

III. SCOPE AND PURPOSE OF THE ASSESSMENT

3.1 SCOPE OF THE ASSESSMENT

The assessment was conducted through defining 5 survey blocks (1,600 ha each), as a square block covering some sections beyond the high priority areas of biodiversity but not cover

some portions of the defined high priority areas (see Fig. 1). The assessment focused on mammal, herpetofauna and plants as the target species that are highly possible to present in the project area and relevant to the nature of the project and so the target species must be confirmed their presence or absence from the assessment 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), Owston’s Civet (*Chrotogale owstoni*, EN), 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).

3.2 OBJECTIVE OF THE ASSESSMENT

The main objective of the assignment was to understand the current status of biodiversity, focused on globally threatened species, the “target” species of the project area.

Knowledge gain can be used for planning for prevention and mitigating adverse impacts from planning process to construction and operations of the project development.

3.3 SURVEY PERIOD

The assessment from July 11 to August 3, 2021 for dry season and in December, 2021 for wet season as the detailed schedule below:

- Wet season survey

Date	Activity
11/07/2021	Traveled from VTE to Sekong Province
12/07/2021	Traveled to Dak Cheung, met with DAFO and to SB1 – fieldwork
13/07/2021	SB1 – fieldwork and village interviews – Ban Dak Dom
14/07/2021	SB1 – fieldwork
15/07/2021	SB1 – fieldwork
16/07/2021	SB2 – fieldwork
17/07/2021	SB2 – fieldwork
18/07/2021	SB2 – fieldwork
19/07/2021	SB2, and returned to Dak Cheung and to next fieldwork
20/07/2021	SB5 – fieldwork and village interviews – Ban Prao
21/07/2021	Survey block 5 – fieldwork
23/07/2021	SB5 – fieldwork
24/07/2021	SB5 – fieldwork
25/07/2021	SB3 and SB4 – fieldwork village interviews – Ban Dak Dreun
26/07/2021	SB3 and SB4 – fieldwork by main team in parallel
27/07/2021	SB3 and SB4 – fieldwork by main team in parallel
28/07/2021	SB3 and SB4 – fieldwork by main team in parallel
29/07/2021	Field data checks

30/07/-1/8/2021	Team Wrap up
02/08/2021	Return to Pakse
03/08/2021	Return to VTE

- Dry season survey

Date	Activity
05/12/2021	Travel from VTE to Sekong Province
06/12/2021	Travel to Dak Cheung, and camping at site - fieldwork.
07/12/2021	SB1 – fieldwork
08/12/2021	SB1 – fieldwork
09/12/2021	SB1 – fieldwork
10/12/2021	SB2 – fieldwork
11/12/2021	SB2 – fieldwork
12/12/2021	SB2 – fieldwork
13/12/2021	SB2 – fieldwork, return to Dak Cheung and to then SB5
14/12/2021	SB5 – fieldwork
15/12/2021	SB5 – fieldwork
16/12/2021	SB5 – fieldwork
17/12/2021	SB3 – fieldwork
18/12/2021	SB3 – fieldwork
19/12/2021	SB3 – fieldwork
20/12/2021	SB3 – fieldwork and then to SB4
21/12/2021	SB4 – fieldwork
22/12/2021	SB4 – fieldwork
23/12/2021	SB4 – fieldwork
24/12/2021	SB4 – fieldwork and then return to Dak Cheung
25/12/2021	Team Wrap up
26/12/2021	Return to Pakse
27/12/2021	Return to VTE

3.4 SURVEY SPECIALIST TEAM AND EXPERTISES

The technical team of 5 experts and 8 assistants, including the participants from Provincial and District Offices, and some military and local villagers who joined the surveys, made a total of 17 personnels. The expert team was permitted to conduct the survey for both wet and dry seasons (see Annex 9). A sub-team for mammal, herpetology and botany as each sub-team had one lead specialist with assistants (see Table 1a, 1b and Fig. 2).

Table 1a. List of experts and assistants

<i>Field</i>	<i>Name of Specialist</i>	<i>Degree</i>	<i>Field of expertise</i>	<i>Years of Experience</i>	<i>Tasks</i>
Lead Specialist Team					
<i>Team Leader, Mammal</i>	<i>Phaivanh Phiapalath</i>	<i>PhD</i>	<i>Wildlife surveys & Protected Areas</i>	<i>20+</i>	<i>Team Leader and Mammals</i>
<i>Herpetofauna</i>	<i>Peter Brakels</i>	<i>M.Sc</i>	<i>Reptile</i>	<i>7</i>	<i>Reptile</i>
<i>Herpetofauna – snake</i>	<i>Nathanael Maury</i>	<i>M.Sc</i>	<i>Reptile</i>	<i>10</i>	<i>Herpetology</i>
<i>Botany</i>	<i>Phetlasy Souladeth</i>	<i>PhD</i>	<i>Botany/taxonomy</i>	<i>10</i>	<i>Botany and habitats</i>
<i>Field Team leader, Camera trap</i>	<i>Thananh Khotpathoom</i>	<i>PhD</i>	<i>Wildlife/bird Camera trapping</i>	<i>15</i>	<i>Wildlife inventory, Camera trapping</i>
Assistant Specialist Team					
<i>Plant</i>	<i>Metmany Soukhavong</i>	<i>PhD can.</i>	<i>Plant</i>	<i>7</i>	<i>Botany</i>
<i>Mammal</i>	<i>Duangphachanh Souvansai</i>	<i>M.Sc</i>	<i>Mammal</i>	<i>5</i>	<i>Primate</i>
<i>Herpetofauna</i>	<i>Nina Pou Maury</i>	<i>B.Sc</i>	<i>Reptile</i>	<i>4</i>	<i>Herpetology</i>
<i>GIS</i>	<i>Sounthone Thilavong</i>	<i>B.Sc</i>	<i>GIS and mapping</i>	<i>5</i>	<i>GIS and Mapping</i>
<i>Assistant</i>	<i>Vilasack Chanthabouasone</i>	<i>Diploma</i>	<i>Wildlife inventory</i>	<i>5</i>	<i>Field assistance</i>
<i>Assistant</i>	<i>Nep Thonephakdy</i>	<i>Certifica.</i>	<i>Wildlife inventory</i>	<i>5</i>	<i>Field assistance</i>
Government Assistant Team					
<i>GoL Assistant</i>	<i>Somchit Boulaphone</i>	<i>Diploma</i>	<i>Veterinarian, PAFO</i>	<i>30</i>	<i>Field assistance</i>
<i>GoL Assistant</i>	<i>Thongkham Boudtavong</i>	<i>Diploma</i>	<i>Veterinarian, DAFO</i>	<i>25</i>	<i>Field assistance</i>
<i>Military</i>	<i>Thongkhoun</i>	<i>Certifica.</i>	<i>Patrol</i>		<i>Field assistance</i>
<i>Military</i>	<i>Sengnisone</i>	<i>Certifica.</i>	<i>Patrol</i>		<i>Field assistance</i>
<i>Military</i>	<i>Choy Leuanlaisao</i>	<i>Certifica.</i>	<i>Patrol</i>		<i>Field assistance</i>

In addition, we had the local villagers participated in the survey which varied from survey block to survey block, but on average of 4 persons at a time. Their participations were useful as their knowledge in not only about the site but also wildlife information.

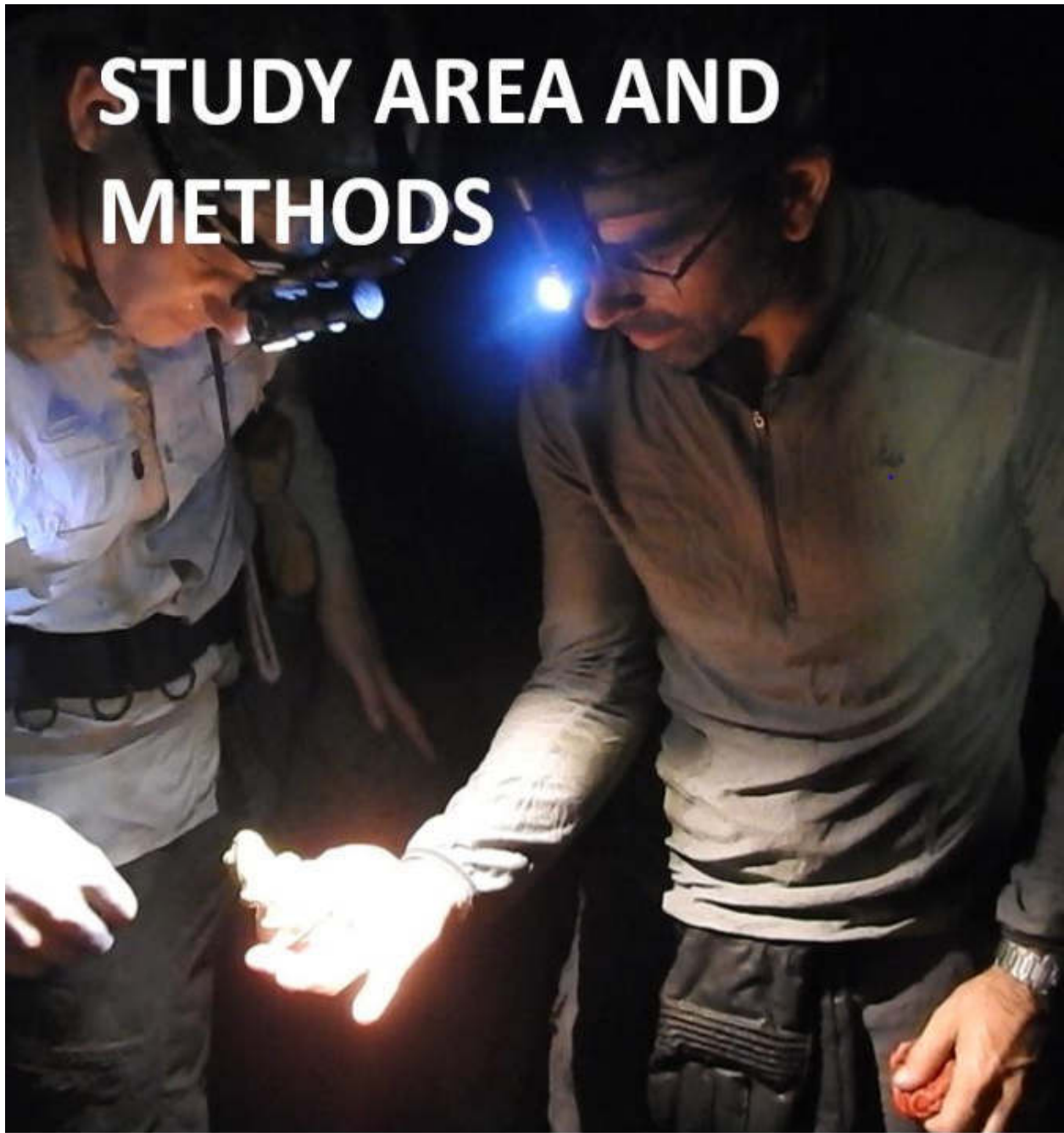
Table 1b. List of village participants in the survey and key informants

No	Names	Name of Villages	Ages	Responsibility
1	Mr. Sengvanphone	Ban Dak Dom	53	Village Chief
2	Mr. Khamson	Ban Dak Dom	58	Village Elderly
3	Mr. Khamvong	Ban Dak Dom	46	Village militia

4	Mr. Chitmany	Ban Dak Dom	39	Village militia
5	Mr. Sengnisone	Ban Dak Dom	32	Solder
6	Mr. Khamvong	Ban Dak Dreun	40	Village Chief
7	Mr. Sonenivong	Ban Dak Dreun	45	Village militia
8	Mr. Deng	Ban Dak Dreun	65	Village Elderly
9	Mr. Sone	Ban Dak Dreun	36	Teacher
10	Mr. Kham	Ban Dak Dreun	37	Villager
11	Mr. Puni	Ban Dak Dreun	26	Villager
12	Mr. Sengchanh	Ban Prao	54	Village Chief
13	Mr. Thongchanh	Ban Prao	65	Village Elderly
14	Mr. Vong	Ban Prao	29	Village Youth
15	Mr. Mith	Ban Prao	18	Village Youth
16	Mr. Vieng	Ban Prao	21	Village Youth
17	Mr. Sydachanh	Ban Dak Ta-ork	38	Village militia
18	Mr. Sonexay	Ban Dak Ta-ork	31	Villager
19	Mr. Bounpheng	Ban Dak Kang	54	Village Chief
20	Mr. Bounhing	Ban Dak Kang	60	Villager - Eldery
21	Mr. Bounhiang	Ban Dak Kang	45	Villager
22	Mr. Chandy	Ban Dak Kang	34	Villager



Figure 2. Expert team with field assistants



IV. STUDY AREA AND METHODS

4.1 SURVEY AREA

Sekong Province is located in southern Laos, it is mountainous area and plateau at above 800m a.s.l. which is considered the Annamite Mountain Range – the southern section of the Annamite. The assessment focused in the high priority areas – of the project site in the northeast section at Ban Prao, northwest section at Ban Dak Dreun and the TL section at Ban

Dak Dom and Dak Ta-ok. This mammal, herpetofauna and plant assessment was undertaken in the priority areas of high biodiversity value of the project site for an area of 3,523 ha, of which first zone on the east of 1,189 ha and the second zone on the north of 2,134 ha. Five survey blocks were defined (16 km² per survey block), of which 2 survey blocks in the Zone A - eastern zone and other 3 survey blocks in the Zone B - northern zone (see Fig. 3).

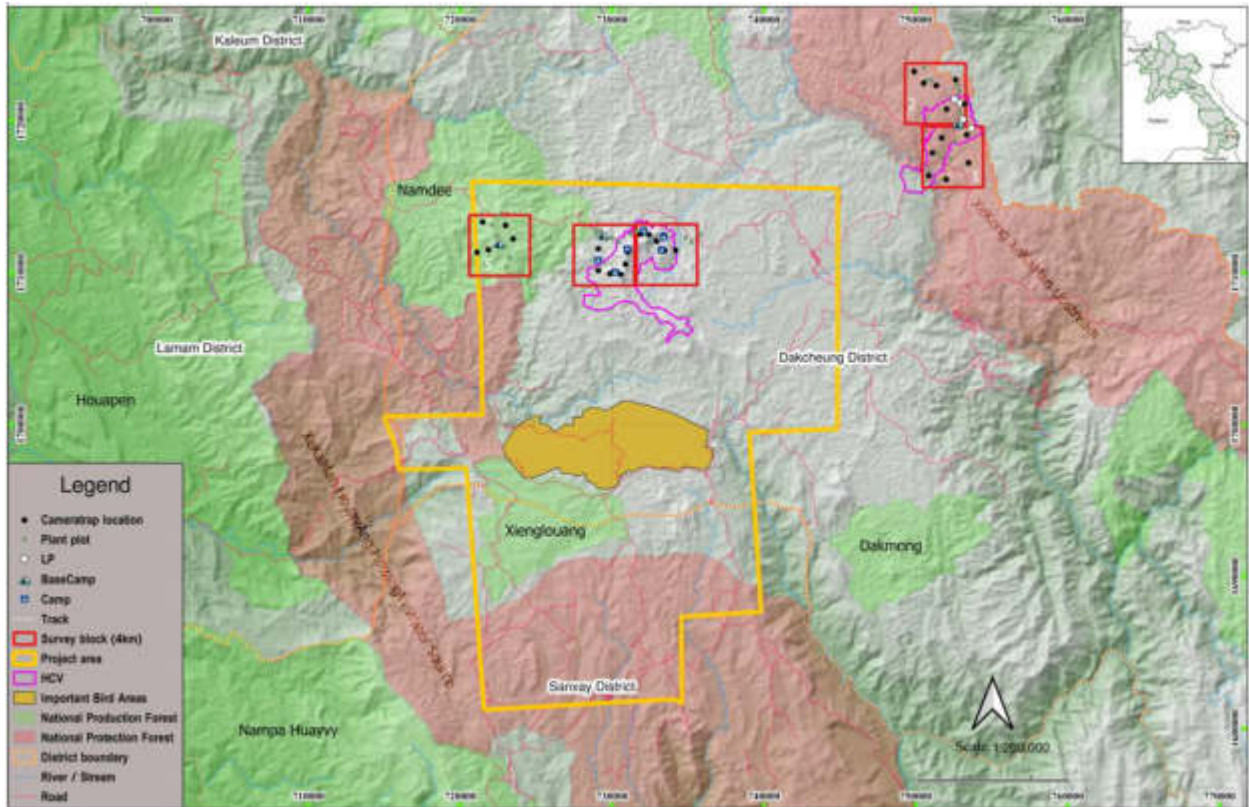


Figure 3. Survey blocks of the assessment in high conservation value areas

4.2 SURVEY METHODS

The mammal, herpetofauna and plant assessment was conducted through village interviews on wildlife information and direct field surveys.

The village interviews were conducted in those villages located relevant to the survey blocks including Ban Dak Dom, Ban Dak Ta-ok, Ban Dak Dreun, Ban Prao and Ban Dak Kang. A majority of local communities in the survey area is Tra Lieng as ethnic uniqueness which can be observed from their typical settlements and cultures. They live and spend most time in forests for collecting forest products and hunting which their knowledge in wildlife is well accepted (see Fig. 4). The knowledge gained from the village interviews was preliminary information of wildlife in the survey area for field verification, focused on globally threatened “target” wildlife species.



Figure 4. Settlement of Tra Lieng, tribal ethnic group of Dak Cheung District

The survey was designed to cover the whole priority area as to confirm where presence or absence of the target species. The field surveys for each survey block were conducted by 3 sub-teams as on mammal, reptiles and plant. Each sub-team defined different habitats of interest for the specific survey which was based on the information given from the village interviews and GIS analysis. The survey was conducted for 3-4 days per survey block for each field campaign (wet season and dry season).

Plant plot surveys were conducted to obtain a list of plant species present in survey block, where density, frequency, presence of threatened species, endemism (first records) of Laos. As plant plots were established for each survey block, a total of 30 plots in 5 survey blocks (6 plots each, 1 plot of 17.85m²).

There were three base camps as Based-Camp 1 (UTM: 752797/1719851, alt: 1,062m a.s.l) for the SB 1 and SB 2 with sub-camps and gibbon listening posts; Based-Camp 2 (UTM: 729390/1712518, alt: 1,298m a.s.l) for SB 3 (UTM: 722525/1711972, alt: 1,404m a.s.l) and SB 4 with 8 sub-camps and gibbon listening posts; and Based-Camp 3 for SB 5 with 1 sub-camp and gibbon listening posts (see Fig. 3 and Fig. 5) as detailed coordinates in Table 2a below:

Table 2a. Coordinates of base-camp and sub-camp (UTM)

No	N	E	Altitude	Name of location	Remarks
1	752797	1719851	1062	Base-Camp 1	
2	753658	1719515	1130	Listening Post 1	Not camping
3	753099	1720108	1045	Listening Post 2	Not camping
4	752926	1721182	1083	Listening Post 3	Not camping
5	752555	1721423	1147	Listening Post 4	Not camping
5	729390	1712518	1298	Base-Camp 2	
6	730994	1711565	1576	Sub-camp/Listening Post 1, SB3	
7	730192	1710031	1456	Sub-camp/Listening Post 2, SB3	
8	729078	1710805	1289	Sub-camp/Listening Post 3, SB3	
9	732071	1712767	1519	Sub-camp/Listening Post 4, SB4	
10	733414	1712349	1474	Sub-camp/Listening Post 5, SB4	
11	733277	1711503	1488	Sub-camp/Listening Post 6, SB4	
12	734131	1709338	1337	Sub-camp, SB4	
13	722515	1711972	1404	Base-Camp 3, SB5	
14	723322	1710817	1229	Sub-Camp 3, SB5	

Detailed descriptions of methodologies on village interviews, field surveys and plant plot survey by each perspective sub-team were provided as following:

4.2.1 Field Surveys

4.2.1.1 Field Surveys for Wildlife by survey block

Further from the village interviews, we obtained where target species would be present and that helped design the survey camps and transects. There were some differences of time efforts and time of observations among sub-teams as the herpetology survey was also conducted at night with night spotting for 4 hours per night from 7.00pm – 10.00pm, 3 nights per survey block.

Geographic coordinates of the survey sites, camps, transects and point counts were recorded. The date and general descriptions of habitats and micro-habitats were recorded for key individuals of wild animals encountered. There were some different techniques used for mammal, reptile and botanic surveys as following:

4.2.1.2 Survey Techniques for Mammals

Surveys for mammals were conducted by survey walk (reconnaissance) with time started from morning at 7.30am to 11.30am and late afternoon from 1.30pm to 5.30pm, but at early at 5.30am for gibbon listening posts. There were a forest walk, specific site and morning listening post (see Fig. 5). The slow-forest walk was used for general mammal survey in the forest to detect animals directly, by calls and other evidences such as footprint, tracks, scratch, dropping and calls/sounds. We walked slowly and quietly in forest, stopped for a few minutes then kept walking crossing various conditions of habitats, including fallows. Any

species' evidences found on ground and tree trunks such as tracks, droppings, scratches, hollows, claw marks, roosting sites, feeding sites etc.

The specific sites were observed along river/stream channels including water body, mineral licks and under fruit trees e.g *figus*. Any important evidences of wildlife found were photographed and collected for specimens, such as droppings so a number of small plastic bags were prepared for this purpose. With any wild animals' evidences found we used a ruler to measure the size of the evidence. Any calls of animal heard were recorded, including any noise detected from animal travel e.g monkey, sounds of fighting etc.

Camera traps (30 units) were installed in all survey blocks (6 units per block) for identifying target ground mammal species. These were set at different heights of camera trap position as from a breast height for targeting a large mammal and lower for a small mammal (see Fig. 5a – 5d). The camera traps were installed in specific locations where supposed to be used by wild animals and deployed for 5 months (see Table 2b and Fig. 3, Fig. 7 & 9).

Table 2b. Location of camera traps (UTM)

Camera trap No.	N	E	Altitude	Remarks
1	751700	1718919	1129	CAM01-Block 1 – Southern Annamite
2	751085	1717937	1120	CAM02-Block 1 – Southern Annamite
3	750847	1716442	1074	CAM03-Block 1 – Southern Annamite
4	752005	1716183	1103	CAM04-Block 1 – Southern Annamite
5	753478	1717282	1096	CAM05-Block 1 – Southern Annamite
6	753351	1719133	1147	CAM06-Block 1 – Southern Annamite
7	749888	1723299	1148	CAM01-Block 2 – Southern Annamite
8	750515	1722523	1236	CAM02-Block 2 – Southern Annamite
9	752624	1722764	1220	CAM03-Block 2 – Southern Annamite
10	753233	1721151	1095	CAM04-Block 2 – Southern Annamite
11	751349	1722368	1248	CAM05-Block 2 – Southern Annamite
12	752030	1720813	1209	CAM06-Block 2 – Southern Annamite
13	731864	1712582	1510	CAM01-Block 3 – Phou Koungking, E
14	732425	1712541	1599	CAM02-Block 3 – Phou Koungking, E
15	733417	1712501	1494	CAM03-Block 3 – Phou Koungking, E
16	732923	1712124	1574	CAM04-Block 3 – Phou Koungking, E
17	733293	1711518	1467	CAM05-Block 3 – Phou Koungking, E
18	733458	1711473	1517	CAM06-Block 3 – Phou Koungking, E
19	734176	1711527	1322	CAM07-Block 3 – Phou Koungking, E
20	731020	1711408	1615	CAM01-Block 4 – Phou Koungking, W
21	730881	1710610	1624	CAM02-Block 4 – Phou Koungking, W
22	730566	1709941	1559	CAM03-Block 4 – Phou Koungking, W
23	729860	1709973	1467	CAM04-Block 4 – Phou Koungking, W
24	729097	1710186	1205	CAM05-Block 4 – Phou Koungking, W
25	729097	1711619	1311	CAM06-Block 4 – Phou Koungking, W

26	722984	1713163	1340	CAM01-Block 5 – Phou Yai, Dak kang
27	723477	1712271	1282	CAM02-Block 5 – Phou Yai, Dak kang
28	721100	1711389	1206	CAM03-Block 5 – Phou Yai, Dak kang
29	721848	1711560	1219	CAM04-Block 5 – Phou Yai, Dak kang
30	721472	1713389	1324	CAM05-Block 5 – Phou Yai, Dak kang

Remarks: 7 camera traps for SB3 due to some species of interest while only 4 camera traps for SB5.

Nonetheless, this was not a systematic or grid system designed for setting up the camera traps due to a small number of camera traps available and the purpose was to assist in identifying additional species. We set up these camera traps for 5 months (Jul-Dec) which supposed to have 4,500 trap days, but some camera traps did not work well. Therefore, 3,233 trap days from 29 cameras were successful and partly successful.

In principle, for 3,233 trap days is possible to capture some species with reasonable distribution. But, the species with very low population would not be captured from camera trapping in short period. It is suggested that the minimum trapping effort on camera traps for 20 ha requires 913 trap-nights (Si *et al.*, 2014) and for the case of our survey area, ca. 500 ha as most potential habitats – the core with intact forest habitats, along the Lao-Vietnam border and the Phou Koungking where the target terrestrial species would be present. If the effort for 2 years with 30 camera traps for these potential habitats can confirm presence or absence of the GT and or rare species in the area.



Figure 5a. Field activities of the assessment



Figure 5b. Field activities of the assessment_sub team to sub-camp



Figure 5c. Field activities of the assessment_camera trap collection



Figure 5d. Field activities of the assessment_field data collection

4.2.1.3 Survey Techniques for Herpetology

The survey for herpetology was conducted in a point count for daytime and for night spotting. The daytime survey usually started from morning at 8.00am to 11.30am and late afternoon from 2.00pm to 5.30pm and night survey from 7pm to 10pm. During day time the designed survey camps survey team searched in various micro-habitats for the amphibian and reptile species. There were various species of frogs and small reptiles including forest frogs, lizard and snakes, in particular. The team searched for the animals under cover on ground, water and trees carefully in each survey block. The main micro-habitats for this taxon that were searched along riverbanks, stream banks, river bushes, bushes around adjacent ponds and wetlands where possible. Where by riverine, any debris, wood or tree that has risen from the water surface were surveyed to detect water monitor, for example. Catching amphibians with barehand in gloves and the main tools used for capturing snake with snake tongs. Collecting some unfamiliar reptile species for detailed identification and photographing in camps with collecting specimen in tissue for DNA analysis.

