotted Linsang	16	1	1,878	2	6.25	0.11
	Stump-tailed Macaque	16	10	1,878	29	62.50	1.54
	Treeshrew sp.	16	1	1,878	4	6.25	0.21
	Yellow-throat. Marten	16	5	1,878	5	31.25	0.27

The relative frequency also significant to consider that photographed species had a wide distribution in the survey area. In the zone A, Eurasian wild pig was maximum (RFI=70.00) and six photographed species were minimum (RFI=10.00). In the Zone B, Annamite Muntjac was maximum (RFI=87.50) with 13 photographed species were minimum (RFI-6.25). For the whole survey area, Annamite Muntjac was also maximum with the relative frequency (RFI=68.97) (see Table 16b).

Table 16b. Variation of wildlife species taken by camera trap and zone

No.	Species	Zone A	Zone B
1	Annamite Muntjac	x	x
2	Black-hooded laughingthrush	x	x
3	Crab-eating Mongoose	x	x
4	Eurasian Wild pig	x	x
5	Small-toothed Ferret Badger	x	x
6	Long-tailed Giant Rat	x	x
7	Masked Palm Civet	x	x
8	Red Muntjac	x	x
9	Silvered Pheasant	x	x
10	Stump-tailed Macaque	x	x
11	Yellow-throated Marten	x	x
12	Bar-backed Partridge		x
13	Black Giant Squirrel		x
14	Blue Whistling-thrush		x

15	Brush tailed Porcupine		x
16	Chinese Serow		x
17	Great Hog Badger		x
18	Northern Pig-tailed Macaque		x
19	Owston's Civet		x
20	Pallas's Squirrel		x
21	Rat sp		x
22	Red Janglefowl		x
23	Red-cheeked Squirrel		x
24	Red-shanked Douc Langur		x
25	Sambar Deer		x
26	Spotted Linsang		x
27	Treeshrew sp.		x
28	East Asian Porcupine	x	
29	Large Indian Civet	x	
30	Red checked Squirrel	x	
31	Wild pig	x	

Figure 17. Wildlife pictures from camera traps

5.3.2.4 Findings by survey block

According to the mammal species records with some reliable village reports a higher number of mammal species were in SB 2 (Annamite), SB3 and SB4 (Phou Koungking). The key findings by Survey block were presented on a number of species records (see Annex 6) and some reliable village reports in the area with highlighting of some important findings by survey block as below:

5.3.2.4.1 Findings by Survey block 1 (Annamite)

The survey for mammal in the Survey block 1 was conducted through village interviews (Ban Dak Dom) and field surveys. The village interviews reported of 37 mammal species, of which 26 species were confirmed in the SB1. During the field observations, most the species were confirmed in the field as identified from song, tracks, sighting and droppings. This, there was a total of 26 mammal species present in this SB. Of which, 6 GT species were confirmed present in the survey block. Of these species, the most important GT and target species for this assessment confirmed in the field are Northern Buff-cheeked Gibbon (EN), Pangolins (CR) and Sambar (VU). Almost all the species were of a low population in this survey block so they are rare to detect and probably be seen occasionally.

5.3.2.4.2 Findings by Survey block 2 (Annamite)

The survey for mammal in the Survey block 2 was conducted through village interviews (Ban Dak Dom) and field surveys. The village interviews reported of 43 mammal species but 32 species were confirmed in the SB 2. During the field observations, most the species were confirmed in the field as identified from song, tracks, sighting and droppings. The survey block was considered high fauna biodiversity of the survey area. Of which, 9 GT species were present in the survey block. The most important GT and target species for this assessment confirmed in the field are Northern buff-cheeked Gibbon (EN), Red-shanked Douc Langur (CR), Sunda Pangolins (CR), Chinese Pangolins (CR), Stump-tailed Macaque (VU), Sun Bear (VU) and Asiatic Black Bear (VU) and Sambar (VU). Almost all the species except Pangolins were of a low population in this survey block so they are rare to detect and probably be seen occasionally.

5.3.2.4.3 Findings by Survey block 3 (Phou Koungking E)

The survey for mammal in the Survey block 3 was conducted through village interviews (Ban Dak Dreun) and field surveys. The village interviews reported of 40 mammal species, of which 26 species were confirmed in the SB3. During the field observations, most the species were confirmed in the field as identified from song, tracks, sighting and droppings. The survey block was considered high fauna biodiversity of the survey area. Of which, 9 GT species were present in the survey block. The largest population of the GT species in this survey block are Stump-tailed Macaque (VU) and Chinese Serow (VU). The most important GT and target species for this assessment confirmed in the field are Red-shanked Douc Langur (CR), Sun Bear (VU), Owston's Civet (EN), Sambar (VU) and Great Hog Badger (VU). Almost all the species except Chinese Serow and Pangolins were of a low population in this survey block so they are rare to detect and probably be seen occasionally.

5.3.2.4.4 Findings by Survey block 4 (Phou Koungking W)

The survey for mammal in the Survey block 4 was conducted through village interviews (Ban Prao) and field surveys. The village interviews reported of 42, of which 28 mammal species were presented in the SB5. During the field observations, most of the species were confirmed in the field as identified from tracks, sighting and droppings. The Survey block was considered high biodiversity of the survey area. Of which, 8 GT species were confirmed their presence in the survey block. The most important and the target species for this assessment were confirmed in the field are Northern buff-cheeked Gibbon (EN), Red-shanked Douc Langur (CR), Sun Bear (VU), Sambar (VU) and Chinese Serow (VU). Almost all the species except Chinese Serow were of a low population in this survey block so they are rare to detect and probably be seen occasionally. Although many sites of feeding sites of Douc Langur were found in the survey block during the wet season survey. Finally, direct observation made in December 2021 and also caught on camera trap. It was believed that would be a small group size (10-15 individuals) in the area.

5.3.2.4.5 Findings by Survey block 5 (Phou Yai)

The survey for mammal in the Survey block 5 was conducted through village interviews (Ban Prao) and field surveys. The village interviews reported of 42, of which 33 mammal species were confirmed their presence in the SB5. During the field observations, most of the species were confirmed in the field as identified from tracks, sighting and droppings. This SB was fairly high biodiversity of fauna in the survey area. There are 6 GT species were present in the survey block, including from camera traps. The largest population of the GT species in this survey block are Stump-tailed Macaque and probably also Northern Pig-tailed Macaque since a high frequency of detection from camera traps. Other GT species would be of a low population in this survey block so they are rare to detect. The most important and the target species for this assessment were confirmed in the field are Sun Bear (VU), Sambar (VU) and Great Hog Badger (VU).

5.3.2.5 Overview of mammal community

Large and medium ground-dwelling mammal community

A large ground-dwelling mammal such as Asian Elephant, Gaur and Banteng are not present in the area today from the village interviews, neither some medium ground-wdelling animal such as Saola, tiger and Leopard. But only some number of other medium ground-dwelling mammal species would occur which are possible to detect from direct observation, signs and droppings. Suitable habitats for this sub-mammal group such as evergreen forest which was entirely in the Survey area. Human pressure from hunting and habitat disturbance has made a low chance to obtain the large and medium ground-dwelling mammal species.

The surveys were conducted through village interviews and field observations to confirm the presence of this sub-mammal group included Sambar, Pangolins, Bears, Serow, Great Hog Badger, Large Indian Civet, Masked Palm Civet, Spotted Linsang and Wild Pig. The medium ground-dwelling mammal community in the Survey area seems to be low in populations.

Feeding sites and holes of Pangolins were quite obviously observed in the SB2 by both wet and dry seasons (see detail in item 5.3.2.6).

Due to on-going hunting, disturbance and habitat loss populations of many mammal species remain low in the survey area. Other ground-dwelling large mammals which are difficult to predict whether they would occur in the Survey area or not. It is reasonably expected, based on credible literatures and village interviews and with sufficient justification help to make the best judgment.

Arboreal large mammal community

The arboreal large mammal community in the Survey area seems to be in reasonable numbers and populations. The sub-mammal arboreal large group were recorded and reported in the survey area included Northern Buff-cheeked Gibbon, Red-shanked Douc Langur, Indochinese Silvered Leaf Monkey, Stump-tailed Macaque and Northern Pig-tailed Macaque and Lorises.

Suitable habitats, for this sub-mammal group such as evergreen forest which was entirely in the Survey area. Human pressure from hunting and habitat disturbance has made low chance to obtain the arboreal large mammal species.

The surveys were conducted through village interviews and field observations to confirm the presence of this sub-mammal group included Northern Buff-cheeked Gibbon, Red-shanked Douc Langur and Stump-tailed Macaque. Gibbon songs were detected in the SB1, SB2 and SB4, a small group of Douc Langur was seen in SB2 and its feeding sites in SB4, as well as for Stump-tailed Macaque in all survey blocks typically the SB5, SB4 and SB2 (see detail in item 5.3.2.6). Evidences of these species were seen in both wet and dry season surveys. However, such as Lorises it was difficult to assess since it is a nocturnal animal and given only small effort of spotlighting was undertaken. Due to on-going hunting, disturbance and some habitat loss, populations of arboreal mammal species remain low in the survey area and made the wild animal very shy.

A small arboreal mammal group such as the Indian Giant Squirrel (provisional), squirrels of the genera *Callosciurus* and *Tamiops* etc were recorded in the SB2 and SB5. Of course, it is difficult to predict whether some other would occur in the Survey area or not. It is reasonably expected, based on credible literatures and village interviews and with sufficient justification help to make the best judgment.

Small mammal community and bats

The small mammal community in the Survey area are mainly rats and bats as at least 5 species of rats and 10 species of bats were reported and some recorded as more bats were observed at night at all survey blocks typically the SB3 and SB4 since more caves were available at Phou Koungking (UTM: 733293/1711518), but these were not in priority of the surveys. Rats were recorded in higher number of detections in SB5 from camera trapping compared to other SBs, probably due to a large portion of secondary forest in the area.

5.3.2.6 Globally threatened species accounts

Following are the records of species considered of global and/or national conservation interest which specific recording sites were given with mapping (see Fig. 18).

Northern buff-cheeked Gibbon *Nomascus annamensis*

Globally Threatened: Endangered (EN); At Risk in Lao PDR; National Category I (Prohibited)

Northern buff-cheeked Gibbon was strictly to southern Laos, the southern Annamite from southern Xe Sap National Protected Area in Sekong Province to the whole part of Attapeu and Champasak Provinces (Duckworth, 2008). This species was reported in the SB1, SB2, SB4, and this species was reported in the south and outside of the SB3, in Phou Katiang.

Gibbon song was heard in the morning of 13 July 2021 at 8.45am to SE, 9.15am SE, 9.30am to E from LP (UTM: 0753658/1719515), and 14 July 2021 at 7.10am to NE and 7.25am to E from LP (UTM: 7529326/1721182 (see Fig. 18 and Annex 6). It was estimated for 2 groups in the SB1, 2 groups in SB2 and 2 groups in SB4. Mr. Vong of Ban Prao saw 2 group in Phou Koungking (SB4) and ca. 4-5 animals per group.

During the dry season, no gibbon song was heard in SB1 and SB2 it was probably due to no sunshine as little rain and cold, but it was heard in SB4 on December 18 at 6.15am, it was for 0.6 km to the south of the Based-camp 2 and another team heard in the further south of the SB4. This species is of national conservation significance and small population found in the survey area especially the SB1, SB2 and SB4. It is anyhow important for national conservation and this species in the survey area is of conservation significance.

Red-shanked Douc Langur *Pygathrix nemaeus*

Globally Threatened: Critically Endangered (CR); At Risk in Lao PDR; National Category I (Prohibited)

Red-shanked Douc occurs mainly in Lao PDR, Vietnam and Cambodia; but Lao PDR supports globally viable population of the species. The habitat range of the species begins from Nam Kading NPA of Bolikhamxay Province to the southernmost country through the entire Annamite Mountain Range from northern Nakai–Nam Theun National Park to Nam Kong National Production Forest of Attapeu Province. It was recorded in a number of conservation forests including outside the protected area system. Also, it could be an indicator species of mammal since it was quite sensitive among other primate species and represents arboreal mammal species.

This species was reported in only SB2, SB3 and SB4. A group of this species was seen very often from September to November by the local villagers of Ban Dak Dom and for the SB2, Mr. Seng and Kham saw a group of this animal in the mountain of Houy At-leum – just 5km away from the village to the northeast. Mr. Sengnisone (solder at military camp 533) saw almost every day in 2020 from October to November during his involvement in the road construction project. He served as security staff for the road construction along the Lao-Vietnam border, runs through the SB2. He saw several groups in the area and ca. 10-15 individuals per group. The police at the Lao-Vietnam Checkpoint also saw a group of douc langurs feeding in fruit trees nearby the Checkpoint in August, 2020 and also just a few months a year from August to October that the animal like occur in the area. Mr. Thongkham (Dak Cheung DAFO) reported the local villagers (Ban Dak Ta-oknoy) captured a juvenile of Douc from the SB2 (see Fig. 16). Mr. Sengnisone saw other 7 animals in SB2 on Dec 5, 2021 as just a week prior to the dry season survey. For the SB3 and SB4 where this animal was

also well reported, Mr. Vong from Ban Prao and Mr. Sonenivong from Ban Dak Dreun reported about the presence of this animal in Phou Koungking, also Mr. Sonenivong hunted it from Phou Koungking (SB3) once in 2019.

During the surveys this animal was seen once in SB2 as 3 animals at UTM: 751402/1722402, probably 5 animals, but fled away quickly; and in SB3 at UTM: 732494/1712585 (from feeding site). The evidences from feeding sites were found in several sites at Phou Koungking (SB4) at UTM: 730836/1710015 to 730838/1710700 (see Annex 6). Finally, during the dry season survey in SB4 as direct observation was made in December 2021 as ca. 7 animals with its photo was taken, and also caught on camera trap.

This species is considered internationally and nationally important for conservation as indicator species and representative a large arboreal mammal. The Survey area supports some reasonable population of this species, especially the SB2. Apart from that, the local reports this animal was seen more often and active from August to October, and also other small size groups in SB3 and SB4. It was believed that would be a small group size (10-15 individuals) in the area. This species is rare in the area, target for hunting as well as internationally and nationally important for conservation the species to be banned for hunting at all in the survey area.

Indochinese Silvered Leaf Monkey *Trachypithecus germaini*

Globally Threatened: Endangered (EN); At Risk in Lao PDR; National Category I (Prohibited)

Indochinese Silvered Leaf Monkey *Trachypithecus germaini* is distinguished from the long known Silvered Langur or Silvered Leaf Monkey *Trachypithecus cristatus* (Boonratana 2013). The *T. germaini* was reported mainly in Dong Phouvieng NPA, especially in the Dong Sakee Sacred Forest (Vongkhamheng *et al*., 2013). Its distribution would extend to southern country but it is unclear the boundary with the *Trachypithecus cristatus* in Champassak and Attapeu Provinces. However, it is recently suggested the whole southern region is the distribution of *T. germaini,* including the survey area (Roos *et al*., 2014).

This species was reported its presence from Ban Dak Dom for SB2, Ban Dak Dreun for SB3 and Ban Prao for SB4. It is estimated that some few groups of this species would present in the area. Still, no any evidence was found during the surveys, made uncertain for this species presence in the area.

Sambar Deer *Rusa unicolor*

Globally Threatened: Vulnerable (VU); At Risk in Lao PDR; National Category I (Prohibited)

The species has a wide distribution in Lao PDR but its population is considerably decreased in many parts of the country. It is a target species for hunting for bush meat so it is now mostly rare in the country (Duckworth *et al*., 1999, Timmins & Duckworth 2013). This species was reported and recorded in the Annamite (SB1 and SB2), also SB3 and SB4 (Phou Koungking). During the surveys, tracks of sambar were observed in SB1 in July, 2021 at UTM: 751361/1722393, 751357/1722333, 751999/1716192; SB2 on 16 July, 2021 at UTM: 751357/1722333; and also, in SB3 on 24 July 2021 at UTM: 734416/1711606; 734540/ 1711897 (see Fig. 18 and and Annex 6). New tracks of this species were seen in SB1 during

the dry season in SB1 on December 9, 2021 and it was also caught on camera trap in SB5 (see Fig. 12c).

Although this species has a small population in the area it is rare and target for hunting as well as its population in the area particularly which was found in the Phou Koungking is considered important for conservation and the species to be banned for hunting at all in the that the area[14].

Chinese Serow *Carpriconis milneedwardsii*

Globally Threatened: Vulnerable (VU), At Risk in Lao PDR; National Category I (Prohibited)

Chinese Serow was reported widely in Lao PDR where in rugged and steep terrain or mountainous areas as it was well reported and recorded in many conservation areas. Serow populations were still found in relatively good numbers in some remote parts of the country. This species was reported in all survey blocks and recorded from its droppings mainly in the SB3 and SB4, also partly SB5. Droppings were found several locations during the surveys on 24 to 27 July 2021 for SB3 at UTM: 732923/1712124 (see Fig. 12), in SB4 at UTM: 729934/170026 to 720969/1711228; and SB3 at UTM: 723011/1713638 (see Fig. 18). Fresh droppings of this species were seen in SB3 and SB4 during the dry season on December 18, 2021 and it was also caught on camera traps in SB3 and SB4 with 5 captures from 4 camera traps (see Fig. 12c, Annex 6 and 7). This species is internationally and nationally important for conservation and its population in the survey area (Phou Koungking) is of conservation significance and that to be legally protected.

Sun Bear *Helarctos malayanus*

Globally Threatened: Vulnerable (VU); At Risk in Lao PDR; National Category I (Prohibited)

Sun Bear was reported widely and in many parts of Lao PDR in the past but only some numbers remain scattered in the country (Duckworth *et al.* 1999). The southern Laos, e.g Xe Pian National Park was comprehensively surveyed in 2010 and found 2 species of Bears which has sympatric habitat in the area (Scotson, 2011). This species was reported in only SB2, SB3, SB4 and SB5 with evidence of claw marks were found in SB2 at UTM: 752479/1722669; 751325/1722243 and in SB4 at UTM: 729339/1710074 (see and Annex 6), and during the dry season survey claw marks of this species were observed again in SB5 (see Annex 4c) but it they were quite old, and sleeping site in SB3. This species is rare, target for hunting as well as internationally and nationally important for conservation the species to be banned for hunting at all in the survey area.

Asiatic Black Bear *Ursus thibetanus*

Globally Threatened: Vulnerable (VU); At Risk in Lao PDR; National Category I (Prohibited)

[14] *Many species are legally protected species according to Lao Law (Aquatic Resource and Wild Animal Law (2007/MAF), but often not protected due to they are hunted and no area is declared for ensuring they are legally protected so the suggestions can vary by justification of species. If the species of considering viable population is suggested to be of conservation significance that need to ban for hunting and necessary to declare a conservation area for their legal protection.*

Asiatic Black Bear populations were reported widely but remain little known on its status in the country. Similarly, the southern Laos e.g Xe Pian National Park was comprehensively surveyed and 2 species of Bears were found living in the same habitats (Scotson, 2011). As the report the Asiatic Black Bear is rarer in the survey area compared to that of the Sun Bear. This species was reported only in SB2 and SB3, and the evidence of claw marks were found in the SB2 at UTM: 751402/1722656 which was identified to this species since it was larger compared to that of Sun Bear, and so this species in the survey area is considered small and not really important for conservation. However, this species is rare, target for hunting as well as internationally and nationally important for conservation the species to be banned for hunting at all in the survey area.

Large antlered Muntjac *Muntiacus vuquangensis*

Globally Threatened: Critically Endangered (CR); At Risk in Lao PDR; National Category I (Prohibited)

Large antlered Muntjac occurs only in the Annamite Mountain Range from upper part of Nakai-Namtheun National Park of Khammouane Province to Dong Ampham NPA of Attapeu Province. This species was reported in the area, the SB 2 and also SB3 and its suitable habitat includes SB2 and SB1, but no any evidence was found. Only Annamite Muntjac (*Muntiacus Truongsonensis*) and Red Muntjac (*Muntiacus muntjak*) were seen directly during the surveys in SB3 and SB2, respectively. The Red Munjac and Annamite Muntjac was in high proportions of detection from tracks and camera trapping especially in SB5.

Although Large Antlered Muntjac is internationally and nationally important for conservation it is uncertain in the area or its population in the survey area is considered small and rare which is hard to detect, and certainly not of conservation significance.

Stump-tailed Macaque *Macaca arctoides*

Globally Threatened: Vulnerable (VU); Potentially At Risk in Lao PDR; National Category I (Prohibited)

Stump-tailed Macaque occurs throughout Lao PDR as it has a widespread distribution in Evergreen Forest, mountainous area and semi-evergreen in limestone habitats. This species was well reported and evidences of their feeding sites were found in frequently in SB2 on 14 July, 2021 at UTM: 751472/1722999 and SB3 on 25 July 2021 at UTM: 722825/1712721 (see Fig. 18 and and Annex 6). Finally, this species was caught on camera traps in highest frequencies especially in SB2, SB3 and SB4 with 50 captures from 13 camera traps (see Fig. 12c, Annex 7). This species is nationally important for conservation and its population in the survey area especially the SB2 and SB3 and SB4 (Phou Koungking) is of conservation significance.

Northern Pig-tailed Macaque *Macaca leonina*

Globally Threatened: Vulnerable (VU); Potentially At Risk in Lao PDR; National Category I (Prohibited)

Northern Pig-tailed Macaque occurs throughout Lao PDR as it has a widespread distribution in the Evergreen Forest, mountainous area and semi-evergreen in limestone habitats. This

species well reported and seen in SB2 on 11 December, 2021(see Fig. 18). Finally, this species was caught on camera traps in SB2 and SB5 with 2 captures from 1 camera trap (see Fig. 12c, Annex 6 and 7). This species is nationally important for conservation and its population in the survey area especially the SB2 and SB5 (Phou Yai) is of conservation significance.

Long-tailed Macaque *Macaca fascicularis fascicularis*

Globally Threatened: Vulnerable (VU); Potentially At Risk in Lao PDR; National Category I (Prohibited)

Long-tailed Macaque occurs in southern Lao PDR (Duckworth *et al*. 1999), inhabiting in various forest habitats including degraded forest "secondary forest" along river valleys, but can be occasionally found in higher area at 1,000m a.s.l. This species was just reported in SB5 as Mr. Bounhing from Ban Dak Kang saw a small troop of this monkey in September 2021 in Phou Yai on north and also on east of Ban Dak Kang. He mentioned its outsanding of a long tail. Mr. Vong from Ban Prao also reported this monkey present in the area. During the survey, no any evidences of this species were found, they would visit the area occasionally. This species is nationally important for conservation and its population in the survey area, in SB5 (Phou Yai) is considered low and certainly not of conservation significance.

Chinese Pangolin *Manis Pentadactyla*

Globally Threatened: Critically Endangered (CR); At High Risk in Lao PDR; National Category I (Prohibited)

Two species of Pangolins inhabit Lao PDR as Sunda Pangolin *M. Javanica* and Chinese Pangolin *M. Pentadactyla*. These two species were reported widely in the country (Duckworth *et al*., 1999) but their populations are becoming very low today due to high demand for trade and led to over harvest. Chinese Pangolin which is smaller and in brownish was reported and recorded in all SBs especially the SB2, SB1, SB3. The villagers from Ban Dak Dom found and collected this animal every year in their village territory. Feeding sites of Pangolins were found in SB2, SB1 and SB3. For SB2, feeding sites and soil pile from hole digging were found at UTM: 750637/1724419; 751037/1723050; 753134/1721101; 751361/1722498; also, for SB1 at UTM: 751113/1717914; 751078/1717929; and 751090/1717921, as well as in SB3 (750623/1723932) and SB4 at UTM: 729628/1709538. Evidences of this animal were found frequently in SB2 and some from SB1 during the dry season survey (see Fig. 18 and Annex 6). Overall observations made understandable that a proportion of this species presence in the Survey area was considered fairly high for the SB2 from the frequency of detection. Of course, Chinese Pangolin is internationally and nationally important for conservation and the Survey area would support some reasonable population of this species so it is of conservation significance.

Sunda Pangolin *Manis javanica*

Globally Threatened: Critically Endangered (CR); At High Risk in Lao PDR; National Category I (Prohibited)

Sunda Pangolin which is larger and in considerably darkish was reported and recorded in the survey area except for the SB5 especially from Ban Dak Dom for the SB2 (Annamite) and

Ban Dak Dreun for SB3 (Phou Koungking). Similar to that of the Chinese Pangolin as they are sympatric animal but it is hardly impossible to distinguish their differences from the evidences found in the field, but size of hole was identified for the difference. This species was found in SB1 at UTM: 753904/1719763; 151740/1717708; 171875/1718740 and SB2 at UTM: 752546/1722746; 750623/1723932 (see and Annex 6). Anyway, the Survey area would support a fairly reasonable population of this species recently. The market price for pangolins has increased considerably resulting in increased harvesting of these animals. These pangolins were sought for sale as they were used for luxury food and traditional medicines, typically in China (e.g. Duckworth *et al.* 1999, Nooren & Claridge 2001, Pantel & Chin 2009). Of course, pangolin is internationally and nationally important for conservation and this species in the survey area especially the SB2 is of conservation significance.

Annamite Striped Rabbit *Negolagus timminsi*

Globally Threatened: Endangered (EN); At Potentially Risk in Lao PDR; National Category I (Prohibited)

Annamite Striped Rabbit occurs only in the Annamite Mountain Range from upper part of Nakai-Nam Theun National Park of Khammouane Province to Dong Ampham NPA of Attapeu Province. It was reported in the area and the local villagers used to hunt it very occasionally. The local villagers, Mr. Seng from Ban Ta-orknoy reported they hunted this animal very occassionally, including last year. Overall, this species was well reported by local villagers in the Survey area especially the SB2 and SB1, this species would be present but not be confirmed. It is internationally and nationally important for conservation and its population in the survey area is considered very low and not caught on camera trap.