4.2.1.4 Survey Techniques for Plants and other flora

The plant survey was conducted to obtain if any important and conservation significance plant species in the survey area by listing plant species with their densities and frequencies, threatened species and endemic species, by survey block. A total of 30 plant plots in 5 survey blocks were conducted (see Table 3). On average elevation of 1,312m a.s.l., which ranges from 1,029m a.s.l., of the Survey block 1 to 1,615m a.s.l., of the Survey block 3.

Table 3. Location of plant plots by survey block (Coordinates)

Survey Block	Plant Plot	UTM		Coordinates		Altitude
		X	Y	N	E	
SB1	1	752943	1719617	15°32'29.5"	107°21'29.7"	1,033
	2	752607	1718678	15°31'59.1"	107°21'18.1"	1,029
	3	752318	1717523	15°31'21.6"	107°21'08.0"	1,054
	4	751395	1717920	15°31'34.8"	107°20'37.2"	1,098
	5	751734	1717636	15°31'25.5"	107°20'48.5"	1,067
	6	752607	1719693	15°32'32.1"	107°21'18.5"	1,075
SB2	1	750740	1722688	15°34'10.1"	107°20'17.0"	1,242
	2	750569	1723483	15°34'36.0"	107°20'11.5"	1,224
	3	751025	1722672	15°34'09.5"	107°20'26.5"	1,248
	4	752726	1722359	15°33'58.7"	107°21'23.5"	1,184
	5	752836	1721953	15°33'45.5"	107°21'27.0"	1,166
	6	752943	1720599	15°33'01.4"	107°21'30.1"	1,048
SB3	1	734837	1712290	15°28'37.4"	107°11'19.9"	1,257
	2	735209	1712032	15°28'28.9"	107°11'32.2"	1,350
	3	735792	1712515	15°28'44.4"	107°11'52.0"	1,351
	4	731614	1712736	15°28'53.0"	107°09'31.9"	1,423
	5	731869	1712562	15°28'47.3"	107°09'40.4"	1,510

	6	732041	1712500	15°28'45.2"	107°09'46.2"	1,615
SB4	1	728886	1712825	15°28'56.8"	107°08'00.5"	1,273
	2	728974	1712562	15°28'48.2"	107°08'03.3"	1,241
	3	729218	1712797	15°28'55.8"	107°08'11.6"	1,309
	4	730017	1712249	15°28'37.7"	107°08'38.2"	1,386
	5	730445	1712019	15°28'30.1"	107°08'52.5"	1,386
	6	731205	1712548	15°28'47.0"	107°09'18.1"	1,407
SB5	1	723071	1710374	15°27'38.9"	107°04'44.6"	1,299
	2	723254	1710986	15°27'58.8"	107°04'51.0"	1,270
	3	722916	1711735	15°28'23.2"	107°04'39.9"	1,347
	4	722424	1712428	15°28'45.9"	107°04'23.6"	1,422
	5	722080	1713133	15°29'09.0"	107°04'12.3"	1,446
	6	722534	1713764	15°29'29.4"	107°04'27.7"	1,405

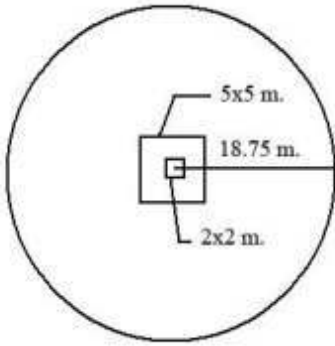
General descriptions of the habitat types by survey block as below:

Survey Block	General description of habitat types	Localities
SB1	Habitat types found in the Survey block 1 were Upper Evergreen Forest and degraded forest as some portions of fallows and agricultural land were found in the central section of the survey block area.	Ban Dak Dom and Ban Dak Ta-ok.
SB2	Habitat types found in the survey block 2 were mainly Upper Evergreen Forest and some degraded forest as some portions of fallows and agricultural land were found in the southwest section of the survey block.	Ban Dak Dom.
SB3	Habitat types found in the survey block 3 were mainly Upper Evergreen Forest (as Montane Evergreen Forest is identified for Phou Koungking) and some degraded forest as some portions of fallows and agricultural land were found in the southern section of the survey block.	Ban Dak Dreun
SB4	Habitat types found in the Survey block 4 were Upper Evergreen Forest (as Montane Evergreen Forest known Phou Koungking) and some degraded forest as some portions of fallows and agricultural land were found in the western section of the survey block.	Ban Prao
SB5	Habitat types found in the Survey block 5 were Upper Evergreen Forest and largely degraded forest – a high portion of fallows and agricultural land were found mainly in the southern section of the Survey block.	Ban Prao and Ban Dak Kang

For each survey block has 6 plant plots (0.1ha each) with a small plot (5x5m) for saplings, and a smallest plot (2mx2m) for herbs and grasses.

Design for Data Collection by Sampling

Plant species and family, number of seedlings, and undergrowth vegetation were recorded as moss, herbs, fern etc. Some important information such as tree species, tree family, its DBH, total height and also specific type of climbers, shrubs, ferns, mosses, herbs and bamboo species, including the number of clumps and its stems per clump. On that account, sampling plant plot consists of 3 types of temporary plots as.



- A circular sample plots with a radius of 17.85 meters (or 0.1 ha): data of trees which are diameter at breast height (DBH) \geq 10 centimeters were recorded. Other significant information was recorded and measured such as tree species, DBH, total height, timber quality and bamboo species, including number of clumps and stems per clump.
- Square plots of 5x5 meters (25 square meters or 0.0025 ha) were established in the middle of the circular plots. Information of small trees and/or saplings (trees whose DBH < 10 centimeters and whose height > 1.3 meters), tree species, number of trees, and height, as well as NTFP species were recorded from these plots.
- Square plots of 2x2 meters (4 square meters or 0.0004 ha) were established within the larger square plots of 5x5 meters. Data concerning plant species, number of seedlings, and undergrowth vegetation was recorded.

Descriptions of habitat and data of each survey block were collected using DAFOR⁵ form as following:

- Unique ID reference for the survey block
- Plot size used; location with latitude and longitude coordinates.
- Date and time of survey and Name of surveyors
- General description of the vegetation:
 - habitat types, dominant species of higher plants
 - maximum and mean height of vegetation
 - vegetation cover (%) and water cover (%)
 - area of bare ground (%)
 - for forest – approximate age and height of main canopy).
- A condition score of each survey block.
- Presence/absence of Red-listed species or other critical habitat triggers
- Presence/absence of alien invasive species.
- Additional remarks and comments (if necessary)
- Photographs to show the location of the plot and to illustrate the habitat type/key species present.

⁵ DAFOR: D - Dominant, A - Abundant, F - Frequent, O - Occasional, R - Rare.

In addition, during the dry season, additional information to support some important plant species⁶ such as flowers and fruits were collected. As well as obtained their distributions in the survey area beyond the plant plots.

Specimen Collection

Specimens of some important plant species that could not be identified in the field are essentially important which were used for further species identification and reference for publication. The specimens were wrapped using newspapers and kept properly, most tree leaves were kept in good shape. They are kept in suitable room condition in the Herbarium of the Faculty of Forestry, NUoL with numbering (see Fig. 6b).

4.2.2 Threat Collection

All key threats found were recorded and photographed as to understand the current level of threats for particular taxon, ecosystem and the survey area. Type of threats were recorded where any evidences of timber logging e.g stumps, logs, camps, hunting camps, hunters, gunshot, snares, people, cattle in forests etc.

4.2.3 Survey effort

Five survey blocks were defined and each SB of 16km² (4km x 4km), covering the whole part of the high priority area of biodiversity. For the terrestrial survey, a team of 13 personnels⁷ with other 4 assistants, made a total of 17 personnel which were divided into 3-4 sub-teams at a time for each SB, but varied from survey block to survey block. As on average of the survey effort in a total of 595 man-days for both wet and dry season or 119 man-days per survey block. In addition, the survey effort with assistance from camera trapping which was installed for 5 months (14/7-14/12) of 30 camera traps for 4,500 trap nights but effectiveness of 71% of 3,233 trap nights⁸. Therefore, the survey effort is considered cover well enough in the survey area (see Fig. 6a-1 & 6a-2).

4.3 DATA PREPARATION AND ANALYSIS

4.3.1 Data Preparation

All information gained from survey blocks and sampling plots were entered into data sheets for making ease for basic analysis and data entry for any analysis program. For plant, a total of 30 plant plots in 5 survey blocks as 6 plant plots were consolidated for each survey block and present by survey block. Nonetheless, only the tree species with a size of DBH \geq 10 cm were used for the analysis and made in number of the tree species listed in the DAFOR data form. Although some non-tree species were not used for the analysis, they were cumulatively listed for the total species account by plant plot (see Annex 1b).

⁶ *The important plant species are those defined globally threatened species as well as possible new species and first records of Laos.*

⁷ *This figure excludes the botanic team*

⁸ *This figure excludes the camera traps of disfunction and partly function.*

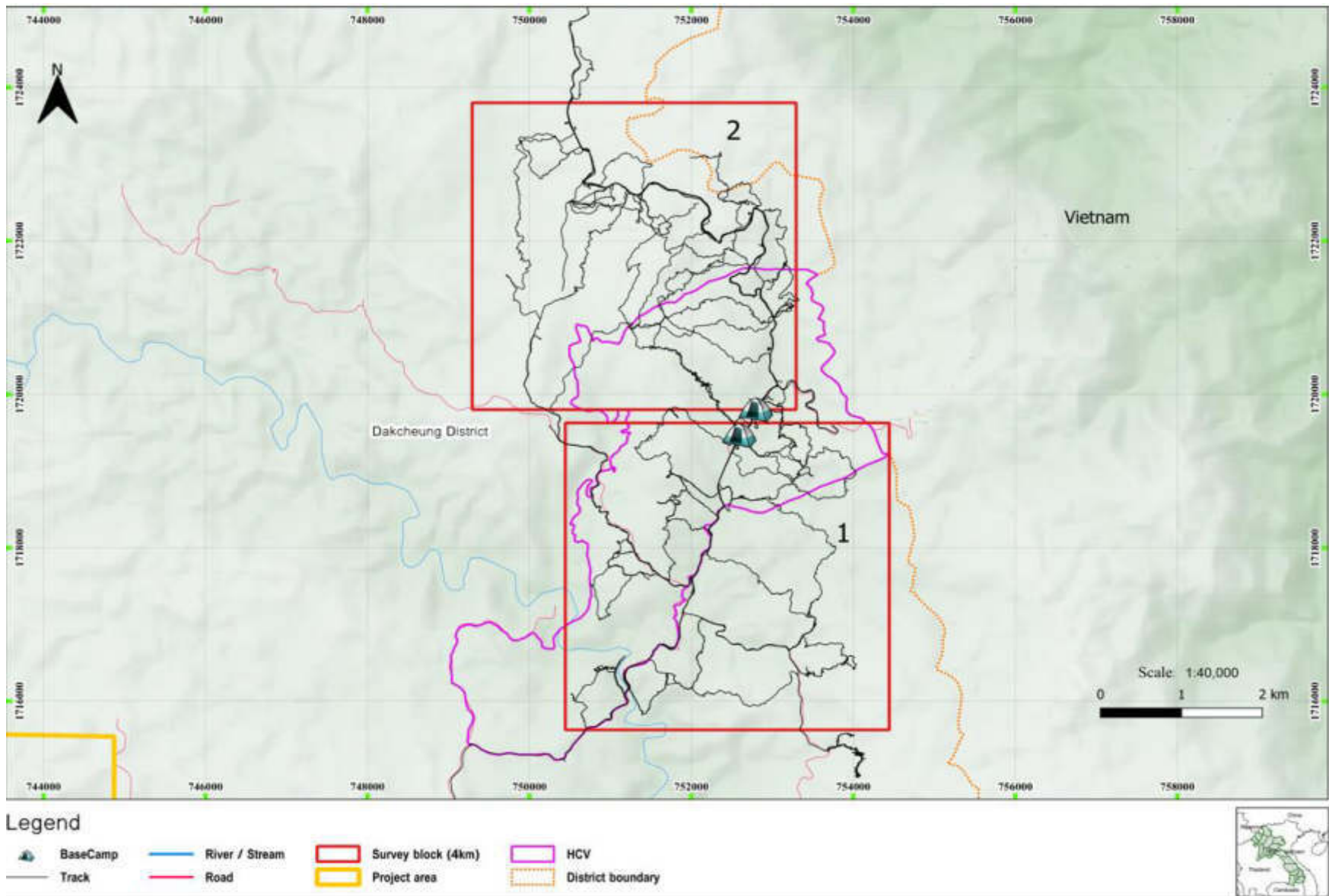


Figure 6a-1. Survey tracks of the survey area for Zone A – Eastern Zone

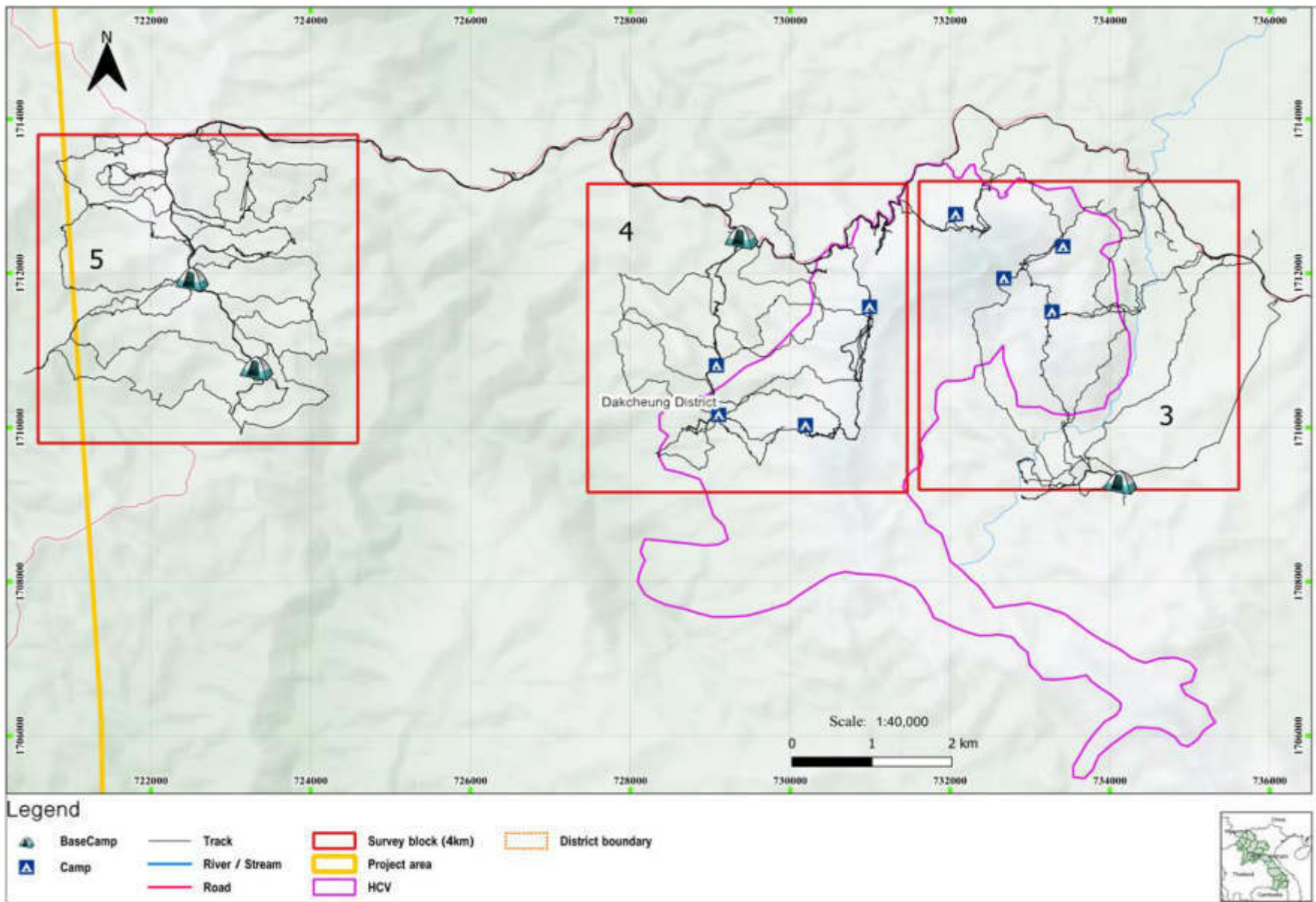


Figure 6a-2. Survey tracks of the survey area for Zone B - Northern Zone

4.3.1.1 Species Identification

Species Identification: in general, all species encountered in the field, any evidences, photos and specimens were identified, using field guides, double checked and discussed with relevant experts when identification of the species were unsure. For flora, the plants were identified using guidebooks. Some species which were not familiar their specimens were collected to compare with specimens available at the herbarium of the National University of Laos (NUoL), Faculty of Forestry. Specimens of plant species were collected, dried in oven, piled in stack and numbered them according to the recording system of the Faculty of Forestry's Herbarium, NUoL which can be revisited for double checking in case of needs for publishing (see Fig. 6b).

For some specimens of uncertainty were checked with international network of experts such as the expert teams of Royal Botanic Garden of Edinburgh, Scotland; Kagoshima University of Japan, Kyusu Open University, Singapore Botanic Garden, Da Lat University of Vietnam, Forest Herbarium of Thailand and Kasetsart University of Thailand (see Annex 10), using photos of the specimens – tree leaf structures for identification.

For first records of plants were checked with external experts and that still some ongoing as some species need some additional supports such as fruits and flowers which were collected and confirmed the same status. For the possible new species to science were checked with external experts of these institutes as some of them were principally confirmed. These possible new species will be officially adopted upon their publications and that will take for 2 years at least.

As well as the herpetofauna, specimens of some herpetofauna species were collected in samples and tissue for DNA analysis and stored at the Faculty of Natural Sciences, NUoL. These specimens - the possible new reptile species are in the process of shipping to North Carolina Museum of Natural Sciences, USA, under the cooperation between NUoL and the North Carolina Museum of Natural Sciences. For first and second records of reptiles were checked with external experts and that still ongoing and in preparation for publication.

It will take time for DNA analysis, as these possible new species will be officially adopted upon their publications and that will take for 2-3 years. Therefore, we prefer them for the time being in the state of possible new species or first records of Laos for the report.

4.3.1.2 Species Records and Listing

The species records were made with GPS coordinates, mainly for important fauna and flora as not only Globally Threatened (GT) species but also Near-Threatened and Endemic species such as first records of Laos, second records of Laos and possible new species (see Annex 3).

The species recorded, including some of them from reliable village reports were listed for the area and arranged by survey block and plant plot. Each species was checked if it is globally threatened, nationally important, first records of Laos/ endemic species or possible new species to science. The GT species were confirmed in the field can be listed in bold **X** (see Table 14b), if only reliable village report can be also listed but not in bold **X**.



Figure 6b. Specimens of plants with numbering at NUoL

The list of fauna species in this report includes some few species from reliable village reports⁹ but the list of GT species did not include those GT species from village reports, the GT species must be confirmed in the field. It is because the GT species are globally concerned if there are with some reasonable populations¹⁰ in the survey area some potential negative impact on the species and their habitats must be described and precautions as prevention and mitigation measures must be in place.

4.3.2 Analysis

The spreadsheet data were used for basic calculations to obtain a list of species presence by Survey block from direct field observations. This was used to obtain frequency of species detection. As the species encountered were rated with an estimate for their current status of low (+), medium (++) and high (+++), also gave if that was found in any evidence, seen or

⁹ *Reliable village report is the provisional data from local villagers with their confidences as it was reported from more than one village with more villagers reported the species presence and so it was given a rate of at least medium (M).*

¹⁰ *The species with a reasonable population for this context is meant that the species with some viable population as frequency of encounters during the survey was not low – at least 3-4 encounters from short field visits.*

detected during the surveys for Occasional (O), Frequent (F), Common (C); however, for the village report of confidence was rated of Low (L), Medium (M), High (H).

For the plant species identifications were conducted in association with botanic networks regionally and internationally. For the species status were analyzed using statistic techniques to obtain density, frequency and abundance. The equations below were used to develop a series of indices (Curtis and McIntosh, 1950):

$$\text{Density (D)} = \frac{\text{Total number of individual tree species}}{\text{Total number of sampling plots studied}} \quad (\text{no/ha})$$

$$\text{Relative Density (RD)} = \frac{\text{Total number of individual tree species}}{\text{Total number of individuals of all species}} \times 100$$

$$\text{Percentage Frequency (PF)} = \frac{\text{Total number of sampling plots which species occurred}}{\text{Total number of sampling plots studied}} \times 100$$

$$\text{Relative Frequency (RF)} = \frac{\text{Total number occurrence of tree species}}{\text{Total number occurrence of all species}} \times 100$$

$$\text{Abundance (AB)} = \frac{\text{Total number of individual tree species}}{\text{Total number of sampling plots of occurrence}}$$

For camera trapping, a free and open-source R package camtrapR was used for data analysis using a new toolbox for flexible and efficient management of data generated in camera trap-based wildlife studies. The result of the analysis was shown in abundance and frequency.

4.4 MATERIALS AND EQUIPMENT

Materials and equipment for the survey were binoculars (4 pairs), cameras (4 units) with good shooting lens capacity, GPS (4 units), Camera trap (30 units), battery Alkaline (3A), Field Guides (mammal, bird, reptile and plants), Data Forms (various forms for each sub-team), absolute alcohol for reptiles, torches, snake tongs, poles (15m) for tree leave collection, scoop nets, newspapers for plant specimen collection, plastic bags, gloves, tents, camps etc.

FINDINGS OF THE ASSESSMENT



Quasipaa cf. verrucospinosa

5 FINDINGS OF THE ASSESSMENT

5.1 HABITATS

The whole survey area was mainly Evergreen Forest with sub-forest type to Upper Evergreen Forest since its elevation above 1,000m a.s.l., and specially for the elevation of

above 1,500m was Montane Forest. The forest habitats of the survey blocks were mainly original forest but some portions of the area were degraded as considered secondary forest and fallows which were found in patterns, including some small coffee plantation in the SB1, and agricultural land – shifting cultivation.

5.1.1 Habitats of Survey block 1 (Southern Annamite)

Habitat types found in the Survey block 1 were Upper Evergreen Forest (UEF) and degraded forest as some portions of fallows and agricultural land were found partly in the central section of the survey block, along the road. The paved road from Dak Cheung town to Lao-Vietnam Checkpoint (Dak Ta-ok¹¹) runs through the north portion of this survey block. The original forest was found on east, northeast and northwest of the Survey block. The most relevant villages in the SB1 were Ban Dak Dom, Dak Ta-ok and 1 military camp. Photos of the forests and forest habitats were taken from the SB1 (see Fig. 7), with examples of forest structures and forest characteristics shown in location numbers from 1.1 to 1.6 accordingly (see Fig. 8a; Annex 5).

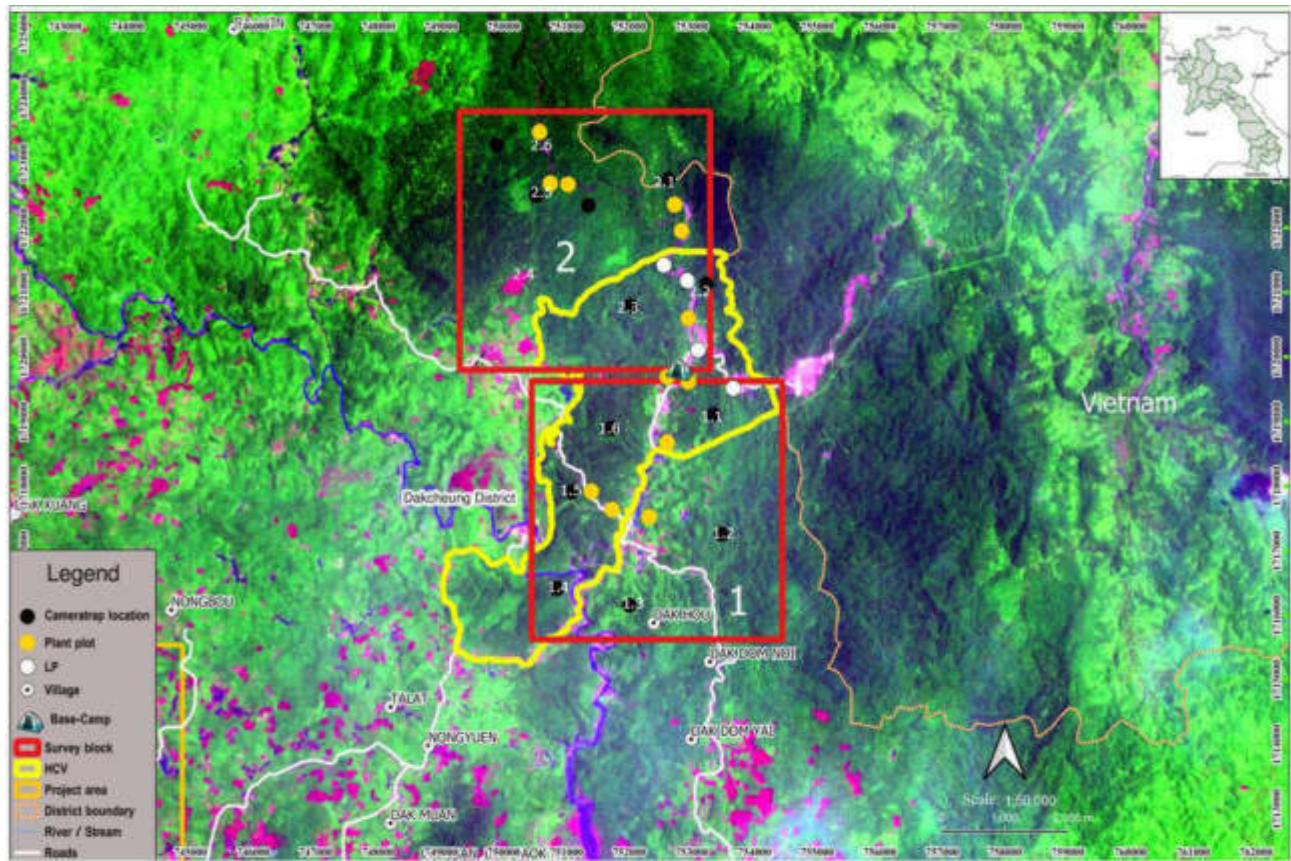


Figure 7. Survey block 1 and 2 with numbers of forest habitat conditions

¹¹ This border checkpoint (Dak Ta-ok) is a local checkpoint but it is under the process for upgrading to an international checkpoint.