Smooth coated Otter *Lutrogale perspicillata*

Globally Threatened: Vulnerable (VU), At Risk in Lao PDR; National Category I (Prohibited)

This otter species distributes in southeast Asia, were reported throughout Lao PDR but their recent status is little known (Duckworth & Hills 2008; Duckworth *et al.,* 1999). Smooth coated Otter populations were found in relatively reasonable numbers in the country with a wide distribution. It is found in scattered populations in a number of rivers and wetlands, mostly slow flow river. It was recorded in Mekong stretch and its tributaries (Dong *et al.,* 2010). However, Asian Small-clawed Otter (*Aonyx cinereus,* VU) was previously reported in the area (Showler *et al.*, 1998), but at high elevation would be suitable habitat for Smooth coated Otter. The Smooth coated Otter species was reported with some confidence in the survey area particularly in Xe Khaman and its tributaries. Local villagers recognized this species from its foot duck morphology as some villagers hunted it in the past. Often, fishing nets of local villagers got damage by otters. This species was reported with confidence in only SB1 and SB2 by Mr. Sengvanphone - villagers of Ban Dak Dom, also for the SB3 by Mr. Khamvong - villagers of Ban Dak Dreun. Yet, during the surveys, one evidence (droppings) were found in Nam Oy of SB3 on December 23, 2021 at UTM: 732896/1709422 (see Annex 12c) and identified to this species based on its habitat suitability. This species is nationally important for conservation but its small population in the survey area is not really of conservation significance.

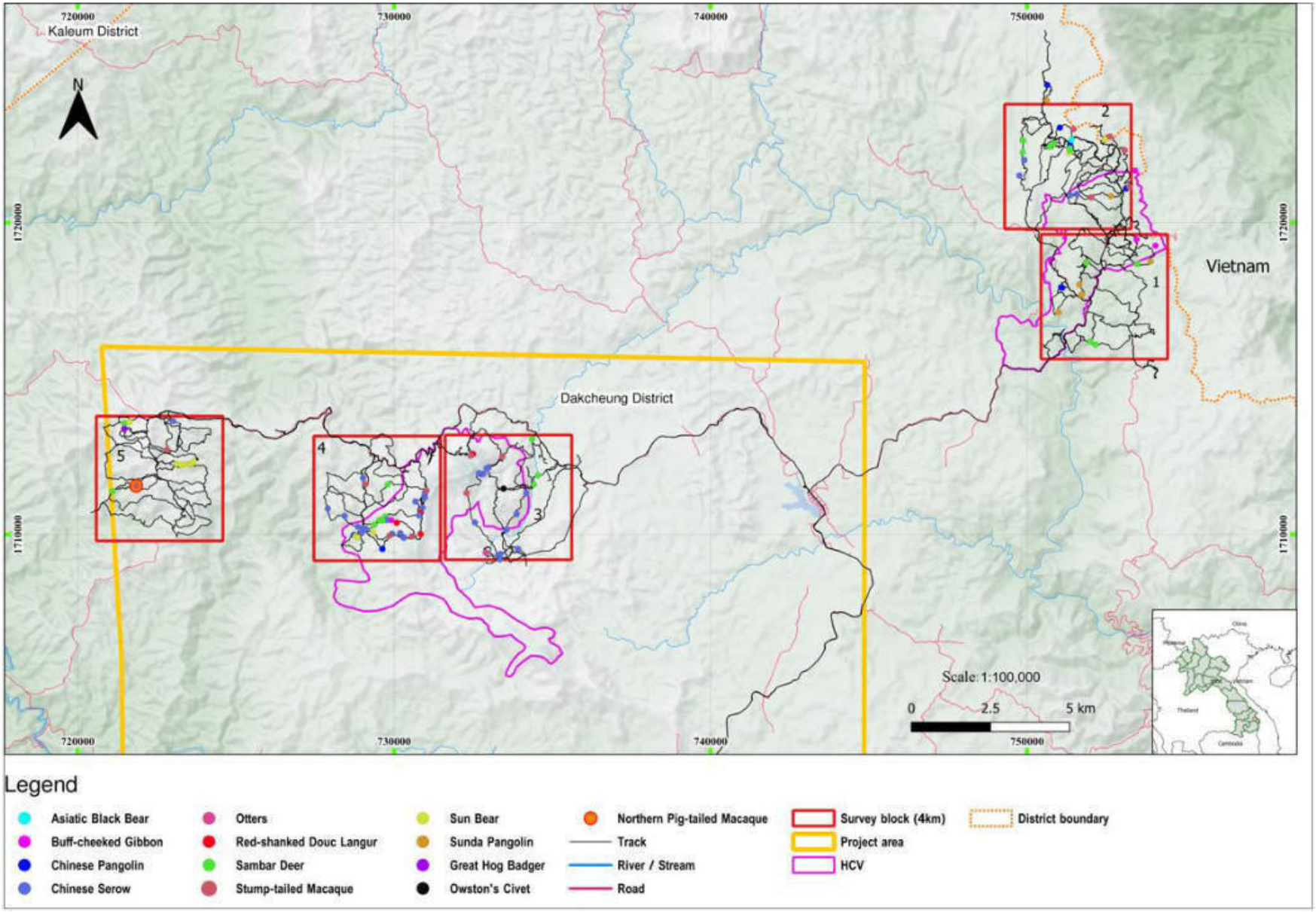


Figure 18. Locations of GT mammal species in the survey blocks

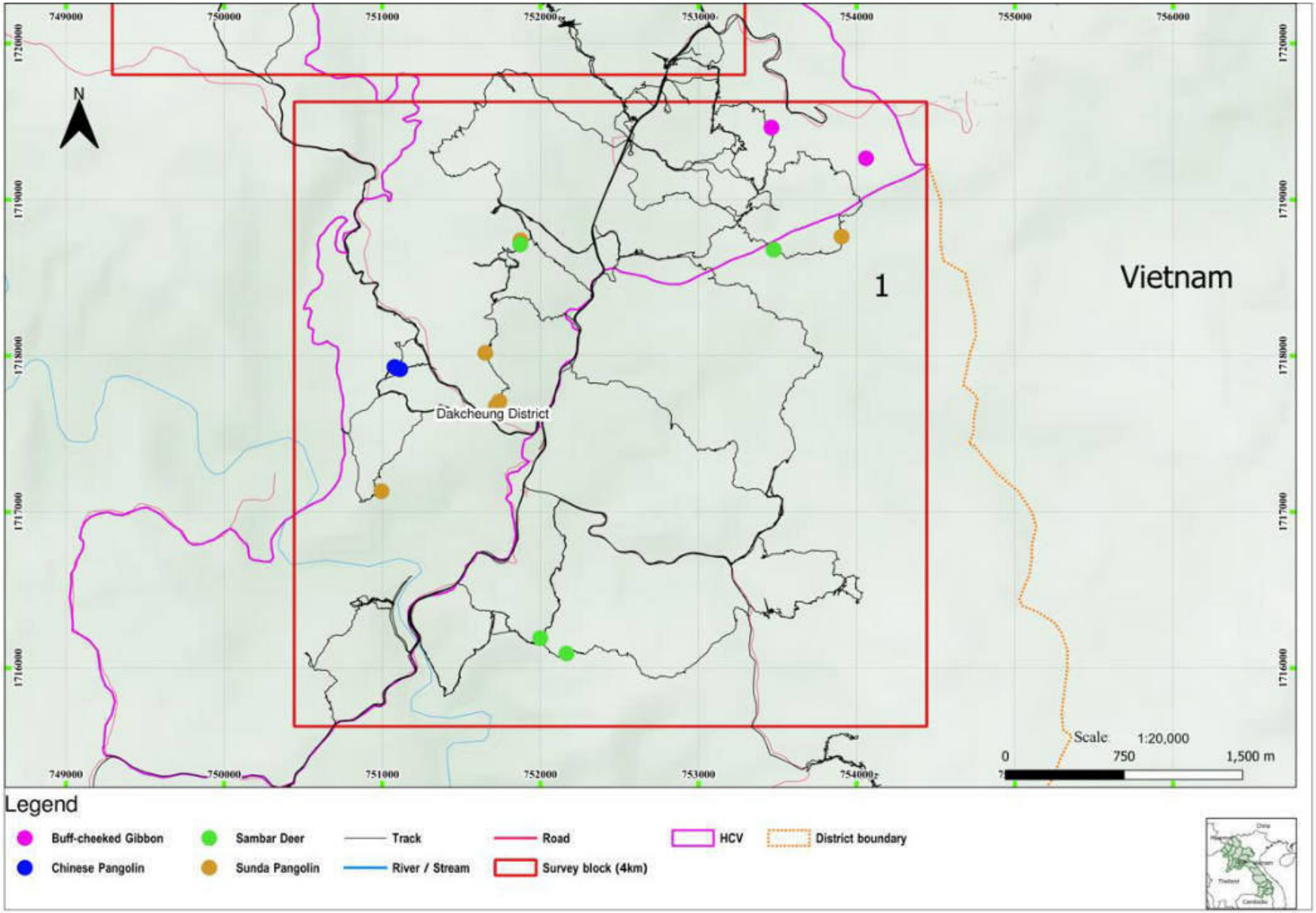


Figure 18-1. Locations of GT mammal species in the SB1 (Annamite)

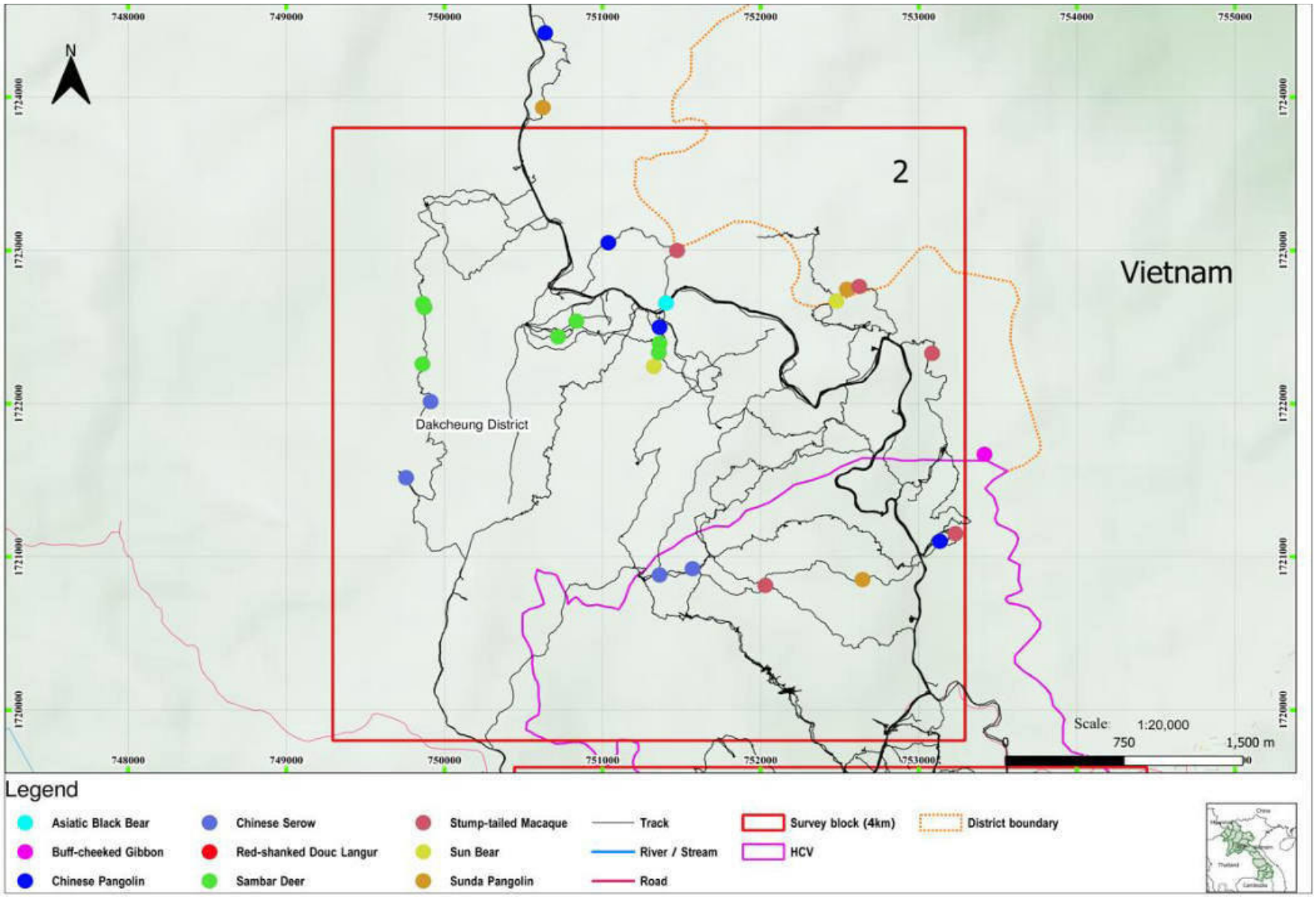


Figure 18-2. Locations of GT mammal species in the SB2 (Annamite)