Figure 8a. Survey block 1 with examples of forest structures

5.1.2 Habitats of Survey block 2 (Southern Annamite)

Habitat types found in the survey block 2 were mainly Upper Evergreen Forest with some portions of secondary forest and degraded forest as fallows and agricultural land were found in the southwest section of the Survey block (see Fig. 7), with examples of forest structures shown in location numbers from 2.1 to 2.6 accordingly (see Fig. 8b).



Figure 8b. Survey block 2 with examples of forest structures

5.1.3 Habitats of Survey block 3 (Phou Koungking - East)

Habitat types found in the survey block 3 were mainly UEF, partly Montane Evergreen Forest in the upper part of the mountain known Phou Koungking and some degraded forest as some portions of fallows and agricultural land were found in the southern section of the Survey block (see Fig. 9 and 10), with examples of forest structures shown in location numbers from 3.1 to 3.6 accordingly (see Fig. 10a).

5.1.4 Habitats of Survey block 4 (Phou Koungking - West)

Habitat types found in the survey block 4 were mainly UEF, partly Montane Evergreen Forest in the upper part of the mountain known Phou Koungking as well as some degraded forest as some portions of fallows and agricultural land were found in the western section of the Survey block (see Fig. 9), with examples of forest structures shown in location numbers from 4.1 to 4.6 accordingly (see Fig. 10b).

5.1.5 Habitats of Survey block 5 (Phou Yai)

Habitat types found in the survey block 5 were mainly UEF with some small portion of Pine forest and largely degraded forest – high portion of fallows and agricultural land were found mainly in the southern section of the Survey block (see Fig. 9 and 10), with examples of forest structures shown in location numbers from 5.1 to 5.6 accordingly (see Fig. 10c).

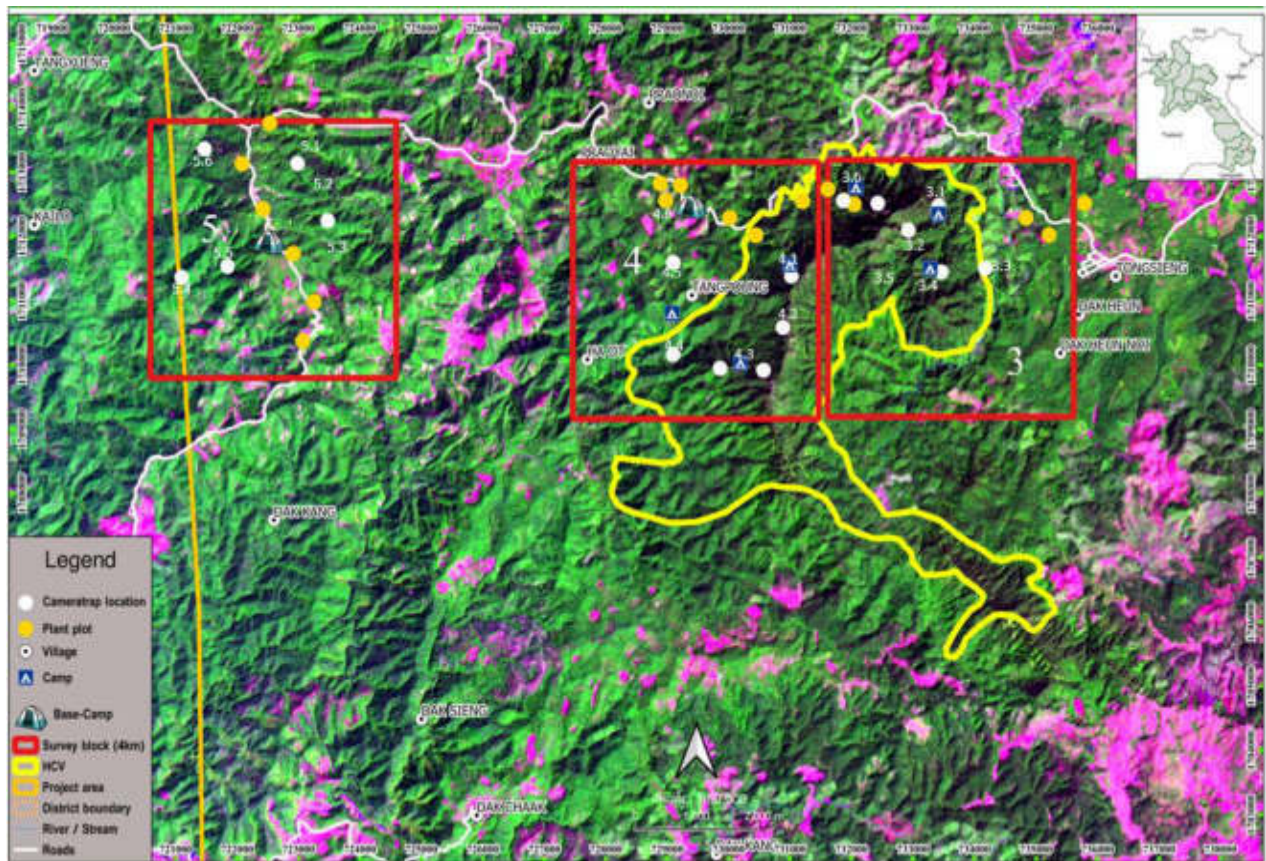


Figure 9. Survey block 3, 4 and 5 with numbers of forest habitat conditions

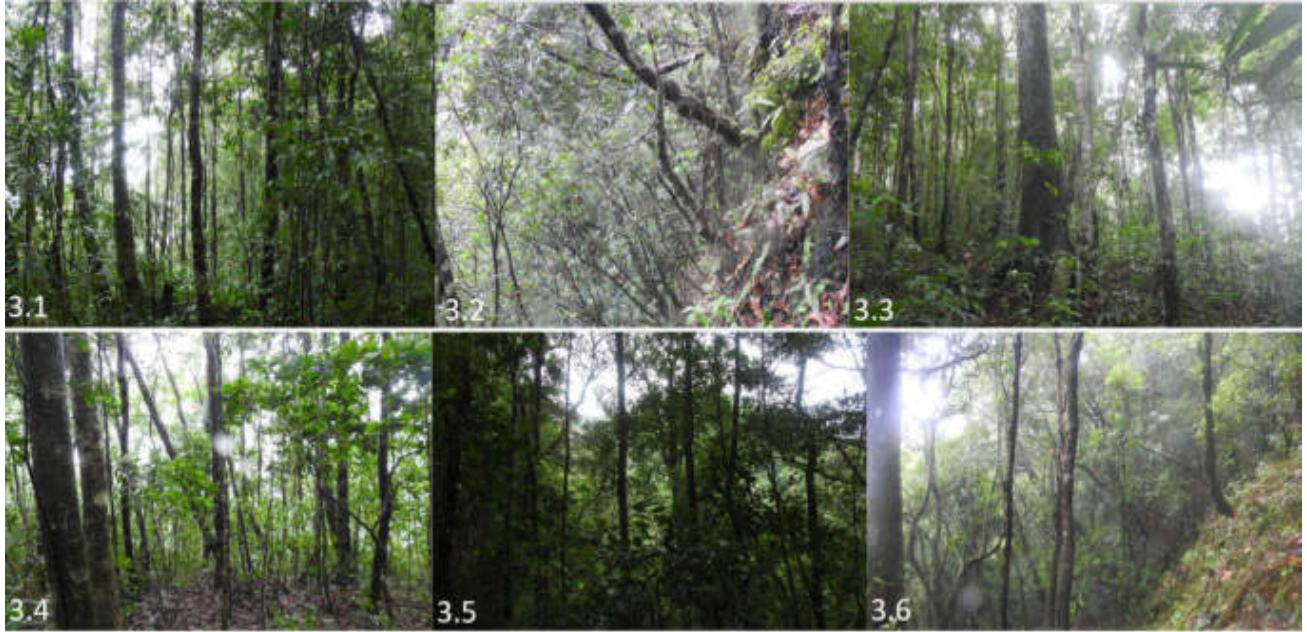


Figure 10a. Survey block 3 with examples of forest structures



Figure 10b. Survey block 4 with examples of forest structures

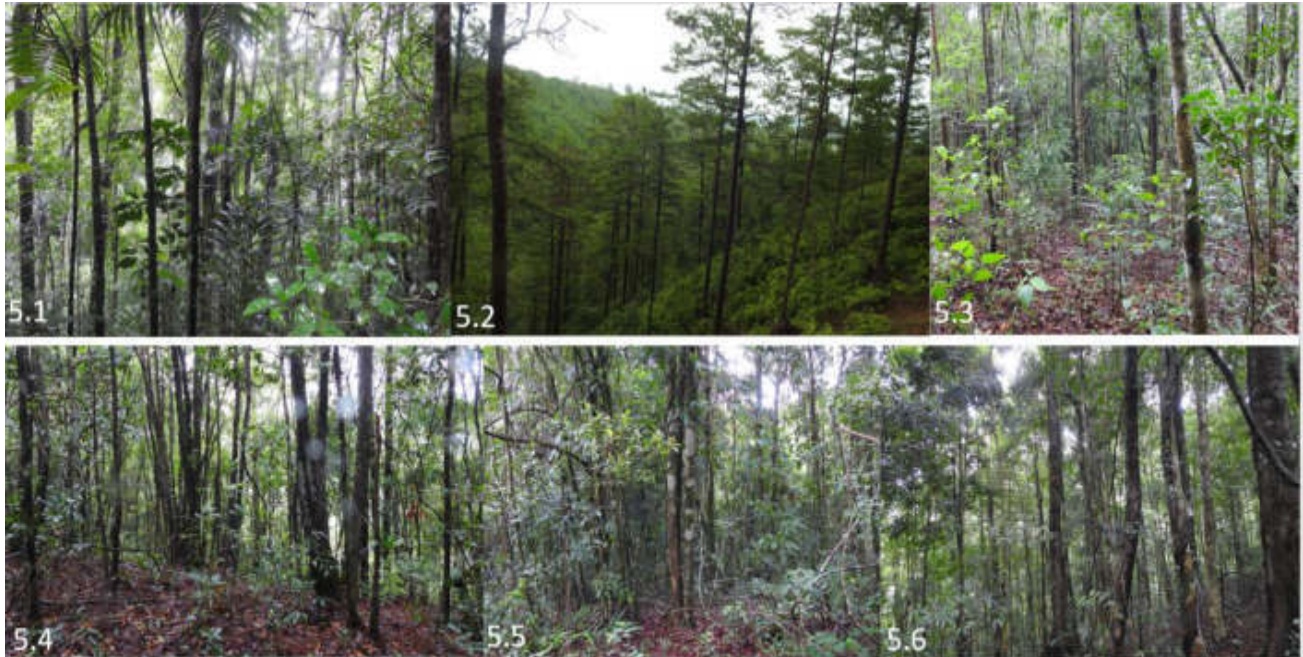


Figure 10c. Survey block 5 with examples of forest structures

5.2 OVERVALL FINDINGS OF FLORA AND FAUNA SPECIES

Wildlife and flora species were recorded in the survey area, made a total of 653 species (115 fauna, and 538 flora species), of which, 44 mammals, 29 reptiles and 42 amphibians. However, only tree species count made a total of 365 species (115 fauna, and 250 tree species), of which, 44 mammals, 29 reptiles and 42 amphibians (see Table 4). Therefore, 250 tree species were recorded for plant analysis, the rest were non-tree species count and some were partly outside the plant plots within the Survey blocks and they were not used for the plant analysis. This figure for the fauna species included some species from reliable village reports such as Python and Cobra that the local villagers used to collect them.

The number of species encounters in the survey area which were divided by different taxa on different categories for species in a total, field confirmed, globally threatened species and the species were photographed (see Annex 2).

A total of 23 Globally Threatened species were confirmed in the field as 14 mammal, 6 reptiles, 1 amphibian and 2 plant species. Other GT species were listed from the village interviews with insufficient provisional information and not confirmed for the GT list such as Elongate Tortoise, Keeled Box Turtle, Asiatic soft-shell turtle, Dhole, Binturong and Pygmy Loris.

Plant: A total of 626 records, representing 538 species from 178 families (including non-tree species), of which 250 tree species and 58 families were recorded. The numbers of species count also included some species were found outside the plant plots to generate a full list of plants in the perspective survey area. Non-tree species were just counted but not used for the analysis.

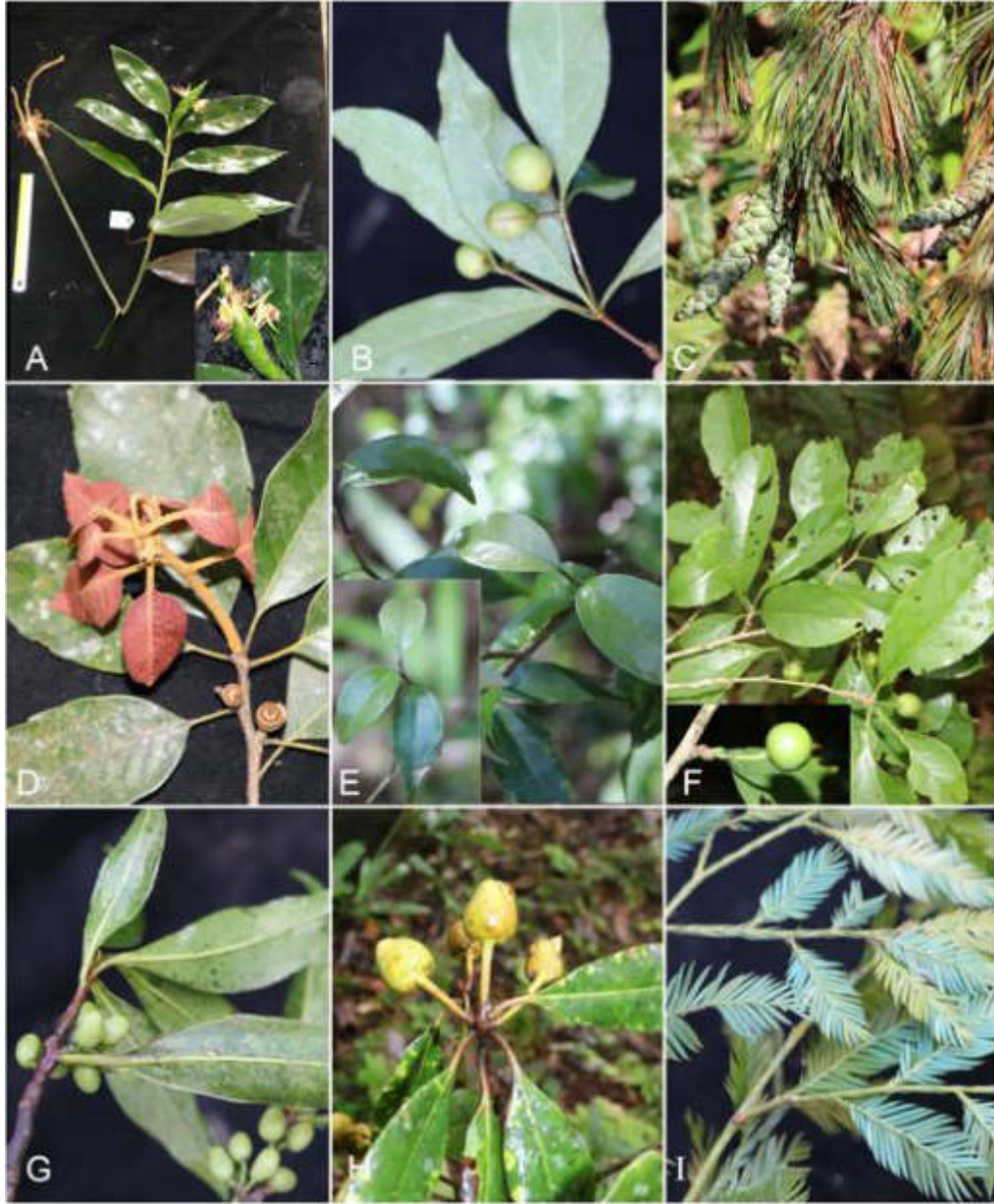
Table 4. Summary of wildlife and tree species by taxon category and survey block

Taxon	Survey Blok 1					Survey Blok 2					Survey Blok 3					Survey Blok 4					Survey Blok 5					Summary				
	Total	Field Confirm.	GT species	Common	Photo	Total	Field Confirm.	GT species	Common	Photo	Total	Field Confirm.	GT species	Common	Photo	Total	Field Confirm.	GT species	Common	Photo	Total	Field Confirm.	GT species	Common	Photo	Total	Field Confirm.	GT species	Common	Photo
Plant (tree)	72	72	0	72	72	68	68	0	68	68	32	32	1	32	32	28	28	1	27	28	50	50	1	49	50	250	250	2	248	250
Bird																														
Mammal	37	26	6	19	16	43	32	8	23	14	40	26	9	17	16	42	28	8	21	16	42	33	6	25	27	59	44	14	33	26
Reptile	10	8	3	5	8	14	11	5	6	7	21	15	3	12	12	17	16	4	12	13	11	11	4	7	8	32	29	6	23	26
Amphibian	13	13	0	13	13	12	12	0	12	12	17	17	0	16	16	16	14	1	13	13	12	12	0	12	13	41	42	1	41	42
Fish																														
Total	132	119	9	109	109	137	123	13	109	101	110	90	13	77	76	103	86	14	73	70	115	106	11	93	98	382	365	23	345	344

Remarks: GT reptile species from the reliable village reports were not included on the GT confirmed list here.

The result showed that the Rubiaceae, Lauraceae and Fagaceae, Annonaceae and Fabaceae were the dominant families with 83 species. 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. A total of only 2 Globally Threatened species were identified in the survey blocks (see Fig. 11a). Excitingly, 10 possible new species to science were recorded, and 29 first records of Laos were found in the survey blocks, mainly in Survey block 2 (see Table 5c, Fig. 11b and 11c).

Mammal: a total of 59 mammal species were reported for their presence but only 44 species (14 GT) were confirmed their presence in the Survey blocks. The fauna species that were directly confirmed in the field with evidences from the field assessment, both direct observation, evidences of tracks, dropping and feeding sites which were photographed (see Fig. 12a, Annex 6 and 7) and many of them from camera trapping (see Fig. 12b and 12c, and Annex 7). A majority of the GT mammal species were of a low population, except Pangolins in the survey block 2 and Chinese Serow in the survey block 3 and 4. As 13 globally threatened mammal species were directly confirmed in the field: 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), Northern Pig-tailed Macaque (*Macaca leonina*, VU), Sambar (*Rusa unicolor*, 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).



A. EN, and First Record: *Zingiber mellis*; **B.** VU: *Pittosporum pauciflorum*; **C.** NT: *Pinus dalatensis*; **D-E.** Data Deficient (DD): **D.** *Quercus thorelii* and **E.** *Stewartia laotica*; **F-I.** Least Concern species (LC): **F.** *Ilex chapaensis*; **G.** *Symplocos wikstroemiiifolia*; **H.** *Anneslea fragrans*; and **I.** *Dacrycarpus imbricatus*.

Figure 11a. Some globally and near-threatened plant species



Figure 11b. Some first records of plant species of Laos from Dak Cheung



Figure 11c. Some possible new plant species of Laos from Dak Cheung



Figure 12a. Some photos and evidences of important mammal species

Yet, some other GT species were reported but insufficient support information from the field survey to confirm their presence such as Annamite Striped Rabbit (*Negolagus timminsi*, EN), Indochinese Silvered Leaf Monkey (*Trachypethicus germaini*, EN), Binturong (*Arctictis binturong*, VU) and Pygmy Slow Loris (*Nycticebus pygmaeus*, EN). Overall, populations of the mammal species in the survey area are low except some reasonable populations of Pangolins in the SB2 and Chinese Serow in SB3 & SB4. More wildlife species were recorded from camera trapping (see Annex 7), with some photographs including some important bird species (see Fig. 12b and 12c).

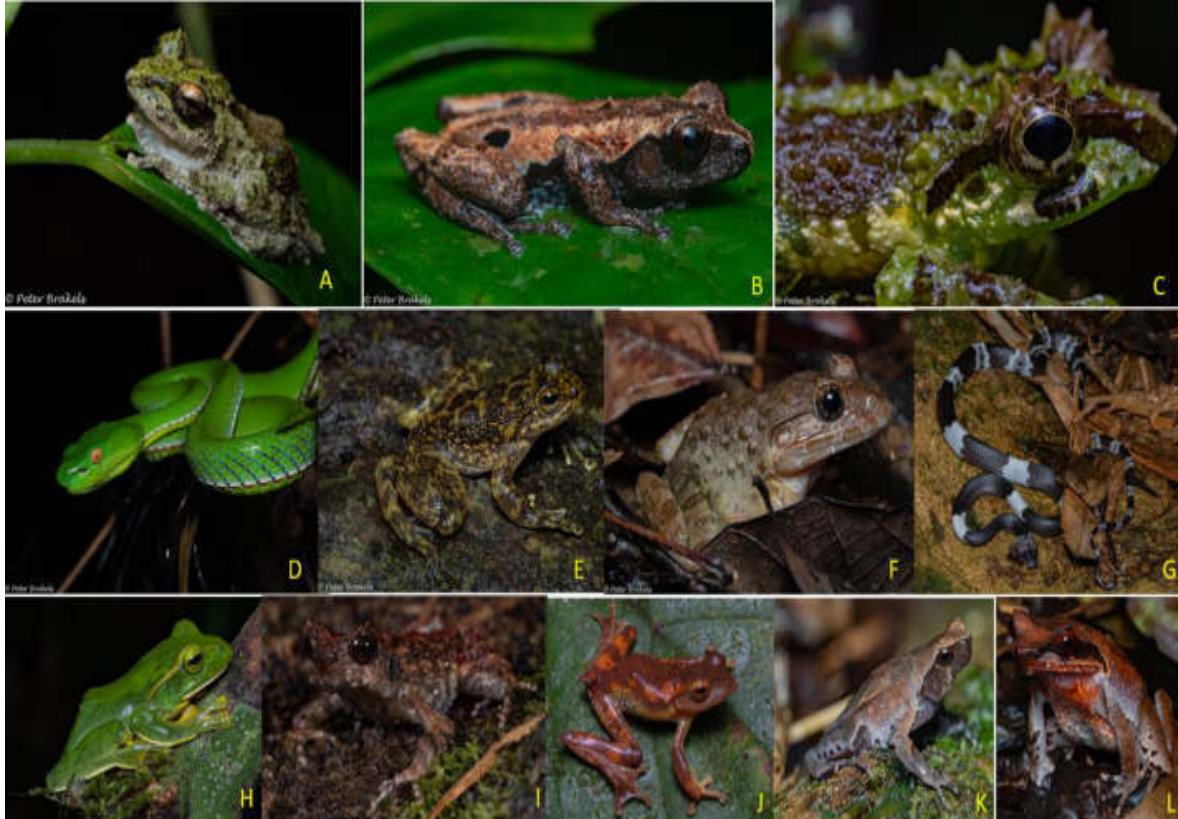
Herpetology: a total of 71 herpetofauna species, of which 42 amphibian and 29 reptile species were confirmed from the field surveys. There were 2 GT species of herpetofauna confirmed from the field as Red River Krait (*Bungarus slowinskii*, VU) in SB2 and Serrate Frilled Treefrog (*Kurixalus cf gryllus*, VU) in SB4. Interestingly, 4 reptile species were first record of Laos, 2 reptile species were second record of Laos and 3 species have not been described yet, they are possible new species to science (see Fig. 13a and 13b).