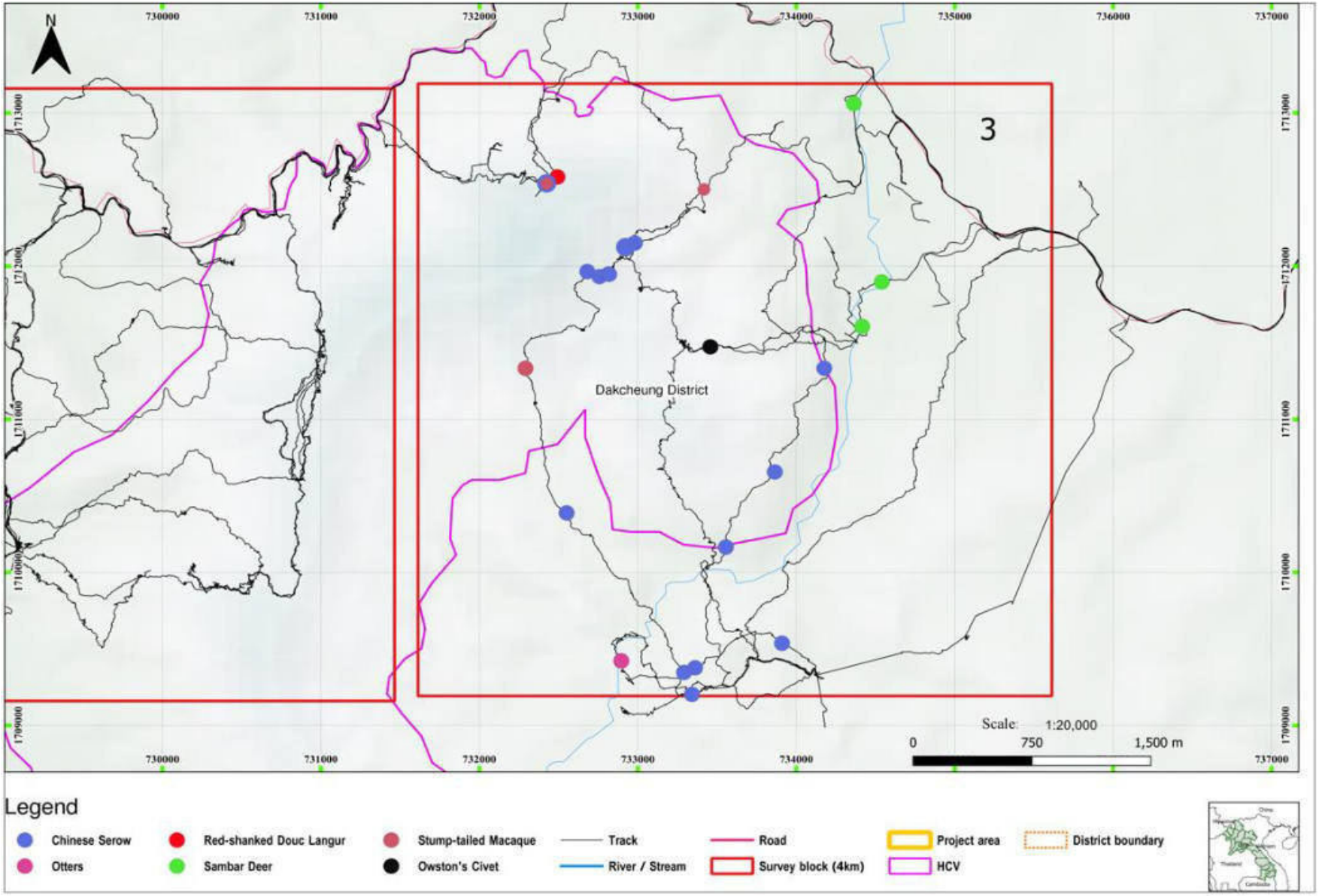


Figure 18-3. Locations of GT mammal species in the SB3 (Phou Koungking - East)

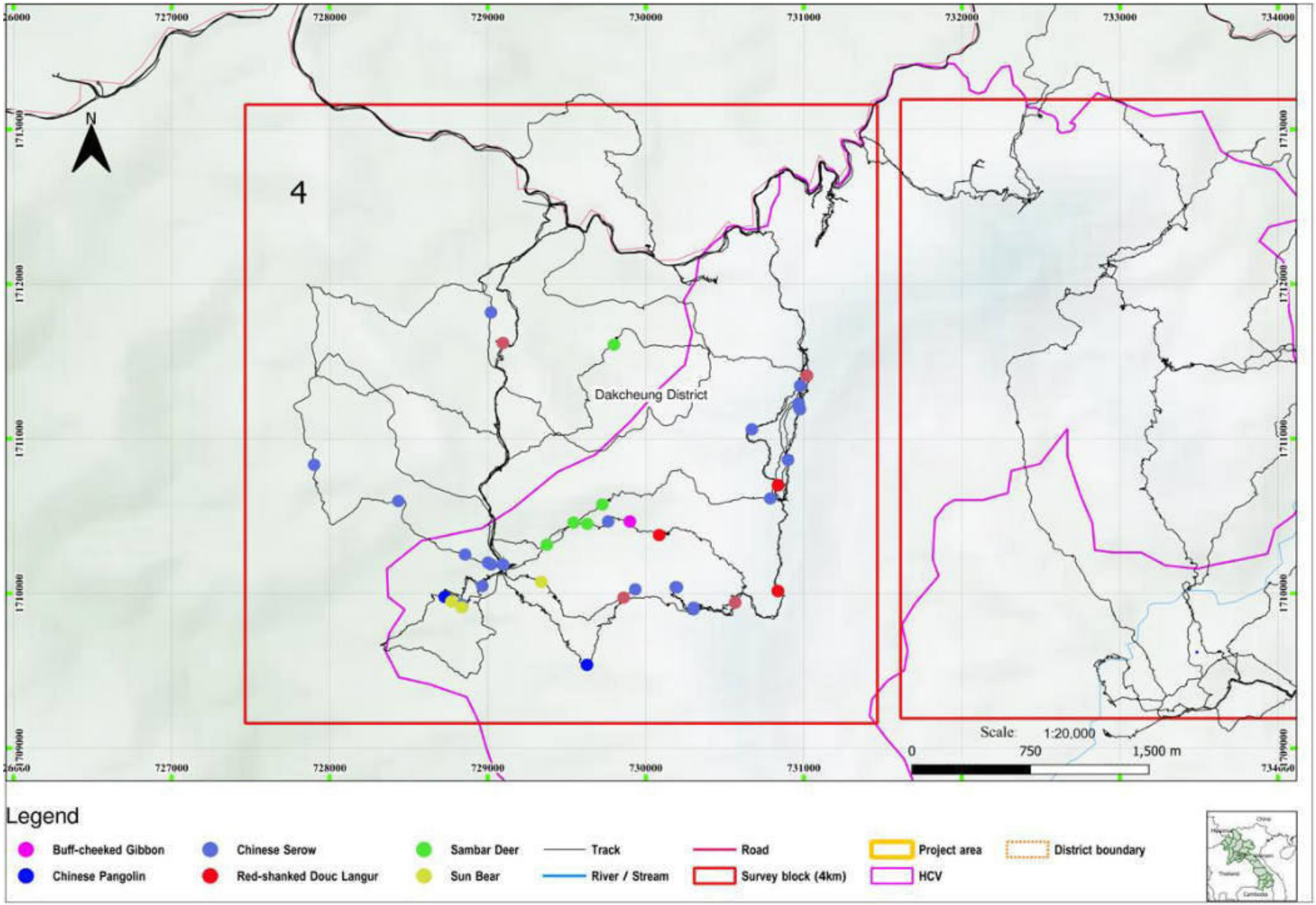


Figure 18-4. Locations of GT mammal species in the SB4 (Phou Koungking - West)

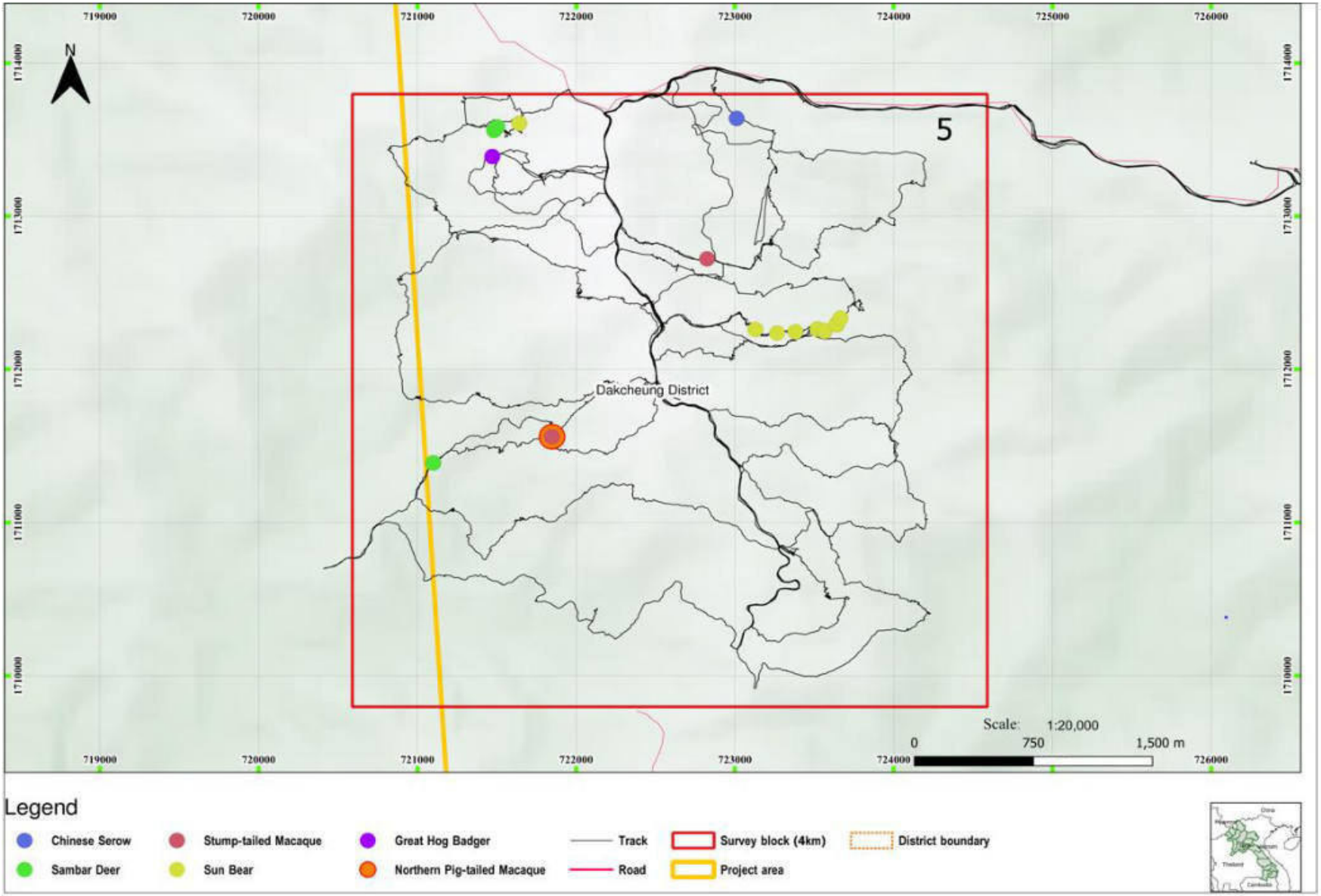


Figure 18-5. Locations of GT mammal species in the SB5 (Phou Yai)

Binturong *Arctictis binturong*

Globally Threatened: Vulnerable (VU), At Potentially Risk in Lao PDR; National Category I (Prohibited)

Binturong was reported throughout Lao PDR, but remain little is known on its status in the country. Direct observation survey of the 1990s also yielded very few records (Duckworth *et al.,* 1999). It was actually reported in most conservation areas of the country but it is rare today. As a nocturnal species it is hard to have its picture in the wild as camera trapping would help capture it. This species was reported in only SB2 and SB3 but in quite low confidence. This species is fairly nationally important for conservation, this species would be present but having neither yet confirmed in the field nor included on the GT confirmed list for this report.

Bengal Slow Loris *Nycticebus bengalensis*,

Globally Threatened: Endangered (EN); Little Known in Lao PDR; National Category I (Prohibited)

This species was reported throughout Lao PDR, but remains little is known on its status in the country. It was reported in all Survey blocks from Ban Dak Dom, Ban Dak Dreun and Ban Prao. Mr. Sengnisone from Ban Dak Dom caught this species at night in Sep 2021. Unfortunately, it was not detected during the night surveys and neither by the herp team. The Survey area would support a very small population of this species so it is unlikely to be of nationally conservation significance. The species was well recognised by local villagers as the Pygmy Slow Loris (*Nycticebus pygmaeus*) is smaller with yellowish, whereas the Bengal Slow Loris is larger with quite whitish. It is therefore not be confused among them. Given in high confidence of village reports on this species occurring in the Survey area, although this species was not confirmed in the field it was certified its presence.

Pygmy Slow Loris *Nycticebus pygmaeus*,

Globally Threatened: Endangered (EN); Little Known in Lao PDR; National Category I (Prohibited)

This species was reported almost throughout Lao PDR, but remain little is known on its status in the country. It is considered difficult to find in the area. Some villagers suggested that the survey area would have only the *N. bengalensis* in the survey area. However, Mr. Sengnisone reported that there are two species present in the territory of Ban Dak Dom. Anyway, it is still in question if the species is present in the area or not.

Owston's Civet *Chrotogale owstoni*

Globally Threatened: Endangered (EN), At Risk in Lao PDR; National Category I (Prohibited)

Owston's Civet occurs in many parts of Lao PDR but its habitat was restricted to Upper Evergreen Forest, along Annamite Mountain Range. It was recently rare due to hunting and probably habitat loss. This species was reported from Ban Dak Dom for the SB2 and Ban Dak Dreun for SB3 and SB4 but insufficient information to support whether the species is present

today. However, it was finally caught on camera trap in SB3 on 16 August 2021 (see Fig. 17; Annex 7). This species is considered rare and present specially in Annamite Range.