Figure 12b. Some photos of mammal species from camera trapping



Figure 12c. Owston's Civet (EN) and dropping of Smooth-coated Otter



A. Serrated Frilled Treefrog *Kurixalus cf. gryllus* (VU) – first record in Laos; B. Truong Son Bug-eyed Frog *Theleiderma truongsongense* – first record in Laos; C. Horned Bush frog *Gracixalus supercornutu*; D. Green snake *Trimeresurus vogeli*; E. Spiny torrent frog *Amolops spinapectoralis* – first record in Laos; F. *Limnonectes cf. poilani* – first record in Laos; G. Mountain wolf snake *Lycodon ruhstrati*; H. Green tree frog *Zhangixalus feae*; I. Han's Horned Frog *Ophryophryne hansii*; J. Inger's treefrog *Rhacophorus robertingeri*; K. *Ophryophryne cf. poilani*; L. *Xenophrys cf. maosonensis*

Figure 13a. Some first records of herpetofauna species from Dak Cheung



Carapace of Impressed Tortoise and Chinese Soft-shell Turtle (VU)

Figure 13b. Some photos of turtles from the villages

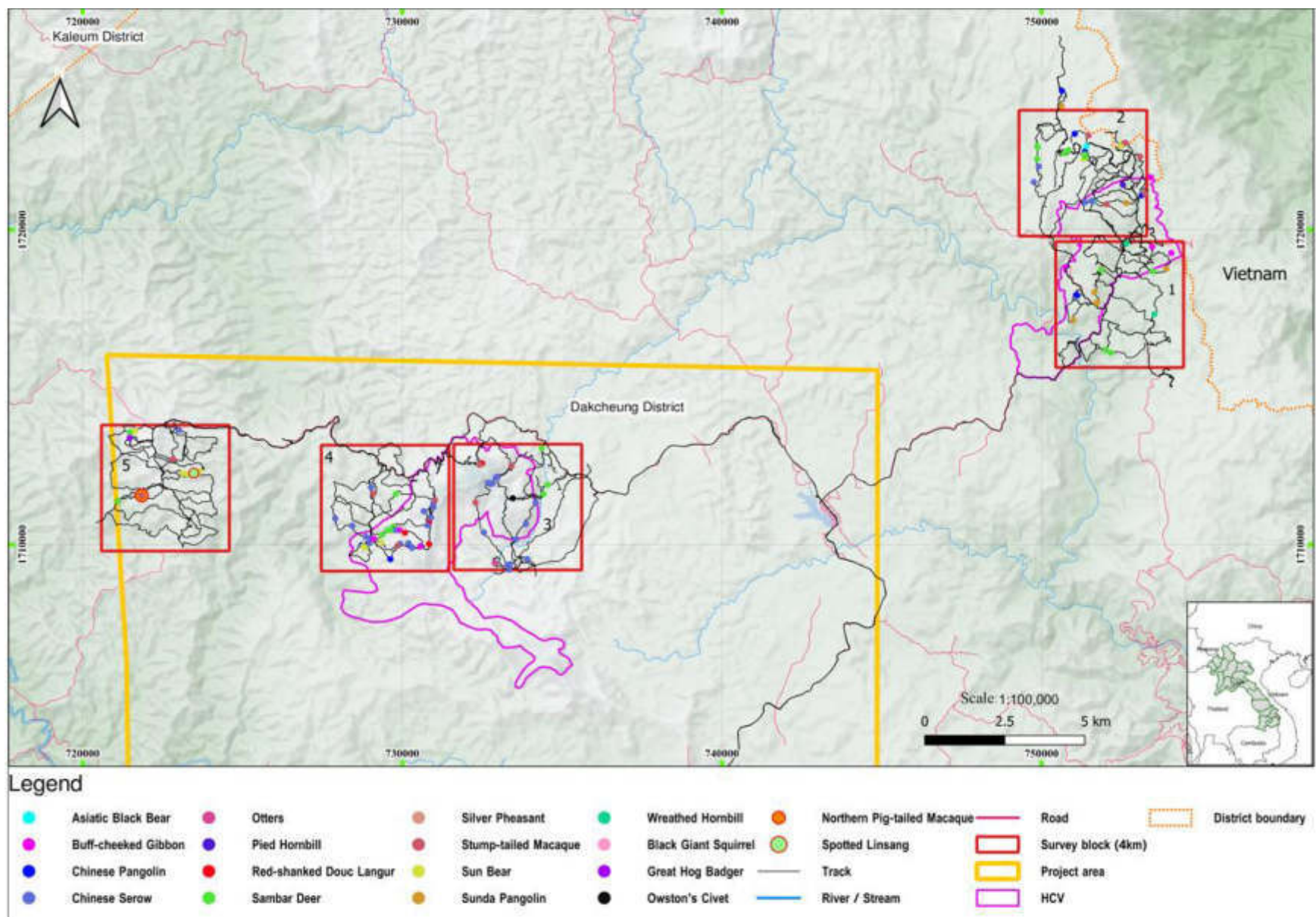


Figure 14. Locations of key wildlife species in the survey blocks

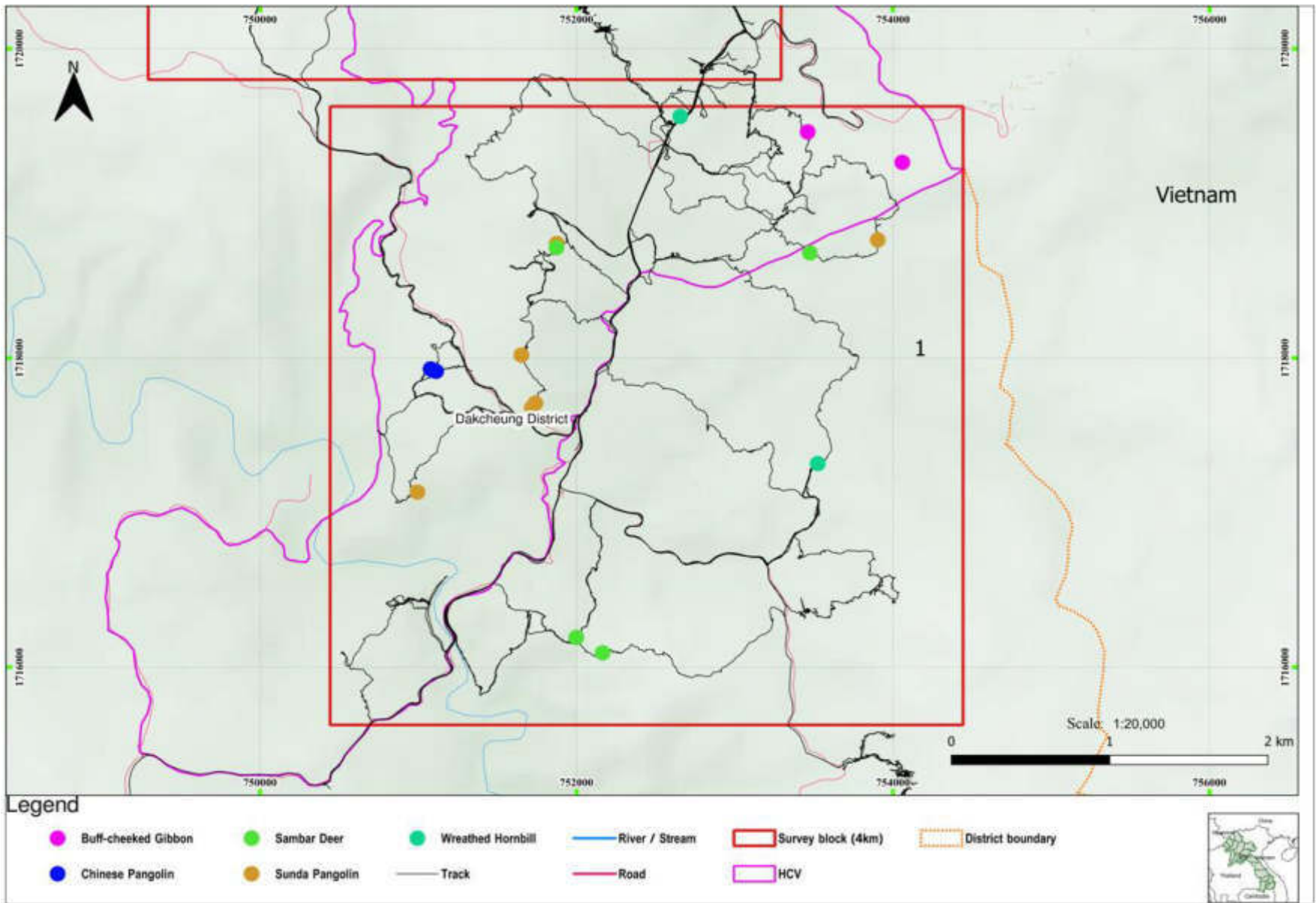


Figure 14a. Locations of key wildlife species in the survey block 1

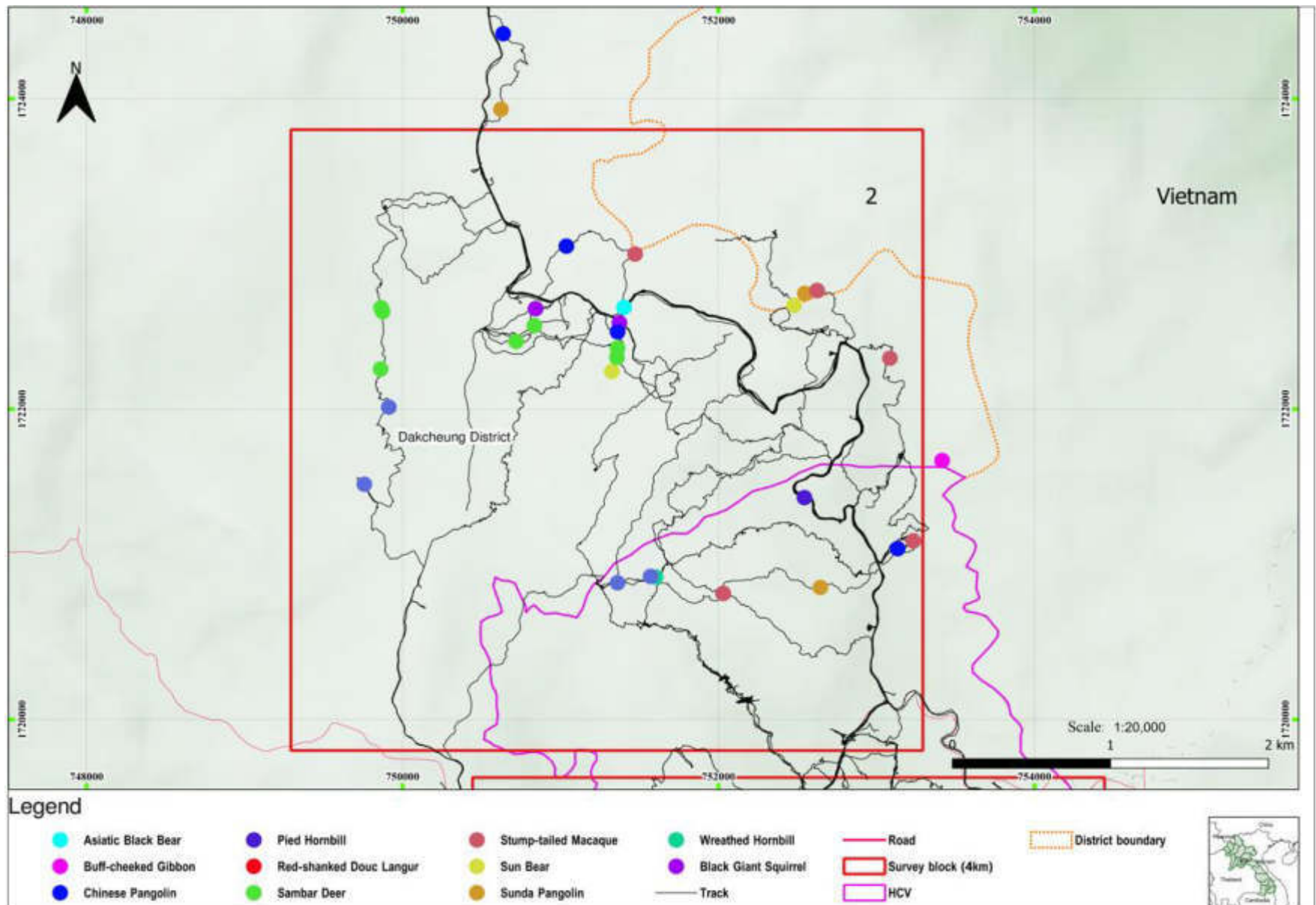


Figure 14b. Locations of key wildlife species in the survey block 2

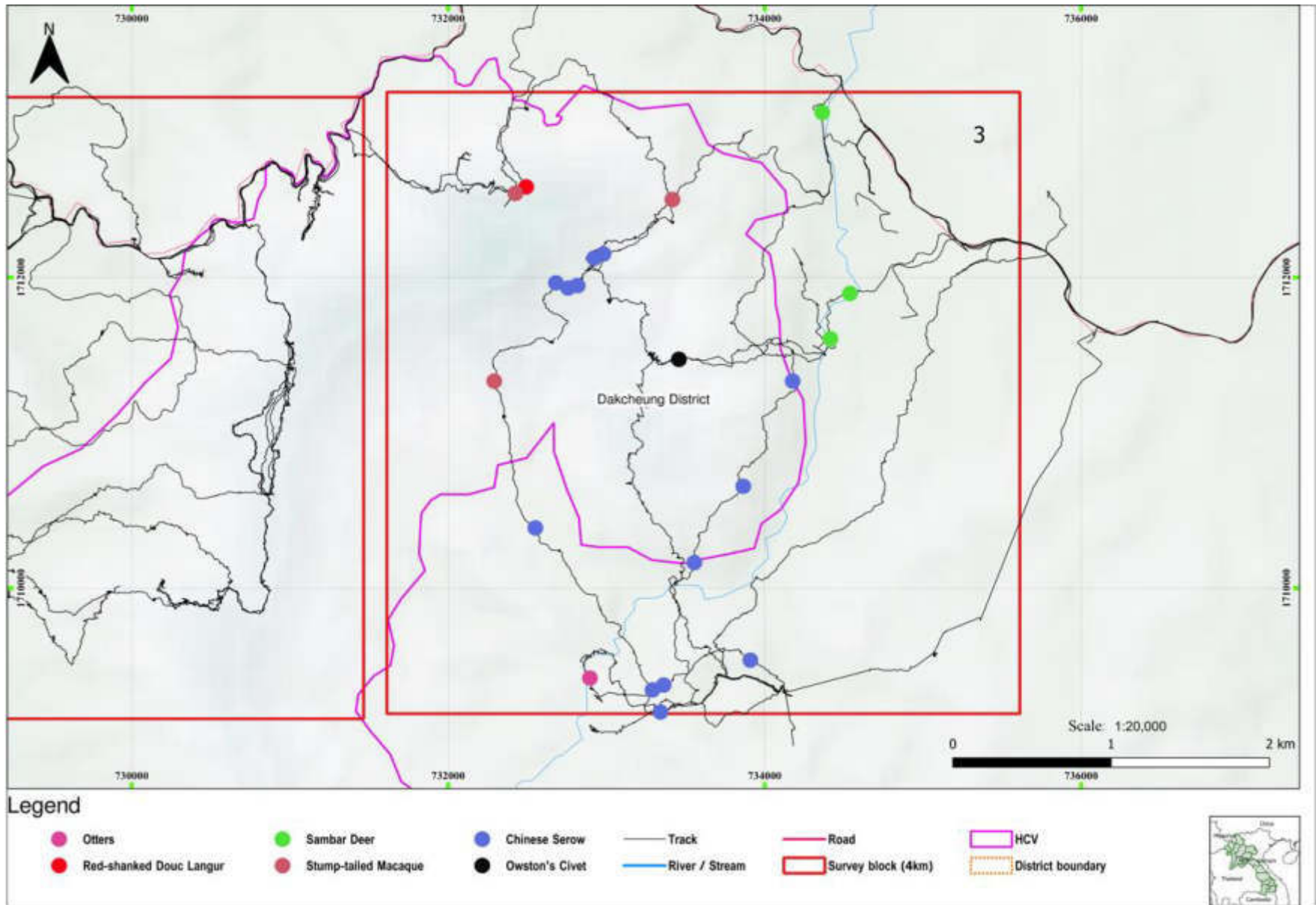
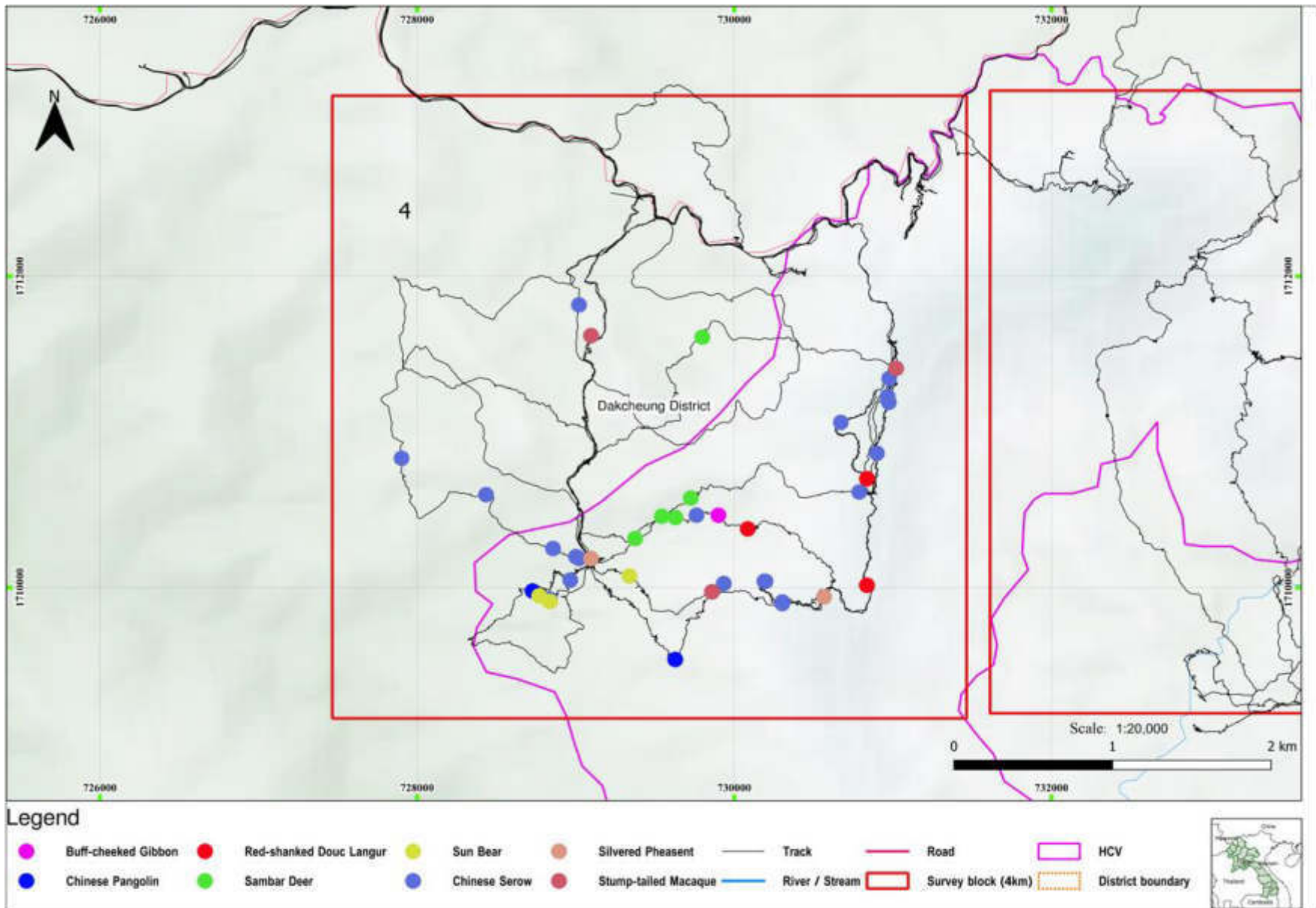


Figure 14c. Locations of key wildlife species in the survey block 3



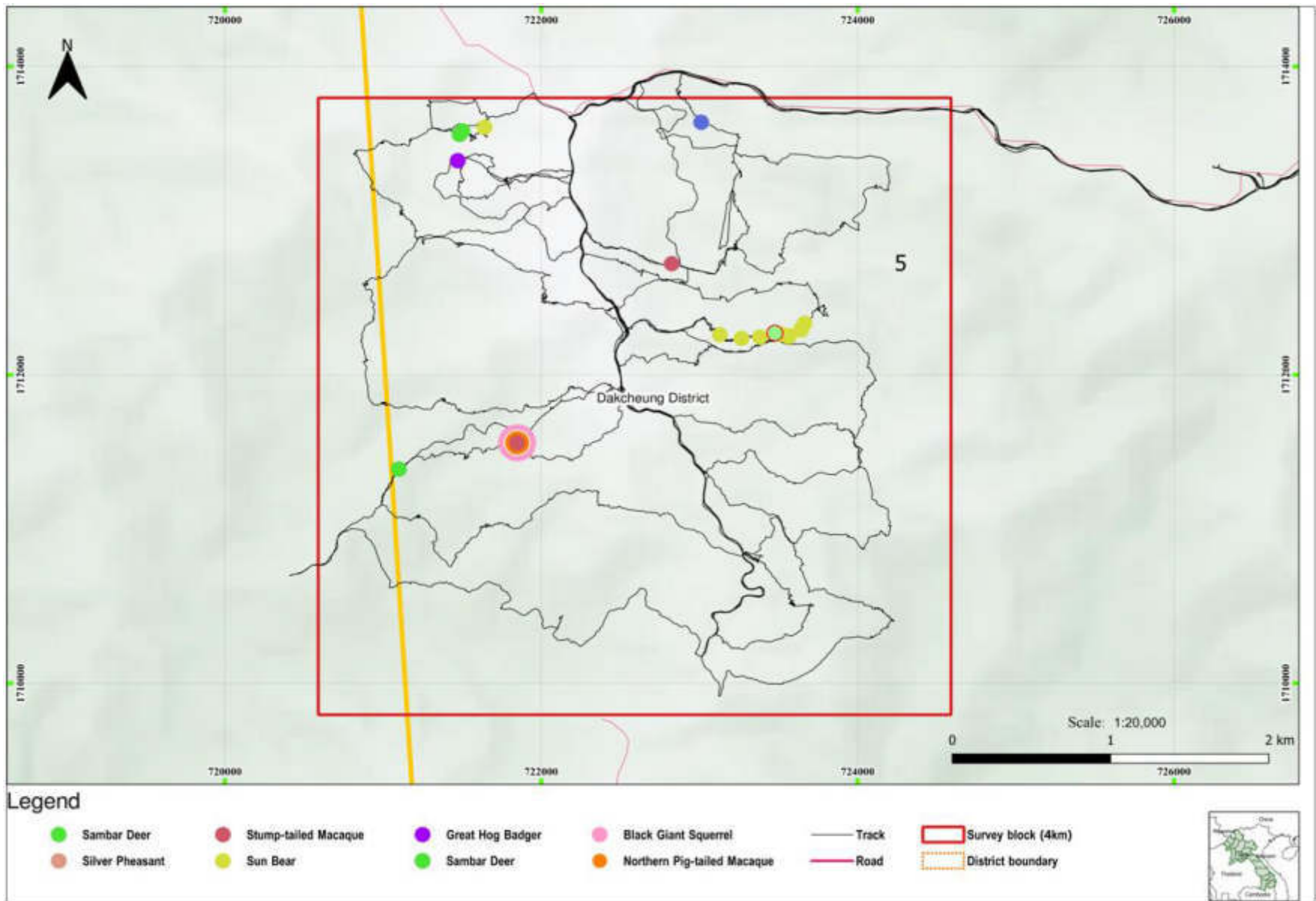
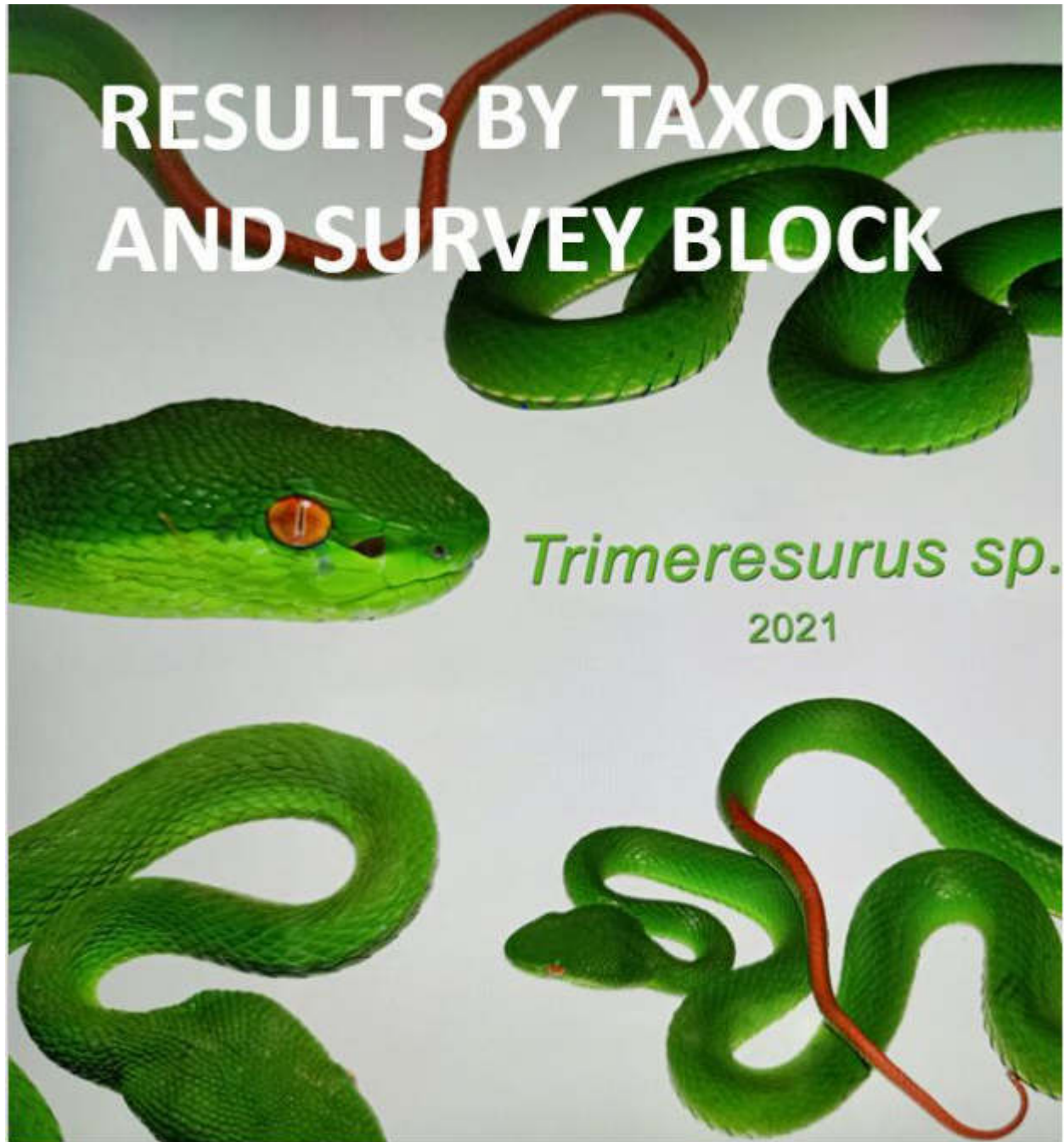
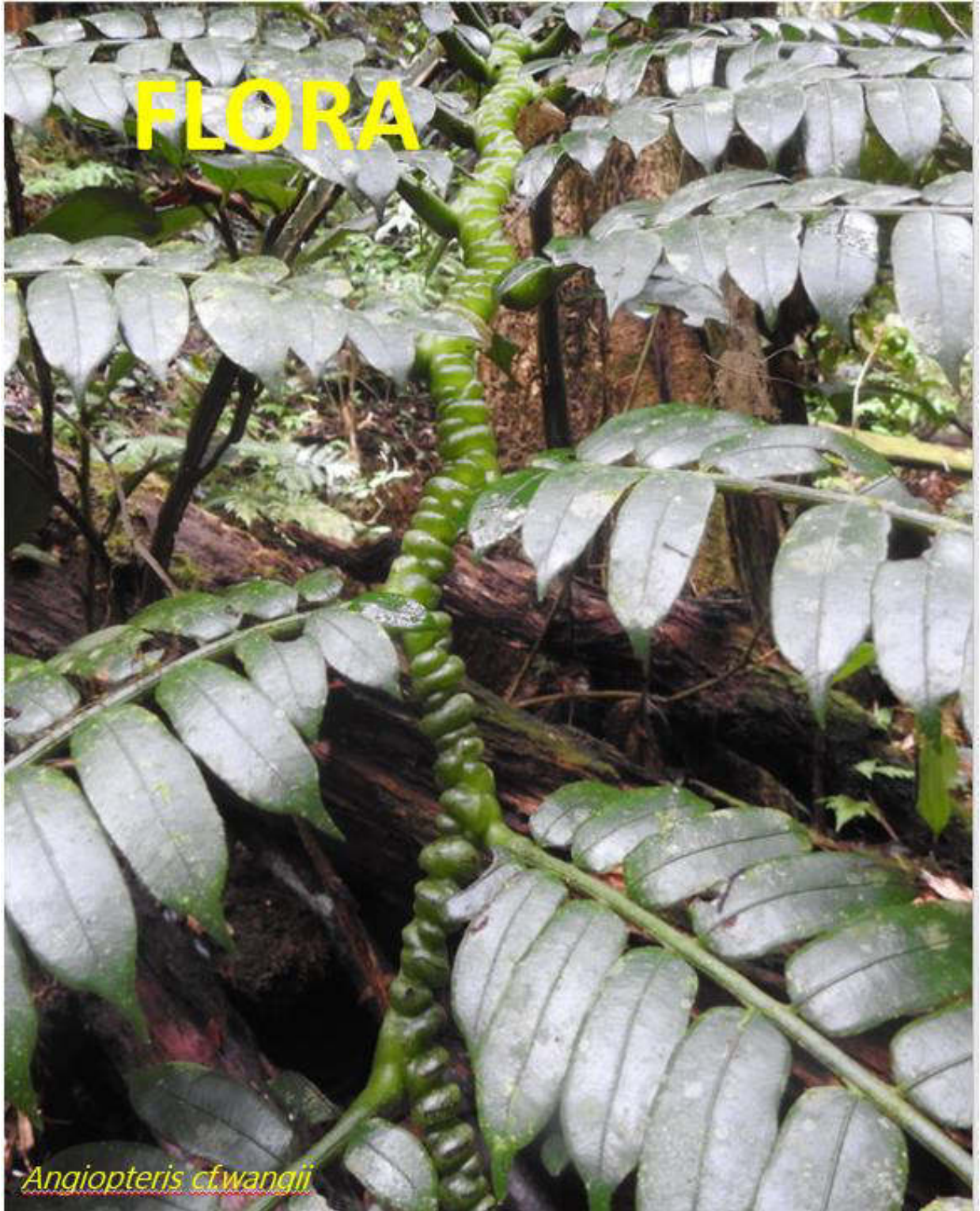


Figure 14e. Locations of key wildlife species in the survey block 5



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 Forest¹² 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

¹²Montane 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 Kounking).