Great Hog Badger *Arctonyx collaris*

Globally Threatened: Vulnerable (VU), At Low Risk in Lao PDR; National Category I (Prohibited)

Great Hog Badger, it occurs throughout the Lao PDR, but little is known on its current status. Occurrence seems to be patchy, with no recent records from the Mekong Plain, which covers most of the western part of the southern half of the country (Duckworth *et al*., 1999). This species was reported in the area but no any evidence of this species was found during the surveys. Anyway, with some confident report from Ban Dak Dom for SB2 and made realized that this species is still present in the area. Finally, it was caught on camera traps for 2 times at UTM: 721472/1713389.

5.3.2.7 First record and possible new species accounts

There were two different species of wild pigs were caught on camera trap, usually known Eurasian Wild Pig (*Sus scrofa*) with its long snout, but one of them was likely *Sus bucculentus* as its shorter snout (see Fig. 19). It is believed there would be identified to this species. As it was rediscovered in 1997 (Grove et al. 1997) after having gone unrecorded since first being described in 1892. The Annamite is the habitat of this species. On the other hand, it is possible to be a hybrid with domestic pig which is hard to make decision from just a picture. Also, Owston's Civet and Spotted Linsang are other rare species which are difficult to obtain their pictures from the wild (see Annex 7) but they were captured on camera trapping.

Figure 19. Morphology of 2 different wild pigs (*sus scrofa and sus bucculentus*)

5.3.2.7 Some other selected species accounts

Black Giant Squirrel *Ratufa bicolor*

Globally– Near–Threatened (NT); Potentially At Risk in Lao PDR; National Category II (Managed)

Black Giant Squirrel occurs throughout Lao PDR but its population has decreased considerably as target hunting species for bush meat and often seen being sold in a local market (Duckworth *et al*., 1999). This species was reported in the SB1, SB2, SB3 and SB4 with confidence for this species presence in the survey area. Previously, Mr. Sonenivong from Ban Dak Dom reported this species was seen in SB3. Through the survey we observed this animal in SB2 on July 2021 and also in the same SB2 on Dec 11 2021. This species was observed again during the dry season survey in the SB2 and SB5, also caught on camera trap in SB5. With some hunting pressure the population of this species would remain in very small number in the Survey area.

In addition, Chinese Goral (*Naemorhedus griseus*) was reported in the SB3 & SB4 but it was not confirmed. It is probably not present.

5.3.2.8 Seasonal variation and distribution of mammal species in the survey area

Distribution of mammal species in the survey area is not really different. They have similar species of composition. Based on the encounters, the Zone A (Annamite) has a higher density of pangolins but the Zone B (Phou Koungking) has a higher density of Stump-tailed Macaque and Chinese Serow. Further northwest such as Phou Yai is only the site where a presence of Northern Pig-tailed Macaque. Among the survey blocks, the higher biodiversity will be in SB2, SB4, SB5 and SB3 and SB.

Seasonaly variation of mammal species is also not different. Mammals are not a migratory species, they do inhabitat where are safe such as for the Zone A (Phou Koungking) is the safe place for many wildlife species. Whereas, for the Zone B, more wildlife species were recorded during wet season. It was reported that douc langur does occur more often from September to November.

5.3.2.9 Recommendations

Through the survey it is realized that the survey area is all critical habitat as it supports a number of GT species so it needs to be careful to interfere the area. Phou Koungking and SB2 should be legally protected for provincial protected area to ensure the remaining at least 9 GT mammal species in the area be legally protected. It can be linked from SB2 to Phou Koungking and Phou Yai which can be established as bio-offset area of the project.

The survey for large mammals covered the study area well and conducted thoroughly except for the southern Phou Koungking known Phou Katieng where at least 4 GT and target species were present and it seems they have a good population of Northern buff-cheeked Gibbon, Red-shanked Douc Langur, Sambar and Bears.

5.3.2.10 Conclusions

The survey of mammals was conducted and covered enough the habitats and species except some small mammals, including bats. Those small mammals are hard to identify from tracks and feeding sites but that they are not really important for this assessment since the target mammal species are medium and large mammals. Through the surveys made a total of 59 animal species, of which 44 mammal species were confirmed in the field, including some species were reported by local villagers from reliable village reports. Of these species, as 14

GT mammal species were confirmed, included 3 CR, 3 EN and 8 VU). The Survey area still holds a high diversity of mammal species especially the SB2 and SB3 but most of them are of a low population, except Pangolins in the SB2 and Chinese Serow and Stump-tailed Macaque in the SB3 and SB4.

Mammal conservation is urgent because many of them are in low numbers so appropriate strategy and mechanism e.g collaborative management should be applied to work with local communities for protecting them from local extinction. Most importantly, Phou Koungking (SB3 and SB4) should be legally established as conservation area e.g provincial protected area.

5.3.3 Herpetology

5.3.3.1 Introduction

The survey area is part of the Southern Annamite Mountain Range which is well dominated by Upper Evergreen Forest and unique habitats for some specialist reptile species. Mostly

the survey area with over 1,000m a.s.l. and some small portion with a higher elevation of 1,500m a.s.l. which is considered Montane Evergreen Forest (MEF).

According to the Integrated Biodiversity Assessment Tool (IBAT) of International Union for Conservation of Nature (IUCN) and some reviews generated a list of 10 GT species in the Survey area. Of these species, 6 GT species were the target species for the reptile survey, included Bourret's Box Turtle (*Cuora bourreti,* CR), Three-horned scale Pitviper (*Protobothrops sieversorum,* EN), Yellow eyed Spadefoot Toad *Leptobrachium xanthops* (EN), Black-breasted Leaf Turtle (*Geoemyda spengleri,* EN), Impressed Tortoise (*Manouria impressa,* VU) and Red River Krait (*Bungarus slowinskii,* VU). Meanwhile, some other GT species were not defined as target species but important to record if they are present.

5.3.3.2 Key findings

Through the survey made a total of 74 herpetofauna species, of which 30 reptile species and 41 amphibian species were confirmed from the field surveys. As globally threatened species of herpetofauna would be still present in the area, but only 3 GT were confirmed from the field as Red River Kriat (*Bungarus slowinskii*, VU), Chinese soft-shell Turtle (*Pelodiscus sinensis,* VU) and Serrate Frilled Treefrog (*Kurixalus cf gryllus*, VU) (see Table 15a and 15b).

Interestingly, 6 reptile species were first record of Laos, 2 second record of Laos and 3 reptile species are considered possible new species as not described yet (see Fig. 13), and detailed list of herpetofauna species were confirmed from the survey area can be found in Annex 3 and Annex 4.

Table 15a. List of Globally Threatened reptile species records and reports in the Survey area

Survey Block	Key reptile species			GT species count by SB
	CR	EN	VU	
SB1 – Annamite			3	3
SB2 – Annamite			5	5
SB3 – Phou Koungking			3	3
SB4 – Phou Koungking			4	4
SB5 – Phou Yai			4	4

Remarks: some reliable report is counted for reptiles.

Table 15b. List of GT and target reptile species records and reports in the Survey area

Common Name	Scientific Name	IUCN *Red List*	Field Conf.	Survey Block					Presence
				1	2	3	4	5	
Bourret's box turtle	*Cuora bourreti*	CR	Report	?	?	?			Uncertain
Elongated Tortoise	*Indotestudo elongata*	EN	Report						Possible

Yellow eyed Spadefoot Toad	*Leptobrachium xanthops*	EN	Report		?	?			
Impressed Tortoise	*Manouria impressa*	VU	Report	**x**	x				**YES**
King Cobra	*Ophiophagus hannah*	VU	Report		x	x	x	x	YES
Burmese Python	*Python bivittatus*	VU	Report		x	x	x	**x**	**YES**
Black-breasted Leaf Turtle	*Geoemyda spengleri*	EN	Report		?	?			
Keeled Box Turtle	*Cuora mouhotii*	EN	Report	?					Possible
Red River Krait	*Bungarus slowinskii*	VU		x	**x**				**YES**
Indochinese Spitting Cobra	*Naja siamensis*	VU	Report		**x**	**x**	x	x	**YES**
Three-horned scale Pitviper	*Protobothrops sieversorum,*	EN	Report		?	?	?		Uncertain
Serrate Frilled Treefrog	*Kurixalus cf gryllus*	VU					**x**	x	**YES**
Asiatic Soft-shell Turtle	*Amyda cartilaginea*	VU	Report						Possible
Chinese Soft-shell Turtle	*Pelodiscus sinensis*	VU		**x**					**YES**
Total				**3**	**5**	**3**	**4**	**4**	**7**

Remarks: The globally threatened herpetofauna species were confirmed including those species from reliable village reports, but only 3 of them were directly confirmed in the field. Some species with low confidence (possible) were not be counted.

5.3.3.3 Findings by survey block

According to the herpetofauna species recorded with some reports showed a higher number of reptile species were in SB3 and SB4 (Phou Koungking) and then the SB2 (Annamite). The key findings by Survey block were presented on a number of species records and reliable village reports in the area with highlighting of some important findings by survey block.

5.3.3.3.1 Findings by Survey block 1 (Annamite)

The survey for herpetofauna in the Survey block 1 was conducted through village interviews (Ban Dak Dom) and field surveys. The village interviews reported of 23 herpetofauna species, of which during the field observations 21 species were confirmed as 9 reptiles and 13 amphibians) were present in the field and mostly photographed. Carapace of the Impressed Tortoise was found in Ban Dak Ta-ok noy. With some reliable village reports there are 3 GT species present in the Survey block, including: Impressed Tortoise (EN), Red River Kriat (VU) and Chinese Soft-shell Turtle (VU). These tortoises were reported in Ban Dak Dom and reported that they used to hunt them but they are considered rare today.

5.3.3.3.2 Findings by Survey block 2 (Annamite)

The survey for herpetofauna in the Survey block 2 was conducted through village interviews (Ban Dak Dom) and field surveys. The village interviews reported of 26 herpo fauna species, of which during the field observations 23 species (11 reptiles and 12 amphibians) were present in the area and mostly photographed. Of which, only 1 GT species, Red River Kriat, but only the Red River Kriat was confirmed from the field in SB2 at 15.555660N/ 107.358260E as was found dead on road. Still, other 4 GT species from reliable village reports including: Impressed Tortoise (EN), King Cobra (VU), Indochinese Spitting Cobra (VU) and Burmese Python (VU). Yet, no field verification as they were just reported by local villagers of Ban Dak Dom. Mostly likely possible GT species are still present in the area are Elongated Tortoise (EN) and Asiatic Soft-shell Turtle.

5.3.3.3.3 Findings by Survey block 3 (Phou Koungking E)

The survey for herpetofauna in the Survey block 3 was conducted through village interviews (Ban Dak Dreun) and field surveys. The village interviews reported of 38 herpo fauna species, of which during the field observations, 32 species (15 reptiles and 17 amphibians) were confirmed in the field and mostly photographed. As 3 GT species from reliable village reports including: King Cobra (VU), Indochinese Spitting Cobra (VU) and Burmese Python (VU).

5.3.3.3.4 Findings by Survey block 4 (Phou Koungking W)

The survey for herpetofauna in the survey block 4 was conducted through village interviews (Ban Prao) and field surveys. The village interviews reported of 33 herpetofauna species, of which during the field observations 30 herpetofauna species (16 reptiles and 14 amphibians) were confirmed in the field and mostly photographed. As 5 GT species from direct observation and reliable village reports including: King Cobra (VU), Indochinese Spitting Cobra (VU), Burmese Python (VU), Impressed Tortoise (EN and Serrate Frilled Treefrog (VU).

5.3.3.3.5 Findings by Survey block 5 (Phou Yai)

The survey for herpetofauna in the survey block 5 was conducted through village interviews (Ban Prao) and field surveys. The village interviews reported of 23 herpetofauna species, of which during the field observations 23 species (11 reptiles and 12 amphibians) were confirmed in the field and some photographed. As 4 GT species from direct observation and reliable village reports including: King Cobra (VU), Indochinese Spitting Cobra (VU), Burmese Python (VU) and Impressed Tortoise (EN).

Through the surveys, the globally threatened and target reptile species is only Red River Krait (*Bungarus slowinskii,* VU) and *Kurixalus cf. gryllus* (VU) were confirmed in the survey area during the wet season survey, 2 turtle species were found during the dry season survey. More efforts for the reptile survey would generate more species to the list of herpetofauna species and that should focus on beginning of wet season.

5.3.3.4 Overview of herpetofauna community

There are several sub-herb communities in the survey area as Snake, Lizard, Turtle and Frogs as following:

Snake community

Snakes were reported widely in Laos which they can adapt to some degraded environments and a number of snake species were reported in the Survey area. They are associated with small rivers, streams where well covered by forest habitats. Snake can be found both daytime and night time but more active at night for feeding. Therefore, spotlighting would be only best survey to detect snakes.

The surveys for snakes were conducted mainly through field observations to confirm the presence of this sub-herp group, mostly the Green Pitviper snake in the family of Vipiridae (4 species), while some other in general environment which some ratsnakes do present and in the family of Colubridae (7 species were recorded in the field). The common species are Vogel's pitviper (*Trimeresurus vogeli*), Brown-spotted pitviper (*Protobothrops mucrosquamatus*), Beauty ratsnake (*Elaphe taeniura*), big-eye bamboo snake (*Pseudoxenodon macrops*) etc.

Lizard community

Lizards were reported widely in Laos which they can adapt to many environments and some numbers of lizard species were reported in the Survey area. They are associated with several environments. As a uniqueness of the Annamite habitats in the survey area so some specific lizard could be present. A majority of the lizards can be found on tree trunk, bushes and ground as well as associated with streams. Lizards can be found both daytime and night time but more active for feeding in night time.

The surveys for lizards were conducted mainly through field observations to confirm the presence of this sub-herp group, mostly the family of Agamidae (4 species) and Scincidae (4 species), included the species of Mountain horn dragon (*Acanthosaura nataliae*), Ziegler's tree lizard (*Pseudocalotes ziegleri*), Blue-trailed skink (*Plestiodon quadrilineatus*) etc. The mountain horn dragon was well presented in the survey area as it was found in all survey blocks and meaning to Annamite it is then considered Annamite horn dragon (see Fig. 20).

Turtle community

Turtles were reported widely in Laos, there are turtle and tortoise which they cannot adapt well to some degraded environments and some numbers of turtle species were reported in the Survey area. The turtles are associated with rivers e.g Xe Khaman and small rivers/streams. The tortoise species are associated with forest habitats as land turtles. Mostly both turtles and tortoises were reported with high confidence but no any of them were confirmed in the field, they are rare and would have a low population in the area. The turtles especially land turtles were under most high threat due to high pressure with assistance from hunting dogs in searching land turtles.

Figure 20. Annamite horn dragon (*Acanthosaura sp)*

Frog community

There are tree dwelling frogs and ground dwelling frogs.

Tree dwelling frogs, tree or arboreal frog community inhabiting trees was mainly present in the Survey area. The sub-amphibian group recorded and reported in the survey area were the family of (Ranidae: *Odorrana, Sylvirana and Amolops*). However, it is not popularly consumed or harvested.

Ground dwelling frogs, the ground-dwelling frog community is the small group living in the Survey area and show low numbers of species and populations. The sub-amphibian group recorded and reported in the survey area.

5.3.3.5 Globally threatened species accounts

Following are the records of species considered of global and/or national conservation interest which specific recording sites were given with mapping, as well as endemic species (first record and possible new species were provided) (see Fig. 21).

Impressed Tortoise *Manouria impressa*

Globally Threatened: Vulnerable (VU); At Risk in Lao PDR; National List I (Prohibited)

The species is a non-aquatic species as land turtle (tortoise); it has a distribution throughout the Lao PDR (Stuart & Platt, 2004). In addition, it occurs from Myanmar across Southern China and Indo–China, southward to Peninsular Malaysia (Zhao & Adler 1993). This species

was reported in 4 survey blocks (except SB5). Local villagers from Ban Dak Dom reported the presence of this species as they collected it occasionally, 2-3 tortoises per year, as well as Ban Dak Dreun used to harvest this tortoise. It is in a very low population and in high market demands as local villager searching for this tortoise for food and sale with assistance from dogs. During the surveys, although with high confidence of local reports on its presence there was no evidence of this species was found in the field but carapace of the species was found in Ban Dak Ta-ok noy so it was finally confirmed its presence.

Bourret's Box Turtle *Cuora bourreti*

Globally Threatened: Critically Endangered (CR); National List I (Prohibited)

Bourret's box turtle is native to Indo–China, especially Lao PDR, and includes central Vietnam (Nguyen *et al*., 2009 and Stuart *et al*., 2011). It is known from central Viet Nam (Nghe An, Ha Tinh, Quang Binh, Thua Thien-Hue, Da Nang, Quang Nam, and Kon Tum provinces), as well as from adjoining Savannakhet Province in Lao PDR (Obst and Reimann 1994, Nguyen *et al*., 2009, Stuart *et al*., 2011). During the surveys, the residents from Ban Dak Dom reported the presence of this turtle in SB2 but it was not really confident since it was no anyone hunted this turtle recently. Pitfall traps were used for trapping freshwater turtles in rivers. This species become very rare today and probably become extinct in the area. During the surveys, no evidence of this species was found. The main threat to the turtle was a hunting for sale in the past, hardly used for food since it is good market price. This species is in high demand from international market in Vietnam.

Keeled Box Turtle *Cuora mouhotii*

Globally Threatened: Endangered (EN); At Risk in Lao PDR; National List I (Prohibited)

The species was originally described from the "Laos Mountains". The species is associated with limestone karst in central and northern Lao PDR (Stuart & Platt 2004, Teynié & David 2010) and occurs in north-eastern India, Myanmar, northern Thailand, southern China and Vietnam (Zhao & Adler 1993). It was only recorded in Laos as a specimen collected from Hin Namno National Park (Stuart & Platt 2004). The species was reported in the survey area including SB2 (Annamite), SB3 and SB4 (Phou Koungking). Through the surveys, no any evidence of this species was found. As searches were conducted in small streams, and probably due to the low population it is difficult to detect.

Elongated Tortoise *Indotestudo elongata*

Globally Threatened: Endangered (EN); At Risk in Lao PDR; National List I (Prohibited)

The species is a non-aquatic species "tortoise" as a land turtle. It is widely distributed across South and Southeast Asia. The species was reported in SB2, SB2 and SB3. Through the surveys, no any evidence of this species was found. It was reported in Ban Dak Dom (SB2) that the villagers (Mr. Kham) collected it 2 years ago. Due to the low population it is difficult to detect and not know if it is still present.

Three-horned scale Pitviper *Protobothrops sieversorum*

Globally Threatened: Endangered (EN)

This species is only known from the Annamite Mountains of Lao PDR and Vietnam (Ziegler *et al*., 2000 and Hermann *et al*., 2002). This species is endemic to evergreen karst forests at low and possibly mid-elevations, in both primary and disturbed forest. It has been found in Phong Nha-Ke Bang National Park (Vietnam) and the Hin Namno National Park, which are part of the biggest continuous karst formation in Indochina and this snake was recorded at 200 and 600 m a.s.l. However, it was not reported nor recorded in the survey area.

Yellow eyed Spadefoot Toad *Leptobrachium xanthops*

Globally Threatened: Endangered (EN)

This species has a distribution mainly in Indo–China, and reported in the highland of southern Lao PDR e.g Sekong Province (Stuart 2005), it is exactly in Phou Koungking (SB3). Known with certainty only from wet evergreen forest at 1,450–1,500m a.s.l. Although probably more widespread in the highlands of southwestern Laos and adjacent Central Highlands of Vietnam. This species was reported in SB2 by Ban Dak Dom and SB3 by Ban Dak Dreum but at very low confidence. During the surveys there was no evidence of this frog was found in the area. Through the surveys, no any evidence of this species was found. Due to the low population it is difficult to detect, this species may occur in the Survey area. Threat to this species was due to habitat loss and ecological changes because of probably climate change. However, it was not reported nor recorded in the survey area

Black-breasted Leaf Turtle *Geoemyda spengleri*

Globally Threatened: Endangered (EN)

Geoemyda spengleri is endemic to Southeast Asia. Geoemyda spengleri inhabits forested hill regions of southern China (Guangdong, Hainan, and possibly Guangxi and Hunan) and northern Viet Nam, including adjoining areas of Lao PDR; its southern extent remains unclear. *Geoemyda spengleri* is primarily terrestrial but occasionally uses streams (Fang 1930). It inhabits in closed forest canopy at mid to high elevations (from 500 to over 1,000 m a.s.l.). This species was reported in SB2 by Ban Dak Dom and SB3 by Ban Dak Dreum but at very low confidence of its presence in the survey area today, it is very difficult to detect. During the surveys there was no evidence of this turtle was found in the survey area.

King Cobra *Ophiophagus Hannah*

Globally Threatened: Vulnerable (VU); Potentially At Risk in Lao PDR; National List I (Prohibited).

The king cobra has a wide distribution in South and Southeast Asia, it occurs widely from India across the Southern China, southward to Indonesia and the Philippines (Zhao & Adler 1993), including Cambodia, Thailand, Laos, Vietnam and Malaysia, and at elevation of 2,000 m a.s.l. It is known throughout Laos as Lao name “Ngou Chong Ang” (Deuve 1970). The animal was reported in SB2 by Ban Dak Dom and SB3 by Ban Dak Dreum and SB4 by Ban Prao, as they used to encounter it occasionally in the past with confidence of its presence in the Survey area today. The species was of high demands from market, as with a lucrative price e.g US$50–70/kg. Through the surveys, during the surveys there was no evidence of this snake was found. Yet, based on the provisional information and the reliable village

reports this species was confirmed its presence in the area as they used to find it very occasionally.

Asiatic Soft-shell Turtle *Amyda cartilaginea*

Globally Threatened: Vulnerable; Potentially At Risk in Lao PDR**.**

The species is quite common and known throughout Lao PDR (Stuart & Platt 2004), including a historical record from Paklay and Bolikhamxay (Smith 1931). Moreover, this species also occurs widely in Southeast Asia, from Myanmar to Indonesia (Asian Turtle Trade Working Group 2000) but it becomes rare today. The species was reported in Ban Dak Dom for SB2, and previous survey by WWF mentioned the presence of this species in Sekong River and its tributaries such as Xe Khaman which runs through the territory of Ban Dak Dom. This species was well reported during the survey but another Soft-shell turtle found so this species is not confirmed but the Chinese Soft-shell Turtle instead. Threat to this animal was the over-exploitation for food and sale.

Chinese Soft-shell Turtle *Pelodiscus sinensis*

Globally Threatened: Vulnerable; Potentially At Risk in Lao PDR**.**

The species is native to China but they are raised widely in the region. The species was not reported from the survey but it was found in Ban Dak Dom by Mr. Sengnisone that he caught it from the small river nearby this village in September 2021. The suitable habitat including Sekong River and its tributaries such as Xe Khaman which runs through the territory of Ban Dak Dom. Although during the survey, no any evidence of the turtle was found but only one was found in Ban Dak Dom (see Fig. 13b) and realized it is present. Threat to this animal was the over-exploitation for food and sale.

Indochinese Spitting Cobra *Naja siamensis*

Globally Threatened: Vulnerable (VU); Potentially At Risk in Lao PDR; National List II (Managed)

Indochinese Spitting Cobra is known throughout Laos, it occurs widely from India across the Southern China, southward to Indonesia and the Philippines (Zhao & Adler 1993). The animal was reported in SB2 by Ban Dak Dom and SB3 by Ban Dak Dreum and SB4 by Ban Prao, as they used to encounter it occasionally in the past with confidence of its presence in the Survey area today. Its population is considered low and quite difficult to detect. Mr. Kham from Ban Dak Dom reported sightings of this snake in the SB1 and SB2. Through the surveys, no evidence of the snake was found. However, based on the provisional information and reliable village reports this species was confirmed its presence as they used to find it occasionally.

Burmese python *Python bivittatus*

Globally Threatened: Vulnerable (VU); At Risk in Lao PDR; National List I (Prohibited)

Burmese python occurs throughout Southern and Southeast Asia, including Cambodia, Thailand, Laos and Vietnam. Ecologically, the Burmese python is often found near marshes

and swamps, and is sometimes semiaquatic, but can also be found in trees. This species was reported in SB2, SB3, SB4 and SB5 but given in medium confidence. Due to a low population today, it is difficult to detect this snake in the Survey area. The snake species was heavily harvested in the area because of the needs for both local and international market and sold as a skin (US$30-50/kg). Through the surveys, no evidence of the snake was found. Given in high confidence and reliable village reports this species was confirmed its presence in the Survey area as they use to find it occasionally, Ban Dak Kang hunted this snake 3 years ago in SB5.

Red River Krait *Bungarus slowinskii*

Globally Threatened: Vulnerable (VU)

Bungarus slowinskii is known only from Viet Nam, where it has been recorded from Yen Bai, Lao Cai, Quang Tri and Quang Nam Provinces (Nguyen *et al*., 2009). It is suspected to occur in adjacent areas of Lao PDR, but has never been recorded there (B. Stuart and Q.T. Nguyen *pers. comm*. 2011). The snake has large extent of occurrence and can be found from 400-700 m a.s.l. This snake is a terrestrial, oviparous snake of mountain regions, which has only been found in or near streams in evergreen forest. This species was reported in all survey blocks with high confidence of its presence today. During the surveys it was found dead on road on 14 July, 2021, in SB2 (UTM: 752925/1721182, alti: 1,080m a.s.l.) (see Fig. 21).

5.3.3.6 First record and possible new species accounts

First records of herpetofauna species in Laos are interesting and with publication of these frog species will change some previously known endemic herpetofauna species of Vietnam to Annamite or Indochina since they are not present in only Vietnam.

FIRST RECORDS

Serrated Frilled Treefrog *Kurixalus cf. gryllus*

Globally Threatened: Vulnerable (VU) and – first record of Laos

This frog was first record in Vietnam and considered endemic to Vietnam in Kon Tum Province at above 1,000m a.s.l. (Nguyen and Eto, 2014), but with this record in Dak Cheung (Southern Annamite) which reveals the species distribution is larger than the previous known range, probably the whole Southern Annamite Mountain Range including the Upper Evergreen Forest of Attapeu Province. During the surveys this frog was found in the SB4 on 21 July, 2021 at UTM: 730980/1712401. This species was only the first record of Laos and endemism to the Annamite, but also one of Globally threatened species.