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	ແກ້ມອ້ນ (Kaem-on)	<i>Adinandra integerrima</i>		F				X	
2	ຂີ້ໝິ່ນຕີ້ (Khem in ton)	<i>Alseodaphne bidoupensis</i>		F		X			
3	ພັບດົງ (Phab dong)	<i>Apodytes dimidiata</i>		F			X		

4	ໝັງ (Miang)	Camellia sp. 1		S					X
5	ດິກດົງ (Dik dong)	Daphniphyllum beddomei		F			X		
6	ແຊງແຊວ (Saeng seo)	Elaeocarpus dubius		F	X	X			
7	ມູນດົງ (Moun dong)	Elaeocarpus limitaneus		F		X			
8	ປິກ (Pik)	Gymnanthes remota		F				X	
9	ຕ້າງ (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	ກໍຊ້າງ (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	ລະມຸດຊາງ (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	ສຸມດອກນ້ອຍ (Soum dok-noi)	Pittosporum pauciflorum	G					X	X
20	ເໝືອດດົງ (Maud dong)	Polyosma dolichocarpa		F		X			
21	ດູກໄກ່ (Douk kai)	Psychotria cambodiana		F				X	
22	ກໍລັງບຽງ (Kor langbian)	Quercus langbianensis	N	F				X	
23	ກໍ (Kor)	Quercus sp.1		S	X				
24	ເໝືອດກອນຕຸມ (Maud kontum)	Sarcosperma kontumense		F		X			
25	ຄອມປໍ (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	ກູດກິບມ້າ (Khouk kipma)	Angiopteris wangii		F		X			
33	ຕິນຈຳ (Tin cham)	Ardisia gracilentata		F			X	X	X
34	ປະດັບຫີ (Padab hin)	Argostemma bariense		F		X			
35	ມັດ (Mud)	Bredia sp.		S		X			
36	ມຸຍ (Moiu)	Brachytome wallichii		F				X	
37	ເຂັມດົງ (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 purpose¹³. 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	<i>Acronychia pedunculata</i>	ເປົ້າແຂບທອງ (Pao khaeb thong)	Rutaceae	
2	<i>Aglaia tomentosa</i>	ຍິງກະສັງ (Gnong kasang)	Meliaceae	
3	<i>Alniphyllum</i>	ຍານດົງ (Gnan dong)	Styracaceae	
4	<i>Anacolosia clarkei</i>	ແຄະ (Khae)	Olacaceae	
5	<i>Anacolosia griffithii</i> Mast.	ແຊະ (Sae)	Olacaceae	
6	<i>Aporosa yunnanensis</i>	ເໝືອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
7	<i>Artocarpus</i>	ມ້ປ່າ (Mee pa)	Moraceae	
8	<i>Calophyllum pisiferum</i>	ກະທົງ (Ka thueng)	Calophyllaceae	
9	<i>Carallia brachiata</i>	ບັງນັງ (Bong nang)	Rhizophoraceae	
10	<i>Castanopsis acuminatissima</i>	ໄມ້ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
11	<i>Cinnamomum curvifolium</i>	ຈວງ (Juang)	Lauraceae	
12	<i>Clerodendrum cyrtophyllum</i>	ພວງພີ້ (Phoung phee)	Lamiaceae	
13	<i>Cleyera cf. bokorensis</i>	ໄກ້ (Kaii)	Pentaphylacaceae	
14	<i>Cratoxylum sumatranum</i>	ຕີ້ ທິວ (Ti To)	Hypericaceae	
15	<i>Dacrydium elatum</i>	ຮິ່ງຫອມ (Hinh hom)	Podocarpaceae	
16	<i>Diospyros filipendula</i>	ຄັ ນຈັ ສິງ (Kai jong)	Ebenaceae	
17	<i>Diplospora sp.1</i>	ສັງນ (Sean)	Rubiaceae	
18	<i>Diplospora sp.2</i>	ສັງນ (Sean)	Rubiaceae	
19	<i>Elaeocarpus dubius</i>	ແຊງແຊວ (Saeng seo)	Elaeocarpaceae	
20	<i>Elaeocarpus griffithii</i>	ມຸນ (Moun)	Elaeocarpaceae	
21	<i>Endospermum diadenum</i>	ຕະພີ ຫໍ່ຟອງ (Té phong)	Euphorbiaceae	
22	<i>Engelhardtia serrata</i>	ຟ້າວຂຽວໜາມ (Phao khiew)	Juglandraceae	
23	<i>Engelhardtia cf. roxburghiana</i>	ຟ້າວຂຽວ (Phao khiew)	Juglandraceae	
24	<i>Engelhardtia sp.1</i>	ຟ້າວ (Phao)	Juglandraceae	
25	<i>Exbucklandia tonkinensis</i>	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* (ໄມ້ກໍ່ເດືອຍ, Mai Kor deau) with its density of 13.33 tree/ha following by *Symplocos atrilivacea* (ເໝືອດຄອມ, 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	<i>Castanopsis acuminatissima</i>	ໄມ້ກໍ່ເດືອຍ (Mai Kor deau)	Fagaceae		8	13.33	4.94
2	<i>Symplocos atriolivacea</i>	ເໝືອດຄອມ (Maud khom)	Symplocaceae		7	11.67	4.32
3	<i>Syzygium lineatum</i>	ຫວ້າຈ່ອຍ (Wha joi)	Myrtaceae		7	11.67	4.32
4	<i>Machilus sp.1</i>	ຕອງຫອມ (Tong Hom)	Lauraceae		6	10.00	3.70
5	<i>Schima crenata</i> Korth.	ຄາຍໂສ້ (Khai Soh)	Theaceae		6	10.00	3.70
6	<i>Syzygium antisepticum</i>	ສະເມັກແດງ (Samek deang)	Myrtaceae		6	10.00	3.70
7	<i>Lithocarpus corneus</i>	ໄມ້ກໍ່ຫຼັບ (Mai Kor Rab)	Fagaceae		5	8.33	3.09
8	<i>Litsea umbellata</i>	ບົງຮ້າງ (Bong hang)	Lauraceae		5	8.33	3.09
9	<i>Nephelium hypoleucum</i>	ຄໍ່ແລນ (Kho lane)	Sapindaceae		5	8.33	3.09
10	<i>Aglaia tomentosa</i>	ຍິງກະສັງ (Gnong kasang)	Meliaceae		4	6.67	2.47
11	<i>Aporosa yunnanensis</i>	ເໝືອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae		4	6.67	2.47
12	<i>Cinnamomum curvifolium</i>	ຈວງ (Chuang)	Lauraceae		4	6.67	2.47
13	<i>Cleyera bokorensis</i> cf.	ໄກ້ (Kaii)	Pentaphylacaceae		4	6.67	2.47
14	<i>Quercus sp.1</i>	ກໍ່ (Kor)	Fagaceae		4	6.67	2.47
15	<i>Sterculia parviflora</i>	ປໍ່ໃບໃຫ້ຍ (Por baiyai)	Malvaceae		4	6.67	2.47

Frequency: The highest frequency of species were *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau); *Symplocos atriolivacea* (ເໝືອດຄອມ, Maud khom); *Lithocarpus corneus* (ກໍ່ຫຼັບ, Kor Rab); *Aglaia tomentosa* (ຍິງກະສັງ, Gnong kasang); *Cinnamomum curvifolium* (ຈວງ, Chuang), *Madhuca pierrei* (ລະມຸດຊາງ, Lamout sang), and *Magnolia braianensis* (ຈໍ່ ປີປໍ່hampi Pa) with their frequency of 50% each following by *Machilus sp.1* (ຕອງຫອມ, Tong Hom), *Schima crenata* (ຄາຍໂສ້, Khai Soh), *Syzygium antisepticum* (ສະເມັກແດງ, Samek deang) and *Litsea umbellata* (ບົງຮ້າງ, 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	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		3	50.00	2.91
2	<i>Symplocos atriolivacea</i>	ຄອມ (Maud khom)	Symplocaceae		3	50.00	2.91
3	<i>Lithocarpus corneus</i>	ກໍ່ຫຼັບ (Kor Rab)	Fagaceae		3	50.00	2.91

4	<i>Aglaia tomentosa</i>	ຍິງກະສັງ (Gnong kasang)	Meliaceae		3	50.00	2.91
5	<i>Cinnamomum curvifolium</i>	ຈວງ (Chuang)	Lauraceae		3	50.00	2.91
6	<i>Madhuca pierrei</i>	ລະມຸດຊາງ (Lamout sang)	Sapotaceae		3	50.00	2.91
7	<i>Magnolia braianensis</i>	ຈຳປີປ່າ (Champi Pa)	Magnoliaceae		3	50.00	2.91
8	<i>Machilus sp.1</i>	ຕອງຫອມ (Tong Hom)	Lauraceae		2	33.33	1.94
9	<i>Schima crenata</i>	ຄາຍໂສ້ (Khai Soh)	Theaceae		2	33.33	1.94
10	<i>Syzygium antisepticum</i>	ສະເມັກແດງ (Samek deang)	Myrtaceae		2	33.33	1.94
11	<i>Litsea umbellata</i>	ບິງຮ້າງ (Bong hang)	Lauraceae		2	33.33	1.94
12	<i>Nephelium hypoleucum</i>	ຄໍແລນ (Kho lane)	Sapindaceae		2	33.33	1.94
13	<i>Cleyera cf. bokorensis</i>	ໄກ້ (Kaii)	Pentaphylacaceae		2	33.33	1.94
14	<i>Quercus sp.1</i>	ກໍ່ (Kor)	Fagaceae		2	33.33	1.94
15	<i>Sterculia parviflora</i>	ປໍໃບໃຫ້ຍ (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. bidoupsensis* (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 considered 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	<i>Acer laurinum</i>	ກ່ວມ (Kuam)	Sapindaceae	
2	<i>Alangium</i> sp.1	ສະລິກດົງ (Salik dong)	Cornaceae	
3	<i>Alseodaphne bidoupensis</i>	ຂີ້ໝິ້ນຕີ້ (Khemtin ton)	Lauraceae	
4	<i>Anneslea fragrans</i>	ແກ້ມອື້ນ (Kaem oun)	Pentaphylacaceae	
5	<i>Aporosa yunnanensis</i>	ເໝືອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
6	<i>Calophyllum dryobalanoides</i>	ພະອົງ (Pha-ong)	Calophyllaceae	
7	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
8	<i>Castanopsis piriformis</i>	ກໍ່ຂີ້ໝູ (Kor khemou)	Fagaceae	
9	<i>Chionanthes ramiflorus</i>	ເຂົ້າສານຫຼວງ (Khaosan luang)	Oleaceae	
10	<i>Cinnamomum javanicum</i>	ແຄຫອມ (Khae hom)	Lauraceae	
11	<i>Dacrycarpus imbricatus</i>	ຮິ່ງຂຽວ (Hinh khiew)	Podocarpaceae	
12	<i>Dacrydium elatum</i>	ຮິ່ງຫອມ (Hing hom)	Podocarpaceae	
13	<i>Diospyros filipendula</i>	ຄັນຈ້ອງ (Khan jong)	Ebenaceae	
14	<i>Elaeocarpus dubius</i>	ແຊງແຊວ (Saeng seo)	Elaeocarpaceae	
15	<i>Elaeocarpus griffithii</i>	ມູນ (Moun)	Elaeocarpaceae	
16	<i>Elaeocarpus limitaneus</i>	ມູນດົງ (Moun dong)	Elaeocarpaceae	
17	<i>Endospermum diadenum</i>	ຕະພົງ (Ta phong)	Euphorbiaceae	
18	<i>Engelhardtia serrata</i>	ຟ່າວຂຽວໜາມ (Phao khiew)	Juglandraceae	
19	<i>Eurya</i>	ຫາງດີ (Hang dee)	Pentaphylacaceae	
20	<i>Exbucklandia</i>	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
21	<i>Fagraea ceilanica</i>	ຕັງນີ້ (Tang nok)	Gentianaceae	
22	<i>Garcinia hanburyi</i>	ສົ້ມປໍ່ (Som pong)	Clusiaceae	
23	<i>Garcinia pedunculata</i>	ສົ້ມໂມງ (Som mong)	Clusiaceae	
24	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae	
25	<i>Heptapleurum cambodianum</i>	ຕ້າງ (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* (ຕ້າງ, Tang) and *Symplocos anomala* (ເໝືອດນ້ອຍ, Maud noi), Maud) with their densities of 15.00 tree/ha each, following by *Dacrydium elatum* (ຮຶງຫອມ, Hing hom) with its density of 13.33 tree/ha; and *Litsea baviensis* (ບຶງຫອມ, Bong hom), *Polyosma* sp.1 (ເໝືອດໂລດ, Maud lod), *Xanthophyllum ellipticum* (ແສງດົງ, 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	<i>Heptapleurum cambodianum</i>	ຕ້າງ (Tang)	Araliaceae		9	15.00	5.03
2	<i>Symplocos anomala</i>	ເໝືອດນ້ອຍ (Maud noi)	Symplocaceae		9	15.00	5.03
3	<i>Dacrydium elatum</i>	ຮຶງຫອມ (Hing hom)	Podocarpaceae		8	13.33	4.47
4	<i>Litsea baviensis</i>	ບຶງຫອມ (Bong hom)	Lauraceae		7	11.67	3.91
5	<i>Polyosma</i> sp.1	ເໝືອດໂລດ (Maud lod)	Escalloniaceae		7	11.67	3.91
6	<i>Xanthophyllum ellipticum</i>	ແສງດົງ (Seng dong)	Polygalaceae		7	11.67	3.91
7	<i>Castanopsis piriformis</i>	ກໍ່ຂີ້ໝູ່ (Kor khemou)	Fagaceae		6	10.00	3.35
8	<i>Lithocarpus corneus</i>	ກໍ່ຫຼັບ (Kor Rab)	Fagaceae		6	10.00	3.35
9	<i>Machilus angustifolia</i>	ຕອງຫອມໃບແຄບ (Tong Hom bai khaeb)	Lauraceae		6	10.00	3.35
10	<i>Neolitsea tomentosa</i>	ໄຟເດືອນຫ້າຂົນ (Fai deuanha khon)	Lauraceae		6	10.00	3.35
11	<i>Garcinia pedunculata</i>	ສົມໂມງ (Som mong)	Clusiaceae		5	8.33	2.79
12	<i>Ilex excavata</i>	ໄຂ່ມັດ (Khai mod)	Aquifoliaceae		5	8.33	2.79
13	<i>Alseodaphne bidouensis</i>	ຂີ້ໝື່ນຕີ້ (Khemti ton)	Lauraceae		4	6.67	2.23
14	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		4	6.67	2.23
15	<i>Illicium roseum</i>	ຈັນບານ (Chan ban)	Schisandraceae		4	6.67	2.23

Frequency: The highest frequency of species were *Symplocos anomala* (ເໝືອດນ້ອຍ, Maud noi), *Xanthophyllum ellipticum* (ແສງດົງ, Seng dong), and *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau) with their frequencies of 66.67% each, following by *Heptapleurum cambodianum* (ຕ້າງ, Tang), *Dacrydium elatum* (ຮຶງຫອມ, Hing hom), and *Litsea baviensis* (ບຶງຫອມ, 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	<i>Symplocos anomala</i>	ເໝືອດນ້ອຍ (Maud noi)	Symplocaceae		4	66.67	3.74
2	<i>Xanthophyllum ellipticum</i>	ແສງດົງ (Seng dong)	Polygalaceae		4	66.67	3.74
3	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		4	66.67	3.74
4	<i>Heptapleurum cambodianum</i>	ຕ້າງ (Tang)	Araliaceae		3	50.00	2.80
5	<i>Dacrydium elatum</i>	ຮຶງຫອມ (Hing hom)	Podocarpaceae		3	50.00	2.80
6	<i>Litsea baviensis</i>	ບຶງຫອມ (Bong hom)	Lauraceae		3	50.00	2.80

7	<i>Neolitsea tomentosa</i>	ໄຟເດືອນຫ້າຂົນ (Fai deuanha khon)	Lauraceae		3	50.00	2.80
8	<i>Ilex excavata</i>	ໄຂ່ມິດ (Khai mod)	Aquifoliaceae		3	50.00	2.80
9	<i>Lithocarpus pierrei</i>	ກໍ່ກັກ (Kor Kak)	Fagaceae		3	50.00	2.80
10	<i>Aporosa yunnanensis</i>	ເໝືອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae		3	50.00	2.80
11	<i>Elaeocarpus dubius</i>	ແຊງແຊວ (Saeng seo)	Elaeocarpaceae		3	50.00	2.80
12	<i>Polyosma sp.1</i>	ເໝືອດໂລດ (Maud lod)	Escalloniaceae		2	33.33	1.87
13	<i>Castanopsis piriformis</i>	ກໍ່ຂໍ້ໝູ (Kor khemou)	Fagaceae		2	33.33	1.87
14	<i>Machilus angustifolia</i>	ຕອງຫອມໃບແຄບ (Tong Hom bai khaeb)	Lauraceae		2	33.33	1.87
15	<i>Alseodaphne bidoupensis</i>	ຂໍ້ໝິ່ນຕີ້ (Khemou 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, understory 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 dimidiata*, *Daphniphyllum beddomei*, *Heptapleurum cambodianum*, *Lithocarpus elephantum*, *Lithocarpus pierrei*. In addition, 4 species of lower plants: *Ardisia gracilentia*, *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	<i>Acer laurinum</i>	ກ່ວມ (Kuam)	Sapindaceae	
2	<i>Anneslea fragrans</i>	ແກ້ມອື່ນ (Kaem oun)	Pentaphylacaceae	
3	<i>Apodytes dimidiata</i>	ພັບດົງ (Phab dong)	Icacinaceae	
4	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
5	<i>Castanopsis clarkei</i>	ກໍ່ໜາມ (Kor nam)	Fagaceae	
6	<i>Chionanthes sp.1</i>	ເຂົ້າສານຫຼວງ (Khaosan luang)	Oleaceae	
7	<i>Dacrycarpus imbricatus</i>	ຮຶງຂຽວ (Hinh khiew)	Podocarpaceae	
8	<i>Daphniphyllum beddomei</i>	ດິກດົງ (Dik dong)	Daphniphyllaceae	
9	<i>Engelhardtia serrata</i>	ພ່າວຂຽວໜາມ (Phao khiew)	Juglandaceae	
10	<i>Exbucklandia tonkinensis</i>	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
11	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae	
12	<i>Heptapleurum cambodianum</i>	ຕ້າງ (Tang)	Araliaceae	
13	<i>Ilex sp.1</i>	ໄຂ່ມົດ (Khai mod)	Aquifoliaceae	
14	<i>Illicium roseum</i>	ຈັນບານ (Chan ban)	Schisandraceae	
15	<i>Liquidambar excelsa</i>	ສົບດາວ (Sob dao)	Altingiaceae	
16	<i>Lithocarpus elephantum</i>	ກໍ່ຊ້າງ (Kor xang)	Fagaceae	
17	<i>Lithocarpus pierrei</i>	ກໍ່ກັກ (Kor Kak)	Fagaceae	
18	<i>Litsea martabanica</i>	ໝີ່ບົງຫອມ (Mee bonghom)	Lauraceae	
19	<i>Madhuca pierrei</i>	ລະມຸດຊາງປ່າ (Lamout sang pa)	Sapotaceae	
20	<i>Neolitsea zeylanica</i>	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae	
21	<i>Pinus kesiya</i>	ແປກສາມໃບ (Peak sambai)	Pinaceae	
22	<i>Rhododendron simsii</i>	ກູຫຼາບປ່າ (Koulab pa)	Ericaceae	
23	<i>Rhodomyrtus tomentosa</i>	ໂພງແກ້ມ (Phong kaem)	Myrtaceae	
24	<i>Schima crenata</i>	ຄາຍໂສ້ (Khai Soh)	Theaceae	
25	<i>Semecarpus reticulata</i>	ນ້ຳກຶງດຳ (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* (ໝີ່ບົງຫອມ, 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	<i>Schima crenata</i>	ຄາຍໂສ້ (Khai Soh)	Theaceae		15	25.00	9.37
2	<i>Lithocarpus elephantum</i>	ກໍ່ຊ້າງ (Kor xang)	Fagaceae		14	23.33	8.75
3	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		10	16.67	6.25
4	<i>Litsea martabanica</i>	ໝີ່ບົງຫອມ (Mee bonghom)	Lauraceae		10	16.67	6.25
5	<i>Symplocos lucida</i>	ເໝືອດພູ (Maud phou)	Symplocaceae		9	15.00	5.62
6	<i>Neolitsea zeylanica</i>	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae		8	13.33	5.00
7	<i>Liquidambar excelsa</i>	ສິບດາວ (Sob dao)	Altingiaceae		7	11.67	4.37
8	<i>Daphniphyllum beddomei</i>	ດິກດົງ (Dik dong)	Daphniphyllaceae		7	11.67	4.37
9	<i>Syzygium attenuatum</i>	ຫວ້າສະເມັກ (Wha samek)	Myrtaceae		7	11.67	4.37
10	<i>Dacrycarpus imbricatus</i>	ຮຶ່ງຂຽວ (Hinh khiew)	Podocarpaceae		7	11.67	4.37
11	<i>Illicium roseum</i>	ຈັນບານ (Chan ban)	Schisandraceae		6	10.00	3.75
12	<i>Symplocos caudata</i>	ເໝືອດມົນ (Maud mon)	Symplocaceae		6	10.00	3.75
13	<i>Rhododendron simsii</i>	ກູຫຼາບປ່າ (Koulab pa)	Ericaceae		5	8.33	3.12
14	<i>Castanopsis clarkei</i>	ກໍ່ໜາມ (Kor nam)	Fagaceae		5	8.33	3.12
15	<i>Syzygium antisepticum</i>	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* (ໝີ່ບົງຫອມ, Mee bonghom) with their frequencies of 100%, following by *Daphniphyllum beddomei* (ດິກດົງ, 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	<i>Schima crenata</i>	ຄາຍໂສ້ (Khai Soh)	Theaceae		6	100	5.88