Truong son bug-eyed Frog *Theloderma truongsonese*

Globally Threatened: not known as not assessed yet – first record in Laos

This frog was first record in Vietnam and considered endemic to Vietnam in Kon Tum Province at above 1,000m a.s.l. (Nguyen and Eto, 2014), but with this record in Dak Cheung (Southern Annamite) which reveals the species distribution is larger than the previous known, probably the whole Southern Annamite Mountain Range including the Upper

Evergreen Forest of Attapeu Province. During the surveys this frog was found in the SB1 on 13 July, 2021 and SB4 on 20 July, 2021 at 15.478276N/107.154488E, alt:1,455m a.s.l.

Spiny torrent Frog *Amolops spinapectoralis*

Globally Threatened: not known as not assessed yet – first record in Laos

Amolops spinapectoralis occurs in Northern and central montane Vietnam (Gia Lai, Da Nang, Quang Nam, Kon Tum, Phu Yen, and Quang Name Provinces), it is at present only known from a few locations in central Vietnam and endemic to Vietnam - but it is likely to be found more widely in the Vietnamese central highlands as well as in the adjacent southeastern Laos and northeastern Cambodia (Inger *et al*., 1999 and Poyarkov *et al*., 2021). This species inhabits in evergreen forests at elevations of over 700m a.s.l. and montane (wet forest), vertical rock faces adjacent to waterfalls. It can be very abundant locally; however, it is threatened by habitat loss in Vietnam and partly in Laos by expanding agriculture; large areas of forest are being converted to cash crop plantations such as rubber, coffee, and tea. During the surveys this frog was found in the SB3 on 20 July, 2021 at 15.502398N/ 107.368455E, alt: 1,170m a.s.l.

Poilene Frog *Limnonectes cf. poilani*

Globally Threatened: not known as not assessed yet – first record in Laos

Limnonectes cf. poilani is considered a big frog, inhabits in Upper Evergreen Forests at elevations of ca. or over 1,000m a.s.l., mainly montane (wet forest), vertical rock streams and adjacent to waterfalls (Le *et al.* 2018. During the surveys this frog was found in the SB1 on 15 July, 2021 at 15.539671N/107.353805E, alt: 1,065m a.s.l.

In addition, there are other 2 species of second record of amphibian in Laos, and 3 possible new species (see Fig. 21 and Annex 3) as one of them was recorded outside the survey blocks.

NEW SPECIES CANDIDATE

Quaripaa sp. – possible new species to science as it has not been described before.

This species was found in the pond close to the Guesthouse in Dak Cheung town as urban area, just outside the survey blocks. This area is degraded area, it was originally the range of upper evergreen forest.

Xenophrys cf. maosonensis – possible new species to science as it has not been described before. This species was found in small stream of SB2 and SB4. The streams were well covered with healthy upper evergreen forest.

Rhacophorus sp nov – possible new species to science as it has not been described before. This species was found in small stream of SB2. The stream was well covered with healthy upper evergreen forest.

Polypedates sp. – possible new species to science as it has not been described before. This species was found in small stream of SB2. The stream was well covered with healthy upper evergreen forest.

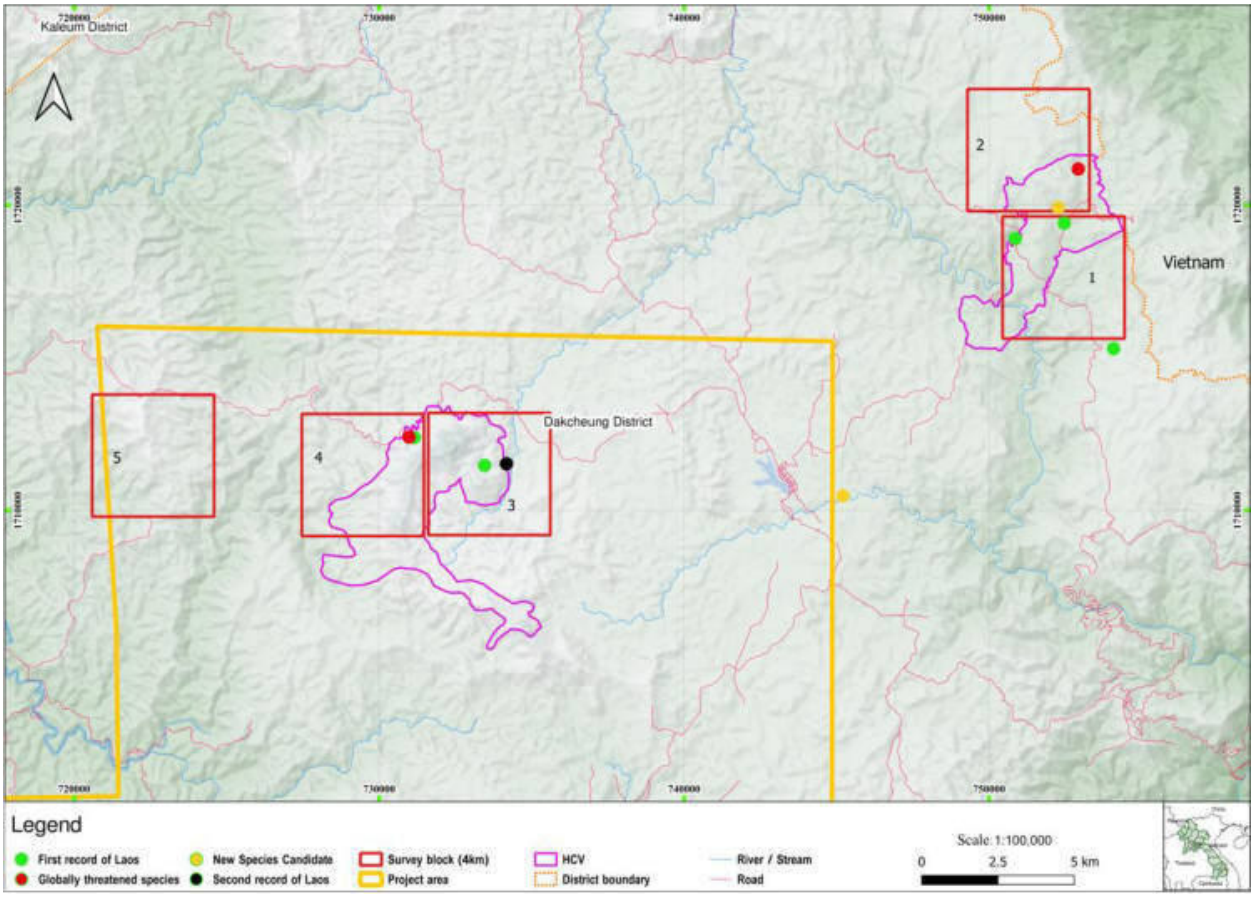


Figure 21. Locations of GT and endemic reptile species in the survey blocks

5.3.3.7 Some other selected species accounts

No any particular herpetofauna species are selected for species accounts.

5.3.3.8 Seasonal variation and distribution of herpetology in the survey area

Herpetofauna species in the survey area have similar distribution but they have different variation by season. Most species are active during wet season especially the beginning of wet season but barely any species can be detected during dry season. Only some few species were found in dry season such as a group of *Limnoectes*, not leaf frog and snakes were found.

5.3.3.9 Recommendations

Herpetofauna (amphibian and reptile species) has been surveyed fairly completely during the surveys. Yet, some numbers of globally threatened species reported could not be confirmed in the field due to some rarity. Therefore, it needs further survey for dry season especially turtles and snakes. Some herpetofauna species with a low population should be surveyed as to identify their habitats for protection.

5.3.3.10 Conclusions

All habitats and micro-habitats are important for herpetofauna communitiy and considered unique for both southern Annamite as well as Phou Koungking (as part of sporadic Annamite, it is Montane Evergreen Forest with submit of 1,700 m a.s.l). Through the surveys of herpetofauna made a total of ca. 73 herpetofauna species were listed, of which 71 species were confirmed from the field survey and other 6 species from reliable village reports.

As 7 globally threatened herpetofauna species (6 reptile and 1 amphibians) were confirmed their presence with some few species from reliable village reports, all is VU species. The SB4 and SB3 (Phou Koungking) generated a high number of herpetofauna species, then SB2, 5 and SB1 (Annamite). But, the GT herpetol fauna species was found in high number in the SB2, then SB4 and SB5.

Further survey of herpetofauna should be conducted in specific habitats in the future to identify a number of species still to be confirmed, especially those GT species. The most important survey blocks for herpetofauna are SB3, SB4 and SB3. These include canopy dwelling herpetofauna species. Moreover, larger size species were not detected due to a low population caused by heavy harvesting specially turtles and snakes.

6. THREATS TO BIODIVERSITY

Threats to biodiversity are mainly for terrestrial species – the mammal, turtles and snakes which are all becoming rare in the Survey area due to hunting, overharvest for trading, some logging activity (SB1) and slash-burned activities for hill rice cultivation and coffee plantation (SB1) so most globally threatened under high threats (see Fig. 22a-22d).

Secondary forest, habitat degradation due to expansion of agriculture was observed widely in SB5, and partly in SB3, SB4, SB1. Also, new road construction was observed in the SB2 which made the habitat fragmented and that will generate new impact on gibbon population in the area from disturbance and hunting. A new transmission of E-Moun Dam was being under construction during the survey as its alignment runs through the northern section of SB5, SB4, SB3 and SB1. Therefore, cumulative impact in the area is and will be from transmission lines of other hydropower power projects such as E-Moun Dam, Xe Khaman Dam, also the military road project, and the proposed logistics park of the International Checkpoint.

Hunting was found more frequency during dry season survey from gunshots and hunters as gunshots were heard 9 times on December 7, 2021 in SB1, and some in other SBs. Hunters

were found during the survey and evidences from camera traps in all SBs particularly the SB1 and SB5. Snare lines were found occasionally in the forests. Hunting some GT species, including Gibbon and Red-shanked Douc Langur were reported but mostly by opportunistic encounters. As well as collecting juvenile Douc for sale by the villagers of Ban Ta-ok noy was reported as they caught it from the SB2.

Figure 22a. Some evidences of threats (hunting and logging)

Figure 22b. Hunting (Porcupine), trapped dead animal and snares

Figure 22c. Hunters captured on camera traps

Figure 21d. Road construction along the Lao-Vietnam Border and TL clearance

The mammal is a large animal and easily detected by a hunter and its capacity of moving is difficult and needs habitat connectivity. Searching animals with assistance from domestic dogs will exaggerate the level of expiration of many species particularly tortoises. Only Phou Kounking (SB3 and SB4) are fairly protected by traditional belief as sacred place and difficult to access due to highly steep slopes. The SB1, SB5 and SB2 received higher threats.

7. CONCLUSIONS

The Survey area holds important wildlife community with a number of fauna and flora species recorded, including some numbers of globally threatened species especially mammal and endemic species for herpetofauna and plants. Although the survey area was not declared as any conservation area, a total of 23 Globally Threatened species were confirmed in the area (14 mammal, 6 reptile, 1 amphibian and 2 plant species).

The target species that were directly confirmed in the field including Northern buff-cheeked Gibbon (*Nomascus annamensis*, EN), Red-shanked Douc Langur (*Pygathrix nemaeus*, CR), Chinese Pangolin (*Manis Pentadactyla,* VU), Sunda Pangolin (*Manis javanicus*, CR), Stump-tailed Macaque (*Macaca arctoides*, VU), Sambar (*Rusa unicolar*, VU), Chinese Serow (*Capricornis milneedwardsii*, VU), Annamite Striped Rabbit (*Negolagus timminsi*, EN), Owston's Civet (*Chrotogale owstoni*, EN), Impressed Tortoise (*Manouria impressa,* VU) and Red River Kriat (*Bungarus slowinskii*, VU). Also, other GT species were confirmed but not on the target species as Serrate Frilled Treefrog (*Kurixalus cf gryllus*, VU), Stump-tailed Macaque (*Macaca arctoides*, VU), Northern Pig-tailed Macaque (*Macaca leonina, VU*), Chinese Serow (*Capricornis milneedwardsii*, VU), Sun Bear (*Helarctos malayanus, VU)* and Asiatic Black Bear *(Ursus thibetanus, VU),* Great Hog Badger (*Arctonyx collaris*, VU) and Smooth-coated Otter (*Lutrogale perspicillata*, VU).

Interestingly, apart from GT species there are 48 endemic species were found in the survey blocks, of which 29 first plant records of Laos, 4 first herpetofauna records of Laos, 2 second herpetofauna records of Laos, 10 possible new plant and 3 possible new herp species were defined for possible new species to science for the time being.

In addition, the area is interesting sites for wildlife survey or research, including birds and amphibians, will be SB3 and SB4 (Phou Koungking) as outstanding biodiversity with uniqueness of habitat – Montane Evergreen Forest at up to 1,700 m a.s.l. This hotspot of biodiversity should be legally established as conservation area in the future.

Meanwhile, some incidental records from the mammal, herpetofauna and plant assessment on bird and fish can be found in Annex 8.

REFERENCES

ADB. (2010). Greater Mekong Sub-region Biodiversity Conservation Corridors Project (pp. 68). Biodiversity Conservation Corridors in Southern of Lao PDR.

Akhavong S. (2017). Diversity of Bird Species in Training and Model Forest of Faculty of Forest Sciences, National University of Laos: A case study of Napo Village, Sangthong District, Vientiane Capital.