2	Castanopsis acuminatissima	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		6	100	5.88
3	Litsea martabanica	ໝໍ້ບົງຫອມ (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	ສິບດາວ (Sob dao)	Altingiaceae		5	83.33	4.90
9	Syzygium attenuatum	ຫວ້າສະເມັກ (Wha samek)	Myrtaceae		5	83.33	4.90
10	Dacrycarpus imbricatus	ຮຶງຂຽວ (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 considered 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	<i>Antidesma japonicum</i>	ໝ້າພູ (Mao phou)	Phyllanthaceae	
2	<i>Castanopsis acuminatissima</i>	ກໍ່ເຕືອຍ (Kor deau)	Fagaceae	
3	<i>Dacrydium elatum</i>	ຮຶງຫອມ (Hinh hom)	Podocarpaceae	
4	<i>Daphniphyllum majus</i>	ດິກດົງ (Dik dong)	Daphniphyllaceae	
5	<i>Elaeocarpus griffithii</i>	ມູນ (Moun)	Elaeocarpaceae	
6	<i>Exbucklandia tonkinensis</i>	ໂພກາບລາງ (Pho kablang)	Hamamelidaceae	
7	<i>Garcinia pedunculata</i>	ສົ້ມໂມງ (Som mong)	Clusiaceae	
8	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae	
9	<i>Gymnanthes remota</i>	ປິກ (Pik)	Euphorbiaceae	
10	<i>Ilex chapaensis</i>	ໄຂ່ມິດຊາປ່າ (Khai mod sapa)	Aquifoliaceae	
11	<i>Ilex excavata</i> Pierre	ໄຄ້ຂາວ (Khai mod)	Aquifoliaceae	
12	<i>Illicium</i> sp. 1 ***	ຈັນ (Chan)	Schisandraceae	
13	<i>Lindera bokorensis</i>	ບົງບໍກໍ (Bong bokor)	Lauraceae	
14	<i>Lithocarpus harmandii</i>	ກໍ່ໝັ້ນ (Kor man)	Fagaceae	
15	<i>Litsea martabanica</i>	ໝີ່ບົງຫອມ (Mee bonghom)	Lauraceae	
16	<i>Litsea umbellata</i>	ບົງຮ້າງ (Bong hang)	Lauraceae	
17	<i>Macaranga kurzii</i>	ແສ້ (Sae)	Euphorbiaceae	
18	<i>Milletia leucantha</i>	ຄໍາພີ່ຕາຄວາຍ (Khamphée ta-khouay)	Fabaceae	
19	<i>Morinda</i> sp.	ຍໍປ່າ (Gno pa)	Rubiaceae	
20	<i>Neolitsea zeylanica</i>	ໄຟເດືອນຫ້າ (Fai deuanha)	Lauraceae	
21	<i>Pinus kesiya</i>	ແປກສາມໃບ (Peak sambai)	Pinaceae	
22	<i>Pittosporum pauciflorum</i>	ສຸມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae	VU
23	<i>Polygala tonkinensis</i>	ຕ້າງໄກ່ (Tang kai)	Polygalaceae	
24	<i>Pyrenaria poilaneana</i>	ໝັງດົງ (Miang dong)	Theaceae	
25	<i>Quercus langbianensis</i>	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* (ບົງຮ້າງ, Bong hang) with its density of 18.33 tree/ha, following by *Garcinia pedunculata* (ສົ້ມໂມງ, Som mong) and *Ilex chapaensis* (ໄຂ່ມິດຊາປ່າ, 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	<i>Litsea umbellata</i>	ບົງຮ້າງ (Bong hang)	Lauraceae		11	18.33	7.14
2	<i>Garcinia pedunculata</i>	ສົ້ມໂມງ (Som mong)	Clusiaceae		10	16.67	6.49
3	<i>Ilex chapaensis</i>	ໄຂ່ມິດຊາປ່າ (Khai mod sapa)	Aquifoliaceae		10	16.67	6.49
4	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae		9	15.00	5.84
5	<i>Elaeocarpus griffithii</i>	ມູນ (Moun)	Elaeocarpaceae		9	15.00	5.84
6	<i>Lithocarpus harmandii</i>	ກໍ່ໝັ້ນ (Kor man)	Fagaceae		9	15.00	5.84
7	<i>Symplocos wikstroemiifolia</i>	ຄອມປ່ (Khom pa)	Symplocaceae		8	13.33	5.19
8	<i>Gymnanthes remota</i>	ປີກ (Pik)	Euphorbiaceae		7	11.67	4.55
9	<i>Dacrydium elatum</i>	ຮຶງຫອມ (Hinh hom)	Podocarpaceae		6	10.00	3.90
10	<i>Daphniphyllum majus</i>	ດິກດົງ (Dik dong)	Daphniphyllaceae		6	10.00	3.90
11	<i>Litsea martabanica</i>	ໝໍ້ບົງຫອມ (Mee bonghom)	Lauraceae		6	10.00	3.90
12	<i>Pittosporum pauciflorum</i>	ສຸມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae		6	10.00	3.90
13	<i>Polygala tonkinensis</i>	ຕ້າງໄກ່ (Tang kai)	Polygalaceae		6	10.00	3.90
14	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae		5	8.33	3.25
15	<i>Ilex excavata</i> 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* (ບົງຮ້າງ, Bong hang), *Ilex chapaensis* (ໄຂ່ມິດຊາປ່າ, Khai mod sapa), *Castanopsis acuminatissima* (ກໍ່ເດືອຍ, Kor deau), *Lithocarpus harmandii* (ກໍ່ໝັ້ນ, Kor man), *Gymnanthes remota* (ປີກ, Pik), *Daphniphyllum majus* (ດິກດົງ, Dik dong), *Pittosporum pauciflorum* (ສຸມດອກນ້ອຍ, 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	<i>Litsea umbellata</i>	ບົງຮ້າງ (Bong hang)	Lauraceae		6	100	4.92
2	<i>Ilex chapaensis</i>	ໄຂ່ມິດຊາປ່າ (Khai mod sapa)	Aquifoliaceae		6	100	4.92
3	<i>Castanopsis acuminatissima</i>	ກໍ່ເຕືອຍ (Kor deau)	Fagaceae		6	100	4.92
4	<i>Lithocarpus harmandii</i>	ກໍ່ໝັ່ນ (Kor man)	Fagaceae		6	100	4.92
5	<i>Gymnanthes remota</i>	ປີກ (Pik)	Euphorbiaceae		6	100	4.92
6	<i>Daphniphyllum majus</i>	ດິກດົງ (Dik dong)	Daphniphyllaceae		6	100	4.92
7	<i>Pittosporum pauciflorum</i>	ສຸມດອກນ້ອຍ (Soum dok-noi)	Pittosporaceae		6	100	4.92
8	<i>Polygala tonkinensis</i>	ຕ້າງໄກ່ (Tang kai)	Polygalaceae		6	100	4.92
9	<i>Garcinia pedunculata</i>	ສົ້ມໂມງ (Som mong)	Clusiaceae		5	83.33	4.10
10	<i>Elaeocarpus griffithii</i>	ມູນ (Moun)	Elaeocarpaceae		5	83.33	4.10
11	<i>Symplocos wikstroemiifolia</i>	ຄອມປ່ (Khom pa)	Symplocaceae		5	83.33	4.10
12	<i>Dacrydium elatum</i>	ຮິງຫອມ (Hinh hom)	Podocarpaceae		5	83.33	4.10
13	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae		5	83.33	4.10
14	<i>Ilex excavata</i> Pierre	ໄຂ່ຂາວ (Khai mod)	Aquifoliaceae		5	83.33	4.10
15	<i>Pyrenaria poilaneana</i>	ໝັງງຸງດົງ (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., *Ixora* 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 gracilentia*) 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	<i>Acer laurinum</i>	ກ່ວມ (Kuam)	Sapindaceae	
2	<i>Aporosa terapleura</i>	ໝີອດພູ (Maud phou)	Phyllanthaceae	
3	<i>Aporosa yunnanensis</i>	ໝີອດໃບແຫຼມ (Maud bai-laem)	Phyllanthaceae	
4	<i>Balakata baccata</i>	ລັບແລ (Lab lae)	Euphorbiaceae	
5	<i>Benkara</i>	ຄັດເຄົ້າ (Khat khao)	Rubiaceae	
6	<i>Calophyllum pisiferum</i>	ກະທິງ (Ka thueng)	Calophyllaceae	
7	<i>Camellia kissii</i>	ໝັງງອາມ (Miang arm)	Theaceae	
8	<i>Camellia</i> sp.1	ໝັງງ (Miang)	Theaceae	
9	<i>Castanopsis acuminatissima</i>	ກໍ່ເດືອຍ (Kor deau)	Fagaceae	
10	<i>Cinnamomum curvifolium</i>	ຈວງ (Juang)	Lauraceae	
11	<i>Cinnamomum</i>	ຈວງ (Juang)	Lauraceae	
12	<i>Diospyros</i>	ໝາກເກືອ (Mak keau)	Ebenaceae	
13	<i>Elaeocarpus griffithii</i>	ມຸນ (Moun)	Elaeocarpaceae	
14	<i>Engelhardtia serrata</i>	ຟ່າວຂຽວໝາມ (Phao khiew)	Juglandraceae	
15	<i>Garcinia pedunculata</i>	ສົ້ມໂມງ (Som mong)	Clusiaceae	
16	<i>Gardenia</i>	ພຸດຜາ (Phout pha)	Rubiaceae	
17	<i>Gironniera subaequalis</i>	ຫາງແມງໄອ່ (Hang maeng-ai)	Cannabaceae	
18	<i>Gomphandra</i>	ພູຟ່າ (Phou pha)	Stemonuraceae	
19	<i>Goniothalamus</i>	ເຂົ້າຫຼາມດົງ (Khao-larm dong)	Annonaceae	
20	<i>Gymnanthes remota</i>	ປີກ (Pik)	Euphorbiaceae	
21	<i>Heptapleurum cambodianum</i>	ຕ້າງ (Tang)	Araliaceae	
22	<i>Ilex chapaensis</i>	ໄຂ່ມິດຊາປ່າ (Khai mod sapa)	Aquifoliaceae	
23	<i>Illicium tenuifolium</i>	ຈັນບານ (Chan ban)	Schisandraceae	
24	<i>Lindera annamensis</i>	ລິນດາລາກ້ານແດງ (Lindara Kan-daeng)	Lauraceae	
25	<i>Lithocarpus harmandii</i>	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* (ໝີ່ບົງຫອມ, Mee bonghom) with its density of 21.67 tree/ha; and *Lithocarpus harmandii* (ກໍ່ໝິ້ນ, Kor man) with its density of 20 trees/ha, *Calophyllum pisiferum* (ກະຫຼິງ, Ka thueng) with its density of 16.67 and *Acer laurinum* (ກ່ວມ, 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	<i>Machilus angustifolia</i>	ຕອງຫອມໃບແຄບ (Tong Hom bai Khaeb)	Lauraceae		14	23.33	7.82
2	<i>Litsea martabanica</i>	ໝີ່ບົງຫອມ (Mee bonghom)	Lauraceae		13	21.67	7.26
3	<i>Lithocarpus harmandii</i>	ກໍ່ໝິ້ນ (Kor man)	Fagaceae		12	20.00	6.70
4	<i>Calophyllum pisiferum</i>	ກະຫຼິງ (Ka thueng)	Calophyllaceae		10	16.67	5.59
5	<i>Acer laurinum</i>	ກ່ວມ (Kuam)	Sapindaceae		9	15.00	5.03
6	<i>Aporosa terapleura</i>	ເໝືອດພູ (Maud phou)	Phyllanthaceae		5	8.33	2.79
7	<i>Balakata baccata</i>	ລັບແລ (Lab lae)	Euphorbiaceae		5	8.33	2.79
8	<i>Lithocarpus pierrei</i>	ກໍ່ກັກ (Kor Kak)	Fagaceae		5	8.33	2.79
9	<i>Litsea cambodianum</i>	ບົງຂະເໝນ (Bong khmer)	Lauraceae		5	8.33	2.79
10	<i>Pinus kesiya</i>	ແປກສາມໃບ (Peak sambai)	Pinaceae		5	8.33	2.79
11	<i>Symplocos theifolia</i>	ເໝືອດດົງ (Maud dong)	Symplocaceae		5	8.33	2.79
12	<i>Syzygium claviflorum</i>	ຫວ້າຫິນ (Wha hin)	Myrtaceae		5	8.33	2.79
13	<i>Castanopsis acuminatissima</i>	ກໍ່ເຕືອຍ (Kor deau)	Fagaceae		4	6.67	2.23
14	<i>Gymnanthes remota</i>	ປີກ (Pik)	Euphorbiaceae		4	6.67	2.23
15	<i>Heptapleurum cambodianum</i>	ຕ້າງ (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* (ຕອງຫອມໃບແຄບ, Tong Hom bai Khaeb) and *Acer laurinum* (ກ່ວມ, Kuam) with their frequencies of 83.33%, following by *Balakata baccata* (ລັບແລ, Lab lae), *Symplocos theifolia* (ເໝືອດດົງ, Maud dong), *Castanopsis acuminatissima* (ກໍ່ເຕືອຍ, Kor deau), *Gymnanthes remota* (ປີກ, Pik) and *Quercus* (ກໍ່, 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. %
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1	Machilus angustifolia	ຕອງຫອມໃບແຄບ (Tong Hom bai khaeb)	Lauraceae		5	83.33	4.67
2	Acer laurinum	ກ່ວມ (Kuam)	Sapindaceae		5	83.33	4.67
3	Balakata baccata	ລັບແລ (Lab lae)	Euphorbiaceae		4	66.67	3.74
4	Symplocos theifolia	ເໝືອດດົງ (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	ກະຫຼົງ (Ka thueng)	Calophyllaceae		3	50.00	2.80
10	Lithocarpus pierrei	ກໍ່ກັກ (Kor Kak)	Fagaceae		3	50.00	2.80
11	Litsea cambodianum	ບົງຂະເໝນ (Bong khmer)	Lauraceae		3	50.00	2.80
12	Lindera annamensis	ລິນດາລາກ້ານແດງ (Lindara Kan-daeng)	Lauraceae		3	50.00	2.80
13	Nephelium hypoleucum	ຄໍ່ແລນ (Kho lane)	Sapindaceae		3	50.00	2.80
14	Podocarpus pilgeri	ກະດອງ (Ka-dong)	Podocarpaceae		3	50.00	2.80
15	Camellia kissii	ໝັງງອາມ (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 Kounking) 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 Kounking 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).

Meanwhile, 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 fleuryi*), it is a tree, found in SB2 and SB5

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

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

5.3.1.6 First record and possible new species by survey 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 pierreii* (Hickel & A. Camus) A. Camus, *Ardisia gracilentata* 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 records 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).

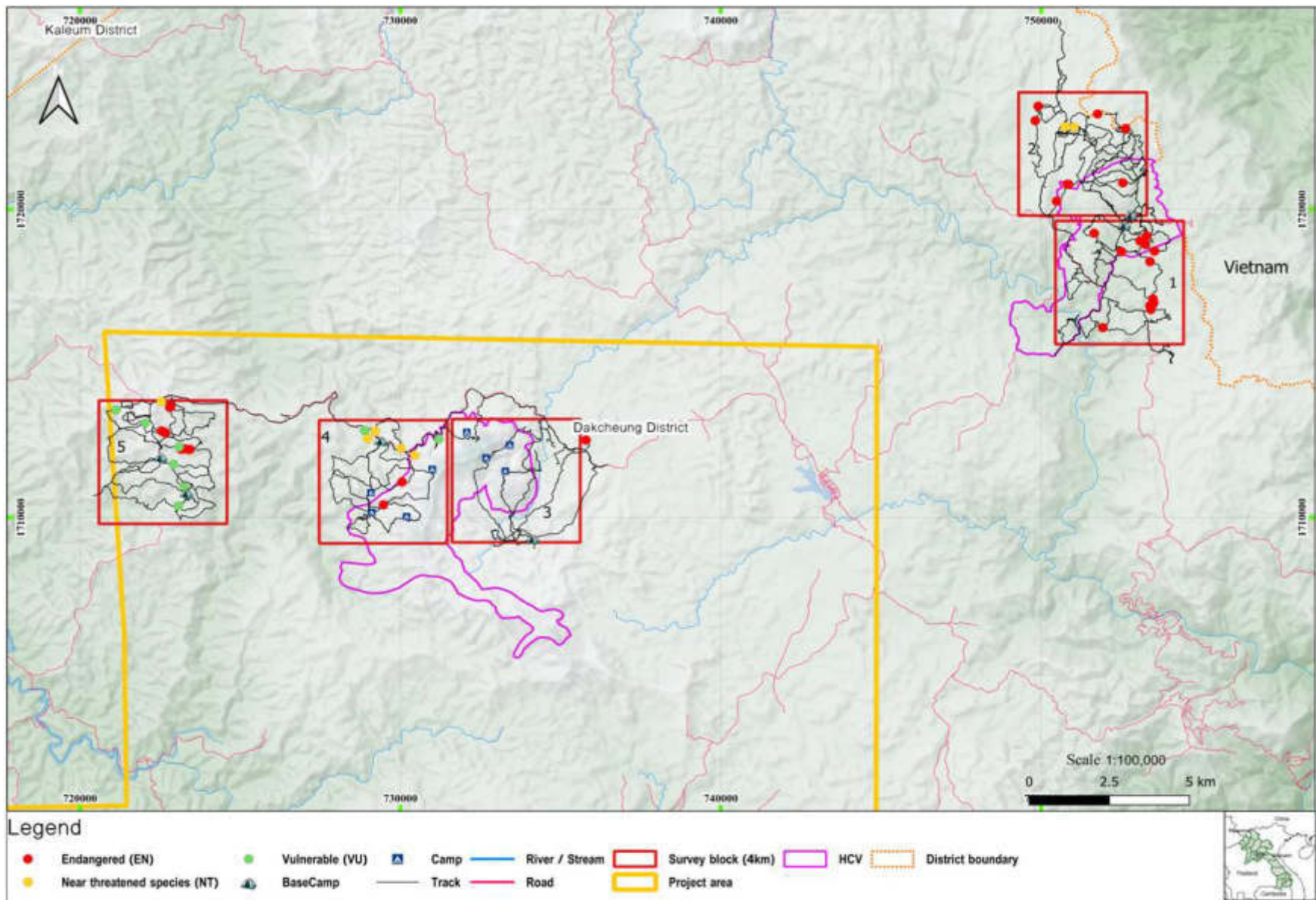


Figure 16-1. Locations of Global Threatened and Near-Threatened plant species in the survey blocks

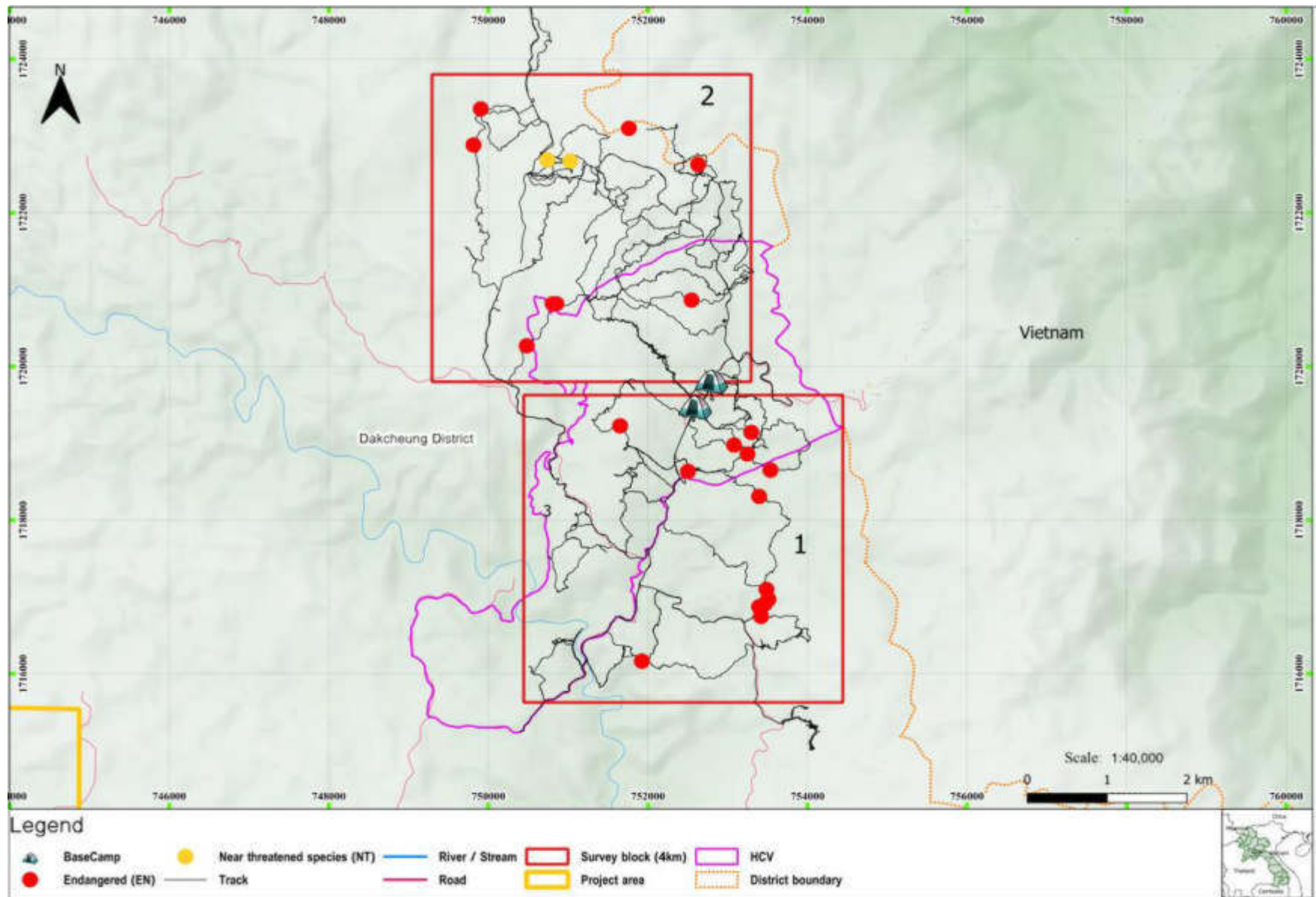


Figure 16-1a. Locations of Global Threatened and Near-Threatened plant species in the Zone A (Annamite)

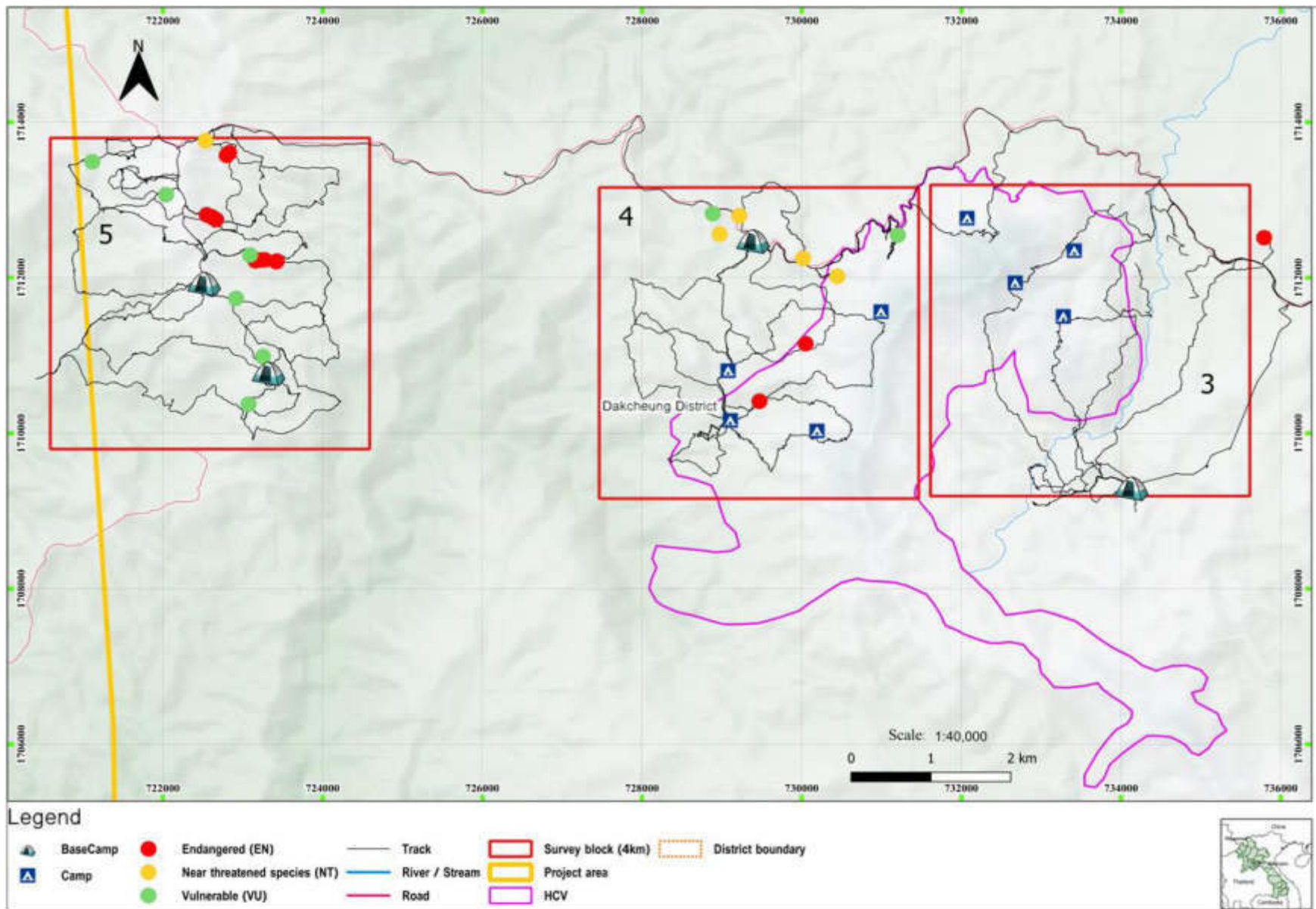


Figure 16-1b. Locations of Global Threatened and Near-Threatened plant species in the Zone B (Phou Koungking)

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.

Khem in ton (*Alseodaphne bidouensis*), 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 gracilentata*), 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.

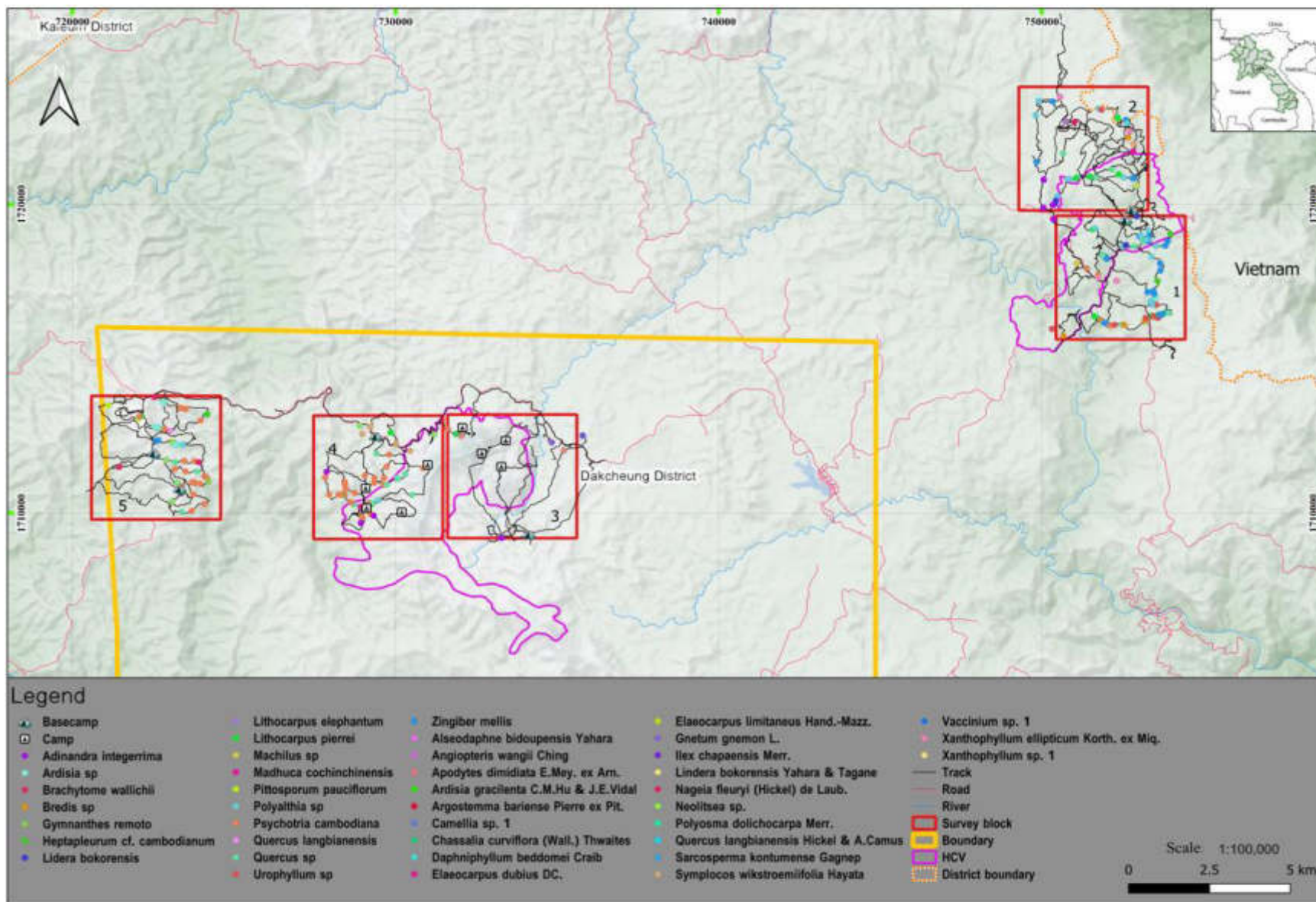


Figure 16-2. Locations of endemic plant species in the survey blocks

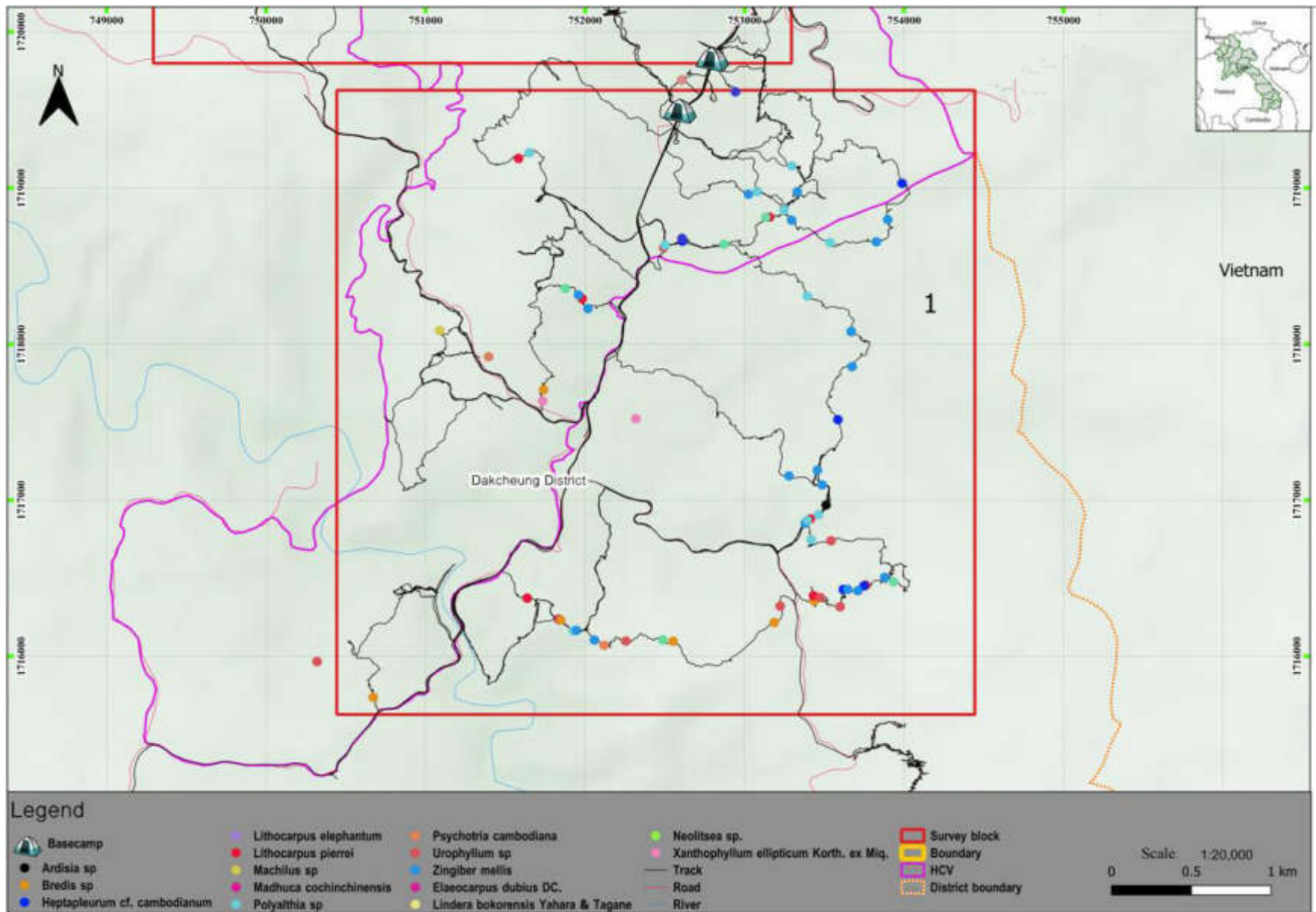


Figure 16-2a. Locations of endemic plant species in the survey block 1

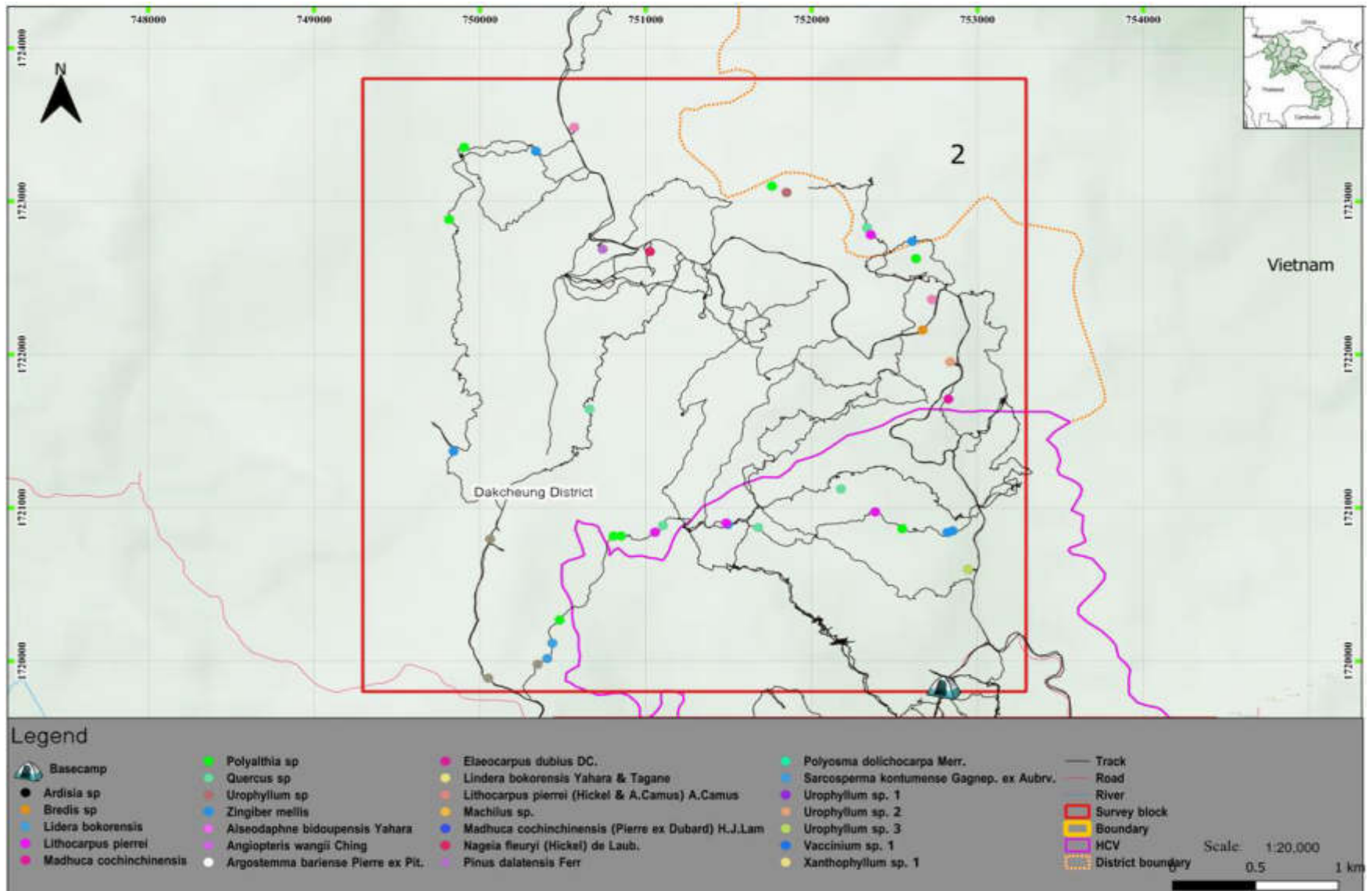


Figure 16-2b. Locations of endemic plant species in the survey block 2

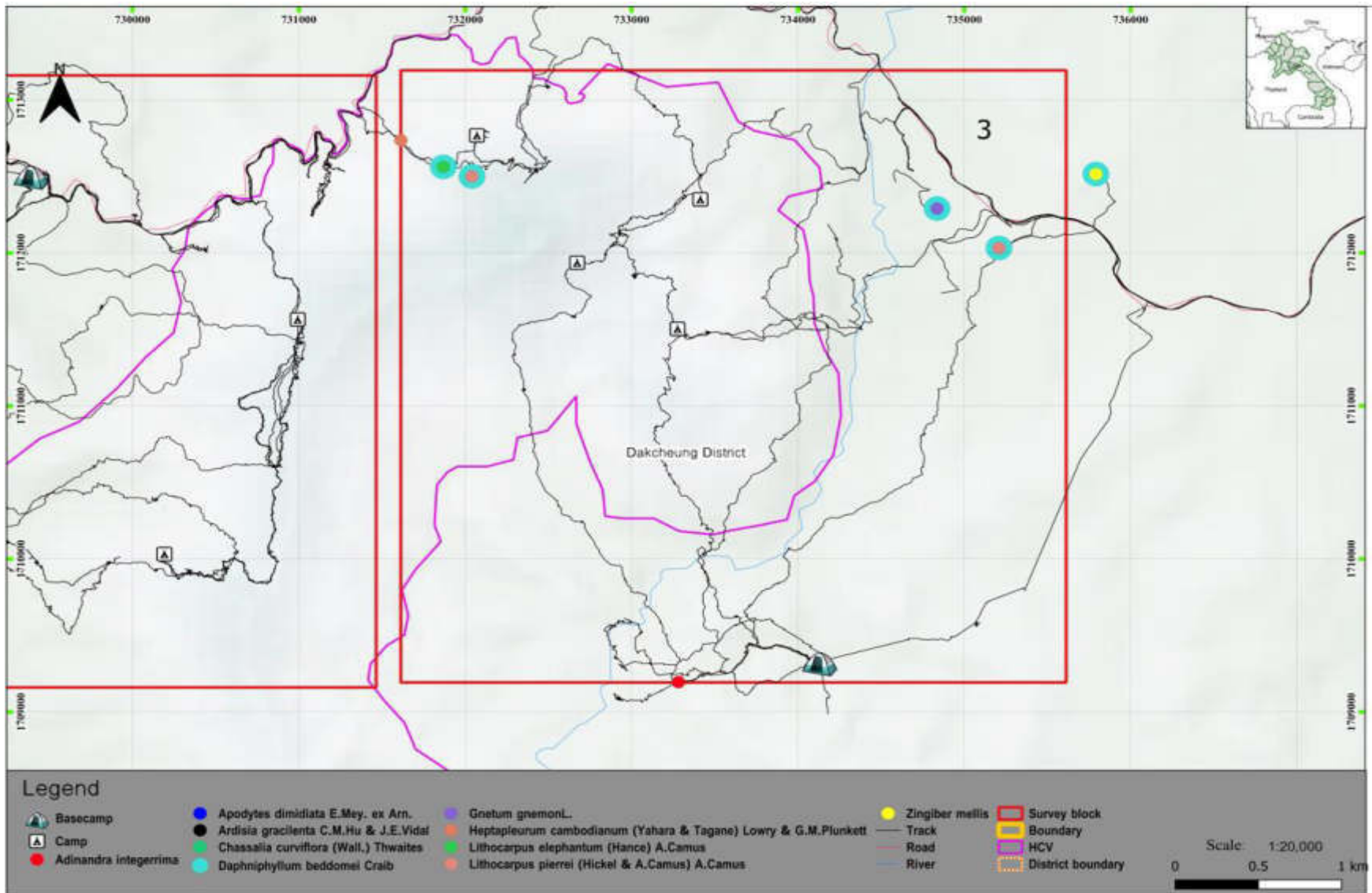


Figure 16-2c. Locations of endemic plant species in the survey block 3

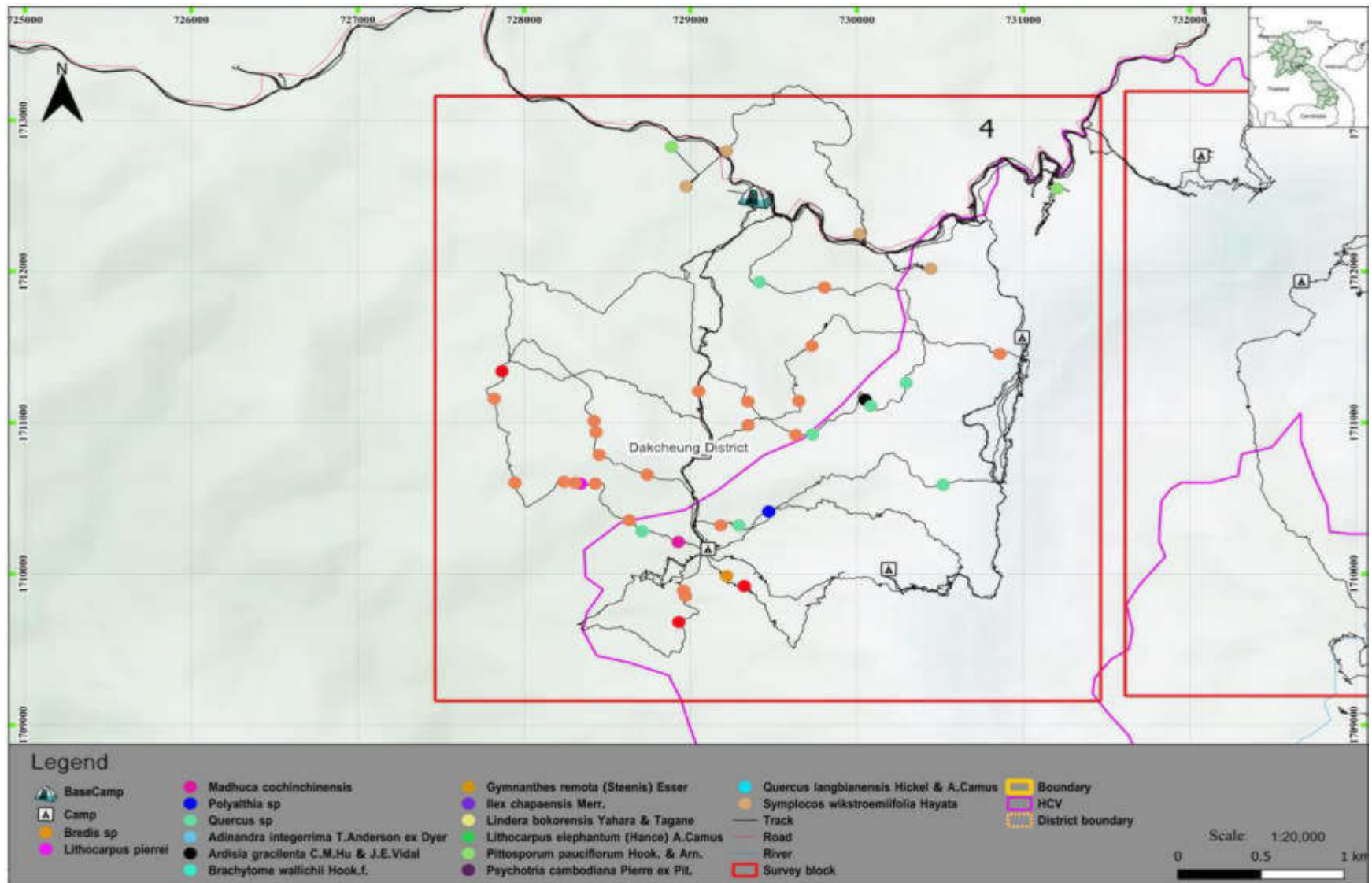


Figure 16-2d. Locations of endemic plant species in the survey block 4

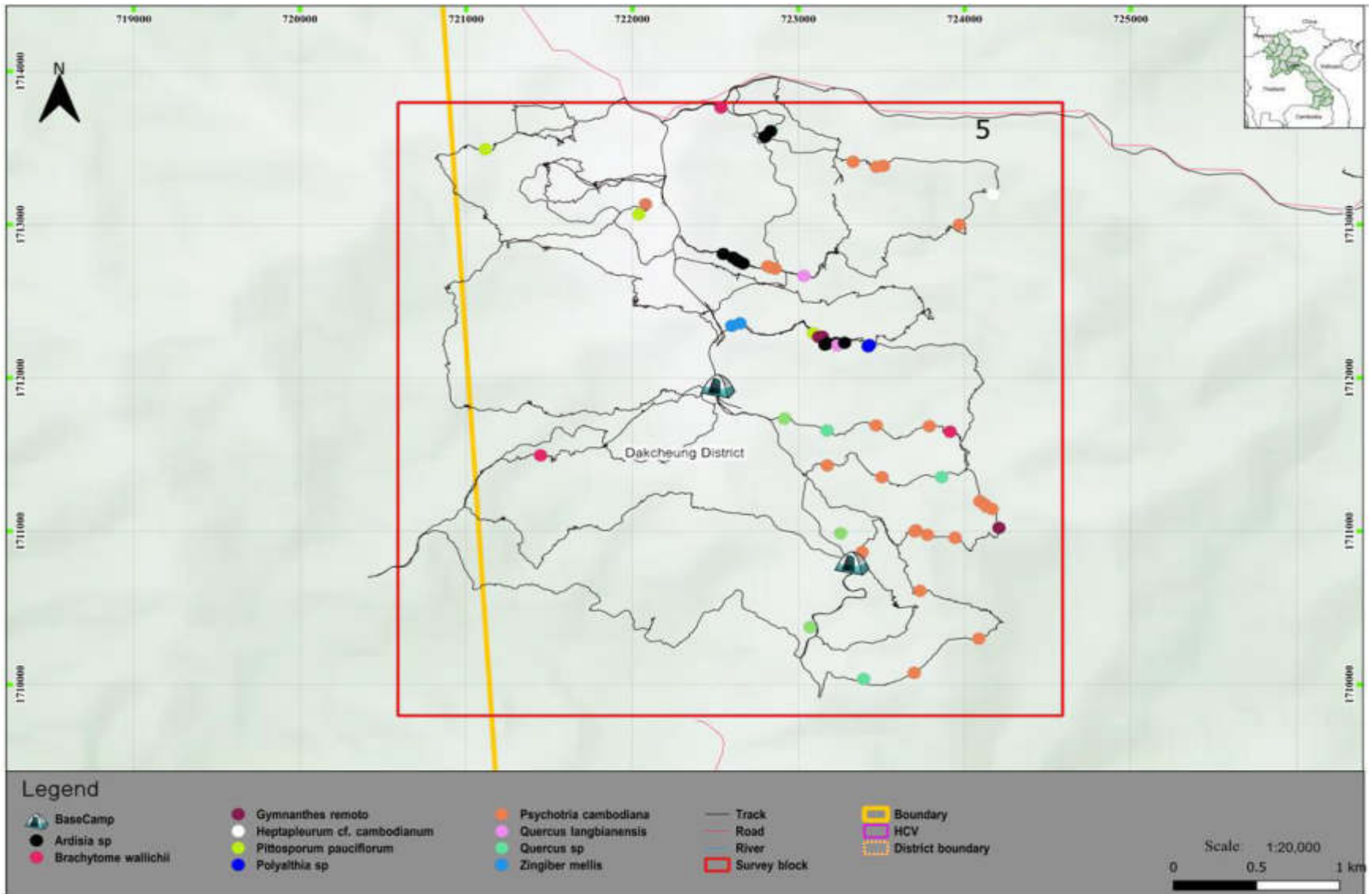


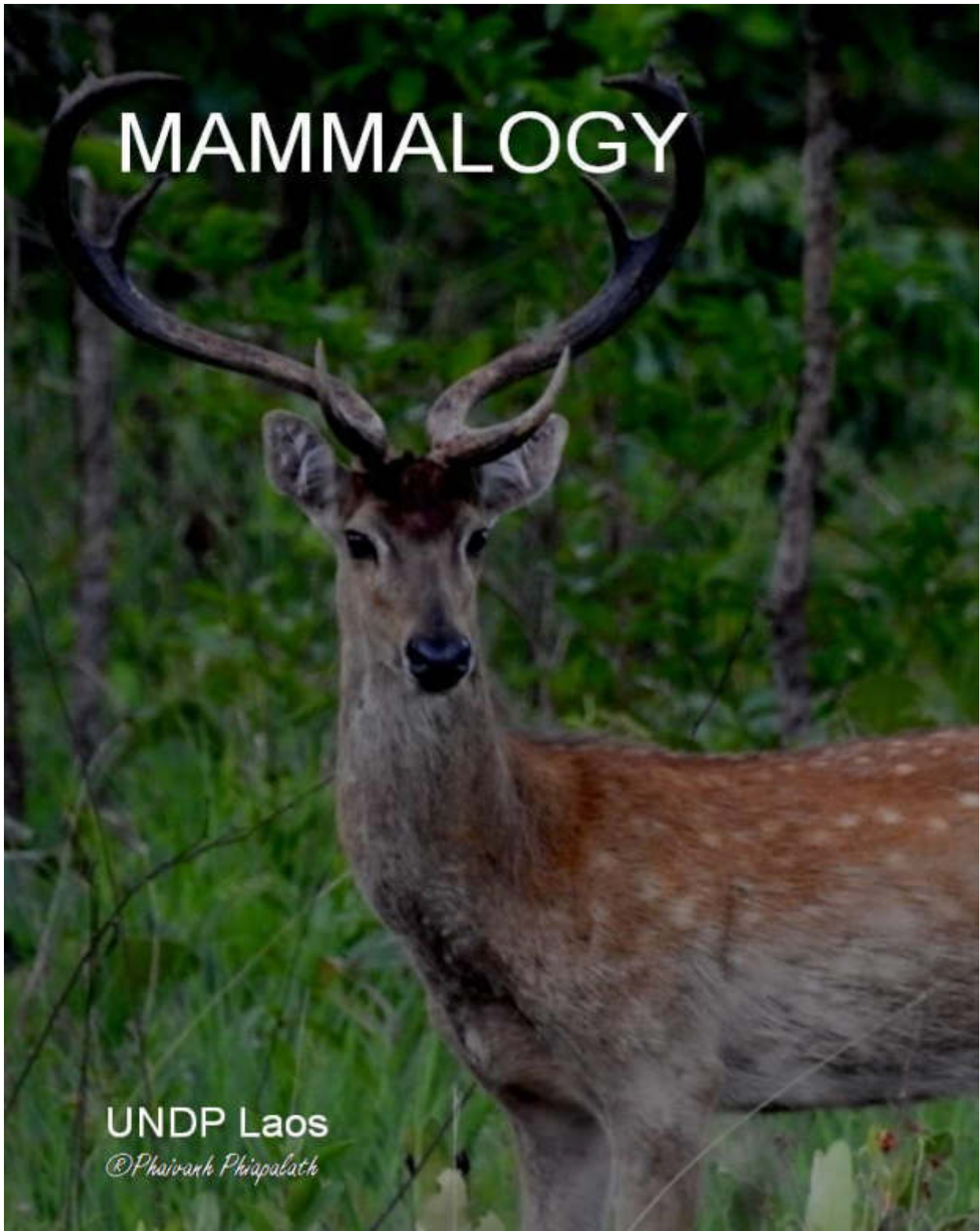
Figure 16-2e. Locations of endemic plant species in the survey block 5

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 Kounking 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 Kounking). The Southern Annamite having any biodiversity assessment undertaken before, made little is known about the biodiversity status of the area. Also, Phou Kounking 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 <i>Red List</i>	Field Conf.	Freq	Survey Block					Presence
					1	2	3	4	5	
Northern Buff-cheeked Gibbon	<i>Nomascus annamensis</i>	EN	x	+	x	x	x	x		Yes
Red-shanked Douc Langur	<i>Pygathrix nemaeus</i>	CR	x	+		x	x	x	?	Yes
Indochinese Silvered Langur	<i>Trachypeticus germaini</i>	EN	Report			?	?	?	?	Uncertain
Large antlered Muntjac	<i>Muntiacus vuquangensis</i>	CR	Report		?	?				Uncertain
Chinese Pangolin	<i>Manis pentadactyla</i>	CR	x	++	x	x	x	x		YES
Sunda Pangolin	<i>Manis javanica</i>	CR	x	+	x	x	?	?		YES
Owston's Civet	<i>Chrotogale owstoni</i>	EN	x			x	x	x		YES
Annamite Striped Rabbit	<i>Negolagus timminsi</i>	EN	Report	?	?		?	?		Uncertain
Sun Bear	<i>Helarctos malayanus</i>	VU	x	+	x	x	x	x	x	YES
Smooth-coated Otter	<i>Lutrogale perspicillata</i>	VU	x		x	x	x	x		YES
Binturong	<i>Arctictis binturong</i>	VU	Report			?	?	?		Uncertain
Chinese Serow	<i>Capricornis</i>	VU	Report	++			x	x	x	YES
Asiatic Black Bear	<i>Ursus thibetanus</i>	VU	x	+		x	?			YES
Stump-tailed Macaque	<i>Macaca arctoides</i>	VU	x	+++	x	x	x	x	x	YES
Northern Pig-tailed Macaque	<i>Macaca leonina</i>	VU	x	++	x	x	x	x	x	YES
Bengal Slow Loris	<i>Nycticebus bengalensis</i>	EN	Report		x	x	x	x	x	Yes
Pygmy Slow Loris	<i>Nycticebus pygmaeus</i>	EN	Report				?	?		Uncertain
Sambar	<i>Rusa unicolor</i>	VU	x	+	x	x	x	x	x	YES
Great Hog Badger	<i>Arctonyx collaris</i>	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/vents	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 Jangfowl	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-dwelling 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 Kounking (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 Kounking (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 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 area¹⁴.