Asian Turtle Trade Working Group. (2000). *Amyda cartilaginea.* In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>.

Biggs, R., Scholesa, R. J. and Reyersb, B. (2004). Assessing biodiversity intactness at multiple scales. Bridging Scales and Epistemologies Conference, Alexandria Egypt, 17-20 March 2004

Biggs, R., Reyers, B. and Scholes, R. J. (2006). A biodiversity intactness score for South Africa. South African Journal of Science Vol: 102

Boonratana, R. (2013). The Indochinese Silvered Leaf Monkey *Trachypithecus germaini* (sensu lato) in Lao PDR. *Primate Conservation* 26: 75–87.

Boulenger, G. A. (1893). *Catalogue of the Snakes in the British Museum (Natural History). Volume I., Containing the Families Colubridæ Aglyphæ, part.* Trustees of the British Museum (Natural History). (Taylor and Francis, Printers). London. xiii + 448 pp. + Plates I.- XXVIII. (*Zamenis korros*, pp. 384-385.)

Brien, O. A., Townsend, K., Hale, R., Sharley, D. and Pettigrove, V. (2016). How is ecosystem health defined and measured? A critical review of freshwater and estuarine studies. Eco. In (69: 722-729). University of Melbourne, Victoria, 3010, Australia.

Coudrat, C. N. Z., Duckworth, J. W. and Timmins, R. J. (2012). Distribution and conservation status of the Red-shanked Douc (*Pygathrix nemaeus*) in Lao PDR: an update. American Journal of Primatology 74: 874-889.

Cox, M. J., Hoover, M. F., Chanhome, L. and Thirakhupt, K. (2012). The Snake of Thailand. Chulalongkorn University Museum of Natural History. 844 pp.

Das, I. (2010). A field guide to the Reptiles of Thailand & South-east Asia. Myanmar, Thailand, Laos, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, Java and Bali.*Asia Book*. 376 pp.

Dong, T., Tep, M., Lim, S., Soun, S. and Chrin, T. (2010). Distribution of Otters in the Tropeang Roung, Koh Kong Province, Cambodia. *IUCN Otter Spec. Group Bull.* 27 (2): 63 – 77.

Duckworth, J.W., Salter, R. E. and Khounboline, K. (1999). Wildlife in Lao PDR: 1999 status report. Vientiane: The World Conservation Union (IUCN), Wildlife Conservation Society (WCS) and Centre for Protected Areas and Watershed Management (CPAWM). Vientiane, Lao PDR.

Duckworth, J. W., Tizard, R. J., Timmins, R. J., Thewlis, R. M., Robichaud, W. G. & Evans, T. D. (1998). *Bird records from Laos, October 1994–August 1995*. *Forktail* 13: 33–68 (including errata sheet distributed with *Forktail* 14).

Francis, M. C (2001). A Photographic Guide to the Mammals of Thailand and Southeast Asia. Asia Books, Bangkok, Thailand.

[GLCF]Global Land Cover Facility. (2010). "Landsat-TM imagery". Available online:ftp://ftp.glcf.umd.edu/glcf/Landsat/WRS2/p126/r049/L71126049_049200 91224.ETM-GLS2010/ Downloaded on 13 April 2018

Groves, C. P, Schaller, G. B, Amato, G. and Khounboline, K. (1997). Nature 386

IBAT, Integrated Biodiversity Assessment Tool of IUCN: https://www.iucn.org/theme/business-and-biodiversity/our-work/business-approaches-and-tools/integrated-biodiversity-assessment-tool-ibat-business

Inthakoun, L. and Delang, O. C (2008). Lao Flora, A Checklist of Plants found in Laos. www. http://laoflora.com

IUCN (2020). The IUCN Red List of Threatened Species. Version 2020 [On-line]. Available: http//:www.iucnredlist.org/

Inger, R. F., N. L. Orlov, and I. S. Darevsky. (1999). Frogs of Vietnam: A report on new collections. Fieldiana. Zoology. New Series 92: 1–46.

Kottelat, M. (2011). Fishes of the Sekong drainage in Laos, especially from the Xe Kaman. Co-Management of freshwater biodiversity in the Sekong Basin. Worldwide Fund for Nature – Greater Mekong Programme, Vientiane, Lao PDR.

Nanthavong, K., Lamxay, V. and C. Vongkhamheng (2019). Field report Flora survey in the Southern Biodiversity Corridors. The Carbon Assessment Consultancy for the GMS Biodiversity Corridors Conservation project, Vienitane, Lao PDR.

Nature (1997). Vol. 386, 27 March 1997

Nguyen, T.T., M. Matsui, and H.M. Duc. (2014). A new tree frog of the genus Kurixalus (Anura: Rhacophoridae) from Vietnam. Current Herpetology 33:101–111

McCormack, T. & Stuart, B. (2016). Cuora bourreti. The IUCN Red List of Threatened Species 2016: T163447A115303472. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T163447A1009344.en

Le, D. T. T., Rowley, J. J. L. Tran, D. T., Ngoc, T and Houang H. D (2018). Diet Composition and Overlap in a Montane Frog Community in Vietnam. Herps Cons & Bio: 13(1) 205-215.

Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgress, N. D., Powell, G. V. N., Underwood, E. C., D'Amico, J. A., Itoua, I., Strand, H. E., Morrison, J C., Loucks, C. J., Allnutt, T. F., Ricketts, T. H., Hura, Y., Larmreus, J. F., Wettengel, W. W., Hedao, P., and Kassem, K. R. (2001). Terrestrial ecoregions of the world. A new map of life on earth. Bioscience 51(11): 933-938

Parr, J. (2008). Guide to the Mammal of Lao PDR. WWF Lao PDR Programme, Vientiane, Lao PDR.

Picheansoonthon C, Koonterm S (2009) Two new Kaempferia L. (Zingiberaceae) from southern Laos. Taiwania 54(3): 219–225. Vongkhamheng, C., Phiapalath P., Vongkhamheng J. and Bounkong, C. (2012). Conservation initiative of Indochinese Silvered Leaf Monkey (Trachypithecus germaini) in Dong Phouvieng National Protected Area, Savannakhet, Lao PDR.

Phiapalath, P., Khotpathoom, T. Soukhavong, M. and Thilavong, S. (2021). Final Draft Report of Rapid Ecological Assessment at Monsoon Windfarm Power Project, Dak Cheung District, Environmental Resource Management (ERM), Thailand.

Poyarkov, N. A., Jr., T. V. Nguyen, E. S. Popov, P. Geissler, P. Pawangkhanant, T. Neang, C, Suwannapoom, and N. L. Orlov. (2021). Recent progress in taxonomic studies, biogeographic analysis, and revised checklist of amphibians of Indochina. Russian Journal of Herpetology 28 (3A): 1–110 (DOI: 10.30906/1026-2296-2021-28-3A-1-110).

Rahman, S., Platt, K., Das, I., Choudhury, B.C., Ahmed, M.F., Cota, M., McCormack, T., Timmins, R.J. & Singh, S. (2019). Indotestudo elongata (errata version published in 2019). The IUCN Red List of Threatened Species 2019: T10824A152051190.

Rapport, D.J., Costanza, R., McMichael, A.J., (1998). Assessing ecosystem health. Trends Ecol. Evol. 13, 397–402.

Roos, C., Boonratana, R., Supriatna, J., Fellowes, J. R., Groves, C. P., Nash, S. D., Mittermeier, R. A. (2014). An updated taxonomy and conservation status review of Asian primates. *Asian Primates Journal*.

Rundal, W. P (1999). Forest habitats and flora in Lao PDR, Cambodia and Vietnam. Department of Ecology and Evolutionary Biology, University of California, USA.

Showler, D. A., Davidson, P., Vongkhamheng, C. and Salivong, K. (1998). A wildlife and habitat survey of the Southern Border of Xe Sap NPA and the Dak Cheung Plateau, Sekong Province, Lao PDR. Department of Forestry/Wildlife Conservation Socieity.

Si, X., Kays, R. and Ding, P. (2014). How long is enough to detect terrestrial animals? Estimating the minimum trapping effort on camera traps. PubMed/Peerj. DOI:10.7717

Smitinand, T., Vidal, J.E. and Hô, P.H. 1990. Dipterocarpaceae. *Flore du Cambodge du Laos et du Vietnam* 25: 41.

Smith, M. A. (1931). The fauna of British India, including Ceylon and Burma. Reptilia and Amphibia. Vol. I. Loricata, Testudines. London: Taylor & Francis.

Soury, A. (2007). Sacred forests: a sustainable conservation strategy? Wageningen University.

Stewart, C., George, P., Rayden, T. & Nussbaum, R. (2008). *Good practice guidelines for High Conservation Value assessments: A practical guide for practitioners and auditors. ProForest. Oxford, UK*

Stuart, B., Nguyen, T.Q. & Bain, R. (2012). Protobothrops sieversorum. The IUCN Red List of Threatened Species 2012: T178708A1542311. http://dx.doi.org/10.2305/IUCN.UK.2012- 1.RLTS.T178708A1542311.e

Stuart, B. & Nguyen, T.Q. (2012). Bungarus slowinskii. The IUCN Red List of Threatened Species 2012: e.T192221A2057605. http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T192221A2057605.e

Stuart, B.L., J.J.L. Rowley, D.T.A. Tran, D.T.T. Le, and H.D. Hoang. (2011). The Leptobrachium (Anura: Megophryidae) of the Langbian Plateau, southern Vietnam, with description of a new species. Zootaxa 2804:25–40.

Stuart, B. L. (1999). Amphibians and Reptiles. Pp. 43–67 in Duckworth, J. W., Salter, R. E. and Khounboline, K. (compilers). Wildlife in Lao PDR: 1999 status report. IUCN–The World Conservation Union/Wildlife Conservation Society/Centre for Protected Areas and Watershed Management, Vientiane.

Stuart, B. L. and Platt, S. G. (2004). Recent records of turtles and tortoises from Laos, Cambodia, and Vietnam. Asiatic Herpetological Research 10: 129–150.

Stuart, B. L. (2005). New frog records from Laos. *Herpetological Review* 36: 473–479.

Stuart, B. L., Heatwole, H. F., and Tan, F. L. (2006). Record of the little-knownRana Nigrotympanica Dubois,1992 (Amphibia: Ranidae) from northern Laos. Hamadryad 30: 108–113.

Stuart, B. L. and Bain, R. H. (2005). Three new species of spinule-bearing frogs allied to Rana Megatympanum Bain, Lathrop, Murphy, Orlov and Ho, 2003 from Laos and Vietnam. Herpetologica61: 478–492.

Stuart, B., van Dijk, P. P. and. Herdrie, D. B. (2001). Turtles of Thailand, Laos, Vietnam and Cambodia 2001, Wildlife Conservation Society, Vientiane, Lao PDR.

Stuart, B., Nguyen, T.Q. & Bain, R. (2012). Protobothrops sieversorum. The IUCN Red List of Threatened Species 2012: T178708A1542311. http://dx.doi.org/10.2305/IUCN.UK.2012/1.RLTS.T178708A1542311

Stuart, B. L., Phimmachak, S., Seateun, S. and Sivongxay, N. (2012). A new Leptobrachium (Anura: Megophryidae) from the southeastern Laos. Zootaxa 3155: 29–37.

Stuart, B. L., Phimmachak, S., Sivongxay, N., Seateun, S. and Sheridan. J. A. (2013). A new Philautus (Anura: Rhacophoridae) from northern Laos allied to P. abditus Inger, Orlov & Darevsky,1999. Zootaxa 3745: 73–83.

Svengsuksa, B. & Vidal, J. E. (1997). Les Diptérocapacées du Laos. Adaptation de "Flore du Cambodge, du Laos et du Vietnam" Université Nationale du Laos, Vientiane, Laos.

Svengsuksa, B., Pravongviengkham, S., Bounmala, S., Phophalith, C., Phongsa, K. and Ounmany, S. (2003). *Birds of Lao PDR.* National University of Laos, BirdLife International and Wildlife Conservation Society, Vientiane, Lao PDR.

Taylor, E. H. (1962). The amphibian fauna of Thailand. University of Kansas Science Bulletin 43: 265–599.

Thewlis, R. M., Timmins, R. J., Evans, T. D., and Duckworth, J. W. (1998). The status of key species for bird conservation in Laos. Bird Conserv Int 8: 1-159.

Thewlis, R. M., Duckworth, J. W., Anderson, G. Q. A., Dvorak, M., Evans, T. D., Nemeth, E., Timmins, R. J. & Wilkinson, R. J. (1996*). Ornithological records for Laos*, 1992–1993. *Forktail* 11: 47–100.

Timmins, R. & Duckworth, J.W. 2016. Muntiacus truongsonensis. The IUCN Red List of Threatened Species 2016: T44704A22154056. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T44704A22154056.

Timmins, R.J. and Vongkhamheng, C. (1996). A preliminary wildlife and habitat survey of Xe Sap National Biodiversity Conservation Area and Mountains to the South, Salavan Province, Lao PDR. WCS Laos, Vientiane.

Vidal, J. E. (1960). Les forets du Laos. Bois et Forêts des Tropiques 70: 5-21.

Wongsuwan, P. (2008). A New Species of Hedychium (Zingiberaceae) from Southern Laos, *Taiwania,* 53(4): 401-405.