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 Muntjac 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 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 Kounking) 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 outstanding 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 occasionally, 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.

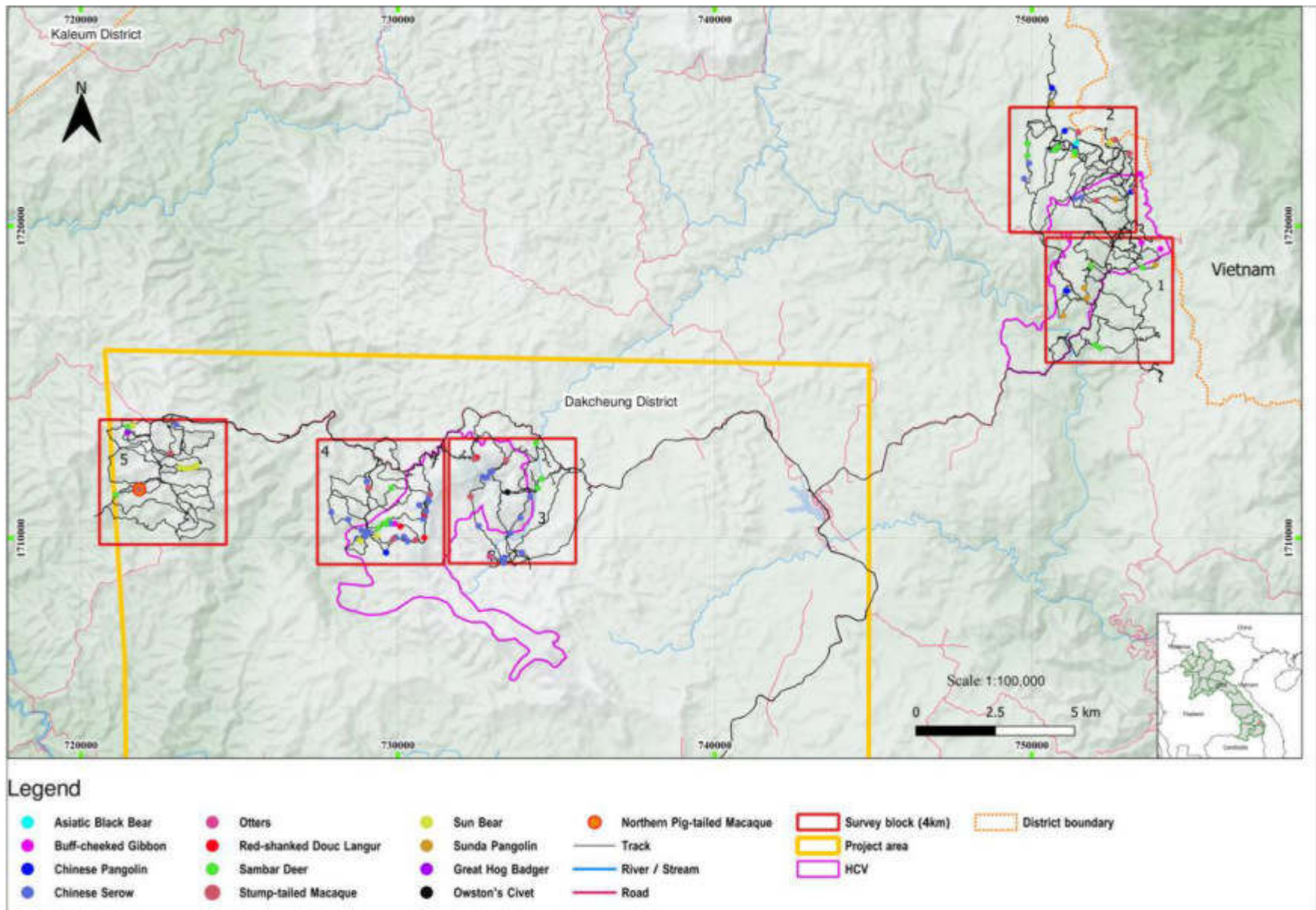


Figure 18. Locations of GT mammal species in the survey blocks

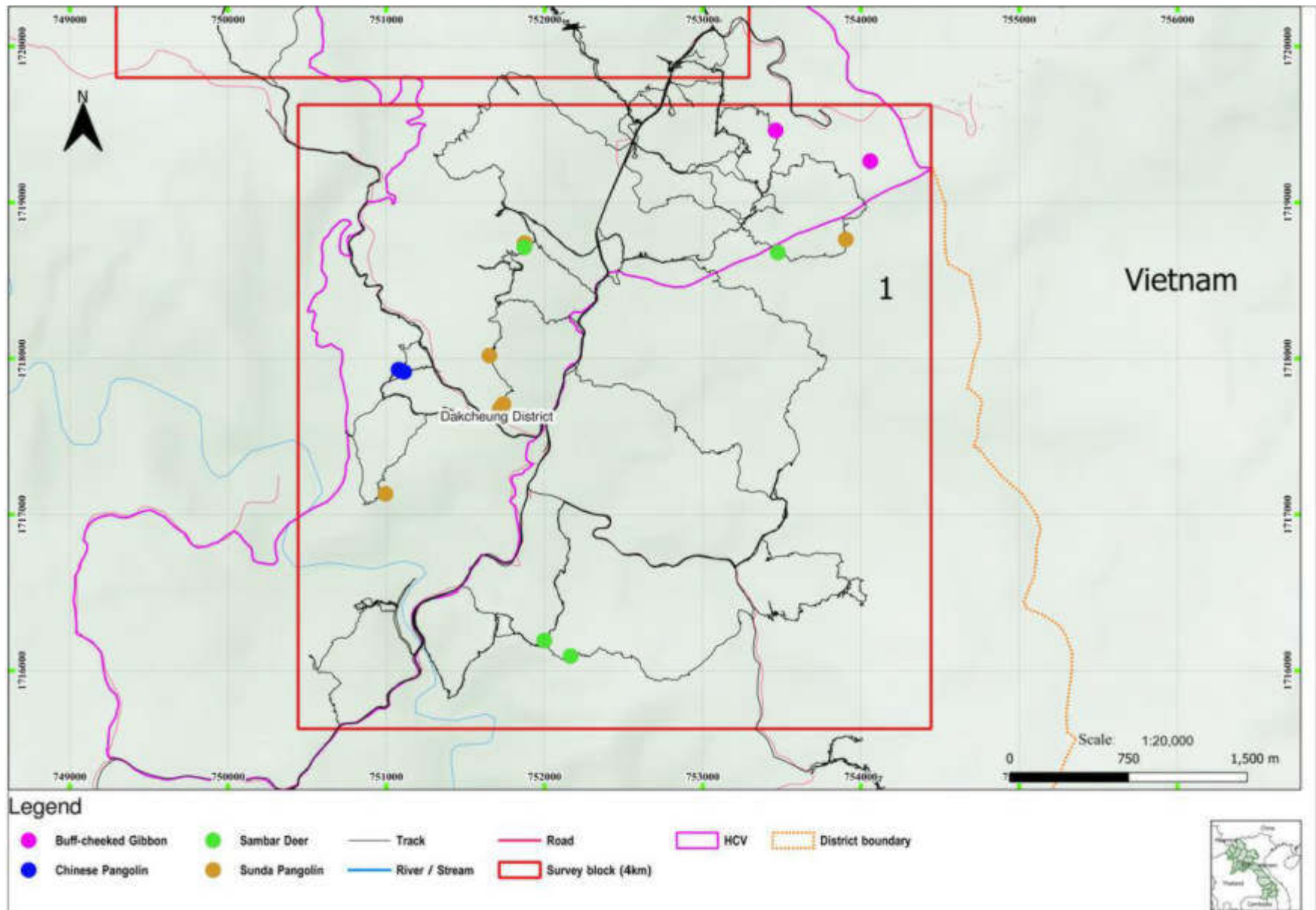


Figure 18-1. Locations of GT mammal species in the SB1 (Annamite)

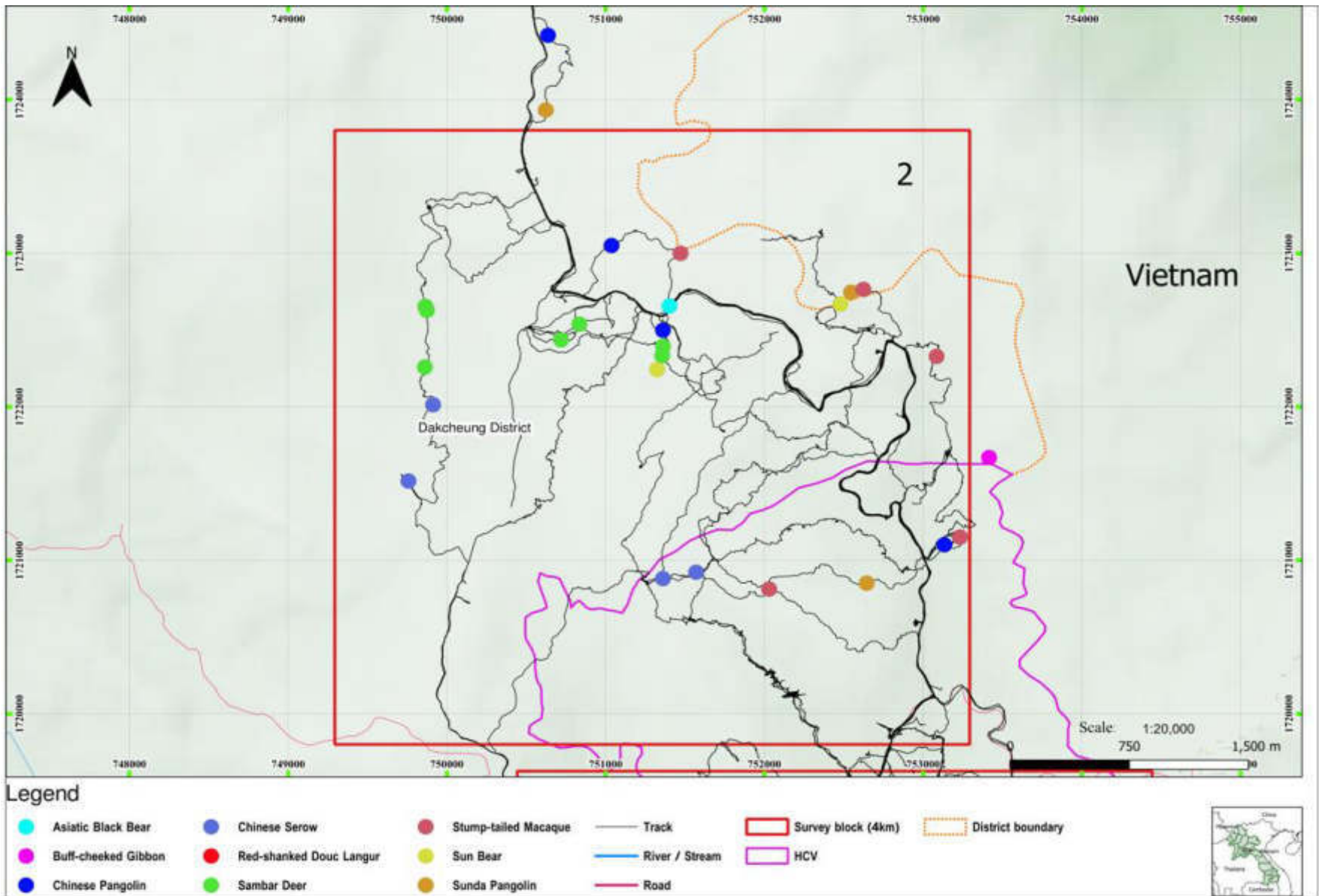


Figure 18-2. Locations of GT mammal species in the SB2 (Annamite)

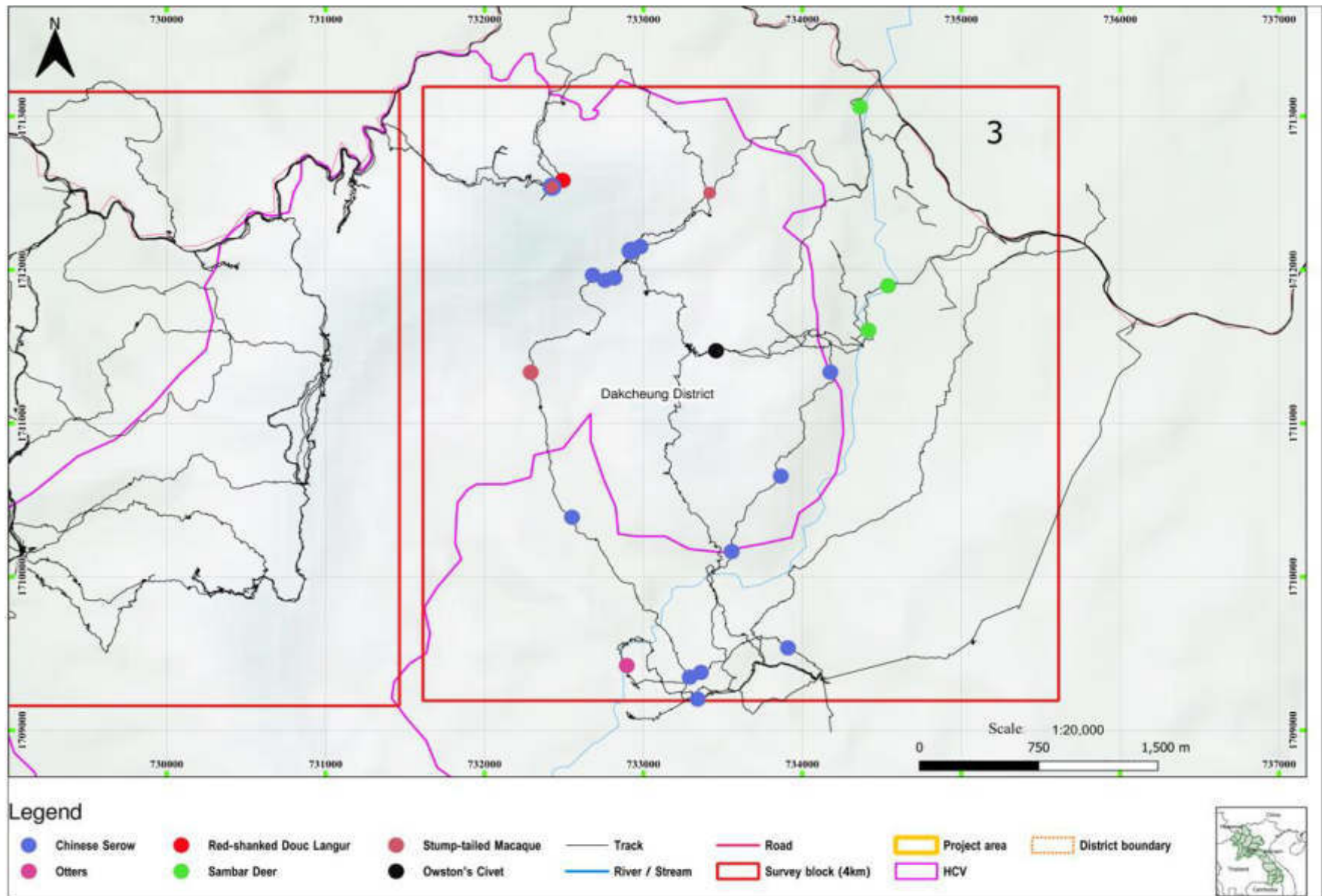


Figure 18-3. Locations of GT mammal species in the SB3 (Phou Koungking - East)

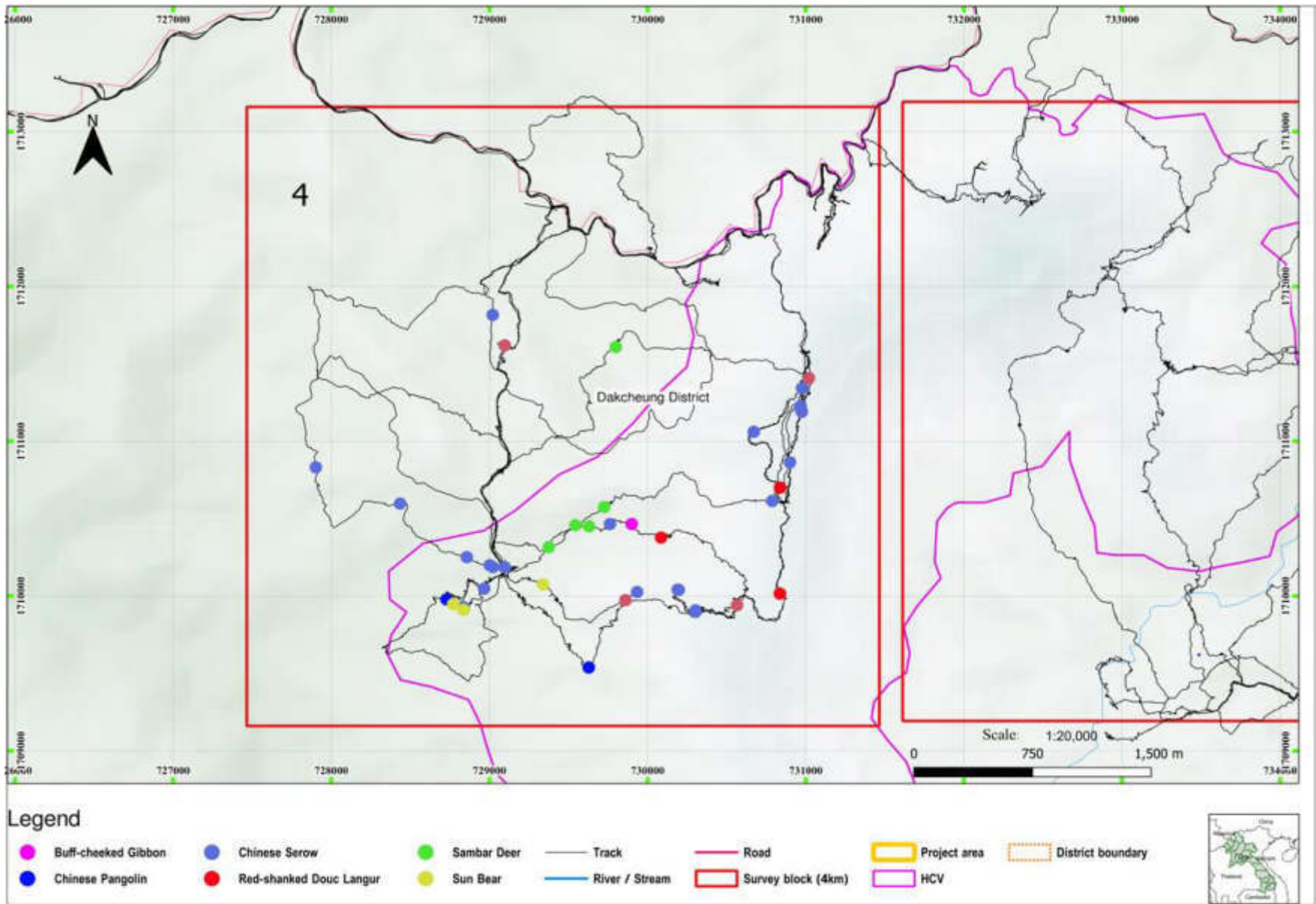


Figure 18-4. Locations of GT mammal species in the SB4 (Phou Koungking - West)

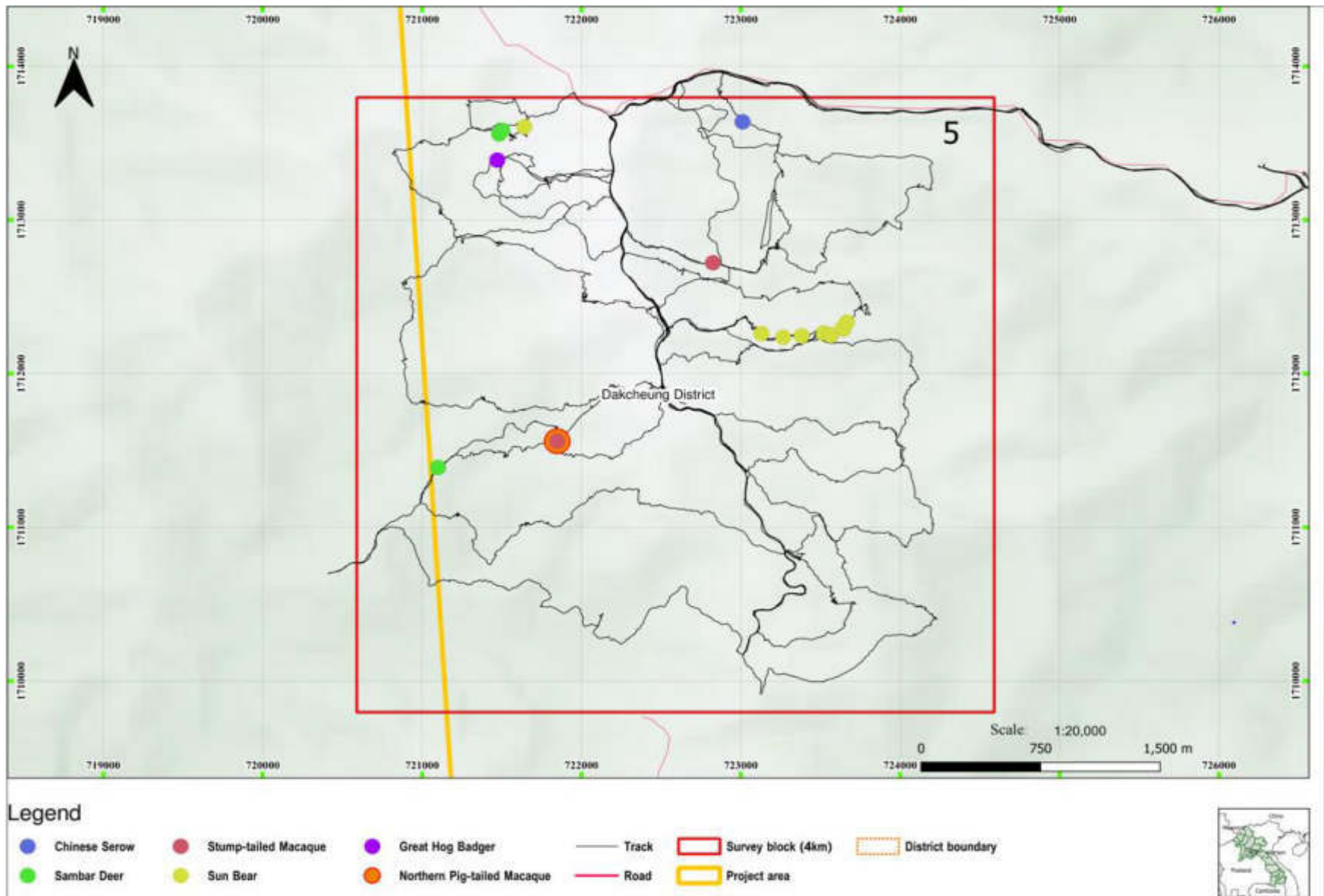


Figure 18-5. Locations of GT mammal species in the SB5 (Phou Yai)